

Second Compendium of Low Carbon Pulse

Covering October 6, 2021 to March 31, 2022

The author of each edition of Low Carbon Pulse included in this Compendium is MJ Harrison.



Introduction

About the form and substance of this Compendium:

This Second Low Carbon Pulse Compendium is to include each edition of Low Carbon Pulse published from October 29 2021 to March 31, 2022.

The form of each edition of Low Carbon Pulse included in this Second Low Carbon Pulse Compendium takes the form published, subject to a further proof reading and ensuring consistency so that this Second Compendium can be read, as a whole, as a coherent publication.

EDITIONS OF LOW CARBON PULSE	
E 29 : Monday Oct 6 2021 to Friday Oct 29, 2021	E 30 : Monday Nov 1 to Sunday Nov 14, 2021
E 31 : Monday Nov 15 to Sunday Nov 28, 2021	E 32 : Monday Nov 29 to Thursday December 16, 2021
E 33 : Friday Dec 17, 2021 to Sunday Jan 23, 2022	E 34 : Monday Jan 24 to Sunday Feb 6, 2022
E 35 : Monday Feb 7 to Sunday Feb 20, 2022	E 36 : Monday Feb 21 to Sunday Mar 6, 2022
E 37 : (short-form): Monday Mar 7, 2021 to Thursday Mar 31, 2022	E 37 : (long-form): Monday Mar 7, 2021 to Thursday Mar 31, 2022
E 38 : Summary of IPCC WGIII Report, WETO 2022 - Apr 14, 2022	

In addition to each edition of Low Carbon Pulse, this Second Compendium includes three **Report on Reports**. Each **Report on Reports** covers in detail the key findings and issues arising from key papers, reports and studies (**publication**) published in the applicable two month period. Each publication covered in a **Report on Reports** is mentioned in an edition of Low Carbon Pulse (and a link to it is included in that edition). The benefit of **Reports on Reports** was identified in June 2021 – Reports on Reports allow coverage of publications in more detail than the format and length of Low Carbon Pulse allows.

REPORTS ON REPORTS	
September and October 2021	November and December 2021
January and February 2022	March and April (to be included in Edition 39)

About the author of this Second Compendium:

Low Carbon Pulse is authored by Michael Harrison. Michael writes on Saturdays and Sundays. In addition to writing Low Carbon Pulse, Michael authors sibling publications (both alone and with colleagues) across a range of industry sectors (click [here](#) and [here](#) for the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the **Hydrogen for Industry (H24I)** series, click [here](#) and [here](#) for the Ports, Logistics and World Trade and Waste Compendiums respectively). Michael is a prolific speaker, having presented on the subject matter of climate change, energy transition and net zero on over 80 occasions in calendar year 2021, and on 12 occasions to March 31, 2022.

Monday to Friday, Michael works on projects and transactions across a number of industries and sectors: energy and power (including renewables), e-fuels and future fuels (including ammonia, hydrogen (of all colours), and methanol), infrastructure development (including for CCS / CCUS, giga-factories, pipelines and shared infrastructure), mining and natural resources (including metals and minerals key to energy transition), oil and natural gas (including on CCS / CCUS), LNG, ports (and their hinterlands), shipping and land transport (predominantly rail and road), iron and steel, telecommunications, waste and water. Michael works on projects and transactions from West Africa, East Africa, North Africa, the Middle East, Asia and to the US West Coast.

Notes of thanks:

While Michael is the author of Low Carbon Pulse, Michael works with two to three colleagues on each edition, who add links and who proof. In this context, shout-outs to Florence Chen (devoted to the task since March 2021, and without whose support the author would have "lost the plot" a long time ago), and to Ali Helmes and Sophie Crichton (both of whom have found time to proof while doing their busy day jobs).

Michael Harrison, Senior Partner, Energy, Resources, and Infrastructure

Low Carbon Pulse - Edition 29

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to **Edition 29** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**). This Edition 29 is split into two parts:

- the Friday Edition: covering Government announcements and policy issues; and
- the Sunday Edition: including all material and significant project announcements for the period from Monday October 4, 2021 to Saturday October 30, 2021 (inclusive of each day).

Please click [here](#) for the **First Low Carbon Pulse Compendium**, which comprises **Editions 1 to 28** of Low Carbon Pulse. Click [here](#) for the **Second Low Carbon Pulse Compendium**. Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

On **October 19, 2021**, an **Anniversary Edition** of Low Carbon Pulse was published reflecting on the 12 months since the publication of **Edition 1** on October 6, 2020, and looking forward to the next 12 months (which is also included in **the Low Carbon Pulse Compendium**).

On **November 16, 2021**, normal service will be resumed with **Edition 30** of Low Carbon Pulse covering news in the period from Sunday October 31, 2021 to Sunday November 14, 2021. The Appendix to **Edition 30** will include the Reports on Reports for September and October. **Edition 31** of Low Carbon Pulse will be published in the usual two week cycle on November 30, 2021. **Edition 32 (The Magic Johnson Edition)** will be published on Friday December 17, 2021 and **Edition 33 (The Larry Bird Edition)** after the Christmas and western New Year holiday season and in advance of Lunar New Year.

Progress to COP-26:

- **Expectations – somewhere between heightened and sky high:**

- **New York, Milan and Glasgow – Great Cities, Great Expectations:**

After the weeks beginning September 20, 2021 (in New York), and September 27, 2021 (in Milan), the great and the good continued to prepare for the 26th session of the Conference of Parties (**COP-26**) of the United Nations Framework Convention on Climate Change opening this coming Sunday, October 31, in Glasgow, Scotland. The great and the good have been gathering in Glasgow for the last few days, and en route many of the great and good have been making announcements, and caucusing, on progress towards **NZE**.

As US Special Climate Change Envoy, Mr John Kerry, said in Milan:

"The bottom line is, folks, as we stand here today, we believe we can make enormous progress in Glasgow, moving rapidly towards new goals that science is telling us we can achieve".

President of **COP-26**, Mr Alok Sharma, set out the UK Government Goals for **COP-26**, the fourth of those Goals including the finalisation of the **Paris Rulebook**. Mr Sharma has been quoted as saying that reaching agreement of the **Paris Rulebook** will be more difficult than achieving agreement of the Paris Agreement.

One senses that Mr Sharma is right, and yet just because something is difficult does not mean that it is not pursued.

Third time lucky with the **Paris Rulebook**!

- **COP-26 Countdown:**

During this week-beginning October 25, 2021, five [Low Carbon Pulse – COP-26 Countdown features](#) were published covering the four key goals outlined for **COP-26** by the UK Government as the host of **COP-26** (the **Four Pillars**).

This **Edition 29** of Low Carbon Pulse does not repeat the **Four Pillars** or the subject matter of them.

- **Top line to bottom line:**

30 years and counting: It is a little over 30 years since the United Nations Intergovernmental Panel on Climate Change (**IPCC**) released its [First Assessment Report](#) in 1990. In a little over 30 years, the mass of **GHGs** present in the climate system has doubled. Among other things, this increase in the mass **GHG** emissions in the climate system reflects increasing population, prosperity and urbanisation.

The bottom line is that by 2030, **GHG** emissions need to be reduced by 45% (at least) to ensure that average increases in global temperatures stay within the bottom end of the responsible range between the **Stretch Goal** and the **Stabilisation Goal** i.e., between **1.5°C** to **2°C** (**Responsible Range**), and a reduction of 50% is required to achieve the **Stretch Goal**. This analysis is drawn from the [UNFCCC NDC Synthesis Report](#) (**Synthesis Report**) which synthesises information from the latest nationally determined contributions (**NDCs**) of 164 out of 191 Parties to the Paris Agreement as at July 30, 2021. While it is known that **GHG** emissions must be reduced, **GHG** emissions are projected to increase. It is the **Synthesis Report** that projects the **Catastrophic Pathway** about which UN Secretary General, Mr Antonio Guterres, has warned.

In the week leading up to **COP-26**, the **Synthesis Report**, together with the **Commitment and Production Gap**, has probably received more concerned coverage in news feeds and opinion pieces than any other matter.

Commitment and Production Gap: The United Nations Environment Programme (**UNEP**) publishes a production gap report annually. On October 20, 2021, the **UNEP** published the [2021 Production Gap Report](#) (**PGR**). Each production gap report assesses the gap between **NDCs** (covered in the **Synthesis Report**) and the planned and projected fossil fuel production. The authors of the **PGR** note that while countries have made **NZE** commitments and increased their **NDCs**, they, "... have not explicitly recognised or planned for the rapid reduction in fossil fuel production that these targets will require".

GHG emission reduction gap: The **PGR** notes that given current plans and projections, by 2030, the production of fossil fuels will exceed levels that are consistent with achieving the **Stretch Goal** - by 240% more in the case of coal, by 57% more in the case of oil and by 71% more in the case of natural gas. The "policy setting hand" and the "practical, real world, hand" are not coordinated. As a result, there is a gap.

If the gap is not bridged or narrowed, it is expected that the current bottom line (as projected) will result in at least a 16% increase in **GHG** emissions by 2030. This is not consistent with achieving the **Stretch Goal** (which requires a reduction in **GHG** emissions by 45% (at least)) rather it is aligned with, what UN Secretary General, Mr Antonio Guterres has termed, a **Catastrophic Pathway**.

Tracking to 2.7°C: UN Secretary General, Mr Antonio Guterres, pulled no punches in his address to the United Nations General Assembly in September. Mr Guterres expressed extreme concern, critically, that the world is on a catastrophic pathway to a **2.7°C** increase in average global temperatures compared to pre-industrial times (**Catastrophic Pathway**) without significant and immediate increases in the rate of **GHG** emission reductions. As is readily apparent from the science based reports: greater **GHG** emission reductions are needed, and the rate of those reductions needs to increase. No matter the direction from which any discussion is approached, the discussion needs to coalesce around the need for "greater and faster reductions".

The First Pillar (of the **Four Pillars**) for **COP-26** contemplates staying within the **Responsible Range**, while "keeping in touch" with the **Stretch Goal**.

"Faster, Higher, Stronger Together": Earlier in 2021, Mr Thomas Bach, President of the Olympic Committee, suggested the addition of the word **"Together"** to the Olympic motto, **Faster, Higher, Stronger**. Borrowing shamelessly from Mr Bach, the rate of reduction in, and the rate of removal of, **GHG** emissions need to be faster and higher, and the commitments stronger.

More than this, Article 2.2 of the Paris Agreement provides: "*This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances*".

- **Reducing the GHG emission reduction gap:**

Functioning rule book required: Increased **GHG** reduction commitments (through increased **NDCs**) will bridge or narrow the gap in concept, but equally important as increased **NDCs** is the use of an accepted and common monitoring and reporting framework by referenced to which reductions in **GHG** emissions will be monitored, and, through that monitoring, measured and determined, and **GHGs** emissions verified.

This will be achieved by the bolstering of the [2018 Paris Rulebook](#) (developed but not finalised at COP-24 in Katowice, Poland, and COP-25 in Madrid, Spain) in its final form, with the bolstered Rulebook being the **Paris / Glasgow Rulebook**. The **2018 Paris Rulebook** was agreed, in part, in December 2018 at COP-24, and provides guidelines for countries to achieve the outcomes provided for under the Paris Agreement. Given that the **2018 Paris Rulebook** was agreed, in part, it is incomplete, critically around key elements of accounting and accountability for **NDCs**.

As has been noted by many commentators, because the Paris Agreement is a bottom-up agreement, Parties to the Paris Agreement set their own targets (i.e., their **NDCs**), set policies as the means of achieving those targets, set the standards used to account for them, and as such to monitor and to report on their achievement. Ideally, the **Paris Rulebook** will provide for standardisation.

Trust and verify: For the author, while not headline grabbing, progress on the **Paris Rulebook** is the most pressing outcome required to achieving progress to **NZE**: along with increased **NDCs** and commitments to development and deployment of renewable electrical energy, it is critical, to monitor achievement of progress to respond to circumstances in which progress is not being made, and to verify what progress has been made.

At the moment, the **2018 Paris Rulebook** does not require countries to narrow or to bridge the gap between projected fossil fuel use and their **NDCs**. It is possible to see some folk seeking to "paper over the gap" by use of **International Market Mechanisms** under Article 6 of the Paris Agreement. Papering over a crack is not advisable. Papering over a gap, even less so!

One of the most debated areas, if not the most debated area, is the use of carbon credits (and cross-border emissions trading), including to bridge or to narrow the gap. This debate appears set to take centre stage.

- **The 2021 Report:** A key point of reference for the author continues to be the **IPCC Sixth Assessment Report – Climate Change, The Physical Science Basis (2021 Report)**. It is understood that the **2021 Report** is in the *Final Government Distribution phase*, a phase that is to end on November 26, 2021, being a date after **COP-26** finishes.

During the weeks leading up to **COP-26**, a number of news outlets reported on "leaks" of correspondence arising from the consultation process as part of the *Final Government Distribution phase*. While the author has not seen any of the correspondence, given the nature of the *Final Government Distribution phase*, the author does not read too much into the reported correspondence: the science will not change; how to achieve **NZE**, and the pace at which it is achieved, is the subject of debate, validly so.

By mid-February 2022, the **Summary for Policymakers** will be pretty in final form – see **Edition 35** of Low Carbon Pulse. (The **2021 Report** comprised a Summary of Policymakers in draft – see **Edition 24** of Low Carbon Pulse.)

The **2021 Report** continues to be the oracle, providing the range of outcomes from which **COP-26** has to choose.

- **A reminder of the key provisions of the Paris Agreement:** While frequent readers of Low Carbon Pulse will be familiar with the key provisions of the Paris Agreement, for convenience they are set out below:

KEY PROVISIONS OF THE PARIS AGREEMENT FOR COP-26	
<p>Article 2.1: This Agreement ... aims to strengthen the global response to the threat of climate change ... including by:</p> <p>(a) Holding the increase in global average temperatures to well below 2°C [Stabilisation Goal] above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C [Stretch Goal] above pre-industrial levels, recognising that this would significantly reduce the risk and impacts of climate change;</p> <p>(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and</p> <p>(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.</p>	<p>Article 4: In order to achieve the long-term temperature goal set in Article 2, Parties aim to reach <i>global peaking of greenhouse gas emissions as soon as possible, ... and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals to sinks in greenhouse gas in the second half of this century ...</i></p> <p>Article 6: 1. Parties recognise that some Parties choose to pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity. 2. Parties shall, where engaging on a voluntary basis ... promote sustainable development, and ensure ... integrity and transparency ... and shall apply <i>robust accounting</i> ... to ensure .. <i>avoidance of double counting</i> consistent with guidance adopted by the Conference of Parties ...</p>

Progress to COP-26 continued ... :

- **Top Agenda Items:**

Four Pillars: As noted above, during this week beginning October 25, 2021, Low Carbon Pulse – published five **COP-26 Countdown features** dealing with the four key goals outlined for **COP-26** by the UK Government as the host of **COP-26** (the **Four Pillars**).

The **Four Pillars** are as follows:

1. Secure global net zero by mid-century and keep 1.5 degrees within reach;
2. Adapt to protect communities and natural habitats;
3. Mobilise finance; and
4. Work together to deliver.

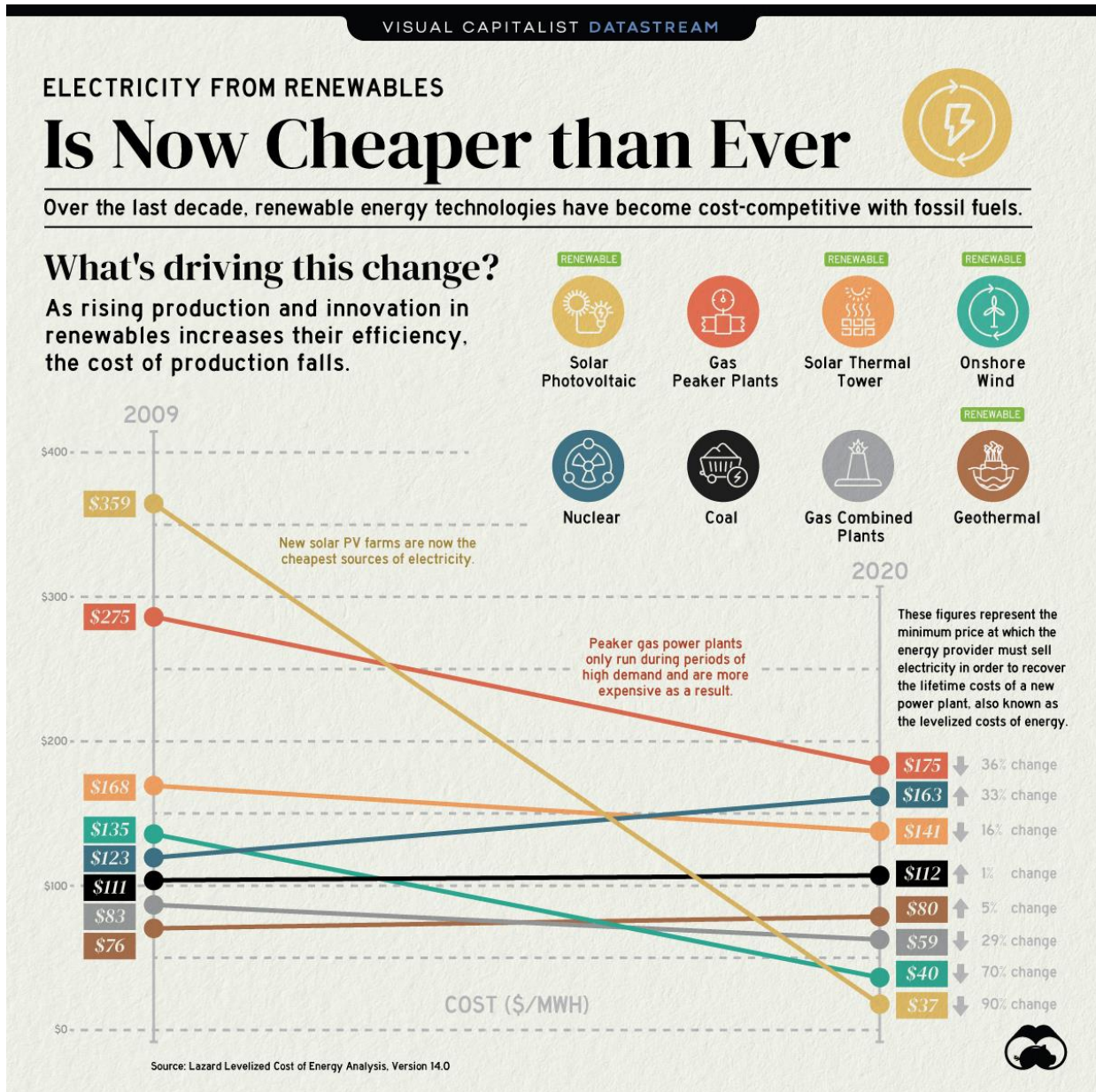
From the **Four Pillars**, and related matters, the agenda items at, or towards, the top of folks' lists are likely to be:

- **NDCs and Paris Rulebook:** Commitments to **NDCs**, or commitments to increased **NDCs**, accompanied by the **Paris Rulebook** to provide a clear, monitorable and verifiable pathway towards **NZE**, are key to the success of **COP-26**. Progress on these matters will be a clear indication of the success of **COP-26**.

Commitments to, or commitments to increased **NDCs**, represent the first step for some countries, and longer strides for others. To avoid miscalculation of progress to achieving **NDCs** and **NZE**, the **Paris Rulebook** is needed, both to monitor (and to provide the basis for measurement and determination of reductions in **GHG** emission) and to verify reductions in **GHG** emissions, and to achieve efficient deployment of technologies and initiatives on a basis that recognises and responds to any non-achievement of **GHG** emission reduction commitments.

Also the **Paris Rulebook** is needed to provide a clear basis to monitor and to verify the use of carbon credits to offset compliance or mandatory obligations or to allow corporations to use carbon credits to manage their progress towards **NZE**.

- **Hydrogen, Here and Now:** Defined commitments to the development of: (i) Carbon Capture and Storage (**CCS**), and Carbon Capture Use and Storage (**CCUS**) including to allow the development of Blue Hydrogen production capacity are needed; and (ii) renewable electrical energy capacity, solar and wind (off-shore and on-shore), to develop sufficient renewable electrical energy to allow the production of Green Hydrogen as soon as practicable, is needed. (See **Editions 26** and **27** of Low Carbon Pulse, including under [Government needed to guide to achieve timely development.](#))
- **Solar, Here, There and Everywhere:** The ever declining cost of photovoltaic solar electrical energy may be regarded as a function of markets (not necessarily free markets given the need for Government) working at their best, and critically, to lower the cost of producers of equipment, supplying domestic and international markets, allowing the deployment of photovoltaic solar at a scale that results in the lowest electrical energy costs in history, and the increasing development of battery electric storage systems (**BESSs**).



In some markets, these outcomes have been achieved before use of photovoltaic solar has been incentivized by the funding and other policy support provided by Government.

As a result of these dynamics, the Levelized Cost of Energy (**LCOE**) for photovoltaic solar electrical energy has become the lowest of any source of electrical energy in many markets.

From **COP-26**, it is hoped that developing countries, including those in Africa, East Asia, South East Asia and the Pacific Islands, will emerge with funding support programs to maximise deployment of photovoltaic solar development, both roof-top and utility.

Further, it is hoped that President Xi Jinping's proposal for a global high voltage direct current (**HVDC**) renewable energy network receives the "air-play" that it deserves. (See **Edition 32** of Low Carbon Pulse.)

- **Article 6 Agenda:** It is clear that a number of countries and organisations attending **COP-26** will seek to focus on carbon credits and trading in them, including to allow off-set against emission reduction commitments and liabilities, and the development of carbon credit trading. As noted above (and below), increased carbon credits, in theory, will narrow the gap between the projected increase in **GHG** emissions and the **NDCs** of some countries. It is critical to keep in mind that the use of carbon credits, while important, will not achieve the level of **GHG** emission reductions required to achieve **NZE**. The effective use of carbon credits, and the development of trading platforms for high-quality carbon credits, will "buy time" for the corporations purchasing them and for the rest of us by slowing the rate of increase in **GHG** emissions.

The slowing of the rate of increase in **GHG** emissions will slow the rate at which we deplete the global carbon budget, but ultimately decarbonisation of activities giving rise to **GHGs** is required.

- **A price on carbon:** A number of commentators have suggested that a global price on carbon should be on the **COP-26** agenda.

While a global price on carbon would link directly to the market for carbon credits, the author does not consider that a price on carbon is an appropriate agenda item for **COP-26** or any Conference of Parties.

This is not because a price on carbon is not a good idea in the right setting, but because the imposition of a global price on carbon would have to take account of current policy settings (including current customs and excise duties and taxes on fossil fuels) in each country. It is "a third rail" that is best left untouched at **COP-26**.

A carbon price is a tool used to encourage participants in markets to move to lower, low or no carbon technologies. In some countries a carbon price makes sense, but it makes sense only if it is set at a level that encourages the development and deployment of lower, low or no carbon technologies (and those technologies are available or on the horizon) – this is the logic for any carbon price, whether set through an emissions trading scheme or as a carbon tax, or both.

The "price on carbon versus technology" debate is one that the Federal Government of Australia has been sharing for a while: technology, not a carbon price (or, in Australian parlance, a "carbon tax"), will result in progress to achieving **NZE**. The Federal Government of Australia is committing tax-payer money to support the development of technologies which the Government hopes will find a market.

The debate that the Federal Government of Australia has shared is incomplete in that it ignores the rate at which reductions in **GHG** emissions need to be achieved, and that a price on carbon provides a benchmark for the cost of a lower, low or no carbon technology displacing carbon. This debate will no doubt continue.

- **Global energy demand and markets:** On October 6, 2021, S&P Global Platts reported on the assessment of the **US EIA** (the **US Energy Information Administration**). The S&P Global Platts [report](#) notes that the projection of the **US EIA** in its **International Energy Outlook (IEO)** is that global energy demand will grow by 47% by 2050, and oil and natural gas will remain the largest source of energy.

The assessment of the **US EIA** "underscores the stark challenges ahead for transitioning away from fossil fuels and curbing global warming emissions".

The **IEO** is stark. It is stark because it is the counterfactual to the aspirational **NZE**, and emphasises the importance of the reduction of **GHG** emissions by 45% (or more) by 2030, if not sooner. As noted in previous editions of Low Carbon Pulse, leaving decarbonisation to markets will not result in **NZE**.

As noted above, there is a **Commitment and Production Gap**, and it needs to be addressed. **COP-26** will not resolve the **Commitment and Production Gap**, but this gap needs to be discussed, and the **Paris Rulebook** needs to address how Parties to the Paris Agreement will address this gap.

As noted above, and to provide emphasis, in the week leading up to **COP-26**, the **Commitment and Production Gap** has received more concerned coverage than any other matter. This is a good thing.

- **Papers, Reports and Studies – Thick and Fast:**

- **A good year for publications:** Throughout 2021 the mass and volume of, and the speed at which, publications have been released has increased, in part in anticipation of **COP-26**. This has been the case, in particular, since May 18, 2021.

Since May 18, 2021, in addition to the **2021 Report**, the following reports have been published, from earliest first, to most recent last (all summarised in Low Carbon Pulse):

- **International Energy Agency** - [Net Zero by 2050 – A Roadmap for Global Energy Sector \(IEA Roadmap\)](#);
- **International Renewable Energy Agency** - [World Energy Transitions Outlook \(IRENA WETO\)](#);
- **Wood Mackenzie** - [How to scale up carbon capture and storage](#);
- **BloombergNEF** - [New Energy Outlook, 2021](#); and
- **S&P Global Platts** - [Platts Global Integrated Energy Model – Strategic Planning for a world in transition](#).

- **Paper, Paper everywhere – too much ink to drink in:** In the lead up to **COP-26**, many papers, reports and studies have been published. In the context of **COP-26**, the following seem to the author to be the most relevant:

- **IEA GH2R:** On October 5, 2021, the International Energy Agency (**IEA**) continued its prolific year with the publication of its [Global Hydrogen Review 2021 \(IEA GH2R\)](#).

As always with **IEA** publications, the **IEA GH2R** is both helpful and informative, and as such well-worth a read, and continues the consistent engagement of the **IEA** in respect of hydrogen (see [The Future of Hydrogen Report](#)). Of particular interest to the author is the **Hydrogen Projects Database**.

The key message from the **IEA GH2R**, in particular for the purposes of **COP-26**, is one that will be familiar to readers of Low Carbon Pulse: the role of Government is central to the development of both the Blue Hydrogen and Green Hydrogen industries, and as such the associated development of hydrogen and hydrogen-based fuels.

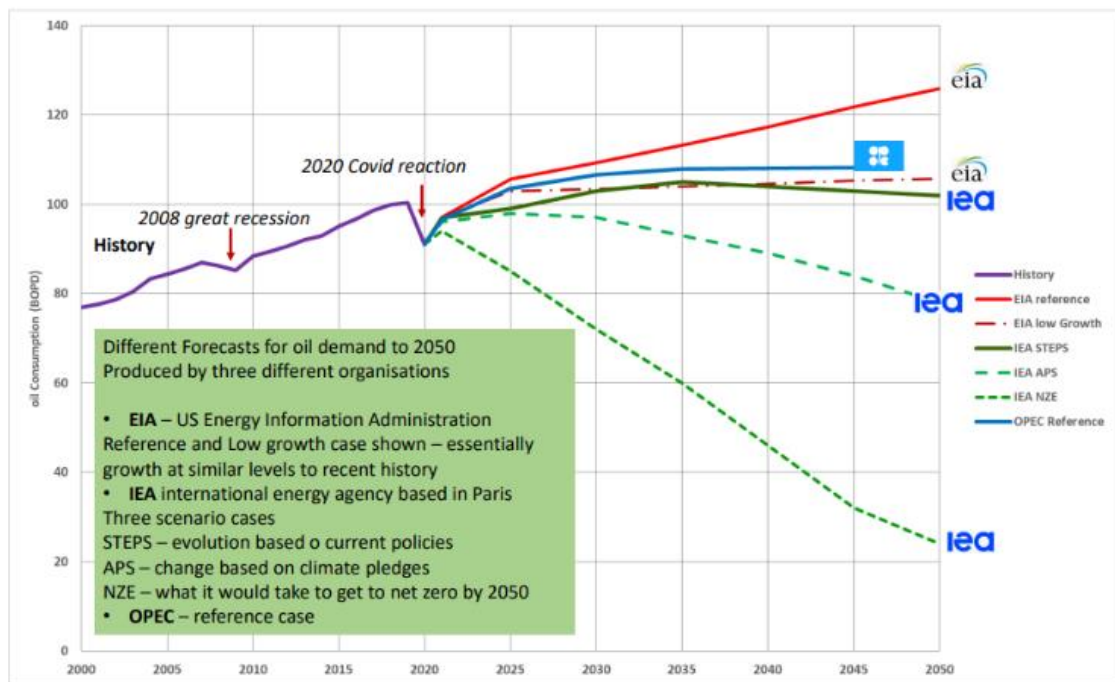
This key message is consistent with the messaging from the **IEA** since well before **Edition 1** of Low Carbon Pulse. **Edition 27** of Low Carbon Pulse (under [A role for Government in the development of supply and demand for hydrogen](#)) referenced an opinion piece from Wood Mackenzie: "... [COP-26] must go far beyond setting new emission targets. Ensuring that hydrogen is not just a "fuel of the future", but a fuel that needs to be ... implemented into global society from today [and] should be top of the agenda".

The **IEA GH2R** will be considered in detail in the **October Report on Reports** (in the Appendix to **Edition 30** of Low Carbon Pulse).

- **US EIA - IEO:** On October 6, 2021, the **US EIA** published its [International Energy Outlook \(IEO\)](#). As noted above, the **IEO** may be regarded as an assessment of what supply and demand will be given current policy settings, and as such without material and significant initiatives that change this direction of travel. (The **October Report on Reports** will consider the **IEO** in detail.)

This **IEO** is a read for the positive realist, determined to press for progress on the basis of higher and faster **GHG** emissions, and stronger enforcement, together. This said, the positive realist needs to understand that the **US IES** may be regarded as plotting a demand / consumption curve above those plotted by others in the recent past, as illustrated by the graph below:

Comparing Different Oil Demand Forecasts to 2050



- **IEA - CCH4R:** On October 7, 2021, the **IEA** published its [Curtailling Methane Emissions from Fossil Fuel Operations \(CCH4R\)](#). It will be no surprise to readers of Low Carbon Pulse that the headline from the **CCH4R** is that the reduction in methane (**CH₄**) emissions is "among the most impactful ways to combat near-term climate change".

As noted in the [Anniversary Edition](#) of Low Carbon Pulse, one of the areas of progress since October 2020 has been the recognition of the need to address **CH₄** emissions, culminating in the **Global Methane Pledge**, signed by the European Commission (**EC**) and the US on September 17, 2021.

As at noon on October 29, 2021, 24 countries have committed since then, including Argentina, Indonesia, Italy, Mexico, and the UK, with New Zealand considering joining, and the Kingdom of Saudi Arabia has committed to joining.

The **IEA** has been advocating consistently for a focus on **CH₄** emissions for some time, and will no doubt continue to do so.

The **CCH4R** notes (as the **IEA** has noted on a number of occasions) that:

"Methane has contributed around 30% of the global rise in temperature to date ... Emissions from fossil fuel operations present a major opportunity [to limit global warming in the near term] since the pathways to reduction are both clear and cost-effective".

The **CCH4R** will be covered in detail in the **October Report on Reports** (in the Appendix to **Edition 30** of Low Carbon Pulse).

In passing, it is important to note that while the focus of the **CCH4R** is **CH₄** arising from the extraction, production and transportation of fossil fuels, **CH₄** arises from agriculture, forestry and other land use (**AFOLU**) and waste and waste water. At the same time as **CH₄** emissions from fossil fuel operations are being targeted, **CH₄** emissions from waste and waste water need to be addressed (see below **A role for Government in decarbonising AFOLU** and **A role for Government in the development of Bioenergy**).

As noted in other editions of Low Carbon Pulse, **AFOLU** is challenging, but addressing waste, in particular landfill, and waste water, should take place alongside addressing **CH₄** emissions from fossil fuel production. This requires policy settings and implementation from Government to align with waste management system developments in all countries.

- **IEA - IEA WEO:** On October 13, 2021, the **IEA** published its [World Energy Outlook 2021 \(IEA WEO\)](#). The key message from the **IEA WEO** is that the world is in energy transition, but the rate of progress towards energy transition, and the achievement of progress towards **NZE**, needs to increase.

The **IEA WEO** will be covered in the **October Report on Reports** (in the Appendix to **Edition 30** of Low Carbon Pulse).

- **IRENA - DESS Roadmap:** On October 13, 2021, the International Renewable Energy Agency (**IRENA**) published its [A Pathway to Decarbonize the Shipping Sector by 2050 \(DESS Roadmap\)](#).

The **DESS Roadmap** notes that currently the shipping sector uses fossil fuels, and that it is necessary to displace fossil fuels so as to reduce **CO₂** emissions. The **DESS Roadmap** provides a description of the ways and means to the displacement of fossil fuels so as to achieve an 80% reduction in **CO₂** emissions by 2050.

Director General of **IRENA**, Mr Francesco La Camera provides a clear picture:

"[The DESS Roadmap] clearly shows that cutting CO₂ emissions in such a strategic, hard to abate sector, is technically feasible through [the use of] green hydrogen fuels."

IRENA contemplates that up to 70% of the fuels used in the shipping sector by 2050 will be hydrogen-based fuels. Without necessarily wanting to pick winners, **IRENA** suggests that the use of e-ammonia could provide close to 45% of the energy demand from the shipping sector by 2050. (This contrasts with the views of others that tend to favour e-methanol.)

In some ways, the **DESS Roadmap** may be regarded as conservative given the initiatives already "on the water", critically, the progress that the shipping industry is making in the use of hydrogen-based fuels (see **Editions 26** and **27** of Low Carbon Pulse).

The shipping sector is increasing, some might say intensifying, efforts to reduce the **GHG** emissions arising from the sector. By way of a reminder, the shipping sector gives rise to up to 3% of global **GHG** emissions (expressed in **CO₂-e** terms), with the International Maritime Organisation suggesting 2.9% and **IRENA** suggesting around the same. A recent [article](#) (entitled [Enduring waves of climate change: Maritime Decarbonization, a tempest before the calm](#)) from the ever accurate S&P Global Platts provides a balanced perspective, noting the scale of the task, balanced with the achievability of the task.

The **October Report on Reports** (contained in Appendix to **Edition 30** of Low Carbon Pulse) will consider the **DESS Roadmap** in detail.

- **IEA - UAC Paper:** On October 19, 2021, the **IEA** published its paper [Phasing Out Unabated Coal – Current status and three case studies \(UAC Paper\)](#). The **UAC Paper** carries forward one of the key findings in the **IEA WEO** – critically, the need to end investment in new unabated coal-fired power plants, and to retrofit, and to repurpose, existing coal-fired capacity.

As is typical in **IEA** publications, the **UAC Paper** contains a number of recommendations: **1.** Allow sufficient time for consultation and implementation of phase out plans; **2.** Provide support for affected communities, including workers; **3.** Ensure that security of electrical energy supply is maintained as "a cornerstone of phase-out policies"; **4.** Implement carbon pricing; **5.** Improve the climate for investment in clean electricity and the necessary infrastructure; and **6.** Consider conversion of coal generation assets.

Recommendations **1** to **3**, and **5** and **6** will come as no surprise.

The implementation of recommendation **4** (Implementing carbon pricing) may come as a surprise given the need to accelerate the retirement of coal-fired power generation is more about development of new renewable electrical energy capacity as soon as practicable, than use of a carbon price.

- **IEA - NZE ES Report:** On October 20, 2021, the **IEA** published its report [Achieving Net-Zero Electricity Sectors in G7 Members \(NZE ES Report\)](#).

The **NZE ES Report** was requested by the UK (which holds the **G7** this year). As might be expected, the **NZE ES Report** builds on the finding from the **IEA Roadmap** published on May 18, 2021.

The **NZE ES Report** will be considered in detail in the **October Report on Reports** (in the Appendix to **Edition 30** of Low Carbon Pulse).

- **The Economist weighty reflection:**

In the October 9, 2021 edition of The Economist, the venerable publication reflected on the size of the current hydrogen industry, at 90 million metric tonnes per annum (**mmtpa**) and USD 150 billion.

Given current technologies (steam methane removing, grey hydrogen production and gasification, black or brown hydrogen production), around 6% of the natural gas and 2% of coal production is used each year to produce this 90 **mmtpa** of hydrogen.

The production of the 90 **mmtpa** gives rise to between 850 and 900 **mmtpa** of **GHG** emissions, or around 1.8% of the 50 Giga-tonnes **CO₂-e GHG** emissions arising each year.

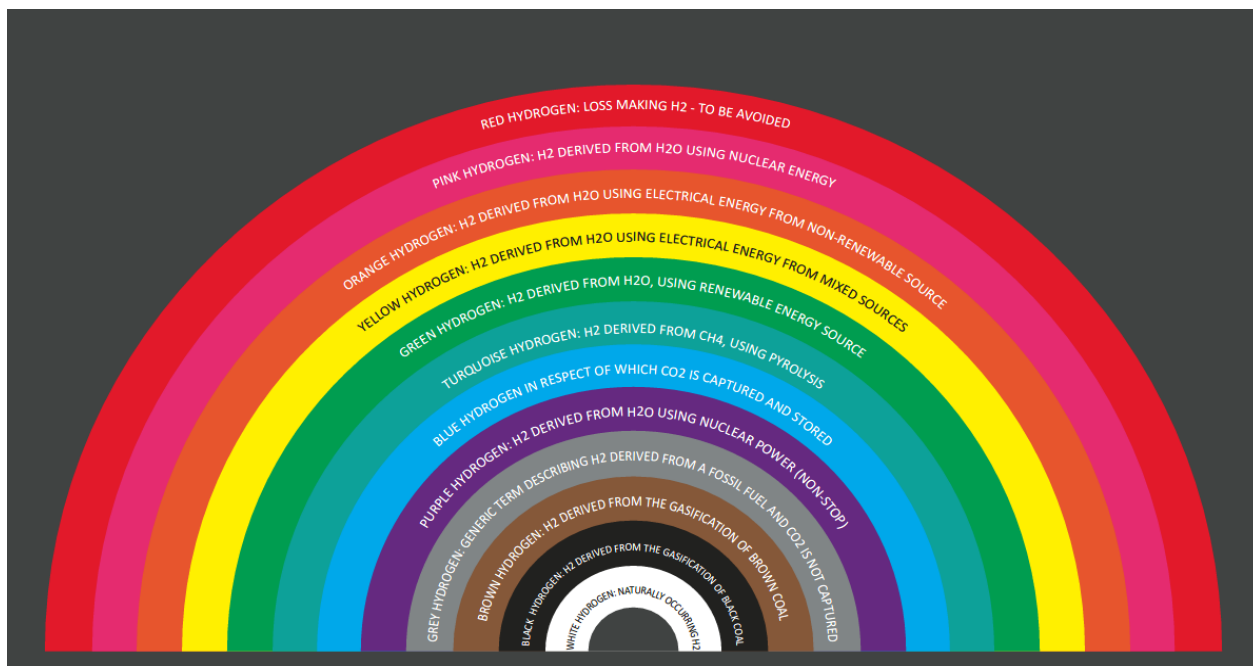
As such, hydrogen produced using these technologies is not going decarbonise the production of energy carriers to displace hydrocarbons; rather CCS / CCUS to produce Blue Hydrogen and electrolyzers and renewable electrical energy will do this.

The Economist notes the degree of difficulty and the scale of the endeavour. To remind the reader of the various colours of hydrogen, the Ashurst Hydrogen Rainbow is included on the following page.

For those who have heard the author present on these facts and stats, the message is not new. For those, coming to these facts and stats for the first time, lest there be any doubt, hydrogen and hydrogen-based fuels are needed to

achieve **NZE**, but to avoid unintended consequences, it is critical that progress to Green Hydrogen production is aries as speedily as possible.

Ashurst Hydrogen Rainbow:



Ashurst Hydrogen Rainbow ©Ashurst 2021

[**Note:** Some authors / commentators use Purple Hydrogen to refer to the production of hydrogen using coal or petcoke gasification using CCS to capture the **CO₂** arising.

In South Australia, White Hydrogen is being referred to as Gold Hydrogen, reflecting the rush to acquire exploration licenses]

The **Ashurst Hydrogen Rainbow** (a creation of the author of Low Carbon Pulse), is intended to provide an aide memoire to the reader. It is noted that the author of Low Carbon Pulse took liberties with both the colour coding of hydrogen and the spectrum: adding Red Hydrogen (at the top of the **Rainbow**) to represent the difficulty of making a return on any early stage clean or low hydrogen project, and adding Grey, Brown, Black and White (at the bottom of the **Rainbow**) for completeness of the colours that are used to describe hydrogen.

• **G20 activity and commitments in the lead up to COP-26:**

- **UK All Green Electrons by 2035:** On October 4, 2021, UK Prime Minister, Mr Boris Johnson announced that by 2035 all electrical energy dispatched to satisfy load in the UK would be matched by renewable electrical energy. This is the perfect response to the impact of the shortage of natural gas on the electrical energy prices in the UK: the best cure for higher prices is higher prices, resulting in increased supply or in a switch to another technology or increased use of an existing technology.

Stating the obvious, the switch to an existing technology is occurring, and needs to accelerate. Until the switch reaches a tipping point, the UK Government, like many countries around the world, needs an energy security policy (sufficient supply side to avoid sustained higher prices).

While an inconvenient truth, the UK and **EU** countries may need more gas-fired power stations to provide energy supply to match demand, and those gas-fired power stations will have to be developed with CCS / CCUS. As frequent readers of Low Carbon Pulse, and sister publications of Low Carbon Pulse, will know, this is a long-standing perspective of the author of Low Carbon Pulse.

- **UAE comments to NZE by 2050:** On October 7, 2021, the United Arab Emirates (**UAE**) committed to reduce its **GHG** emissions to **NZE** by 2050 – see below (under **GCC Countries update**) for more detail.
- **Turkey ratifies the Paris Agreement: Edition 28** of Low Carbon Pulse noted the good news arising from the United National General Assembly during the week beginning September 20, 2021, including that Turkey had committed to ratify the Paris Agreement. The commitment had to be ratified by the parliament of Turkey. On October 8, 2021, the parliament of Turkey ratified the accession of Turkey to the Paris Agreement.
- **ROK increases NDC:** On **October 18, 2021**, the Republic of Korea (**ROK**) increased its **NDC** from 26.3% to 40% by 2030, compared to **GHG** emission levels in 2018. This is considered in more detail below under **Republic of Korea (ROK) News**.
- **Saudi Arabia commits to NZE by 2060:** On October 24, 2021, the Kingdom of Saudi Arabia (**KSA**) committed to reduce its **GHG** emissions to **NZE** by 2060.
The commitment of the **KSA**, and the associated steps to implementation (see below under **GCC Countries update**) demonstrate in the clearest of terms the economic, environmental and social transformation that is upon us.
- **Australia commits to its version of NZE by 2050:** As noted in **Edition 28** of Low Carbon Pulse, the Federal Government of Australia has been the subject of scrutiny by the international community and its own citizens because it had not committed to the achievement of **NZE** by 2050.
On October 26, 2021, the Federal Government of Australia announced its commitment to **NZE** (see below under **Australia – Weighted Progress** for the reported perspectives on the commitment).

- **UK Global investment Summit:** The UK Government hosted the UK Global Investment Summit (**GIS**), on October 19, 2021.
Notable announcements from the **GIS** are captured in the following press release – click [here](#) – from the UK Government providing a high level overview of the outcomes and commitments from the **GIS**.
During the week of **GIS**, the UK Government announced two strategies: **Net Zero Strategy: Build Back Greener** and **Heat and Building Strategy**. These strategies are consistent with the Build Back Better initiative that arose from the [G7 summit](#).

Roles to be played to reduce GHG emissions:

As foreshadowed in previous editions of Low Carbon Pulse, ahead of **COP-26**, current and relevant matters would be considered, including the roles to be played by key players.

Edition 28 of Low Carbon Pulse contemplated that this **Edition 29** would cover the Role of Government in decarbonising Agriculture Forestry and other Land Use (**AFOLU**) and the development of bio-energy. It contemplated also that the Role of Carbon Credits and Coal would be considered. We have covered Carbon Credits, but not Coal (the **LIAC Paper** does this effectively).

- **A role for Government in decarbonising AFOLU:**

- **Decarbonising AFOLU:**

Edition 28 of Low Carbon Pulse noted that **AFOLU** is hard to decarbonise. In many countries, some may say in most countries, agriculture has cultural, political and social significance. In the interests of food security and political expediency, in many countries agriculture receives direct and indirect funding support, including policy settings intended to ensure maintenance of the value of certain crops.

Given these dynamics, the decarbonisation of the **AFOLU** sector is best regarded, and is best calibrated, on a country by country, area by area, basis.

- **Do no harm, but do it quickly!**

In this context, there is a role for Government in ensuring that it "does no harm" having regard to the areas within a country in which it seeks to set policies that will result in a reduction in **GHG** emissions. In the context of "doing no harm", there is a role for Government at a number of levels. In the collection of waste, rather than crop burning (over 3.5% of **GHG** emissions expressed in **CO₂-e** terms), and providing value to landholders to avoid deforestation (close to 2.5% of **GHG** emissions). In these areas alone, there is close to 7% of the total mass of **CO₂-e GHG** emissions "in play".

In addition, Governments can encourage afforestation and reforestation and wilding of land, and practices to reduce the mass of **GHG** emissions arising, including to provide value for these forms of land use, including by use of carbon credits. These activities have value in that they remove **GHG** emissions from the climate system. The removal of **GHG** emissions from the climate system means that the rate at which our global carbon budget is being depleted will slow. Governments are now acting on the ability of certain trees and crops to absorb **CO₂**.

- **Giving value to GHG land use that removes GHGs:**

The most potent **GHG** emission arising from agriculture is **CH₄**, including raising livestock (around 5.8% of **GHG** emissions expressed in **CO₂-e** terms) and growing certain crops (up to 2.2%). (**CH₄** is more potent than **CO₂**) (see **Edition 27** of Low Carbon Pulse).

As noted above, initiatives to collect waste, to change land use and to remove **GHG** emissions from the climate system will allow progress to decarbonising the **AFOLU** sector, but given the potency of **CH₄**, more needs to be done. What needs to be done in terms of **CO₂** removal activities needs to be determined and planned by Governments. And countries that export products that have given rise to **CH₄** emissions need to do more still.

- **Government to assess and to plan:**

A key part of planning needs to consider the trees, and other vegetation (**green carbon**), that can achieve the highest levels of **CO₂** absorption (**sequestration capacity**) on a sustainable basis within areas of countries. Governments are ideally placed to map and to monitor trees and other vegetation to assess the sequestration capacity of trees and vegetation, above and below ground.

In addition, the use of coastlines and the nearshore in certain regions of the world offer potentially vast sequestration capacity (**blue carbon**). For example, mangrove forests and swamps, and areas with sea-grasses and tidal marshes, provide ecosystems that can absorb **CO₂**. For Government, the task is to assess how much of the coastline and the nearshore can be used to progress the development of **blue carbon** sequestration capacity.

- **Blue carbon v. Green Carbon:**

It is estimated that one mangrove tree will absorb 12.4 kg of **CO₂** a year on average. Taking the benchmark of the **KSA** to plant 50 billion trees (see **Edition 13** of Low Carbon Pulse), 50 billion mangrove trees will absorb 620 million metric tonnes (**mmt**) per annum (**mmtpa**). It is possible to plant 5,000 mangrove trees per hectare, with each hectare absorbing 62 metric tonnes (**mt**) per annum (**mtpa**) of **CO₂**. 50 billion mangrove trees could be planted on 10,000,000 hectares.

In contrast, a palm tree will absorb around 2.3 kg of **CO₂** a year. On October 25, 2021, the US State of Florida announced plans to replace palm trees with native canopy trees, which absorb a greater mass of **CO₂**. Palm oil trees are different, and the data on their ability to absorb **CO₂** has quite a spread. Taking the highest estimate of the spread at 57.6 **mtpa** per hectare, palm oil trees appear comparable with mangrove swamps. This is not to suggest deforestation and planting of palm oil trees (the broader challenges with palm oil are well known and beyond the scope of this **Edition 29** of Low Carbon Pulse), rather it is to provide a point of comparison.

By way of further comparison, a pine tree will absorb around 10 kg of **CO₂** a year. On the basis that there are approximately 1,000 trees per hectare, the pines trees in that hectare will absorb 10 **mtpa** of **CO₂**.

- **Bamboo a super-absorber:**

"Higher, Faster, Stronger" is a good description for bamboo: bamboo is a super-absorber of **CO₂**, storing **CO₂** in its biomass, particularly its root system (its extensive root system being good for soil quality, preventing soil erosion and assisting in the restoration of soil-depleted areas). For these reasons, the planting of bamboo may be regarded as integral to long-term agricultural redevelopment and agroforestry.

As with the reporting on the capacity of palm oil to absorb **CO₂**, the reporting on the capacity of bamboo to absorb **CO₂** varies somewhat. At the higher end, one hectare of bamboo is reported to be able to absorb between 17 and 20 **mtpa** of **CO₂**. Bamboo is fast growing, and mature groves of bamboo can be established within two to three years. Bamboo is an effective above ground carbon and below ground carbon absorber.

For every 10 million hectares of land used to grow bamboo, between 170 and 200 **mtpa** of **CO₂** will be absorbed each year. India is estimated to have around 12.4 million hectares of bamboo groves.

- **Assessment of AFOLU:**

For each country, an immediate focus should be the assessment and analysis of the use of trees, other vegetation and crops, best suited to the environment in which they are grown, including the return of land to the wild (and paying for the benefit of doing so). An assessment of this kind will yield an understanding of optimal land use, from both an economic and environmental perspective, and a means to realise value from carbon credits.

- **A role for Government in the development of Bioenergy:**

- **Background:**

The **IEA Roadmap** and the **IRENA WETO** both identified the development of bio-energy capacity as key to achieving **NZE** under the scenarios outlined in them. As noted in previous editions of **Low Carbon Pulse**, **bio-energy** is energy derived or produced from biomass, whether that energy is in gaseous, liquid or solid form. Bio-energy is derived from organic matter, not from fossilised organic matter.

The sources of biomass for use as feedstock or fuel are many and varied, but in the context of **GHG** emissions, the organic waste stream arising from human activities provides a renewable resource that, if collected, processed and used, can reduce **GHG** emissions, avoiding or reducing **CH₄** (and **CO₂**) emissions on the decomposition of that organic matter, and the displacement of fossil fuels with that bio-energy.

The importance of the reduction in **CH₄** emissions is explained in **Edition 27** of **Low Carbon Pulse**. Reflecting this, the **EU** and **US** have recently committed (in the **Global Methane Pledge**) to reduce **CH₄** emissions by a third within the next decade (see **Edition 27** of **Low Carbon Pulse**), and reported on above.

- **Bio-energy and carbon:**

For the production of bio-energy to be carbon-neutral, it must be combined with bio-energy carbon capture and storage, **BECCS**, or with bio-energy carbon capture and use or storage, **BECCUS**. For bio-energy production using **BECCS** to make a contribution to a reduction in **GHG** emissions, it must displace another electrical energy source or energy carrier source, and, in any event, it must result in a carbon neutral outcome (rather than a carbon removal outcome) so as not to give rise to an increase in **GHG** emissions.

This is where Government has a role to play. As has been noted in respect of **CCS / CCUS** in the context of carbon clusters (invariably located around ports and the hinterlands of ports), the storage of **CO₂** is likely to require Government funding support, and also Government risk support. It is no surprise that both the **IEA Roadmap** and the **IRENA WETO** contemplate tying the development of the bio-energy to **BECCS / BECCUS** to capture and to store the **CO₂** arising from the production of bio-energy.

- **Waste management plans and systems required:**

Progress towards achievement of **NZE** is not a zero sum game. More than that, it is to be expected that there will be increased scrutiny of the life-cycle and **GHG** emission footprint of asset and infrastructure life, and responsibility for recovery and recycling of organic matter giving rise to **GHG** emissions (in the same way as with metals and mineral and plastics, this is a topic for a sibling publication of **Low Carbon Pulse**).

Across all human activities, waste arises and **GHG** emissions arise. Globally, Government has a role to play in the development of waste management systems from the point of the waste arising to the point of recycling, re-use, or disposal, including the recycling and re-use of biomass, and the disposal into storage of **CO₂**.

- **Bio-energy and AFOLU sector:**

The broader **AFOLU**, waste and waste water sectors are estimated as giving rise to up to 95% of anthropogenic **CH₄** emissions globally. Given the impact of **CH₄** emissions on climate change, there is an immediate and present reason to capture the life-cycle of carbon in the **AFOLU** and waste and waste water cycles. Organic matter in waste and waste water decomposes. The rate of decomposition varies. On decomposition, **CH₄** and **CO₂** arise.

Capturing the life-cycle of carbon is best framed and achieved through Government collection and consolidation initiatives. These will include the derivation and production of biogas, and biomethane for pipeline gas, from waste to displace natural gas over time. Further, if **CO₂** arising on the production and use of biogas or any other biofuel is captured and used, and matched by new growth biomass to absorb an equivalent mass of **CO₂** arising on oxidation / use of that biogas or other biofuel, the promise of bio-energy will be realised.

In the agricultural sector, the implementation of policy settings of this kind would become the core of an environmentally and economically sustainable sector, including by use of the digestate arising from the derivation and production of bio-gas, and the use of cover crops and perennial crops.

- **Interface with progress to NZE and progress to Net-Zero Waste:**

While this piece is intended to identify the role of the Government in the development of bio-energy, the author thought that it may be helpful to outline the role of Government more broadly in the waste sector as progression is made towards the achievement of **NZE**, and as such outline the policy settings that are emerging and likely will emerge. The collection and recycling of **Net Zero Waste** is a key economic and environmental issue.

As progress towards **NZE** is made, the mass of waste arising on the extraction of metals and minerals, on the manufacture of equipment and infrastructure, on the transportation and installation of that equipment and infrastructure, and at the end of the life-cycle of that equipment and infrastructure, will increase. The most

prominent waste streams from progress towards the achievement of **NZE** are solar panels and wind-turbines, **Net-Zero Waste** if you will (not to be confused with the existing use of this phrase to describe another policy setting – Net-Zero Waste to landfill).

More broadly, the policy settings for the management of **E-Waste** and **Net-Zero Waste** are very much in the process of being re-based in the context of **E-Waste** and formulated in the context of **Net-Zero Waste**. The phrase **E-Waste** is used to describe waste that arises from electronic equipment used for business, domestic, industrial or scientific use, including equipment needed for Information and Communications (**ICE**).

In a recent [report](#), it is estimated that between 2.1 and 3.9% of global **GHG** emissions arise from equipment that becomes **E-Waste**. In part, this reflects that the production of **ICE** gives rise to **GHG** emissions (including some of the more potent **GHG** emissions), housed in plastics that are not designed for recycling, using heavier metals, the life-cycle of which needs to be understood and captured. Ultimately, all residual material needs to be captured for safe and sustainable recycling or disposal.

Improved and new policy settings are needed if extraction and manufacturing is to be decarbonised in the case of **ICE**, and if **GHG** emissions are to be avoided in the case of equipment and infrastructure manufactured and developed, for the purposes of achieving progress towards **NZE**.

Policy settings for Recovery, recycling and disposal of materials arising at the end of life-cycle needs to be contemplated sooner rather than later, and the means of recovery, recycling and disposal developed by Government or with its support, and their use mandated.

Note: Net-Zero Waste is not yet a concept, but for present purposes it includes waste that arises from the extraction, manufacture, transportation and use of equipment and infrastructure developed for the purposes of reducing **GHG** emissions, including on the extraction of metals and minerals used in the manufacture of solar panels and wind towers and turbines, and energy storage systems (including **BESSs** and **HESs**) on the manufacture of those panels, towers and turbines, and systems, and on recovery and recycling of resources from them at the end of their life-cycles, and the means of disposal of any material that cannot be recovered or recycled.

• Role of carbon credits in progress to achieving **NZE**:

○ **Background:**

There has been considerable coverage around the role of carbon credits in achieving **NZE**, not least because of the record high prices being paid for carbon credits in both compliance / mandatory markets (**Mandatory Markets**) and in voluntary markets (**Voluntary Markets**).

In **Mandatory Markets** (typically, in the context of an emissions trading scheme structured as a cap-and-trade), carbon credits have value if they can be used to acquit, i.e. can be used to offset, an obligation to match the **GHG** emissions arising from the activities of a corporation with emissions trading permits (**ETPs**) that organisation is required to acquire under that emissions trading scheme. In this context, the value of carbon credits will be a function of the operation of the **Mandatory Market**, including the market price of **ETPs** and the consequences (including liability) under that emissions trading scheme for not acquitting or being able to offset.

In **Voluntary Markets**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions (and, in the longer term, **NZE** on the basis of carbon neutrality). Previous editions of Low Carbon Pulse have covered the uses of words and phrases in this context, but ultimately, decarbonisation takes time, and needs to be achieved across Scopes 1, 2 and 3 emissions. To buy time, while still reducing **GHG** emissions on a net-basis, corporations buy carbon credits.

In the context of **Voluntary Markets**, the value of carbon credits is less well-defined than in a **Mandatory Market** and will tend to depend on the position of the corporation buying the carbon credits, and whether the carbon credits are going to underpin a transaction (for example, the sale of carbon neutral cargo of liquified natural gas or oil or an investment).

○ **Carbon credits and decarbonisation:**

Acknowledging that some folk will debate this, the perspective of the author is that ultimately decarbonisation of activities is the only means of achieving **NZE**, and as such the role of carbon credits is to place a value on activities that remove **CO₂** from the climate system: the value is quantified in mass, with one metric tonne of **CO₂** having a value.

As **NZE** is achieved, the carbon sinks absorbing **CO₂** the subject of the carbon credits should be used to remove **CO₂** in the climate system on an absolute basis.

○ **The value of **CO₂** removal:**

The benefit of the removal of **CO₂** from the climate system is that it reduces the rate at which the global carbon budget is depleted, and in the case of **CO₂** that is removed from the climate system that is not subject to a carbon credit scheme, that removal of **CO₂** gives rise to a net-reduction in the **GHG** emissions.

○ **The challenges with carbon credits:**

Generally the challenge with carbon credits is the monitoring, measurement and determination, and auditing and verifying (**accounting and accountability**) the mass of **CO₂** actually removed from the climate system and sequestered in a carbon sink.

As noted in [Edition 16](#) of Low Carbon Pulse, it is thought that the mass of **GHG** emissions assumed to be being sequestered in carbon sinks is greater than the actual **CO₂** that is actually sequestered, and is being sequestered, in those sinks. This is important, because they need to be the same. If they are not the same, the purpose of carbon credits is not being achieved.

Specifically, the challenge with carbon credits issued in some countries (developed and developing) is that some carbon credits are issued in respect of activities that do not remove **CO₂** emissions from the climate system. This is a challenge that appears to the author to be becoming more marked.

Further, the basis of **accounting and accountability** in some countries does not provide a level of assurance that **CO₂** is being removed. For those purchasing carbon credits, this matters. The fact that there is an increasingly segmented market for carbon credits tends to reflect that this matters.

- **Greater rigour around carbon credits:**

Carbon credits are issued by Governments, reflecting the policy settings of those Governments. It is hoped that at **COP-26**, there is discussion and progress as to the basis upon which carbon credits should be issued so as to provide a level of consistency globally.

Further, it is hoped that the basis of standards of **accounting and accountability** to be applied are developed, and that those standards are carried forward in the laws and regulations of each country issuing carbon credits, and compliance with those standards will be required so as to access the higher prices that are being paid for high-quality carbon credits.

- **Visual Capitalist background material:**

- The Visual Capitalist provides a [Voluntary Markets 101](#) outline, among other things, outlining the four key participants in the voluntary carbon credit markets – **1.** project developers, **2.** standards bodies, **3.** brokers (including those acting as brokering intermediaries for Governments) and **4.** end buyers. The link is accessed with a click. The link has an accompanying descriptive narrative. In passing, it is noted that Governments are key, both as framers and as possible participants in voluntary carbon credit markets.
- In addition to the Visual Capitalist, Shell has recently published [Exploring the Future of the Voluntary Carbon Market](#), developed by it in collaboration with BCG. The publication is well-worth a read, providing a balanced perspective. The **October Report and Reports** will consider the publication in more detail.

Climate change reported and explained and Visualisation and Listening Platforms and Tools, and useful materials:

At this point in recent Editions of Low Carbon Pulse, sections have been included on **Climate change reported and explained** and, as appropriate, **Visualisation and Listening Platforms and Tools, and useful materials**. To manage the length of this **Edition 29** of Low Carbon Pulse, this sections is not included, but will return in future editions.

GCC counties update:

- **United Arab Emirates commits to NZE by 2050:** On October 6, 2021, the United Arab Emirates (**UAE**) became the first Gulf Cooperation Council (**GCC**) country to commit to achieving **NZE**. This commitment is material and significant in a global context, and for the **UAE** it will spark a "once in a generation", or possibly even, as some have noted, a "one-of-a-kind", shift in the economy of the **UAE**, driven and effected by the level of investment required to effect the shift to what will be a photovoltaic solar and wind and Blue Hydrogen and Green Hydrogen economy.

The **UAE** is ahead of the curve in many ways, having already realised capital through its program selling interests in infrastructure assets and selling down interests in operating businesses, including on listing of them.

- **Engie firm perspective:** In [Arab News](#) on October 9, 2021, Chief Executive of Engie in the **KSA**, Mr Turki Al-Shehri, expressed considerable enthusiasm around the development of Green Hydrogen, contrasted with caution around the development of Blue Hydrogen projects because these projects have become "*much more difficult*" to finance.

While a number of commentators may have questioned the development of Green Hydrogen, those at the forefront of the development of Green Hydrogen projects are convinced of the need and that progress is occurring: "*... it's a global energy changer. Green hydrogen is coming. Even before it was a buzzword, [Engie has been spending roughly] €60 million a year on green hydrogen research around the world*".

The **KSA** has some of the best renewable electrical energy resources globally, and as a result, some of the world's lowest cost electrical energy: **KSA** has reliable sunshine rates during the day, and reliable winds at night. This was proved up further on October 18, 2021 as the **KSA** announced the Round 3 of the **NREP** (see **KAS shortlists bidders on Round 3 of renewables** below).

- **Masdar in the news:**

- **Republic of Turkmenistan closer ties:** On October 10, 2021, Masdar (Abu Dhabi Future Energy Company) announced that it had signed a strategic agreement to explore renewable energy opportunities in the Republic of Turkmenistan. This builds on the commitment demonstrated by Masdar regionally. As noted previously, Masdar is a member of the elite club of global "go to investors" in the renewable energy sector.
- **Masdar credit rating:** Consistent with the role of Masdar as a member of the elite club of global "go to investors", Masdar has obtained a credit rating to assist in its facilitation of, and investment in, projects.

- **Egyptian Ammonia Plant:** On October 14, 2021, it was announced that Fertiglobe (a joint venture between ADNOC and OCI Chemical (world leading producer of soda ash)) and Scatec (a leading renewable electrical energy producing corporation) have entered into an agreement with the Sovereign Wealth Fund of Egypt (**SFE**) to develop a 50 – 100 MW electrolyser to produce Green Hydrogen as feedstock for the production on Green Ammonia.

The Green Hydrogen production facility is to be located near Ain Sokhna, close to existing facilities of a subsidiary of Fertiglobe, EBIC. Under the agreement, Scatec is to build, operate and own (a majority interest) the Green Hydrogen facility, with the Green Hydrogen to be supplied to EBIC to produce Green Ammonia.

See: [Scatec partners with Fertiglobe and the Sovereign Fund of Egypt to develop green hydrogen as feedstock for ammonia production in Egypt](#); [Fertiglobe Partners with Scatec and the Sovereign Fund of Egypt to Develop Green Ammonia Project in Egypt](#)

- **New hydrogen production plant in KSA:** On October 11, 2021, the Saline Water Conversion Corporation and Cummins announced that they intend to develop a hydrogen production facility in the **KSA**.

See: Cummins [website](#); Saline Water Conversion Corporation [website](#)

- **KSA home of the world's biggest BESS:** On October 16, 2021, Huawei Digital Power (**HDP**) and SEPCOIII (EPC contractor for the Red Sea Project as part of the development of NEOM (see **Update on NEOM** below)) signed a contract under which HDP is to supply a 400 MW / 1,300 MWh **BESS**.

See: [Huawei to Power the World's Largest Energy Storage Project](#)

- **OQ signs JDA:** On October 17, 2021, it was reported widely that OQ (the Omani state-owned energy company) had signed a Joint Development Agreement with Dutco, Linde and Marubeni to undertake feasibility studies to assess the development of a 400 MW Green Hydrogen and Green Ammonia production facility (**SalalahH2 Project**) in Oman's Salalah Free Zone. The **SalalahH2 Project** will make use of OQ's existing ammonia production plant at Salalah.

As reported in previous editions of Low Carbon Pulse (see **Editions 18, 20 and 26**), OQ is progressing a Green Hydrogen within the Duqm Special Economic Zone with DEMA (leading Belgian corporation).

- **KAS shortlists bidders on Round 3 of renewables: Edition 14** of Low Carbon Pulse reported on the Round 2 of the National Renewable Energy Program (**NREP**). At the inauguration for the Sakaka IPP on April 8, 2021, Crown Prince Mohammad bin Salman bin Abdulaziz announced the results of the tenders for seven large-scale solar capacity projects under the **NREP**. The seven new projects are to be located in Jeddah, Madinah, Quarayyat, Rafha, Rebigh, Al Shuaiba and Sudair.

The 600 MW Al Shuaiba photovoltaic solar project was awarded on the basis of a world record low bid price for electrical energy of USD 0.0104 kWh (a little over 1 cent per kWh, or USD 10.40 per MWh). The Sudair photovoltaic solar project was awarded with the second lowest bid price of USD 0.01239 (1.239 cents per kWh or USD 12.39 MWh). On development, the Sudair photovoltaic solar project will be **KSA's** largest solar project, comprising around 1.5 GW of installed capacity. Approximately 3.6 GW of energy was contracted under Rounds 1 and 2 of the **NREP**.

On October 18, 2021, it was reported widely that **KAS's Renewable Energy Project Development Office (Repdo)** had shortlisted bidders for Round 3 of the **NREP**, with 1.2 GW to be contracted under Round 3. There are two categories of project in Round 3, Category A and Category B.

Category A projects are the 120 MW Wadi al-Dawasir PV IPP (**WADIPP**) and the 80 MW Layla PV IPP (**LIPP**). It is understood that TotalEnergies and Tamasuk Holding Company and the Acwa Power Consortium (comprising Acwa Power, SPIC (Huamghe Hydropower Development Company) and WEHC (Water and Electric Holding Company)) ranked first and second on **WADIPP** and Acwa Power Consortium and Alfanar ranked first and second on the **LIPP**.

Category B projects are the 700 MW Al-Rass PV IPP (**ARIPP**) and the 300 MW Saad PV IPP (**SIPP**). It is understood that the Acwa Power Consortium and Jinko Power ranked first and second on the **ARIPP** and that Jinko and Masdar ranked first and second on the **SIPP**.

As noted above, the Round 2 of the **NREP** resulted in a world record low bid price. Round 3 of the **NREP** has not resulted in new low bid prices, but the pricing is nevertheless at a level that continues the narrative about low photovoltaic solar costs. It is reported that the levelized cost of electricity (**LCOE**) bids have tariffs at the following: **WADIPP** US cents 1.9 kWh, **LIPP** US cents 3 kWh, **ARIPP** US cents 1.5 kWh and **SIPP** US cents 1.5 kWh.

- **Qatar and Shell look to the UK:** On October 19, 2021, on the sidelines of the UK Global Investment Summit (see section entitled **G20 activity and commitments in the lead up to COP-26** above), Qatar Energy (formerly Qatar Petroleum, the state owned leading international energy corporation) and Shell (leading global international energy corporation) signed an agreement under which they will pursue jointly a Blue Hydrogen and Green Hydrogen project in the UK in which they can invest jointly.

- **KSA targets NZE by 2060:** On October 24, 2021, Crown Prince Bin Salman announced that the **KSA** would reduce its **GHG** emissions to **NZE** by 2060, with a reduction of 278 million metric tonnes per annum (**mpta**) of **GHG** emissions by 2030. The financial capacity of the **KSA** makes the achievement of **NZE** by 2060 a high probability.

For these purposes, the Crown Prince announced that the **KSA** would invest USD 186 billion, join the **Global Methane Pledge** (see **Edition 27** of Low Carbon Pulse), plant 450 million trees by 2030 and rehabilitate 8 million hectares of land. It is estimated that the planting of trees and the rehabilitation of land will reduce the **CO₂** emissions by 200 **mmtpa**. This initiative of itself will make a meaningful contribution to progress towards **NZE**.

- **Saudi Aramco targets NZE by 2050:** On October 24, 2021, the world's largest corporation, Saudi Aramco, announced that it would target the reduction in **GHG** emissions to **NZE** by 2050.
- **Saudi Aramco Future Investment Initiative:** On October 27, 2021, Saudi Aramco announced that it had signed a memorandum of understanding with InterContinental Energy and Modern Industrial Investment Holding Group to develop Green Hydrogen and Green Ammonia production facilities in Saudi Arabia. As readers of Low Carbon Pulse will be aware, InterContinental Energy is involved in large scale renewable electrical energy and Green Hydrogen and Green Ammonia projects in Australia and in the **UAE** (see **Editions 2, 18 and 22**).

- **Clean energy partnership between ADNOC and EWEC:** On October 27, 2021, Abu Dhabi National Oil Company (**ADNOC**) and Emirates Water & Electric Company (**EWEC**) formed a clean energy partnership under which **ADNOC** is to be supplied by **EWEC** with clean energy matching 100% of **ADNOC's** electrical energy load.

EWEC will supply clean energy from nuclear and photovoltaic solar sources to **ADNOC** under an off-take agreement. This establishment of the partnership, underpinned by the off-take agreement, is aligned to achieving **NZE** by 2050.

- **Update on NEOM:** The development of NEOM, the smart city, in Tabuk Province, on the coast bordering the Red Sea is progressing, and it is understood that visitors (including tourists) will be welcome from 2024. Key to the development of NEOM is that it is to be powered by 100% renewable electrical energy, including the use of Green Hydrogen. On October 30, 2021, fuelcellsworks.com provided a helpful update. **Editions 31** of Low Carbon Pulse provide further updates.

India moves to centre stage:

- **India PV solar scalable:** Recent editions of Low Carbon Pulse have outlined the policy settings and the private and public sector investment initiatives in India. On October 7, 2021, pv_magazine, reported on a study from Lappeenranta-Lahti University (often mentioned in Low Carbon Pulse) and Wärtsilä.

The headline from the study is that using an all renewable electrical energy system (with 76% photovoltaic solar), and appropriate levels and location of **BESS**, the cost of electrical energy in India could be reduced by up to 50% by 2050, while at the same time making a major contribution to progress towards **NZE**.

The study (and other publications) tends to feed confidence that, in respect of the development, the renewable electrical energy, progress is likely to be made to achieve **NZE** across the electrical energy sector. This should not be

taken for granted, but it is possible for the optimist to conclude that we will get there. The electrical energy sector is however the easiest part of the global economy to decarbonise. The difficult to decarbonise sectors (including cement, chemical and petrochemical, glass and iron and steel) and the transport sector (aviation, road freight and shipping) remain to be decarbonised.

On October 28, 2021, [pv-magazine](#), noted that India is expected to install 14 GW of photovoltaic solar capacity in calendar year 2021, having installed 8.8 GW of capacity in the first nine months. As noted in previous editions of Low Carbon Pulse, the development and deployment of roof-top photovoltaic solar in India is highly prospective. It would appear that this assessment is being realised with 2 GW of the 8.8 GW installed in the first nine months of 2021 being roof-top photovoltaic solar.

On October 29, 2021, [pv-magazine](#), noted that scientists at the KPR Institute of Engineering and Technology have developed a process to recycle silicon from solar panels at the end of their life-cycle. If the process is scalable, it seems to the author to be a significant shift in process technology.

On October 29, 2021, [pv-magazine](#) reported that tenders have been invited for the development of "advanced-chemistry battery cell manufacturing units in India". The tender is open to applications until December 31, 2021. It is reported that bidders must commit to setting up a minimum of 5 GWh of capacity to qualify for subsidies. [**Note:** As of January 17, 2022, it was reported that there were 10 bidders]

- **India and UK to strengthen Clean Hydrogen Partnership: Edition 19** of Low Carbon Pulse reported that on June 1, 2021, India and the UK had enhanced their existing partnership to provide for cooperation in sharing thinking around policy settings, which in turn will respond to, and drive, technology development and investment as both countries progress to electrified and hydrogen economies, driven by the development of renewable electrical energy. More broadly, and in the context of specific outcomes, the provision and sourcing of sustainable finance will be a key part of electrification and the development of a hydrogen economy, in particular clean energy and clean transport technologies and solutions, and the shift to green and to greened businesses.

On October 11, 2021, [h2-view.com](#), reported that India and the UK intend to build on, or rather refine further, their collaboration, through a Government-to-Government agreement so as to contribute to the acceleration of progress towards the development clean energy capacity.

The Government-to-Government agreement was formalised at a meeting of India's Minister for Power and New & Renewable Energy, Mr Raj Kumar Singh, and UK Energy Secretary, Mr Kwasi Kwarteng on October 8, 2021. It is understood that in the context of **COP-26**, the ministers discussed the launch of the India and UK Government **Global Green Grid – One Sun One World One Grid Initiative**.

The Government-to-Government agreement with the UK follows the announcement from the meeting of the **Quad countries** (US, India, Japan and Australia) in late September 2021 at which it was agreed:

1. to cooperate to allow the development of a green-shipping network, with each country to work with each other country to reduce **GHG** emissions arising from the shipping value chain;
2. to establish a Clean Hydrogen Partnership, including for the purposes of technology development and scaling up of hydrogen production on an efficient basis, with the intention to stimulate demand to accelerate trade in clean hydrogen in the Indo-Pacific region; and
3. to increase the Indo-Pacific region's resilience to climate change.

Republic of Korea (ROK) News:

- **ROK increases NDC: Edition 3** of Low Carbon Pulse reported on the commitment of **ROK** to achieving **NZE** by 2050. Since the commitment to **NZE** made on October 28, 2020, there has been expectation that **ROK** would increase its **NDC** from 26.3% by 2030 compared to 2018.

On October 18, 2021, the **ROK** increased its **NDC** to 40% by 2030 compared to 2018. As with the increased **NDC** to which Japan committed in April 2021, this may be regarded as a challenging target for **ROK**. Nevertheless, it is a target that **ROK** will be able to achieve.

- **Doosan Fuel Cell (DFC) Hydrogen R&D project:** On October 22, 2021, **DFC** agreed with Korea West Power and KEPCO to develop a Pure Biogas (Hydrogen) fuel cell R&D project.
- **Blooming good news:** On October 25, 2021, it was announced that Bloom Energy and SK are to expand their blooming partnership to fortify their market leadership in the use of fuel cell technology to generate electrical energy and to establish leadership in the hydrogen economy. The budding and now growing nature of the relationship between Bloom Energy and SK has been covered in Low Carbon Pulse (see **Editions 4, 17 and 22**).

Leaving the poor puns to one side, the expansion of the partnership is good for each corporation and more broadly – both organisations are at the forefront of early adoption of fuel cell technology and first movers in the development and deployment of it.

It is understood that the arrangements underpinning the expansion include SK contracting for equipment supply and service provision (estimated at USD 4.5 billion), and a further equity investment by SK in Bloom Energy.

See: Bloom Energy's [announcement](#)

- **World's Largest Fuel Cell Power Plant opened:** On October 26, 2021, it was reported widely that Korean Southern Power (**KOSPO**) had opened the new Incheon Bitdream Fuel Cell Power Plant (**Bitdream FCPP**). The **Bitdream FCPP** uses fuel cell technology supplied by POSCO Energy and Doosan Fuel Cell. The **Bitdream FCPP** is reported to have capacity of 78.96 kWh, which output can be used to supply electrical energy to up to 250,000 households and hot water for up to 40,000 households. The opening of **Bitdream FCPP** is further realisation of the use of the power companies to use fuel cell technology (see **Edition 2** of Low Carbon Pulse).

Australia – Weighted Progress:

Background: Edition 28 of Low Carbon Pulse included a piece entitled, *Australia – A Curate's Egg*. This description appears unlikely to be revised any time soon.

- **International Monetary Fund (IMF) clear as to Lucky Country's Promise:**

On October 13, 2021, the **IMF** released its [Word Economic Outlook](#). In addition to the role of Australia as a key producer of iron ore, the **IMF** noted the importance of the cobalt, nickel and lithium resources of Australia for the purposes of the required expansion of resources to supply the global battery industry.

The **IMF** notes that demand for the supply of these key metals and minerals will increase dramatically as the scale of the renewable electrical energy industry increases, and an associated increase for battery storage arises, principally for battery electric vehicles (**BEVs**) and battery electric storage systems (**BESSs**).

By way of background, or as a reminder, the five key metals and minerals in the "battery age" (at least for the time being) are; **1.** aluminium, **2.** copper, **3.** cobalt, **4.** nickel and **5.** lithium.

It is anticipated that demand for: **1.** aluminium will increase to allow "light-weighting" to occur, particularly across the transport sector; **2.** copper will increase, with demand for **BEVs** and grid infrastructure (distribution and transmission) and machinery generally; **3.** cobalt is less certain, with its demand profile dependent on technology development; **4.** nickel will increase, with increased supply of nickel effectively responding to the new demand, and in the context of increased demand for (and therefore use of) nickel, stainless steel production will be the primary driver; and **5.** lithium will increase to satisfy demand for lithium-ion batteries, in particular in the stationary energy sector, critically for **BESSs**.

As noted in **Edition 22** of Low Carbon Pulse (in a feature on Form Energy), iron (using iron-air technology) could soon be joining these five metals as key metals in the "battery age". If this potential is realised, Australia will continue its role, and even enhance its role, as a key source of metals and minerals as raw materials to support progress towards the achievement of **NZE**.

- **Scrutiny of Australia:**

In **Edition 28** of Low Carbon Pulse, it was reported that the Federal Government of Australia had yet to commit to meaningful **GHG** emission targets or to **NZE** by 2050. As a result, for some time, the Federal Government of Australia has been under scrutiny by the international community and its own citizens: at once both the lucky country and the recalcitrant country, a country that could lead but a country that chooses not to do so.

On October 26, 2021, the Federal Government of Australia committed to achieving **NZE** by 2050. This commitment was not accompanied by meaningful **GHG** emissions targets on route to **NZE**. The approach manifest in the commitment to **NZE** by 2050 is consistent with the "technology versus carbon tax" debate that the Federal Government of Australia has been sharing in support of the approach that it has been taking (see the section above entitled **A price on carbon**).

The commitment to **NZE** has been criticised from all sides. For those in favour of the commitment to **NZE**, the means of achieving **NZE** has been described as more "prayer than policy" due a lack of meaningful commitments to **GHG** emission reductions before 2030, and an absence of a staged pathway to achieving **NZE** by 2050. For those not in favour the commitment to **NZE**, the criticism is best described as variable, and none of it capable of withstanding reasoned scrutiny.

- **States and Territories continue to make progress:**

- **Queensland:**

On October 13, 2021, Premier Anastacia Palaszczuk committed her State of Queensland to progressing to **NZE** by 2050. This commitment followed a vote the Queensland Parliament on October 12, 2021. This commitment came in a week packed full of announcements about the development of the Green Hydrogen industry across Queensland.

- **South Australia:**

During the week beginning October 25, 2021, the State of South Australia, continued its progress towards becoming a 100% renewable electrical energy State. The State Government of South Australia is committed to achieving net 100% renewables by 2030. The events of the last week tend to indicate that the State of South Australia will achieve this target as early as 2025 at the current rate of progress.

On October 25, 2021, ElectraNet announced the installation of four synchronous condensers (in effect acting as spinning reserve). The installation of the synchronous condensers means that the restrictions on the dispatch of renewable electrical energy across the ElectraNet grid are not as stringent as previously under certain conditions: the restrictions providing a limit to the dispatch of variable renewable electrical energy sources to the grid so as to be assured of continued integrity and stability.

As reported in previous editions of Low Carbon Pulse, the State of South Australia has been a stellar performer, but during the last week it has eclipsed previous achievements with photovoltaic solar and wind reaching 81% at the start of the week, and 85% over three days of the last part of the week.

- **Victoria:**

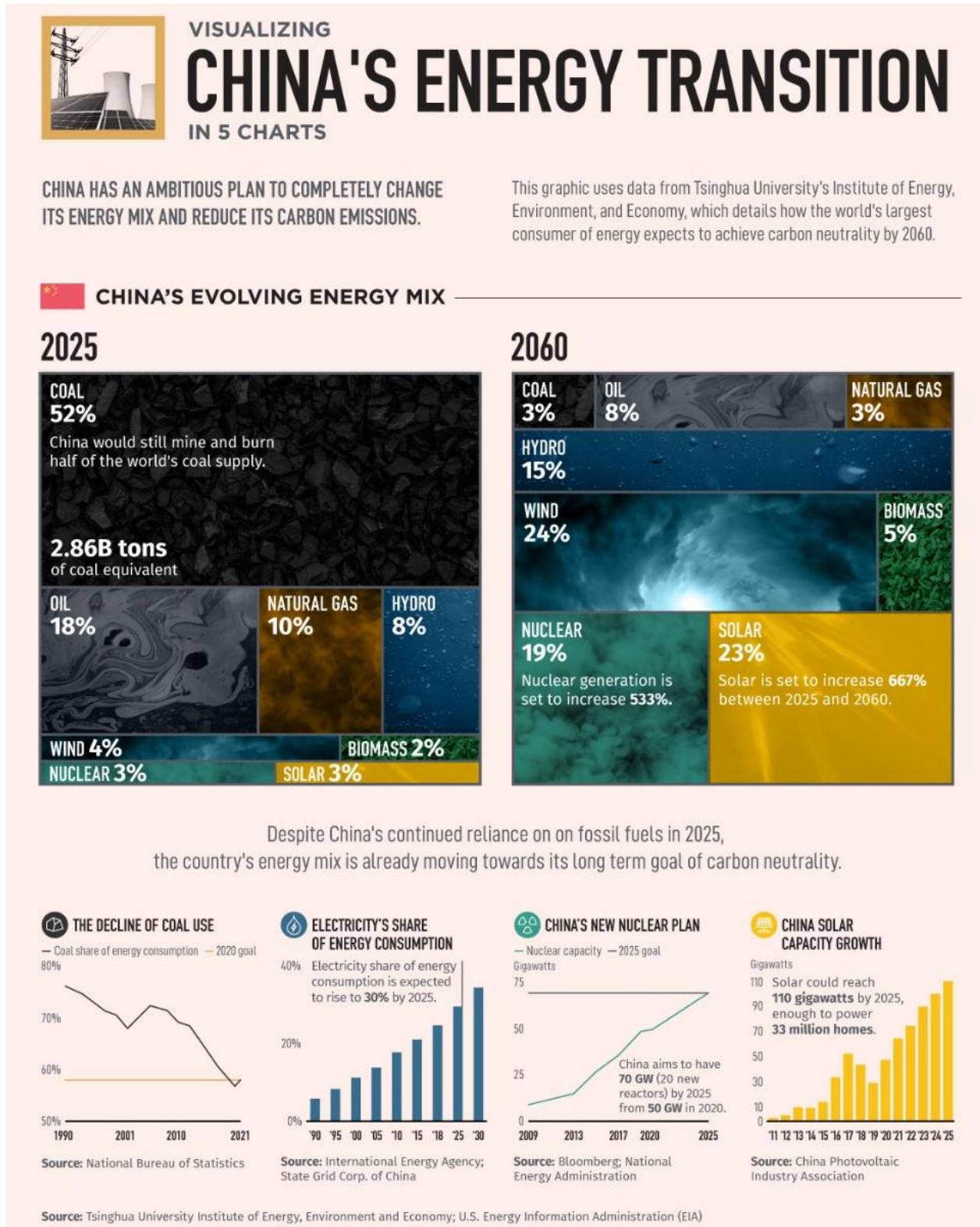
On October 29, 2021, the State of Victoria reported that it achieved a 25% reduction in **GHG** emissions compared to 2005, between 2005 and 2019. The State Government of Victoria has delivered on its pledge to reduce **GHG** emissions by 20% by 2020 (in fact it is has exceeded it), and is well on the way to delivering on its pledges to reduce **GHG** emissions by between 28% to 33% by 2025, and to between 45% to 50% by 2030.

As has been noted previously in Low Carbon Pulse, the eight States and Territories of Australia are both ambitious and progressive in reducing **GHG** emissions and progress towards achieving **NZE**. The ambition and that progressiveness are not static.

- **Australia's hydrogen opportunity: Edition 28** reported on the publication by the Australian Hydrogen Council of its [Unlocking Australia's hydrogen opportunity](#). On October 29, 2021, a Wood Mackenzie [publication](#) outlined further the scale of the opportunity for Australia.

PRC continues to lead the way:

- **PRC energy mix visualised:** Previous editions of Low Carbon Pulse have covered the policy settings for energy transition in **PRC**. On October 10, 2021, the visualcapitalist.com, published five graphics that allow the viewer to visualise the transition from now to 2060 (the year by which the **PRC** has committed to achieve **NZE**).



- **President Xi at the helm:** On October 12, 2021, President Xi Jinping made a [speech](#) to the fifteenth conference of the parties to the Convention of Biological Diversity (**COP-15**). President Xi confirmed the commitment of the **PRC** to achieve peaking of **GHG** emissions by 2030, and **NZE** by 2060. (**Edition 32** of Low Carbon Pulse reports on the first part of **COP-15**, with the second part of **COP-15** to take place in 2022.)

To deliver on these commitments, President Xi said that it would be necessary to introduce policy settings (named "*I+n*") to achieve peaking of **GHG** emissions and then **NZE**. For these purposes, President Xi noted the need to increase the installation of photovoltaic solar and wind in desert areas of the **PRC**.

This is not new (having been noted in **Edition 21** of Low Carbon Pulse, and confirmed in the next piece), but it may be regarded as further demonstration of the commitment of the **PRC** to mobilise sufficient renewable energy resources to achieve peaking and **NZE**, and consistent with the prospect of use of High Voltage Direct Current (**HVDC**) cables to deliver renewable electrical energy. A consistent theme noted by Low Carbon Pulse.

- **PRC continues development of renewables:** On October 29, 2021, it was reported widely that the **PRC's** National Development and Reform Commission (**NDRC**) confirmed that the development of a number of renewable electrical energy projects was proceeding across a number of provinces in the north and north-west of the **PRC**: **1.** Gansu (12.85 GW), **2.** Inner Mongolia (2 GW of photovoltaic solar), **3.** Ningxia, **4.** Qinghai (10.9 GW), **5.** Shaanxi (2 GW), and **6.** Xinjiang (GW).

Once completed, the projects will have combined installed capacity in the region of 30 GW. It is understood that ultra-high voltage connection will be used for the purposes of transmission from generation to load, with some projects to deploy hydrogen energy storage systems (**HESS**).

Bio-energy (including BECCS and BECCUS) update:

- **Background:** As noted in previous editions of Low Carbon Pulse (and touched on above, under **A role for Government in the development of Bioenergy**), **bio-energy** is energy derived or produced from biomass, whether that energy is in gaseous, liquid or solid form. **Bio-energy** is derived from organic matter, not fossilised organic matter.

Note: For the production of **bio-energy** to be carbon-neutral, it must be combined with **BECCS** or **BECCUS**. For **BECCS** / **BECCUS** to make a contribution to a reduction in **GHG** emissions, it must displace another electrical energy source or energy carrier source, and, in any event, it must result in a carbon neutral outcome (rather than a carbon removal outcome) so as not to give rise to an increase in **GHG** emissions.

- **CCUS Development Pathway for the EfW Sector:** On October 5, 2021, a report entitled [CCUS Development Pathway for the EfW Sector](#), produced by Eunomia Research & Consulting, commissioned by waste company, Viridor, notes the ability of the EfW sector to help underpin the continued development of the CCS / CCUS sector in the UK, effectively **BECCS** and **BECCUS**.
- **Repsol, Blue and Green Initiatives:** On October 7, 2021, [rechargenews.com](#), Repsol (world leading oil and gas corporation, head-quartered in Spain) announced plans to develop 200 MW of biogas / biomethane steam reforming capacity (to derive hydrogen from biomass itself derived from biomass) to produce Blue Hydrogen, and 350 MW of electrolyser capacity, powered by renewable electrical energy from 1.8 GW of photovoltaic solar and wind, to produce Green Hydrogen.

It is anticipated that this clean hydrogen capacity will be developed by 2025, with around USD 1.5 billion earmarked for these hydrogen production capacity development initiatives alone.

On October 18, 2021, [the-eic.com](#), reported that this was part of broader initiatives involving the development of 20 GW of renewable electrical energy by 2030, and an investment of €2.5 billion to develop a hydrogen chain by 2030, as part of its renewable hydrogen strategy, with 550 MW to be developed and deployed by 2025 (200 MW of Blue Hydrogen and 350 of Green Hydrogen capacity, as noted above).

See: [Repsol will invest €2.549 billion to boost renewable hydrogen](#)

- **Bio-energy projects:**
 - **Haldor Topsoe demonstration plant:** On October 17, 2021, [biofueldigest.com](#), reported that Haldor Topsoe (leading technology provider, including electrolyzers and its eSMR technology) has commenced operation of a demonstration plant that derives methanol from biogas (a combination of **CO₂** and **CH₄** for the most part, derived from biomass). It is stated that the plant produces sustainable methanol, and has the capacity to produce 10,000 litres of **CO₂** neutral methanol.
 - **Yosemite Clean Energy – Dawn:** On October 29, 2021, it was reported widely, that a site had been secured by CHBC (a member of Yosemite Clean Energy) to develop a carbon-negative renewable hydrogen and renewable natural gas (**RNG**) production facilities in Oroville, California.
As reported, 31,000 kgs (31 metric tonnes) a day of **RNG** and 12,200 kgs (12 metric tonnes) a day of renewable hydrogen will be produced.

- **Carbon neutrality - complete picture:** A [rechargenews.com](#) article notes that:
*"Because biomethane is produced from plant matter that absorbed **CO₂** from the air as it grew, the gas which is produced in large tanks known as anaerobic digesters – it is said to be carbon neutral when burned or cracked".*

As readers of Low Carbon Pulse will know, this is not incorrect, but it is important to add that **CO₂** and **CH₄** arises from the production of biogas / biomethane, and from the production of hydrogen from it, and that **CO₂** and **CH₄** needs to be captured. Of course, the hydrogen gives rise to no **GHG** emissions at the point of use other than water vapour which, while is a **GHG** emission, does not remain in the atmosphere in the same way that **CO₂** and **CH₄** (and other **GHGs**) do.

The purpose of repeating these dynamics is to ensure that it is understood that the use of bio-energy as an integral part of progress to achieving **NZE** is about effective collection systems for bio-energy feedstocks (all of which are carbon intensive), the capture and storage of **CO₂** arising from the use of those feedstocks to produce bio-energy and bio-fuels, and ensuring, through monitoring and verification, that the **CO₂** arising on use of bio-energy / bio-fuels is absorbed by renewable biomass growth.

This is the basis of achieving carbon-neutrality in fact, rather than in concept.

There are many sources of biomass. One of the most fertile grounds is waste arising from the growth of crops, the rearing of livestock, waste arising in the food supply chain (from field to fork) and waste and waste water.

Blue Carbon

- **Back to the future:** Continuing a narrative and a theme (commenced in previous editions of Low Carbon Pulse, added to above under **A role for Government in decarbonising AFOLU**), one of the means of achieving negative **GHG** emissions is through the development of new growth, or the regeneration / restoration, of mangrove swamps and the restoration of wetlands generally (being a generic phrase that includes mangrove swamps, estuaries, and mud-flats), in particular in the tropical areas of the world.

Certain countries have ideal climates and coastlines to develop carbon sinks to sequester carbon. It is estimated that, since 1900, a little over 50% of the global coasted wetlands have been removed.

In addition to the negative **GHG** emission benefits, the restoration of wetlands will provide protection against storm damage as noted in a recent [report](#) from James Cook University, which considers land use in 71 countries having wetlands in the path of storms.

As such, there are two benefits of the new growth and regeneration / restoration: first, the chemical absorption of **CO₂** and, secondly, the physical absorption of the impact of storms (and as such, adaptation to climate change, aligned with Article 2.1(b) of the Paris Agreement).

- **Increasing awareness to be matched by action:** In the context of the development of markets for carbon credits (in particular **Voluntary Carbon Markets** or **VCMS**), discussion around Article 6 of the Paris Agreement has become more pressing.

There is a great opportunity for certain countries, in particular those in the tropical regions of the world, to add to the global carbon budget by the development of new growth and the regeneration / restoration carbon sinks. While this discussion relates to both **Blue Carbon** and **Green Carbon**, it is included here for convenience.

To do this effectively, i.e., in a manner that results in the issue of high-quality carbon credits from the sale of which those countries realise appropriate value, the focus of the discussion around Article 6 and the **Paris Rulebook** needs to be on the assessment of existing carbon sinks and new growth or regeneration / restoration carbon sinks, and accounting and accountability, and the funding of the **three A's (assessment, accounting and accountability)** by developed countries and policy banks.

As noted above, in respect of the [UNFCCC NDC Synthesis Report](#), a **Catastrophic Pathway** awaits unless the rate of **GHG** emission is slowed, reduced and balanced. A key means to slowing, reducing and balancing is the use of carbon credits and allowing their use to off-set **GHG** emission obligations.

In an [article](#) published in October 29, 2021, the Independent Commodity Intelligence Services (**ICIS**) outline the current dynamics surrounding Article 6 of the Paris Agreement and the **VCM**. The article is well-worth a read – it is balanced and clear.

Deep Blue Thinking: On October 27, 2021, [SciTech Daily](#), reported (under [Marine Carbon Sequestration: New Research Delves Into Fate of Ocean Carbon](#)), on new research undertaken by the oft mentioned Lawrence Livermore National Laboratory (**LLNL**), with the work published in the [Proceedings of the National Academy of Sciences](#).

Edition 27 of Low Carbon Pulse reported on a [study](#) from **CSIRO** (Commonwealth [of Australia] Scientific and Industrial Research Organisation) which found that up to 80% of the 715 million tonnes of **CO₂** released to the climate system from Australian bush fires over the southern hemisphere summer 2019/2020 has been absorbed by ocean algal blooms in the Pacific Ocean.

The **LLNL** research builds on concepts arising from **CSIRO** findings. Both studies recognise that algae and plankton are one of the many natural carbon sinks in the **Blue Carbon** setting, and that understanding them is critical.

BESS and HESS -Scale of BESS by 2030:

As renewable electrical energy is developed and deployed, **BESS** (and **HESS**) will be required to ensure that renewable electrical energy is stored to allow dispatch of electrical energy from storage to maintain grid integrity and stability, and to provide electrical energy as the variable nature of renewable electrical energy dispatch necessitates dispatch from **BESS** to match load.

As the scale of development and deployment of renewable electrical energy becomes clearer, so does the scale of the development and deployment of **BESS** (and **HESS**). The analysts at Wood Mackenzie have been assessing and quantifying how much **BESS** may be required.

In Wood Mackenzie's [Global Energy Storage Outlook](#) (published on October 7, 2021), it is estimated that up to 1 TWh of storage may be required.

This assessment is underpinned by reasonably consistent assessments that during 2021, around 12 GW of **BESS** will be installed globally, and an anticipated acceleration of development and deployment of **BESS**, including, in the near term, acceleration in the **PRC**.

The question to which an answer has yet to be firmed is the extent to which **BESS** will be utility, sometimes referred to as in-front of the meter, and off-grid (including to store from roof-top photovoltaic solar), more often than not referred to as behind the meter.

CCS / CCUS and difficult to decarbonize round-up:

- **Norway CCS Potential:** On October 5, 2021, the Director General of the Petroleum Directorate, Ms Ingrid Solvberg, indicated that the continental shelf of Norway had the capacity (in theory at least) to store 1,000 years of **GHG** emissions arising from Norway. As part of the operation of natural gas fields, the two largest two CCS projects, at Sleipner and Snøhvit, are operated in Norway.

Edition 27 of Low Carbon Pulse reported on the application process currently underway for two CCS sites on the continental shelf of Norway. The deadline for the submission of applications is December 9, 2021. As noted in previous editions of Low Carbon Pulse, the continental shelf of Norway is the location of the Equinor, Shell and TotalEnergies **Northern Lights** project (as part of the Longship Project), and the proposed location of CCU for the **CO₂** arising from the **Barents Blue** (Blue Ammonia) project (see **Edition 27** of Low Carbon Pulse).

- Another Oak to Acorn:** Previous editions of Low Carbon Pulse have covered the progress being made by the **Acorn Project**, and its importance to the Scottish Cluster (see **Editions 14, 16, 17, 21** and **22**).

Edition 21 of Low Carbon Pulse noted that the **Acorn Project** was contracting with a number of corporations for the provision of carbon storage services. **Edition 21** of Low Carbon Pulse reported ExxonMobil, Royal Dutch Shell and North Stream Midstream Partners (**NSMP**, owned jointly by the Kuwait Investment Authority and JPMorgan Infrastructure Fund) had signed provisional deals (under memorandums of understanding) with the **Acorn Project**. The underlying business case for the **Acorn Project** is that **CO₂** captured from natural gas processing terminals at St Fergus, Peterhead (and Grangemouth) will be stored by it. The provisional deals with ExxonMobil and Shell are in respect of their terminal and in respect of the **NSMP** owned terminal (with **NSMP** also the owner of the main feeder lines to it).

On October 6, 2021, ExxonMobil announced that it had signed an expression of interest to study the storage of **CO₂** from its Fife Ethylene Plant. The progression to expression of interest in respect of the Fife Ethylene Plant may be regarded as further stride for the **Acorn Project**.

On October 12, 2021, it was reported widely that the **Acorn Project** had agreed to provide carbon storage services in respect of **CO₂** captured at a new Blue Hydrogen facility in the Thames Estuary (**Project Cavendish**), and then transported, using a **CO₂** carrier, from the Thomas Estuary to Peterhead Port (owned and operated by the Peterhead Port Authority), and then on to the **Acorn Project**.

As noted in previous editions of Low Carbon Pulse, the **Acorn Project** is the key element of the **Scottish Cluster** – see **Edition 23** of Low Carbon Pulse. **Project Cavendish** is likewise covered in **Edition 23** of Low Carbon Pulse.

For Storegga Geotechnologies, this is another step in progress towards the realisation of its landmark, market defining, CCS project. CEO of Storegga, Mr Nick Cooper, noted that the signing of a memorandum of agreement with Project Cavendish and the Peterhead Port Authority, "*demonstrates how the Scottish Cluster can decarbonise not only Scottish emitters but those throughout the UK and Europe*".

As noted below, the UK Government selected the **East Coast Cluster** (comprising Net Zero Teesside and Zero Carbon Humber) and **HyNet North West** as the two CCS projects that were to receive government support in the **Track 1 CCS Programme** (see **Edition 23** of Low Carbon Pulse): the policy setting provided for the selection of two CCS projects (as outlined in **Edition 23**).

Notwithstanding the decision of the UK Government in respect of the CCS projects is to receive Track 1 government support, it is understood that the Scottish Cluster, with the **Acorn Project** at its core, will continue to progress, and has the status of "reserve cluster".
- Woodmac on CCS:** In **Edition 28** of Low Carbon Pulse, it was reported that Wood Mackenzie provided an update on the cost of CCS in an opinion piece entitled [*Carbon capture and storage: how far can costs fall?*](#) which provides access to the proprietary report.

Having re-read the Wood Mackenzie piece for the **September Report on Reports**, the author commends the piece to all readers again. As reported in previous editions of Low Carbon Pulse, Wood Mackenzie's view is that between 4 and 6 Gtpa of **CO₂** needs to be captured and stored for these purposes. For the potential of CCS / CCUS to be realised, it is important to realise its potential! Up to 30% of the required reduction in **GHG** emissions could be achieved by effective CCS / CCUS.
- Equinor plans to invest USD 12 billion:** On October 10, 2021, it was reported widely that Equinor (global leading international energy company) intends to invest up to USD 12 billion in the production of Blue Hydrogen using CCS technology. Equinor intends to use natural gas as the feedstock for the production of Blue Hydrogen.

As noted in previous editions of Low Carbon Pulse (and as noted in this **Edition 29**), natural gas gives rise to fugitive **GHG** emissions, and on its use to produce Blue Hydrogen, gives rise to **CO₂** which needs to be captured and stored. As noted above, if **CO₂** is not captured, the production of hydrogen using natural gas as the feedstock gives rise to around 10 metric tonnes of **CO₂** for each 1 metric tonne of hydrogen produced. While this is a rule of thumb, it is a helpful rule of thumb. Given that Equinor is aiming to have a 10% share of the global hydrogen market by 2030, this is going to equate to avoidance of **CH₄** fugitive emissions and capture and storage of significant mass of **CO₂**.
- Carbon Storage Licence granted to Harbour Energy:** On October 10, 2021, the Oil and Gas Authority in the UK granted a carbon storage licence (**CSL**) to Harbour Energy (**HE**). The **CSL** will cover an area in the southern North Sea 140 km off the coast of Immingham, Lincolnshire. **HE** proposes to store **CO₂** in the depleted Rotliegend gas fields, Victor and Viking (the **V Net Zero Project**).

The geological formations in which the **CO₂** will be stored are around 2,743 metres (9,000 ft) below the sea-bed of the North Sea. **CO₂** to be injected into the **V Net Zero Project** will be transported using the existing pipeline to the Victor / Viking fields. A new pipeline will transport **CO₂** from the point source of capture to the on-shore connection point on the existing pipeline, for transportation into storage.
- Repsol outlines the Sakakemang CCS project:** On October 13, 2021, Repsol outlined its plan to develop a CCS project as part of the Sakakemang natural gas development project, off the coast of Sumatra, Indonesia.

It is understood that the CCS project will store up to 2 million metric tonnes per annum (**mmtpa**). As understood, the CCS project will involve the use of the depleted Gelam and Dayung natural gas fields to effect enhanced gas recovery from the Sakakemang project.
- Decarbonisation of cement and concrete production globally:**

 - More progress towards NZE:** **Edition 28** of Low Carbon Pulse reported that Hansen Cement had produced clinker using a 100% net zero mix of heat-temperature fuels in its cement kiln.

Also **Edition 28** of Low Carbon Pulse reported that Governor of California, Mr Gavin Newsom, signed SB 596 which mandates the reduction of carbon emissions per ton of cement produced by 40% by 2035, compared to 2019.

In addition, the California Air Resources Board is to develop a **NZE** strategy to decarbonise the production of cement completely by 2050.

On October 12, 2021, global cement and concrete makers outlined steps to reduce **CO₂** emissions by "an additional 25%" by 2030, and to progress to **NZE** by 2050; conservatively a reduction of this magnitude would result in a 5 giga-tonne (i.e., 5 billion metric tonnes) reduction in **CO₂** emissions assuming a linear rate of reduction.

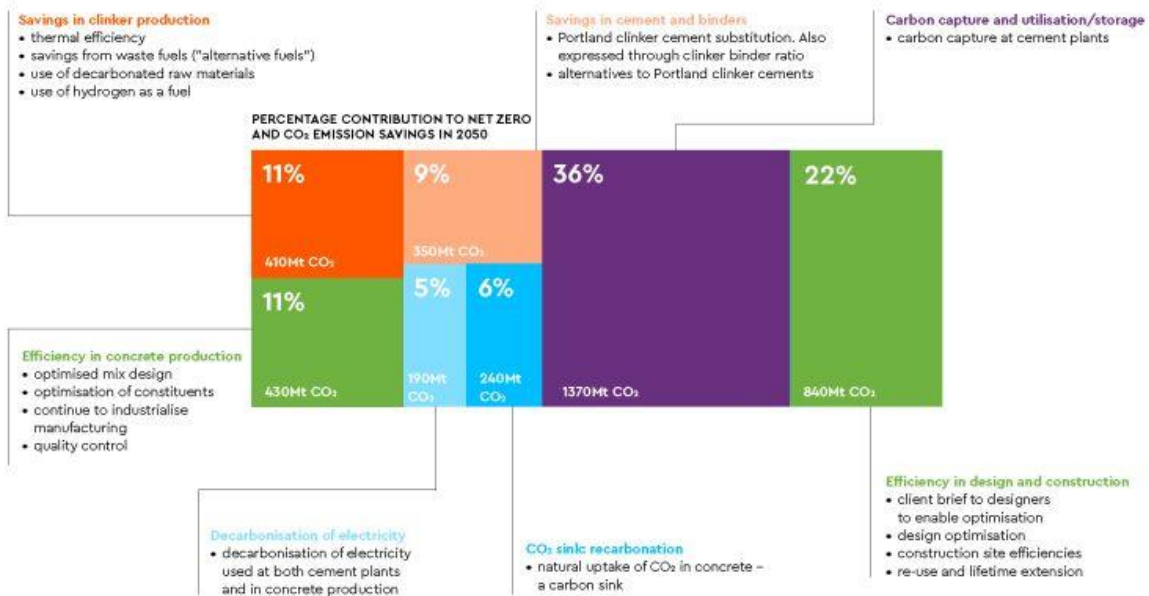
It is reported that the cement and concrete industry will transition to carbon-free technologies for the high-heat temperatures required to produce clinker, carbon capture to capture the **CO₂** arising on the use of limestone to produce clinker, and new chemistry and manufacturing technology.

- **Background to the need to achieve NZE:** The [second article](#) in the **Shift to Hydrogen (S2H2)** series provides details on the mass of **GHG** arising from the production of cement and concrete globally. **Edition 28** of Low Carbon Pulse noted that the cement production industry needed to decarbonise the production of clinker as the process of producing clinker releases **CO₂**.

Decarbonisation of the production of clinker can be achieved by the use of high-heat temperature non-fossil fuels and the capture of **CO₂** arising naturally from the limestone used to produce the clinker.

- **Further background:** **CO₂** arises from the production of clinker as follows: **CO₂** arises from both the use of fossil fuels or other carbon intensive fuels and the production of clinker from limestone, i.e., calcium carbonate (**CaCO₃**): for every molecule of **CaCO₃** used to produce cement, one molecule of **CO₂** arises: stated another way, for each metric tonne of cement produced, one tonne of **CO₂** emissions arise. As such cement requires both a reduction in carbon intensive fuels and the capture of **CO₂** to decarbonise.
- **Concrete Future:** The graphic below is the best summary that the author has seen of explaining the anatomy of what is required to achieve **NZE** across the cement and concrete industry.

ACTIONS TO A NET ZERO FUTURE



- **Concrete Present:** The Global Cement and Concrete Association estimates that around 14 billion m³ of concrete is poured to cast each year (1 m³ of concrete has a mass of approximately 2.41 metric tonnes). The mass of cement produced and concrete poured to case is going to increase as urbanisation increases globally.

The production of cement alone give rise to between 7% and 8% of **GHG** emissions. As noted above, one metric tonne of cement gives rise to one metric tonne of **CO₂**.

- **Track 1 outcomes announced:** **Edition 23** of Low Carbon Pulse outlined the industrial carbon clusters and hydrogen hubs around the UK which are in the process of being developed, and a number of them awaiting the outcome of applications for government support in **Track 1** of the **CCUS Programme**.

The **CCUS Programme** is consistent with key outcomes in the [Ten Point Plan for a Green Industrial Revolution \(10 Point Plan\)](#).

On July 30, 2021, the UK Government announced five eligible projects for its **CCUS** (cluster sequencing) **Programme**, detailed below:

- **DelpHYnus Project:** a combined development from Neptune Energy to capture, haul and store **CO₂** from the South Humber Industrial area and the production of Blue Hydrogen at the site of the former Theddlethorpe Gas Terminal, with **CO₂** arising on production of Blue Hydrogen being captured, hauled and stored;

- **East Coast Cluster:** a combination of the Equinor led **Zero Carbon Humber**, the BP led **Net Zero Teesside** projects, and the Northern Endurance Partnership (**NEP**). The **NEP** founding members comprise BP, Eni, Equinor, National Grid, Shell and TotalEnergies;
- **HyNet North West:** a combination of clean hydrogen production (up to 3.8 GW by 2030, or 80% of the 5 GW target in the **10 Point Plan**), and CCS, with storage in the Eni UK depleted gas field in Liverpool Bay. The clean hydrogen production would be phased in as follows: 350 MW 2025, 1 GW 2026, and 3.8 GW 2030;
- **Scottish Cluster:** while the **Acorn Project** is key, the sources of **CO₂**, being ten (including from Grangemouth, Peterhead and, latterly, the Isle of Grain), with eight anticipated to have capture capacity in place by 2027; and
- **VNZ Cluster:** Harbour Energy is the sole developer of the Viking Net Zero (**VNZ**) concept, developing the depleted Viking Field sourcing **CO₂** from the Immingham (including from EPUKI, Phillips 66, PRAX, and VPI) – see section entitled **CCS / CCUS and difficult to decarbonize round-up** above.

On October 19, 2021, the UK Government announced the results of applications for government support in **Track 1** of the **CCUS Programme**. The **East Coast Cluster** and the **HyNet North West** projects were selected for government support. The Scottish Cluster was selected as a "reserve cluster". It is clear that the quality of each of the five eligible projects was very high. Had all five eligible projects proceeded, they would have provided production capacity for up to 9.7 GW of low-carbon hydrogen by 2030, 4.7 GW more than the 5 GW contemplated in the **Ten Point Plan**.

(From earlier communications, the announcement had been expected on October 25, 2021.)

Shortly after announcing the outcome of **Track 1** of the **CCUS Programme**, the UK Department for Business, Energy and Industrial Strategy [announced](#) new investment in the Net Zero Strategy, noting in the period since the announcement of the **Ten Point Plan** (see **Edition 4** of Low Carbon Pulse), the UK Government has "*mobilised GBP 26 billion of government capital investment for the green industrial revolution*".

- **ExxonMobil CCS Hub in WY:** On October 21, 2021, [Natural Gas World](#) reported the Exxon Mobil Corporation (leading global international energy corporation) is to expand its CCS capacity at the LaBarge natural gas field in Wyoming. It is understood that the expansion will increase CCS capacity by 1 million metric tonnes per annum (**mmtpa**) of **CO₂**. The LaBarge field is known for its high level of **CO₂** at about 65%, with 21% **CH₄**, 7% **N** and 5% **H₂S** and 0.6% **He**.

- **ExxonMobil CCS Hubs in SEA:** On October 25, 2021, [Channel News Asia](#), reported that ExxonMobil Corporation (leading global international energy corporation) is considering the development of CCS Hubs in South East Asia (**SEA**). **Edition 27** of Low Carbon Pulse reported on the plans of ExxonMobil Corporation to develop a CCS Hub in the Gulf of Mexico to store up to 50 million metric tonnes per annum (**mmtpa**) of **CO₂**.

It is understood that ExxonMobil is "*studying the concept of placing **CO₂** capture hubs in some of Asia's heavy industrial areas such here in Singapore and then connecting them to **CO₂** storage locations elsewhere in the region*".

While this concept is not new, the fact that ExxonMobil is considering the concept is encouraging: there is no organisation as expert at assessing the capacity of depleted fields.

Editions 20 and **21** of Low Carbon Pulse reported that Singapore does not have suitable sub-surface structures (under land or sea) suitable to allow use for CCS, and as such the ExxonMobil study is aligned with these findings.

- **From Greening Smelters to formation of carbonates:** **Editions 20, 21** and **26** of Low Carbon Pulse have reported on initiatives of Rio Tinto to green its smelters. On October 20, 2021, Rio Tinto announced plans to invest in the development and deployment of up to 5 GW of photovoltaic solar and wind capacity to provide renewable electrical energy for its Boyne Island and Tomago smelters.

In addition, Rio Tinto has announced that it will develop and deploy a further 1 GW of renewable capacity to provide electrical energy for its iron ore mines in the Pilbara region of Western Australia. The development and deployment of renewable energy is part of the commitment of Rio Tinto to reduce its **GHG** emissions by 15% by 2025, and 50% by 2030. The accompanying price tag of achieving this reduction is estimated to be AUD 7.5 billion, and is stated to focus on the decarbonisation of its aluminium and iron ore divisions.

On October 27, 2021, Rio Tinto announced that it had signed a memorandum of understanding with Carbix, under which Carbix is to use land surrounding Rio Tinto's ISAL smelter in Straumsvik, Iceland, to store carbon captured from industrial facilities and plants around Europe.

The carbon captured will be liquified at the point source of capture, and transported by vessel to the Coda Terminal, Iceland, with the **CO₂** to be re-gasified at the Coda Terminal, and dissolved into water (creating carbonated water). The carbonated water is to be injected into rocks underground. On injection into the rocks, the rocks will release cations (being an ion (atom or atoms) with a positive charge), including calcium, iron and magnesium. These elements combine with the **CO₂** dissolved in the carbonated water to produce carbonates that are stored within rock. The carbonates are stable, and this process can be regarded as storing **CO₂** permanently.

CO₂ use and transportation:

- **CO₂ liquefaction:** On October 8, 2021, Hz-Inova (**HZI**) announced that it has contracted with **CO₂ Energie AG** to develop a plant to separate and to liquefy **CO₂** from an existing biogas facility. The biogas (and biomethane) is derived from biomass processed at a digestion facility (presumably using anaerobic digestion technology). The capture and the liquefaction of the **CO₂** will allow the **CO₂** to be transported and used or possibly stored.
- **CO₂ carriers:** On October 10, 2021, it was announced that the Northern Lights Joint Venture has awarded contracts for the construction of two dedicated **CO₂** carriers. The construction contract has been awarded to Dalian Shipbuilding Industry Co., Ltd (located in Dalian, Liaoning province, the **PRC**.)

Each **CO₂** carrier has 7,500 m³ of containment capacity (to carry liquefied **CO₂** under pressure), with delivery scheduled for mid-2024. The **CO₂** carriers are to be Norwegian flagged, and classified by leading international classification society, DNV.

The procurement of the two **CO₂** carriers represents further progress in the realisation of the Northern Lights Project (as part of the Longship Project) reported on in previous editions of Low Carbon Pulse (see **Editions 2, 3, 11, 16, 17, 19** and **20**).

- **Captured CO₂ as feedstock for methanol:** The use of captured **CO₂** to produce methanol (**CH₃OH**) is being undertaken. The use of **CO₂** to produce **CH₃OH** will give rise to clean or e-methanol if renewable electrical energy is used to provide the electrical energy required to produce methanol. The production of methanol using **CO₂** involves the use of electrical energy to combine **CO₂** with **H₂** to produce **CH₃OH**.

As noted in previous editions of Low Carbon Pulse, the combustion of methanol will give rise to **CO₂**, and as such it is not a no / non carbon fuel. If however the **CO₂** is captured from the processing of biomass (for example on bio-fuel production, using **BECCS** or **BECCUS**), in theory at least, if biomass is grown that will absorb and equivalent mass of **CO₂**, that bio-methanol may be characterised as carbon neutral.

E-Fuels / Future Fuels / Now Fuels:

- **JERA continues to make progress:**

- **JERA and Yara joined by Idemitsu Kosan:** **Edition 17** of Low Carbon Pulse (under **Yara and JERA leading the way from WA to Tokyo Bay**) reported on the signature of a memorandum of understanding between JERA Co, Inc or **JERA** (the largest power generation company in Japan, being a joint venture between Tokyo Electric Power and Chubu Electric Power) and Yara International ASA (world leader in ammonia production) to work together in the production and delivery of, and supply chain development, for Blue Hydrogen and Green Hydrogen.

On October 5, 2021, it was reported widely that **JERA**, Yara and Idemitsu Kosan had signed a memorandum of understanding (**MOU**) to explore the establishment of a domestic distribution network for ammonia from Idemitsu Kosan's Tokuyama Complex, the establishment of a bunkering business at the Tokuyama Complex and the optimisation of the use of ammonia. Given the parties to the **MOU**, it may be expected that it will result in the development of discussion around the production and use of fertiliser for the agriculture sector, and ammonia for the power sector, using the refining capacity and existing infrastructure and refining capacity of Idemitsu.

As has been reported in earlier editions of Low Carbon Pulse, **JERA** is at the forefront of the use of ammonia to transition to "zero-emission thermal power plants".

- **IHI and JERA co-firing:** In addition to the Yara / JERA news, **Edition 18** of Low Carbon Pulse reported (under **IHI and JERA granted means to commence co-firing**) that IHI Corporation (**IHI**) and **JERA** had received notice of acceptance of their joint grant application to undertake a demonstration project to co-fire ammonia in the generation of thermal power using Units 4 and 5 of **JERA's** 1 GW Hekinan Thermal Power Station.

On October 6, 2021, it was reported widely that **IHI** and **JERA** had commenced co-firing of coal and ammonia at the Hekinan Thermal Power Station. The commencement of co-firing is part of a program (scheduled to complete in March 2025), with the objective of co-firing ammonia (20%) and coal (80%). As noted in **Edition 17** of Low Carbon Pulse, Unit 5 is being used to develop the co-firing burner, with Unit 4 to be used as the co-firing burner is scaled up.

- **JERA opens office in UAE:** Reflecting on activity in **GCC** countries, **JERA** is opening an office in the **UAE**. This is significant because **JERA** is the largest electrical energy generator in Japan, and it is an early adopter of hydrogen-based fuels, including in its blending of ammonia for use in thermal power stations.

It is to be expected that **JERA** will procure Blue Hydrogen and Blue Ammonia in the near term, and Green Hydrogen and Green Ammonia in the medium to longer term.

- **See: JERA** announcements [here](#), [here](#) and [here](#).

- **Austria production and storage = HESS:** On October 5, 2021, it was reported widely that ADX Energy and Windkraft Simonsfeld had agreed to develop Green Hydrogen production and storage facilities to be located in the Northern Vienna basin. The Green Hydrogen will be produced using a proton exchange membrane (**PEM**) electrolyser, with the renewable electrical energy from wind power and with the Green Hydrogen to be stored underground to act as a **HESS** to be used to maintain grid integrity and stability.

See: ADX Energy [website](#); Windkraft Simonsfeld [website](#)

- **Plug Power, keeps plugging away:**

As readers of Low Carbon Pulse will know, the activities of Plug Power, Inc., are reported reasonably consistently, which is a function of the activity of Plug Power.

For example, **Edition 28** of Low Carbon Pulse reported that:

*"one of the first movers in the development of supply side Green Hydrogen, Plug Power Inc., is continuing its roll-out of Green Hydrogen production capacity in the US with the development of a production facility in Fresno County, California (**Fresno Facility**)".*

In the news cycle for this **Edition 29** of Low Carbon Pulse, even by the standards of Plug Power, it has been busy:

- **Plug Power and SK Group progress:**

Edition 5 of Low Carbon Pulse reported that on January 7, 2021, Plug Power Inc. and SK Group intended to form a strategic alliance with the objective of accelerating the development of the hydrogen economy in the **ROK**, and Asian markets more broadly. In January 2021, Low Carbon Pulse described, "Plug Power, Inc. is a clear leader in fuel cell technology, Green Hydrogen production and distribution", and that "the SK Group is active in the fuel cell technology, fixed and mobile uses of fuel cell technology, including working with Bloom Energy on a number of fixed fuel cell technology projects."

On October 6, 2021, it was reported widely that Plug Power and SK Group (leading Republic of Korea chaebol, and leader in progress towards **NZE**) had entered into a joint venture to develop and deploy technology so as to accelerate the development of the hydrogen economy across Asian markets. Given the expertise Plug Power and SK Group, it is to be expected that they will work together to develop electrolysers, fuel cell systems and technologies, and hydrogen refuelling infrastructure.

It is understood that Plug Power and SK Group intend to develop a giga-factory so as to allow the production of electrolyzers and fuel cell systems and technologies at scale.

See: Plug Power [website](#); SK Group [website](#)

- **Plug Power Inc and FMG progress:** Dr Andrew Forrest, AO (founder of Fortescue Metals Group, one of the Big Three Australian iron ore producers, and before that the driving force behind the development of the enduring Murrin Nickel Project) knows the "real deal" when he sees it. Dr Forrest established Fortescue Future Industries (**FFI**), and is chair of it.

As noted below, on October 10, 2021, Dr Forrest announced the development of a giga-factory at Gladstone, Queensland. On October 14, 2021 Dr Forrest announced that the giga-factory would be developed in a 50 / 50 joint venture with Plug Power, with the giga-factory to develop proton exchange membrane (**PEM**) electrolyzers.

See: FFI [website](#); Plug Power [website](#)

- **Airbus and Plug Power Inc:** On October 12, 2021, Plug Power announced a collaboration with Airbus SE, under which they would work together to mobilise the use of Green Hydrogen across the airport and aviation sector, with Airbus providing insight in respect on the use of Green Hydrogen to power and to propel aircraft, and Plug Power to design, develop and deploy hydrogen infrastructure at airports.

See: Airbus [website](#); Plug Power [website](#)

- **Phillips 66 and Plug Power Inc mobilise:** On October 12, 2021, Plug Power announced that it had signed a memorandum of understanding with Phillips 66 to advance Green Hydrogen across the mobility / transport sector. Phillips 66 and Plug Power are going to work together to develop low carbon hydrogen technology to be designed, developed and deployed across the operations of Phillips 66.

See: Phillips 66 [website](#); Plug Power [website](#)

- **Renault and Plug Power mobilise:** On October 14, 2021, Plug Power and Renault unveiled the first HYVIA hydrogen Renault Mast Van in North America.

See: Renault Group [website](#); Plug Power [website](#)

- **STAMPED for approval - Empire State Building:** On October, 26, it was reported widely that Plug Power had commenced construction of its Green Hydrogen production facility in the Town of Alabama, Genesee County, New York, as part of the Science, Technology and Advanced Manufacturing Park (**STAMP**).

Previous editions of Low Carbon Pulse have noted on **STAMP** (see **Editions 11, 13, and 26**).

- **Lhyfe and Plug Power:** On October 27, 2021, it was reported widely that Plug Power and Lhyfe has agreed to pursue jointly the development of Green Hydrogen facilities across Europe, with the intention to develop and to deploy 300 MW Green Hydrogen facilities by 2025, and to develop a 1 GW production site.

- **Sunfire GmbH (*Sunfire*) responding to demand:** On October 7, 2021, **Sunfire** announced plans to develop and deploy a 500 MW alkaline electrolyser by 2023 to allow it to respond to projected increased demand for Green Hydrogen.

This represents continued progress by **Sunfire**, with the announcement accompanied by news of further fund raising.

See: Sunfire [website](#)

- **Air Products liquefying to satisfy demand:** On October 7, 2021, Air Products (one of the big three industrial gas producers globally, with Air Liquide and Linde) announced that it had started to liquefy 30 metric tonnes of hydrogen a day at its La Porte facility, with the hydrogen being liquefied sourced from the existing Gulf Coast Hydrogen Pipeline, with the liquified hydrogen (**LH₂**) gas. The **LH₂** gas will be delivered from the La Porte facility to industrial customers using tanker-trailers.

See: Air Products [website](#)

- **Horisont Energi and Koole Terminal B.V combine: Edition 23** of Low Carbon Pulse reported that:

1. Port of Rotterdam Authority (**PORA**), Chiyoda Corporation, Koole Terminals, and Mitsubishi Corporation signed an agreement to undertake a study jointly to assess the feasibility of the import of hydrogen to a Koole terminal, using proven hydrogen storage and transportation technology developed by Chiyoda; and

2. **PORA** and Horisont Energi signed a memorandum of understanding (**MOU**) to import Blue Ammonia (produced in northern Norway, at the **Barents Blue** project (**BBP**)) and to store it at the Port of Rotterdam, pending distribution throughout North Western Europe.

On October 8, 2021, it came as no surprise to read that Horisont Energi and Koole Terminals intend to combine to develop an ammonia terminal and storage facility within the Port of Rotterdam.

At the risk of banging the private sector drum too loud and too long, this is another instance of the private sector combining to develop infrastructure ahead of the supply and demand for hydrogen and hydrogen based fuels.

See: Horisont energi [website](#); Koole Terminal BV [website](#)

- **Itochu Corporation and NEL ASA partner:** On October 10, 2021, it was reported widely that Itochu Corporation (leading Japanese trading house) and NEL ASA (leading electrolyser technology supplier) had entered into a strategic partnership in the hydrogen sector. NEL is a manufacturer of both alkaline and proton exchange membrane (**PEM**) electrolyzers, each used in the production of Green Hydrogen.

The purpose of the strategic partnership is to identify hydrogen businesses that Itochu and NEL may develop, including production, transportation and distribution.

See: Itochu [website](#); NEL ASA [website](#)

- **CS Energy and IHI Corporation progress Kogan Hydrogen Demonstration Plant:** On October 12, 2021, it was reported widely that CS Energy (Queensland government owned generation company) and IHI Corporation (**IHI**) are to proceed with the development of the Kogan Hydrogen Demonstration Plant (**KH2DP**) located at CS Energy's Kogan Creek Power Station. The **KH2DP** electrolyser is to be powered by renewable electrical energy at a co-located photovoltaic solar farm with the photovoltaic solar farm utilising **BESS**, and is to deploy a hydrogen fuel cell.

See: CS Energy [website](#); IHI Corporation [website](#)

- **CleanCo and Sumitomo:** On October 13, 2021, it was announced that CleanCo Queensland (Queensland Government owned renewable energy corporation) had signed an agreement with Sumitomo Corporation to join in the development of Green Hydrogen production capacity in Queensland.
- **France set-fair:** On October 12, 2021, French President, Mr Emmanuel Macron, outlined plans to invest €30 billion (USD 35 billion) in the development and support of French corporations to become champions of, and to lead in, innovation. To President Macron it is necessary to "... wage the battle of innovation and industrialisation at the same time ... to re-industrialise" France.

In addition to the development of the hydrogen industry in France, the package will allow the development of smaller scale nuclear reactors, providing renewable electrical energy, and the means to the production of hydrogen from that energy or steam from that energy, or both.

As will be apparent from the **Ashurst Hydrogen Rainbow** (see above) the use of nuclear electrical energy to electrolyse water to produce hydrogen is said to give rise to Pink Hydrogen, and the use of steam arising from cooling in the context of nuclear energy gives rise to Purple Hydrogen.

See: French Government [website](#)

- **The Netherlands ports calling:** On October 12, 2021, VoltH2 announced that it is to commence construction of a 25 MW Green Hydrogen production facility. The Green Hydrogen production facility, to be located in the North Sea Port of Vlissingen, is capable of producing 3,500 metric tonnes per annum (*mtpa*) of Green Hydrogen, and is scalable on modular basis up to 100 MW and 14,000 *mtpa*.

As is the case with many other Green Hydrogen production facilities (and Blue Hydrogen production facilities for that matter), the facility is located in an industrial area / carbon cluster, in proximity to high-voltage power and gas transmission and distribution infrastructure, and adjacent to the European Hydrogen Backbone (see **Editions 13, 14** and **20** of Low Carbon Pulse).

See: VoltH2 [website](#)

- **A Sunday in Queensland, A Wednesday in New South Wales: Edition 28** of Low Carbon Pulse reported that New South Wales (*NSW*), Australia's most populous State, has released a report entitled [Development of a hydrogen industry in New South Wales](#) on September 30, 2021.

On October 13, 2021, the recently appointed Premier of *NSW*, Mr Dominic Perrottet, outlined a AUD 3 billion hydrogen strategy for the State of New South Wales. (The **September Report on Reports** will consider the report and the hydrogen strategy for *NSW*.)

- **Air Projects chooses Eastern Louisiana as the home for Blue Hydrogen Clean Energy Complex:** On October 14, 2021, it was reported widely that Air Products is to develop a USD 4.5 billion Blue Hydrogen Clean Energy Complex (*BH2CEP*).

The *BH2CEP* was announced jointly by Governor of Louisiana, Mr Jon Bel Edwards, and Air Products Chair, Chief Executive Officer and President, Mr Seifi Ghasemi.

Air Products is to build, own and operate *BH2CEP* that will produce Blue Hydrogen, with the Blue Hydrogen to be supplied to customers across Air Products' Gulf Coast hydrogen pipeline network. Key to the *BH2CEP* will be the CCS of *CO₂* arising from the use of technology provided by Haldor Topsoe.

Air Products and Haldor Topsoe are working together on the Green Hydrogen production project for NEOM in *KSA*, and Haldor Topsoe is providing technology for Air Products Blue Ammonia facility in Texas City (producing 3,600 metric tonnes a day of Blue Ammonia).

As reported in previous editions of Low Carbon Pulse, Air Products is one of the Big Three industrial gas corporations, with Air Liquide and Linde.

- **Premium sized Green Hydrogen project on Teesside:** On October 14, 2021, Protium announced the development of a 40 MW Green Hydrogen production facility, with the facility to include *HESS*. The development of the Protium Green Hydrogen production facility adds further to the hydrogen hub forming part of Net-Zero Teesside (See **Edition 23** of Low Carbon Pulse).

- **Green Hydrogen development across the UK:** On October 14, 2021, Octopus Energy and RES announced plans to invest GBP 3 billion by 2030 to develop and deploy Green Hydrogen production capacity across the UK.

- **INEOS continues progress to NZE:** Previous editions of Low Carbon Pulse (see **Editions 22** and **23** and **Edition 28** for most recent coverage) have reported on the commitments made by *INEOS* (UK based international conglomerate) and PetroChina International, including commitments to capture at least 1 million metric tonnes of *CO₂* from activities at Grangemouth petrochemical and refining facilities (*Grangemouth Facilities*) in Scotland.

These activities are significant of themselves, and because of their importance to the *Scottish Cluster* (see **Edition 23** of Low Carbon Pulse), including the *Acorn Project*. The carbon capture and other initiatives are intended to reduce *GHG* emissions from the *Grangemouth Facilities* by 60% by 2030.

As noted in **Edition 28** of Low Carbon Pulse, on September 22, 2021, *INEOS* announced plans to augment the *Grangemouth Facilities* to allow use of hydrogen as a feedstock and fuel. This augmentation will require the investment of GBP 1 billion. *INEOS*'s stated intention is to progress to *NZE* by 2045, in line with the policy setting of the Scottish Government.

On October 18, 2021, *INEOS* announced plans to invest €2 billion (USD 2.3 billion) in the development of Green Hydrogen production facilities across Europe. *INEOS* announced plans to develop and deploy electrolyser plants across Europe, Belgium, Germany and Norway within the next 10 years, with plants in France and the UK also planned.

The first of the electrolyser plants will be a 20 MW electrolyser plant be co-located at *INEOS*' petrochemical complex at Rafnes, Norway, followed by a 100 MW electrolyser plant at *INEOS*' existing facilities in Cologne, Germany.

- **Mississippi Clean Hydrogen Hub (MCH2H):** On October 19, 2021, it was reported that Hy Stor Energy has plans to develop a Clean Hydrogen Hub, working with Connor, Clark & Lunn Infrastructure. It is proposed that the *MCH2H* produce 110,000 metric tonnes (*mt*) per annum (*mtpa*) of hydrogen (or 110,000,000 kilograms).

It is understood that up to 70,000 *mt* of hydrogen will be stored in salt caverns.

As noted in previous editions of Low Carbon Pulse, the storage of hydrogen will be key to its use. Hence the coverage of **HES** in Low Carbon Pulse.

- **Air Liquide accelerates the development of Normandy Green Hydrogen Project:** On October 20, 2021, Air Liquide increased its stake in H2V Normandy, renaming it **Air Liquide Normand'Hy**, so as to accelerate the 200 MW Green Hydrogen production facility at Port-Jerome, using a proton-exchange membrane (**PEM**) electrolyser.

The Green Hydrogen production facility is located within the Normandy carbon cluster / industrial basin, with Air Liquide intending to supply Green Hydrogen to industrial customers and to the mobility / transport sector. The Green Hydrogen production facility will connect to Air Liquide's existing hydrogen pipeline network in Normandy.

- **WEL done – plans to develop clean-ammonia export facility:** On October 25, 2021, it was reported widely that the Woodside Energy Limited (leading energy corporation) intends to develop a clean-ammonia production facility (**H2 Perth project**).

The **H2 Perth project** is to be located in a carbon cluster in an industrial precinct in the southern metropolitan region of Perth, and will produce up to 15,000 metric tonnes of clean-hydrogen a day, with the clean-hydrogen to be used to produce clean-ammonia and hydrogen for export. A final investment decision in respect of the project may be expected in 2024.

- **PowerChina International and Oracle Power Green Flag:** On October 25, 2021, H2-view.com, reported that PowerChina International and Oracle Power had signed a co-operation agreement to develop a 400 MW Green Hydrogen production facility in Pakistan. It is understood that the electrolyzers at the production facility will source renewable electrical energy from photovoltaic solar and wind sources.

- **Aberdeen City Council and BP Green Flag:** On October 25, 2021, it was reported widely that Aberdeen City Council (**ACC**) had selected BP as its preferred bidder on its procurement of a Green Hydrogen Hub in Aberdeen, Scotland.

It is understood that the first stage of the development of the Green Hydrogen Hub is the development of a Green Hydrogen production facility. **ACC** has demand for the supply of Green Hydrogen produced at the production facility to enable it to fuel its fleet of Fuel Cell Electric Vehicle technology buses.

- **ENEOS and FFI combined study:** On October 29, 2021, **ENEOS** (leading hydrocarbon importer into, and refiner in, Japan) announced that it is undertaking a study jointly with Fortescue Future Industries to assess the development of a **Japan-Australia CO₂ free Hydrogen Supply Chain**, sourcing **CO₂** free hydrogen from Western Australia.

As readers of Low Carbon Pulse will recall, **ENEOS** is active in the development of hydrogen and hydrogen-based fuel supply chains: **Edition 27** of Low Carbon Pulse reported that **ENEOS** and Petronas (the national oil company of Malaysia) signed a memorandum of understanding for the development, jointly, of a clean hydrogen supply chain between Malaysia and Japan; **Edition 26** of Low Carbon Pulse reported on the study of a hydrogen and hydrogen-based energy carrier supply chain starting at the Origin Energy Green Hydrogen facility at Gladstone, Queensland, Australia, and terminating at the **ENEOS** refineries in Japan (with **ENEOS** considering the use of Green Hydrogen to produce methylcyclohexane (**MCH**)); and **Edition 10** of Low Carbon Pulse reported on the ground-breaking **Hydrogen Energy Supply Chain** project in the Latrobe Valley, Victoria, Australia, in which **ENEOS** participates with Kawasaki Heavy Industries, Electric Power Development Co., Ltd (J-Power), Iwatani Corporation, Marubeni Corporation, Sumitomo Corporation, AGL Energy Limited, Shell, and Kawasaki Kisen Kaisha, Ltd (K-Line).

- **Linde hopping in Brazil:** On October 29, 2021, it was reported widely that Linde had signed a memorandum of understanding for the development of a Green Hydrogen production facility as part of the Pecem Industrial and Port Complex (**CIPP**). As readers of Low Carbon Pulse will recall, up to 12 memorandums of understanding have been signed in respect of the development of infrastructure at **CIPP**.

Green Metals / Minerals, Mining and Difficult to Decarbonize industries:

- **Forging Means to Green:** Earlier in 2021, **FMG** (driven on by the force of nature that is its founder, Dr Andrew Forrest, AO), committed to achieving **NZE** across its Scope 1 and 2 **GHG** emissions by 2030, if not earlier.

On October 5, 2021, **FMG** announced its intention to achieve **NZE** across its Scope 3 **GHG** emissions by 2040. For those who have worked with Dr Forrest, the apparently impossible becomes the everyday. It has to be said that the world needs a few more folk like Dr Forrest; folk who believe in the need for acceleration, and who have the energy and will to achieve that acceleration.

The Australian Broadcasting Corporation (funded the Federal Government of Australia and its own commercial revenue), reported that **FMG's** Scope 1 and 2 emissions in 2019/2020 were around 2.2 million metric tonnes (**mmt**) of **GHG** emissions. It is estimated that the Scope 3 **GHG** emissions to June 30, 2021, were 252 **mmt**, with 246 **mmt** arising from the production of iron and steel.

SCOPE OF GHG EMISSIONS	
Scope 1	GHG emissions arising directly from activities and assets controlled or owned by the corporation.
Scope 2	GHG emissions arising indirectly from supply of energy to the corporation, including electrical energy and heat by the corporation.
Scope 3	GHG emissions arising indirectly in the supply chain of the corporation, including use of energy.

- **BlueScope to Green Hydrogen:** On October 29, 2021, it was reported widely, that BlueScope Steel Limited (**BSL**) and Rio Tinto were to explore the various pathways to low-carbon iron and steel production, focussing on the use of

high quality Pilbara iron ore and clean-hydrogen so as to displace the use of metallurgical coal at BlueScope Steel's Port Kembla Steelworks. It is understood that the use of Green Hydrogen (as a clean hydrogen) will be prioritised.

Edition 25 of Low Carbon Pulse reported on **BSL's** commitment to achieve **NZE** in respect of its Scope 1 and Scope 2 emissions. **BSL** was to achieve this **NZE** commitment using renewable electrical energy, and Green Hydrogen, rather natural gas (**CH₄**), whether alone or blended with hydrogen.

Edition 21 of Low Carbon Pulse reported that Rio Tinto and POSCO had entered into a memorandum of understanding (**MoU**) to develop, to explore, to demonstrate and to deploy technologies to accelerate the transition of the iron and steel sector to lower, low and no carbon.

Rio Tinto's Chief Commercial Officer at that time, Mr Alf Barros, noted that:

"The [MoU] ... complements Rio Tinto's partnerships with other customers as the industry focus" on Scope 3 emissions.

For Rio Tinto, the **MoU** is a clear demonstration of its commitment to **NZE** (including in respect of Scope 3 emissions).

Hydrogen Cities, Clusters and Hubs, Giga-Factories, and Valleys:

- **Hyundai Plans Big:** On October 7, 2021, Hyundai Mobis announced plans to develop two new fuel cell plants in **ROK**. It is understood that the two new plants (one west of Seoul towards Incheon, and one at Ulsan), costing USD 1.1 billion to develop, will be operational during 2023. The increased fuel cell production capacity, will provide the means to accelerate the development of the hydrogen economy in **ROK** and globally.

- **Hyundai Motor Company (HMC) and Shell Hydrogen (SH₂) combine:** On National Hydrogen and Fuel Cell Day (October 8, 2021), **HMC** North America and **SH₂** announced plans to develop and deploy 48 new hydrogen refuelling stations, and to upgrade 2 more, across the US State of California (**Project Neptune**).

As is becoming increasingly typical, the private sector **HMC** North America and **SH₂** is developing **Project Neptune** with the funding support from Government, in this case the California Energy Commission.

This initiative, combining the means to supply and demand, and allowing efficient development, has become a model globally. (See **Editions 17, 23** and **27** of Low Carbon Pulse.)

See: Hyundai Motor Company [website](#); Shell [website](#)

- **Alignment around a hydrogen valley:** On October 8, 2021, [h2-view.com](#) reported that global mining giant, Anglo American, the Department of Science and Innovation (**DSI**), South Africa, the South African National Development Institute (**SANEDI**), Engie (leading global energy corporation) and Bambili Energy (manufacturer of fuel cell stacks), released the findings from a feasibility study into the development of a hydrogen valley.

The feasibility study finds that there is potential for the development of a hydrogen valley along the commercial and industrial corridor between Durban and Johannesburg.

The hydrogen valley would have three hubs, Joburg to Pretoria, Durban and Richards Bay, and the Limpopo province centred around the Anglo American Mogalakwena platinum Group metals mine.

- **Fortescue Future Industries (FFI) and Queensland Government produce:** One of the dynamics in Australia (noted in previous editions of Low Carbon Pulse) is the forward looking perspective of the Australian private sector and Australian State and Territory Governments.

On October 10, 2021, this was again in evidence. Queensland Government Premier Anastacia Palaszczuk and Dr Andrew Forrest, AO (founder of **FMG**, parent company of **FFI**, and chair of **FFI**) announced the development of an electrolyser manufacturing facility at Aldoga within the Gladstone State Development Area (**GEM**).

As noted above, Plug Power is joint venturing with FMG / FFI, and it appears likely that **FFI** and projects in which **FMG** and **FFI** invest will be one of the cornerstone customers of the joint venture.

See: Queensland Government [website](#); FFI [website](#)

- **thyssenkrupp scale up to 5 GW a year:** On October 10, 2021 it was reported that thyssenkrupp is to scale up electrolyser production to 5 GW a year, from the current 1 GW a year.

For all manufacturers of electrolysers these are momentous times, and for thyssenkrupp, leading the H2Giga Flagship, it is as well-placed as any.

See: thyssenkrupp [website](#)

- **Koch Strategic Platforms and FREYR Battery:** On October 12, 2021, [energy-storage.news](#), reported that Koch Strategic Platforms and FREYR Battery have established a joint venture (**KFJV**) to develop 50 GWh battery cell factories in the US.

The **KFJV** is stated to be considering the use of 24M Technologies' SemiSolid battery technology to achieve higher-energy density. The intention is to progress to development by 2030 to produce batteries for electric vehicles and for energy storage systems.

- **Giga-factory update:** It has been the plan for a while to include a feature on giga-factories in an edition of Low Carbon Pulse. Given the space and word count taken by outlining trends and matters of policy ahead of **COP-26 Editions 25, 26** and **27**, and **28** of Low Carbon Pulse have been weighty in their word count.

Future editions of Low Carbon Pulse will include cover both giga factories and charging and refuelling infrastructure.

Wind round-up:

- **World Bank Winds-up:** On October 5, 2021, it was reported widely that the World Bank had released [Key Factors For Successful Development of Offshore Wind in Emerging Markets](#) (**WB OWF**).

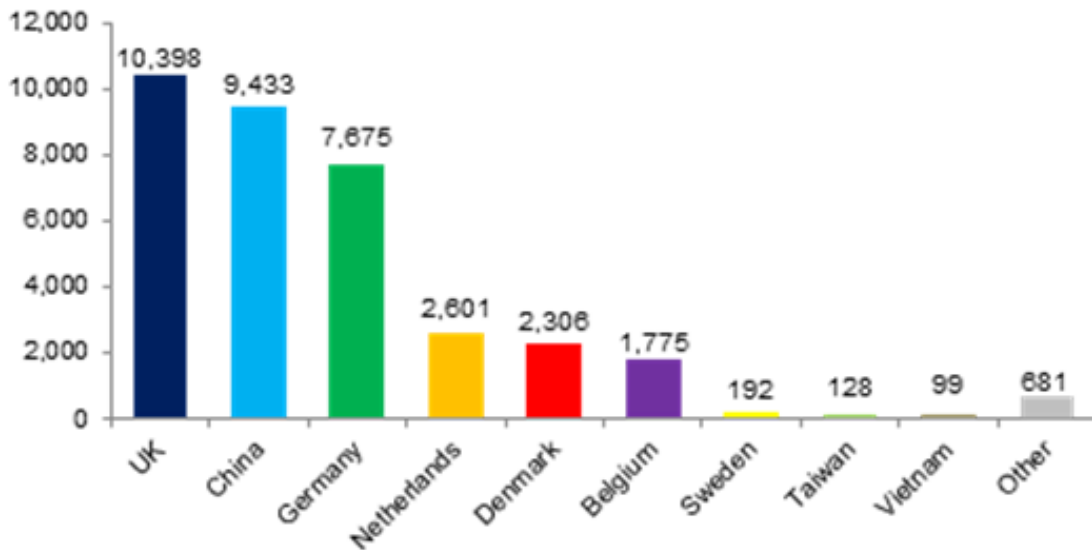
The **WB-OWF** is the work of the Energy Sector Management Assistance Program (**ESMAP**) of the World Bank, and is intended to provide guidelines for Governments in emerging countries as to how best to develop their resources.

The headline from the **WB OWF** is that there is up to 16,000 GW of off-shore wind field capacity capable of development globally in emerging markets, with this capacity seemingly located in 48 countries.

The split between fixed-bottom and floating is 5,500 GW and 10,100 GW.

- **World Wind-up:** On October 6, 2021, it was reported widely that **RenewableUK's Project Intelligence** team had released a [report](#) (**OWF Report**) outlining the global off-shore wind field project profile. The **OWF Report** identifies 413 GW of off-shore wind field projects.

Fully operational offshore wind capacity in MW:



[**Note:** The author of *Low Carbon Pulse* has not verified the basis for the reported GW of off-shore wind field capacity the subject of the **OWF Report**, but it appears consistent with other information that the author has read.]

- **Dutch Wind-up:** On October 6, 2021, it was reported that the Netherland Enterprise Agency (**RVO**) is procuring the undertaking of metocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the Ijmuiden Ver Investigation Area (**IVIA**).
The **IVIA** is one of three off-shore areas identified in the Dutch Offshore Wind Energy Roadmap 2030. The **IVIA** is 62 kms off the west coast of the Netherlands, having an area of 400 km². The **IVIA** has four lots in all, with IVOA I and II to be tendered in to 2023, and IVOA III and IV to be tendered in to 2025.
- **Australia winds getting-up:** As noted consistently in *Low Carbon Pulse* (most recently in **Edition 28** of *Low Carbon Pulse*), Australia has world class off-shore wind resources. As has become typical in the news cycle of each edition of *Low Carbon Pulse*, another major off-shore wind field project is announced off Australia.
On October 8 2021, Alinta (one of Australia's largest integrated energy corporations) announced plans to develop a 1 GW off-shore wind field off the East Coast of Australia and a 300 MW on-shore wind farm in the Pilbara Region of Western Australia.
An [article](#) in *The Guardian* (Australian Edition), entitled "**Good seas, good grids and good wind**": *Australia's tentative first steps towards an offshore wind industry* provides an accurate snap shot of the current state of play.
See: Alinta Energy [website](#)
- **Uruguay unveils united undertaking:** On October 7, 2021, ANCAP (the national oil company of Uruguay) and the Ministries of Environment and Industry for Uruguay unveiled a plan for the development of Green Hydrogen production facilities using renewable electrical energy from off-shore wind fields – the **H2U Offshore** program.
It is understood that the current thinking is to schedule a tender by the end of 2023.
See: ANCAP [website](#)
- **Energy Islands in the UK Sector of the North Sea:** Both Denmark and Germany are developing green power islands in their sectors of the North Sea.
On October 8, 2021, the [New Scientist](#) reported that the UK's National Grid company, the owner and operator of the high-voltage transmission network across the UK, is discussing the development of an energy island. The discussions are said to be three-way, with the National Grid not revealing the other two parties as yet.
If the energy island discussions progress, the suggestion is that the renewable electrical energy dispatched from the energy island will match load in the north west region of Europe.
- **Polish Off-shore wind field tender approaching:** **Editions 14, 18** and **21** of *Low Carbon Pulse* have reported on the off-shore wind field development plans for the Polish sector of the Baltic Sea.
Ahead of the commencement of the auction process for the off-shore sea-bed leases, consortiums are starting to come together.
On October 14, 2021, Ørsted announced that it was partnering with ZE PAK in respect of the upcoming auction.
See: Ørsted [website](#); ZE PAK [website](#)
- **US looks to off-shore wind:** On October 14, 2021, the Biden Administration announced plans to allow the development of seven off-shore wind fields along the East, Gulf and West Coasts of the US: **1.** Gulf of Maine, **2.** New York Bight (between Long Island and New Jersey), **3.** Central Atlantic, **4.** the Carolinas, **5.** the Gulf of Mexico, **6.** California and **7.** Oregon.

- **Lithuania progressing to first off-shore wind field:** On October 18, 2021, offshorewind.biz reported that Lithuania had completed the environment impact assessment in respect of its proposed first off-shore wind field in its sector of the Baltic Sea.
Adopting tried and tested project structures, Lithuania intends to develop the proposed off-shore wind field project using contracts for difference, with the obligation to connect resting with the transmission system operator.
- **BlueFloat Energy and Falck Renewables continue developments:** **Edition 28** of Low Carbon Pulse reported that Falck Renewables (leading Italian renewable energy developer) and BlueFloat Energy (leading off-shore wind developer) had announced that they have entered into a 50:50 joint venture for the purposes developing off-shore wind field (**OWF**) projects off the coast of Italy.
The first project was the 1.2 GW **OWF** project off Brindisi (**Kailia Energia Project**), with projected annual generation dispatch of up to 3.5 TWh.
On October 26, 2021, it was reported widely that the joint venturers are not seeking a permit in respect of a further 1.3 GW of **OWF** projects off the southern coast of the province of Lecce. For the projects to proceed, authorisations will have to be obtained from the Ministero per la Transizione Ecologica and maritime concessions granted by the Ministero delle Infrastrutture and the Port Authority of the Southern Adriatic Sea.

Solar and Sustainable Energy Round-up:

In addition to other news items covered above in respect of solar and sustainable energy, the following news items may be regarded as noteworthy within the news cycle of this **Edition 29** of Low Carbon Pulse.

- **South Africa Renewable Energy Procurement:** On October 29, 2021, pv-magazine, reported on the outcome of the fifth round of the Renewable Independent Power Producer Procurement Program (**REIPPP**).
It is reported that the Department of Mineral Resources and Energy awarded concessions in respect of 25 projects having a combined installed capacity of 2.583 GW, with the projects being within a range of 75 MW to 140 MW. Given the size of the projects, the bids may be regarded as highly competitive, with the lowest bid reported for a 124 MW wind-farm of US cents 2.279 per kWh.

To manage the length of this **Edition 29** of Low Carbon Pulse, the usual features on **Land Transport (automobiles, buses, trains and trucks) round-up, Ports and Shipping Forecast and Aviation and Airports** will be the subject of longer features in subsequent editions to ensure that all material and significant news items are covered.

Low Carbon Pulse - Edition 30

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to the Friday version of **Edition 30** of Low Carbon Pulse for those reading later in the week – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Monday November 1, 2021 to Sunday November 14, 2021 (inclusive of each day). The Friday version includes an Appendix comprising the **Report on Reports for September and October 2021**.

Please click [here](#) for the **First Low Carbon Pulse Compendium**, which comprises **Editions 1 to 28** of Low Carbon Pulse. Click [here](#) for the **Second Low Carbon Pulse Compendium**. Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

Edition 31 of Low Carbon Pulse will be published in the usual two week cycle on November 30, 2021. **Edition 32** (*The Magic Johnson Edition*) will be published on Friday December 17, 2021 and **Edition 33** (*The Larry Bird Edition*) on Tuesday January 25, 2022, after the Christmas and western New Year holiday season, and before Lunar New Year.

Progress at COP-26:

- **Down to earth:**

Edition 29 of Low Carbon Pulse, suggested that expectations for the 26th session of the Conference of Parties (**COP-26**) of the United Nations Framework Convention on Climate Change were somewhere between heightened and sky high.

As US Special Climate Change Envoy, Mr John Kerry, said in Milan (at the pre-**COP 26** meeting in ministers):

"The bottom line is, folks, as we stand here today, we believe we can make enormous progress in Glasgow, moving rapidly towards new goals that science is telling us we can achieve".

Progress was made in Glasgow, but not, as yet, sufficient progress to avoid the worst consequences of climate change.

To ensure that the worst consequences of climate change are avoided, it is necessary to hold the increase in average global temperatures to **1.5°C**. This is clear. As yet, policy settings are not in place to globally achieve this outcome.

- **Down and out in Rome, Up and about in Glasgow:**

Before **COP-26** President of **COP-26**, Mr Alok Sharma, set out the four UK Government Goals for **COP-26** (**Four Pillars**).

The next page or so outlines progress made in respect of the **Four Pillars**.

Four Pillars: In the working week before **COP-26**, 2021, Low Carbon Pulse published five [COP-26 Countdown features](#) describing each of the **Four Pillars**.

In short hand, the **Four Pillars** were as follows:

1. Secure global net zero by mid-century and keep 1.5 degrees within reach;
2. Adapt to protect communities and natural habitats;
3. Mobilise finance; and
4. Work together to deliver (including the finalisation of the **Paris Rulebook**).

- **In summary:**

On the evening of November 13, 2021, **COP-26** ended with the agreement of the [Glasgow Climate Pact \(GPC\)](#). In terms of future action, the **GPC** variously encourages, requests and urges increased levels of action on climate change and resolves on a limited number of matters. One of the resolutions is, "to move swiftly to the full implementation of the Paris Agreement", in light of the agreement on the **Paris Rulebook**.

- **GPC** was agreed to by 197 countries. This is real progress.

While some headlines may read "climb down" in "phasing down of unabated coal-fired power generation" and increased **GHG** emission reductions (**NDCs**) deferred to COP-27, all progress is incremental.

To the author of Low Carbon Pulse, the agreement of the **Paris Rulebook** as always going to the mark of success of **COP-26** (see [Edition 29](#) of Low Carbon Pulse). The [Paris Rulebook](#) was agreed.

- In the context of **Pillar 1**, the **GPC**:

- kept "1.5 degrees within reach .. But, its pulse is weak" with countries responsible for between 85% and 90% (depending on which data source is used) of **GHG** emissions now committed to achieving **NZE** and revised and strengthened **NDCs** to be finalised during 2022; and
- reflects agreement to phase-down of unabated coal-fired power generation capacity.

- In the context of **Pillars 2** and **3**, the **GPC** provides for increased financial support through the Adaptation Fund, with developed countries urged to double, at least, their support to developing countries by 2025.

- In the context of **Pillar 4**, the **Paris Rulebook** agreed:

Before **COP-26**, Mr Sharma had been quoted as saying that reaching agreement of the **Paris Rulebook** will be more difficult than achieving agreement of the Paris Agreement. While it took an extra day, the **Paris Rulebook** was agreed, critically on Article 6, Common Timeframes and transparency. The **Paris Rulebook** is not watertight, but it will float.

[Edition 27](#) of Low Carbon Pulse noted that the compromise was likely, and it was. The **Paris Rulebook** in respect of Article 6 of the **Paris Agreement** reflects that compromise, but it is enough for countries to commence exchange of carbon credits, with the market to distinguish the high-quality carbon credits, and Governments to regulate.

Early in the western New Year, the author of Low Carbon Pulse will publish a standalone piece on the implications of Article 6 of the **Paris Agreement**, and carbon credits.

- **Quotes of COP-26:**

"Two degrees is a death sentence [for small island states]".

Prime Minister of Barbados, Ms Mia Mottley (watch Ms Mottley's speech [here](#))

"What is stopping any other heavy, hard to abate industries from doing the same [i.e., doing what FMG is doing]?"

Nothing. Just the will to make it happen!

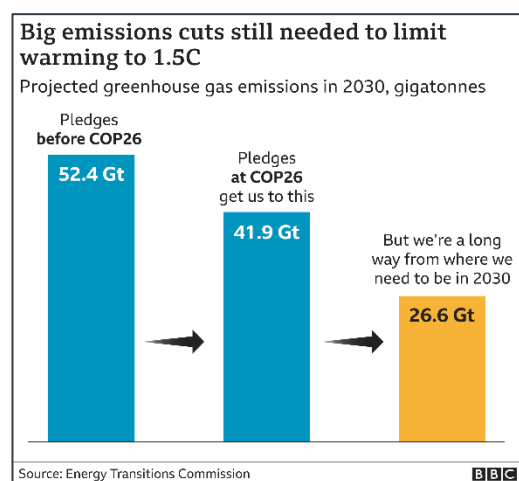
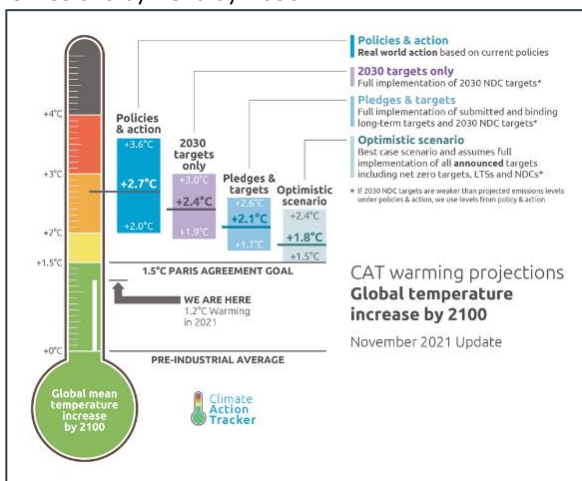
CEO of Fortescue Future Industries, Ms Julie Shuttleworth (watch Ms Shuttleworth's speech [here](#))

"We are still knocking on the door of climate catastrophe ... it is time to go into emergency mode – or our chance of reaching net-zero will itself be net zero"

United Nations Secretary-General, Mr Antonio Guterres on the final day of **COP-26**

- **Context of Climate Change:** Before **COP-26**, United Nations Secretary-General, Mr Antonio Guterres warned of the **Catastrophic Pathway** of a **2.7°C** (see [Edition 28](#), [Anniversary Edition](#), and [Edition 29](#) of Low Carbon Pulse) increase in average global temperatures in a speech given to the General Assembly of the United Nations. During the **World Leaders' Summit** that took place on November 1 and 2, 2021, various leaders committed to increased **NDCs** and to **NZE**.

During **COP-26**, the good folk at the Climate Change Tracker produced one of their excellent visual representations of what increased and new commitments meant. The graphic is included below. In short the best case scenario is to hold the increase in average global temperatures to **1.8°C**. This is positive, but more needs to be done to get hold of the increase in average global temperatures to **1.5°C** (the **Stretch Goal**), including to reduce **GHG** emissions by 45% by 2030.



- **There has been a lot going on at COP-26 and elsewhere:**

One could be forgiven for thinking that **COP-26** was multiple meetings and summits rolled into one. A number of meetings took place just before and at **COP-26**. In addition, many meetings took place on the side-lines at **COP-26**.

- **G20 Rome Summit** took place on October 30 and 31, 2021 (link to [communique](#)) and had climate change on the agenda, with the agenda and the outcomes mirroring the **First Pillar**: "Keeping 1.5 degrees within reach will require meaningful and effective actions and commitment by all countries, taking into account different approaches" and achieving **NZE** "by or around mid-century". An agreed means of achieving this was the "phase-out" of coal. In addition, there was agreement on ceasing to fund the development of new unabated coal-fired power generation capacity, and the commitment to provide funding of USD 100 billion a year to developing countries was restated (aligned with the **Third Pillar**).

On reflection it should not have been a surprise that the outcomes outlined in the communique were consistent with the **Four Pillars**, and as such, the disappointment expressed in some quarters was probably misplaced.

- **World Leaders' Summit** took place on November 1 and November 2, 2021 (link to [communique](#)) at which climate change was on the agenda, and progress was made.

At the **World Leaders' Summit**, held over the first two days of **COP-26**, there were speeches from world leaders (some of whom committed to **NZE** and to increased **NDCs**) and progress on the **Breakthrough Agenda** on the first day, with the second day involving progress on deforestation and methane (**CH₄**) reductions.

- **Breakthrough Agenda and Goals and Agreement:** The four goals of the **Breakthrough Agenda** require the signatories to each of the goals to work together: **1.** to make clean technology and sustainable solutions "the most affordable, accessible and attractive option", for their respective sectors; **2.** to make clean power "the most affordable and reliable option for all countries"; **3.** for zero emission road vehicles to become the new normal; and **4.** for near zero emission steel to become the "preferred choice in global markets" (together the **Glasgow Breakthroughs** and each a **Glasgow Breakthrough**).

The **Breakthrough Agenda** details the many global initiatives to make progress towards, and coordinating activities, to achieve each **Glasgow Breakthrough**.

The International Energy Agency (**IEA**) is to produce an annual report on progress of each **Glasgow Breakthrough**, working with the International Renewable Energy Agency (**IRENA**), and UN High-Level Climate Action Champions and "other institutions, bodies and industry leaders".

The **Breakthrough Agenda and Goals and Agreement** did not grab as many headlines as deforestation and the reduction in **CH₄**, but represented real progress, with iron and steel brought within the climate change framework for the first time. Tellingly, countries producing around 35% of global iron and steel production committed to get close to net zero by 2030.

The general statement in the **Breakthrough Agenda** was endorsed as follows: Australia, Belgium, Canada, Cabo Verde, Chile, Denmark, Egypt, European Union, Finland, France, Germany, Guinea Bissau, India, Israel, Italy, Japan, Kenya, Latvia, Lithuania, Malta, Mauritania, Morocco, Namibia, the Netherlands, New Zealand, Nigeria, North Macedonia, Norway, Panama, the Peoples Republic of China, Portugal, Republic of Ireland, Republic of Korea, Senegal, Slovakia, Spain, Sweden, Turkey, United Arab Emirates, UK, and US.

Each of the four **Glasgow Breakthroughs** were endorsed by some, but not all, of the countries that endorsed the statement in the **Breakthrough Agenda**. The **Glasgow Breakthrough** records the signatories to each.

- **Breakthrough on deforestation and land use:** The highlight of the **World Leaders Summit** may be regarded as the pledge to end deforestation and to reverse land degradation by 2030.

As a practical matter, the pledge covers over 85% of the world's forests, and is accompanied by funding support (with over 40 countries committing to taking action to end deforestation by 2030 by committing USD 12 billion in public finance and USD 7.2 billion in private finance by 2030, often referred to as USD 20 billion).

While the commitment to end deforestation and to reverse land degradation by 2030 is progress, it is hoped that countries will end deforestation as soon as possible, and likewise reverse land degradation.

It is to be hoped that developing countries are able to realise the value from carbon credit trading at the same time as progress is made to end deforestation and reverse land degradation. In this context, it is important that developing countries place appropriate value on initiatives that give rise to the removal of **CO₂** from the climate system, both for the purposes of use to off-set obligations to acquit **GHG** emission obligations and commitment and for the purposes of absolute removal of **GHG** emissions from the climate system. This will be addressed in the standalone article referred to above (under **In Summary – Paris Rulebook**).

- **High Ambition Coalition (HAC) Leaders' aligned NDCs with 1.5°C:** At the **World Leaders' Summit** (over the first two days of **COP-26**), **HAC Leaders** [announced](#) that they were committed to increasing the **NDC's** to align with holding the increase in average global temperatures to **1.5°C (Stretch Goal)** for the purposes of commitments to be made before or at COP-27, to be held in Egypt in 2022.

The **HAC Leaders** include those of countries in the Caribbean and the Pacific, Denmark, France, Germany, the Netherlands, Spain, and the US.

- **Global Methane Pledge - continued momentum:**

While progress on the **Global Methane Pledge** was not part of the formal business at **COP-26**, the approach of **COP-26**, and the presence of world leaders has provided the European Commission (**EC**) and the US with an opportunity to apply diplomacy to increase the number of countries committed to the **Global Methane Pledge**.

Edition 27 of Low Carbon Pulse reported on the signing of the **Global Methane Pledge**, signed by the **EC** and the US on September 17, 2021, and stated:

"The hope, and the objective of the EC and US now has to be to ensure that as many countries as possible join with them in this critical initiative".

Those hopes have been exceeded.

The [Anniversary Edition](#) of Low Carbon Pulse, noted the progress since October 2020 in recognition of the need to address **CH₄** emissions, culminating in the **Global Methane Pledge**. In the lead up to **COP-26**, over 90 countries had committed to the **Global Methane Pledge**.

By the end of the second day of the **World Leaders' Summit**, it was reported that over 105 countries had committed to the **Global Methane Pledge**.

Among those committing to the **Global Carbon Pledge** was Brazil (a top five methane emitter). Australia, India, the Peoples Republic of China (**PRC**), and Russia have not as yet committed to the **Global Methane Pledge**.

It is hoped that India, the **PRC** and Russia will commit, and, as noted below, this may be sooner rather than later in the case of the **PRC** (see **Time for reflection – Know no boundaries**, below). Unfortunately, Australia has ruled out committing.

- **Limiting the increase in global average temperature to well below 2°C imperative:**

In the lead-up to **COP-26** and the **World Leaders' Summit**, authoritative voices from business, industry and science were emphasising the need to stay as close to the **Stretch Goal** as possible, and that the impact of an increase of **2°C** in average global temperatures would be too much.

Chief Scientific Adviser to the UK Government, Sir Patrick Valance, noted that it was crucial that **1.5°C** is kept alive. This was a timely reaffirmation of the core of the Paris Agreement:

"Holding the increase in global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels ..."

In an opinion piece, the case is put cogently by the CEO of Statkraft (global leader in hydropower and Europe's largest generator of renewable electrical energy), Mr Christian Rynning Tønnesen. Please click [here](#) for the opinion piece – it is well-worth a read.

A number of world leaders made a similar point, most powerfully, the Prime Minister of Barbados, Ms Mia Mottley.

An increase of **2°C** above pre-industrial levels will not allow us to avoid the worst effects of climate change, and for some island countries, and for areas of lower lying coastal regions, as Ms Mottley said, a **2°C** increase is a "death sentence".

The UN Secretary-General, Mr António Guterres addressed the **World Leaders' Summit**, among other things, again calling time on fossil fuels, and noting the importance of the **Stretch Goal**. Mr Guterres' [speech](#) is worth a read.

- **Time for reflection:**

- **Know no borders:** The Chair of the International Panel on Climate Change, Mr Hoesung Lee, spoke at the opening ceremony of **COP-26**. Mr Lee reflected that: **"our atmosphere and climate know no borders, the true measure of effectiveness of our collective efforts will be the state of its condition"**.

- **Know no boundaries:** On November 10, 2021, the **PRC** and the US (the two largest emitters of **GHG** globally) announced jointly, in the [Declaration on Enhancing Climate Action in the 2020s](#), that they would work together to fight climate change. In concept, it is difficult to over-state the significance of the **Declaration**. It is hoped that the realisation of the **Declaration** is as significant.

The **PRC** and the US highlight the importance of staying close to the **1.5°C** average increase in global temperature prescribed in the **Paris Agreement**. Aligned with this announcement, the Special Climate Negotiator for the **PRC**, Mr Xie Zhenhua, announced that the **PRC** would cut **CH₄** emissions.

- **Boundless opportunities - Net-zero World Initiative:** On November 3, 2021, the [Net-zero World Initiative \(NZWI\)](#) was announced, with founding partners, Argentina, Chile, Egypt, Indonesia, Nigeria and Ukraine.

The US Department of Energy will lead the **NZWI**, working with corporations, not for profit organisations, thinktanks and universities, including Breakthrough Energy. The detail of the **NZWI** is well-worth a read.

- **Progress by largest emitters:** The five largest emitters of **GHG** emissions are the **PRC**, the US, India, Russia and Japan.

In four sentences for each of India, Russia and Japan, we reflect on the state of play, noting that each country has considerable heavy lifting to do to achieve **NZE** by their respective dates for the achievement of **NZE**; 2070, 2060 and 2050:

- **India:** In the lead up to, and at **COP-26**, India has "shifted the dial" significantly in its policy settings, and the rate of progress.

In many ways India could emerge as a case study in how to continue to achieve economic development while at the same decarbonising and electrifying.

The developed world needs to do more, and to work ever harder, with India so as to allow India to achieve the targets it has set itself.

- **Russia:** The Oxford Institute for Energy Studies (**OEIS**) released a paper entitled [The Russian Perspective on COP-26 and the Key Challenges of the Road to Net Zero](#) in September 2021. The paper is well-worth a read, providing a clear and direct assessment of the road that Russia must travel to reach **NZE**. Russia has committed to achieving **NZE** by 2060, but this commitment has yet to be adopted formally. For Russia, the challenge in progressing to achieving **NZE** is probably greater than for any other country rich in hydrocarbons, but decarbonising the Russian economy offers a once in a hundred year opportunity.

- **Japan:** During **COP-26**, the **OEIS** released a paper entitled [Energy Transition in Japan and implications for gas](#). Most of the heavy lifting in policy setting for Japan was done well in advance of **COP-26**: the commitment to **NZE** by 2050 was made in October 2020, and the increased **NDC**, from 26% to 46% compared to 2013 by 2030, was made in April 2021.

For Japan, the focus is how to accelerate decarbonisation of its heavily hydrocarbon reliant economy to achieve the targets it has set itself. One thing is for sure; its corporations are leading the way in the development of many of the means to decarbonise.

- **Progress at COP-26 against each of the Four Pillars in more detail:**

As noted above, in the working week leading up to **COP-26**, Low Carbon Pulse published features on each of the **Four Pillars**. The next page or so considers the progress made in respect of each of the **Four Pillars**.

- In full **Pillar 1** contemplated:

"Countries are being asked to come forward with ambitious 2030 emission reductions targets, that align with reaching net zero by the middle of the century.

To deliver on these stretching targets, countries will need to:

- *Accelerate the phase out of coal;*
- *Curtail deforestation;*
- *Speed up the switch to electric vehicles;*
- *Encourage investment in renewables."*

Progress was made as follows:

- **Ambitious 2030 emission reduction targets and net zero commitments:** as a general statement, progress was made, and the progress that was made is outlined above (under **In Summary**) and detailed below (under **NDCs and NZE**).

- **From "phase out" to "phase down" of unabated coal:** On November 4, 2021, more than 40 countries signed the [Global Coal to Clean Power Transition Statement \(Glasgow Coal Phase Out Agreement\)](#). This initiative is a further development in not developing unabated coal-fired power generation capacity.

Over the final 24 hours of **COP-26** (extend to November 13, 2021) the phrase "**phase-out**" was replaced by the phrase "**phased-down**". Many countries expressed disappointment with this late change, but in the interests of getting agreement, the change was accepted and reflected in the **Glasgow Climate Pact**. For those developed countries that expressed disappointment, it is hoped that they will "lean forward" and provide assistance to developing countries to "**phase-out**" unabated coal-fired power generation capacity.

Rather than being disappointed by the change, the author of Low Carbon Pulse was pleased, not because of the change itself, but because the author has long noted that developing countries should not commit to reductions and outcomes that they know not to be achievable.

The commitments made need to be reflected in the laws and regulations of countries making those commitments, and the corporations and the populations of those countries have to be able to comply with those laws and regulations.

(The mining and combustion of coal contributes greatly to **GHG** emissions globally including for the purposes of the generation of electrical energy, for the production of clinker in cement manufacture and for the production of iron and steel.)

- **Curtailment of deforestation:** On November 2, 2021, more than 100 countries committed to cease deforestation, and to effect that cessation by 2030.
- **Speeding up switch to electric vehicles (EVs) and encourage investment in renewables:** While the **GCP** touches on these matters tangentially, the **Glasgow Breakthroughs** provide key progress with Acceleration of growth in low carbon hydrogen or renewable hydrogen (one **Glasgow Breakthrough**): 32 countries and the European Union have agreed to work together to develop and to deploy low-carbon hydrogen / renewable hydrogen by 2030 so that "affordable renewable and low-carbon hydrogen is globally available by 2030" (**H2 Target**).

The countries that committed to the **H2 Target** are: Australia, Belgium, Canada, Chile, China, Denmark, Egypt, Finland, France, Germany, Guinea Bissau, India, Ireland, Israel, Italy, Japan, Kenya, Lithuania, Norway, Mauritania, Morocco, Namibia, the Netherlands, New Zealand, Panama, Slovakia, South Korea, Spain, Sweden, Turkey, the UK and the US.

- In full **Pillar 2** contemplated:

"The climate is already changing and it will continue to change even as we reduce emissions, with devastating effects. As COP-26 we need to work together to enable and encourage countries affected by climate change to:

- *Protect and to restore ecosystems; and*
- *Build defences, warning systems and resilient infrastructure and agriculture to avoid loss of homes, livelihoods and even lives".*

Progress was made through emphasis on adaptation (paragraphs 6 to 13 of the **GCP**) and adaptation finance (paragraphs 14 to 19), mitigation (paragraphs 20 to 39), and mitigation and adaptation finance (paragraphs 40 to 60), and loss and damage (paragraphs 61 to 74).

Indeed the **GCP** is dominated by the coverage of adaptation and mitigation, and associated matters. The reason for this is that it is in the area of adaptation and mitigation that most needs to be done among Parties to the **Paris Agreement**, and least has been done so far.

In addition to the action detailed in the **GPC**, as noted above, on the second day of the **World Leaders' Summit** the pledge to end deforestation and to reverse land degradation by 2030 was committed to by countries having 85% of the world's forests.

The International Renewable Energy Agency (**IRENA**) and the Alliance of Small Island States (**AOSIS**) signed an agreement on November 8, 2021 (**Adaptation Day**) at **COP-26**. The agreement is reported to provide for **IRENA** and **AOSIS** to work together to mobilise climate finance and to advance the deployment of renewable energy across the Small Island Developing States (**SIDS**).

This agreement follows an agreement in September 2021 (in contemplation of **COP-26**) under which **IRENA** and **AOSIS** are going to work to install 10 GW of renewable electrical energy capacity across the **SIDS**.

- In full **Pillar 3** contemplated:

"To deliver on our first two goals, developed countries must make good on their promise to mobilise at least USD 100 billion in climate change funding a year by 2020.

International financial institutions must play their parts and we need to work towards unleashing the trillions in private and public sector finance to secure global net zero".

Progress was made in the sense of a clear acknowledgment (through an expression of "deep regret" - see paragraph 44 of the **GCP**) that the goal of mobilising USD 100 billion a year by 2020 "had not yet been met". Developed countries are urged to mobilise "fully on the USD 100 billion a year commitment urgently through to 2025" (paragraph 46), and at least to double "their collective provision of climate finance for adaptation to developing countries from 2019 levels by 2025" (paragraph 18).

- In full **Pillar 4** contemplated:

"We can only rise to the challenges of the climate crisis by working together.

*At **COP-26** we must:*

- *Finalise the Paris Rulebook (the detailed rules that make the Paris Agreement operational); and*
- *Accelerate action to tackle the climate crisis through collaboration between governments, businesses and civil society".*

Progress was made through the agreement of the **Paris Rulebook**. As noted above, for the author the measure of success of **COP-26** (as expressed in **Edition 29** of the Low Carbon Pulse) was the agreement of the **Paris Rulebook**. As noted above, the **Paris Rulebook** will be considered in a stand-alone article early in 2022.

In addition to the framework provided by the **Paris Rulebook**, the **GCP** urges action "to [scale-up further] investments in climate action and calls for a continued increase in the scale and effectiveness of climate finance from all sources globally, including grants and other highly concessional forms of finance" and "to provide enhanced and additional support for activities addressing loss and damage associated with the adverse effects of climate change". It is fair to say that on the side-lines, Mark Carney was working tirelessly to facilitate collaboration and, in so doing, acceleration.

- **NDCs and NZEs:**

While a good number of countries have committed to achieving **NZE** and have increased their **NDCs**, based on population and projected population growth to 2060, the commitment made by the following may be regarded as of particular significance during **COP-26** (with combined current population of 2,170 billion people of 7.9 billion people):

- **Brazil** committed to achieving **NZE** by 2050 (213 million people);
- **India** committed to achieving **NZE** by 2070 (see under **India - Five prime commitments** below for details of further progress) (1.38 billion people);
- **Indonesia** committed to achieving **NZE** by 2060, and to reducing **GHG** emissions by 29% by 2030, or by 41% by 2030 with support from developed countries (273.5 million people).

Given the **ETM SEAP** (see next item under **Central Banks and Policy Banks Progress – Retirement of coal**), Indonesia may phase out coal-fired power generation by 2040 (sixteen years earlier than previously – see **Edition 18** of Low Carbon Pulse detailing the planned phase out of coal-fired power generation in Indonesia);

- **Nigeria** committed to achieving **NZE** by 2060 (206 million people); and
- **Vietnam** committed to achieving **NZE** by 2050 (98 million people).

Countries from which at least 80% (some sources suggest 90%) of **GHG** emissions arise annually have now committed to achieving **NZE**.

Countries that may be regarded as the key coal producers and users, have now committed to achieving **NZE**: Australia, India, Indonesia, Japan, the PRC, Republic of Korea, Russia, South Africa, the US and Vietnam.

- **Central Banks and Policy Banks Progress:** In the lead up to **COP-26**, **Editions 26, 27, 28** and **29** covered the roles to be undertaken by Central Banks and Policy Banks.

- **Retirement of coal: Editions 25** and **27** of Low Carbon Pulse covered the "acquire to retire program". On November 3, 2021, the Asian Development Bank, Indonesia and the Philippines announced the Energy Transition Mechanism (**ETM**) Southeast Asia Partnership (**SEAP**).

The **ERM SEAP** provides a framework to allow the acceleration of the retirement of coal-fired power stations.

In launching the **ERM SEAP**, the Indonesian Finance Minister, Ms Sri Mulyani Indrawati, noted that if Indonesia was to retire coal-fired power generation capacity by 2040, it needed "funding to retire coal earlier and to build the new capacity of renewable energy" (see **Editions 26** and **27** of Low Carbon Pulse).

To illustrate the level of funding required: the Indonesia Government has identified 5.5 GW of coal-fired power generation capacity that could be retired by 2030, at a cost of between USD 25 and 30 billion. The costs of electrical energy supplied to consumers of electrical energy is managed by the Government through its ownership of PT PLN (the Indonesian state-owned power utility corporation). Ms Sri Mulyani Indrawati noted that the cost of electrical energy would have to continue to be managed to ensure that the renewable electrical energy displacing the existing non-renewable electrical energy remained affordable.

- **Invigoration of role of Policy Banks:** The **GCP** calls upon "multilateral development banks" (with other financial institutions and the private sector) to enhance the mobilisation of finance generally, and specifically in respect of adaptation and mitigation, including "how climate vulnerabilities should be reflected in the provision and mobilization of concessional financial resources and other forms of support. In addition, the **GCP** "calls for multilateral development banks and other financial institutions to accelerate the alignment of their financing activities with the goals of the Paris Agreement".

While the Policy Banks have heard and read all of this before, the role of the Policy Banks, and the coordination between them, is central to achieving progress to reduce **GHG** emissions, and to achieving progress to **NZE**.

• **Business and Industry Progress during COP-26:**

- **Where there is a will there is a way:** For the author of Low Carbon Pulse, the quote of **COP-26** from the private sector was:

"What is stopping any other heavy, hard to abate industries from doing the same [i.e., doing what FMG is doing]? Nothing. Just the will to make it happen!"

Ms Julie Shuttleworth, CEO of Fortescue Future Industries. (Watch Ms Shuttleworth's speech [here](#).)

- **Green Hydrogen Catapult:** On November 6, 2021, it was reported widely that the **Green Hydrogen Catapult** (comprising a coalition of leaders from Acwa Power, CWP Global, Fortescue Future Industries, H2Green Steel, Iberdrola, Maersk Mc-Kinney Moller Center, Ørsted, Snam and Yara), with the support of UN High Level Champions for Climate Action, committed to secure finance so as to develop and to deploy 45 GW of electrolyzers by 2026.
- **Mission Possible:** On November 8, 2021, **Mission Innovation** (see **Edition 19** of Low Carbon Pulse), [announced](#) a public-private partnership to accelerate research and development in carbon dioxide removal (**CDR**).
- **Breaking through:** On November 8, 2021, Mr Bill Gates (through [GatesNotes](#)) reflected on the time spent at **COP-26**. The reflections are well-worth a read.

Mr Gates notes that the **"climate conversation has shifted dramatically, and for the better"**. Mr Gates hones in on three principal shifts: **1.** Increased and clear understanding of the role of clean energy innovation, and its place on the agenda; **2.** Increased, and now central role, of the private sector alongside Governments and not-for-profit organisations; and **3.** Increased visibility for climate adaptation. As part of this increased visibility Mr Gates notes the launch of the [Agricultural Innovation Mission for Climate](#).

- **Mark Carney posts:** In a number of posts during **COP-26**, Mr Mark Carney, noted that "tremendous progress" had been made, including that there is "a clear pathway" to mandatory climate-related reporting with **G7** and **G20** both supporting the *IFRS Foundation Sustainability Standards Board*, 90 Central Banks have joined the Network for Greening the Financial System (with the countries of those Central Banks covering 80% of **GHG** emissions globally). The *Glasgow Financial Alliance for Net Zero (GFANZ)* is "the gold standard for net zero commitments in the financial sector" and the "FSB Task on Climate-related Financial Disclosures (**TCFD**) ... help us move to ... finance the transition to net zero". The **GFANZ** is reported to be made of more than 450 financial institutions, including banks, asset managers, and insurers.

• **Less Progress during COP-26 (and therefore more progress required):**

- **Beyond Oil and Gas Alliance (BOGA):** **Edition 28** of Low Carbon Pulse noted that Costa Rica and Denmark are leading **BOGA**. The primary purpose is to persuade countries to commit to a firm date by which they will cease to produce oil and gas. As of November 11, 2021, **BOGA** had 11 signatories.
- **Increased awareness:** The author of Low Carbon Pulse listened to and watched tens of hours of streaming and read tens of thousands of words during **COP-26**. While there is a level of understanding, the nature and the quality of understanding would be enhanced greatly if Governments undertake public information programs.

• **Links to outcomes:**

The following table provides links (drawn from <https://ukcop26.org/the-conference/cop26-outcomes/>) to documents detailing outcomes from **COP-26**.

PROGRESS AT COP-26				
Breakthrough Agenda	COP-26 Catalyst For Climate Action	Adaption Research Alliance (ARA) Joint Statement on Launch	The COP 26 Health Programme	Zero Emission Vehicles Transition Council: 2022 Action Plan
International Aviation Climate Ambition Coalition	COP 26 Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans	Clydebank Declaration for Green Shipping Corridors	New Mission Innovation Missions	The Global Action Agenda for Innovation in Agriculture
Chair's Summary - Policy Dialogue on Accelerating Transition to Sustainable Agriculture through Redirecting Public Policies and Support and Scaling Innovation	Co-Chairs Conclusions of Education and Environment Ministers Summit at COP 26	Supporting the Conditions for a Just Transition Internationally	Focus of Energy Transition Council (ETC)	Joint Statement in Support of the UK-IEA Product Efficiency Call to Action to Raise Global Ambition Through the SEAD Initiative
Global Coal to Clean Power Transition Statement	Statement on International Public Support for the Clean Energy Transition	Mission Innovation- Breakthrough Energy Collaboration Agreement	COP26 World Leaders Summit - Presidency Summary	MDB Joint Climate Statement
Green Grids Initiative - One Sun One World One Grid: One Sun Declaration	Political Declaration on the Just Energy Transition in South Africa	COP26 World Leaders Summit - Statement on the Breakthrough Agenda	Forests, Agriculture and Commodity Trade	Agricultural Commodity Companies Corporate Statement of Purpose
MDB Joint Nature Statement	COP26 IPLC Forest Tenure Joint Donor Statement	COP26 Congo Basin Joint Donor Statement	The Global Forest Finance Pledge	Glasgow Leaders' Declaration on Forests and Land Use

- **Other publications in the context of COP-26:**

- **UNDP Carbon Pricing and Fossil Fuel Subsidies:** The United Nations Development Programme (**UNDP**) has published [A Guide to Carbon Pricing and Fossil Fuel Subsidy Reform: A Summary for Policymakers \(UNDP Guide\)](#). The **UNDP Guide** is a welcomed publication, and is well-worth a read.

Background: The **UNDP Guide** ties policy to the achievement of the [Sustainable Development Goals \(SDG\)](#). As noted in previous editions of Low Carbon Pulse, a detailed consideration of the **SDG** is beyond the scope of Low Carbon Pulse (although not the sibling publications).

Key messages: The key messages from the **UNDP Guide** are: **1.** Carbon pricing is key to reducing emissions and achieving reductions consistent with **NDCs**, and economic benefits; **2.** Carbon pricing can be imposed in a number of ways, but principally through an emissions trading scheme or a tax, or both (see **Edition 11** of Low Carbon Pulse); **3.** Carbon pricing is intended to increase the cost of the use of "polluting fuels and technologies", but must avoid civil unrest; **4.** Carbon pricing should be viewed as both a policy setting to reduce **GHG** emissions and as a revenue raising tool; **5.** International momentum on carbon pricing is gathering pace.

By way of further background: As a general statement the fossil fuel subsidies are effected directly, typically, through subsidising the cost of fossil fuel to users, including by not charging the full cost of production or exempting fossil fuels from a duty, impost or tax that might otherwise apply, or, indirectly, by not regulating activities such that the activities are undertaken that would ensure that the adverse effects of fossil fuel production and use are avoided or mitigated, and the full cost, cradle to grave, of development to decommissioning are subject to a fiscal regime works consistently.

- **Lazard Annual Levelizer:** Lazard (leading investment bank) published its annual [Levelized Cost of Energy Analysis](#) ahead of **COP-26**. The headline from the Lazard Report is consistent with other-findings during 2021, with photovoltaic solar and wind renewable electrical energy generation having an established cost advantage over coal, natural gas and nuclear electrical energy generation.

- **Global Stock Take:**

Mr Lucas Kruitwagen from the University of Oxford (with fellow researchers), has undertaken a study to develop a *Global Inventory* of utility scale photovoltaic solar facilities (being facilities with electrical energy generation capacity greater than 10 kW, excluding residential roof-top photovoltaic solar).

This research was published in [nature.com](#) magazine on October 27, 2021. The research located and mapped 68,661 facilities with between 350 and 500 GW on a plus or minus basis, but including an estimate of 423 GW utility scale photovoltaic solar capacity installed globally to the end of 2018.

- **Oversize is the right size:**

On November 3, 2021, the author came across the pithy phrase "*oversize is the right size*" in relation to the development of renewable electrical energy capacity in the context of [research](#) done by Caldeira.

The headline from the research is that in some countries it should be possible to match renewable electrical energy to load by the installation of a combination of photovoltaic solar and wind renewable electrical energy capacity having in combination equalling 150% of standard generation capacity and with nearly four hours of **BESS** capacity. This combination will result in load matched by dispatch in respect of all but 200 hours in a 8,760 hour standard electrical energy year.

The research is well-worth a read. While the research does not provide a solution based on the use of renewable electrical energy and **BESS**, given that a solution for the 200 hours a year needs to be found, the research does illustrate the continued direction of travel for renewable electrical energy. The obvious solution may appear to be oversized in some locations due to a higher percentage or to increase the **BESS** capacity, or both.

- **Profile and shape sizing – a view from the roof:**

On November 2, 2021, [reneweconomy.com.au](#) reported on the impact on the profile, and shape, of, and price of, electrical energy dispatched across the Australian National Electricity Market of the ever increasing dispatch of renewable electrical energy from roof-top photovoltaic solar installations. The report notes that Australia now has 13 GW of roof-top photovoltaic capacity, with that capacity being added to at a rate of around 3 GW a year.

Climate change reported and explained:

As noted in recent **Editions 26, 27** and **28** of Low Carbon Pulse, the purpose of this section of Low Carbon Pulse is to report the facts and stats as they relate to climate change, and as necessary to provide an explanation. This section was not included in **Edition 29** of Low Carbon Pulse so as to manage the length of that edition.

- **Concentration of CO₂:** Accordingly, the US National Oceanic and Atmospheric Administration (**NOAA**), in the week from October 31 2021 to November 6, 2021 recorded the concentration of **CO₂** in the climate system was 414.17 parts per million (**ppm**).

In the same week in 2020, the concentration of **CO₂** was 411.93 **ppm**.

In the same week in 2011 (ten years ago), the concentration of **CO₂** was 389.8 **ppm**.

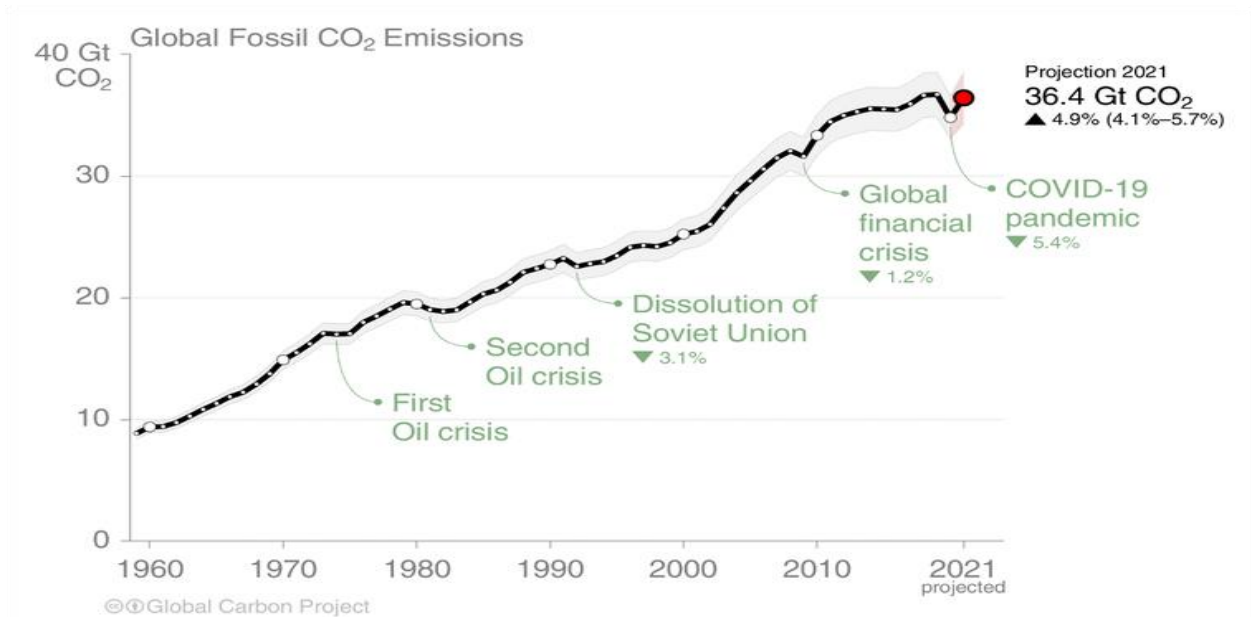
- **Mass of CO₂:** As the end of calendar year 2021 approaches, the early analyses and estimates of total **GHG** emissions from fossil fuels are being published.

On November 4, 2021, a Global Carbon Project (**GCP**) [study](#) is projecting that in 2021 **36.4** giga tonnes (**Gt**) of **CO₂-e** will be emitted into the climate system, compared to 2019 **36.7 Gt** of **CO₂-e**. After the reduction in **GHG** emissions arising in 2020, the level of **GHG** emissions arising in 2021 represents a bounce back – see the graphic at the top of the next page. The bounce-back is a function of a bounce-back to the use of fossil fuels.

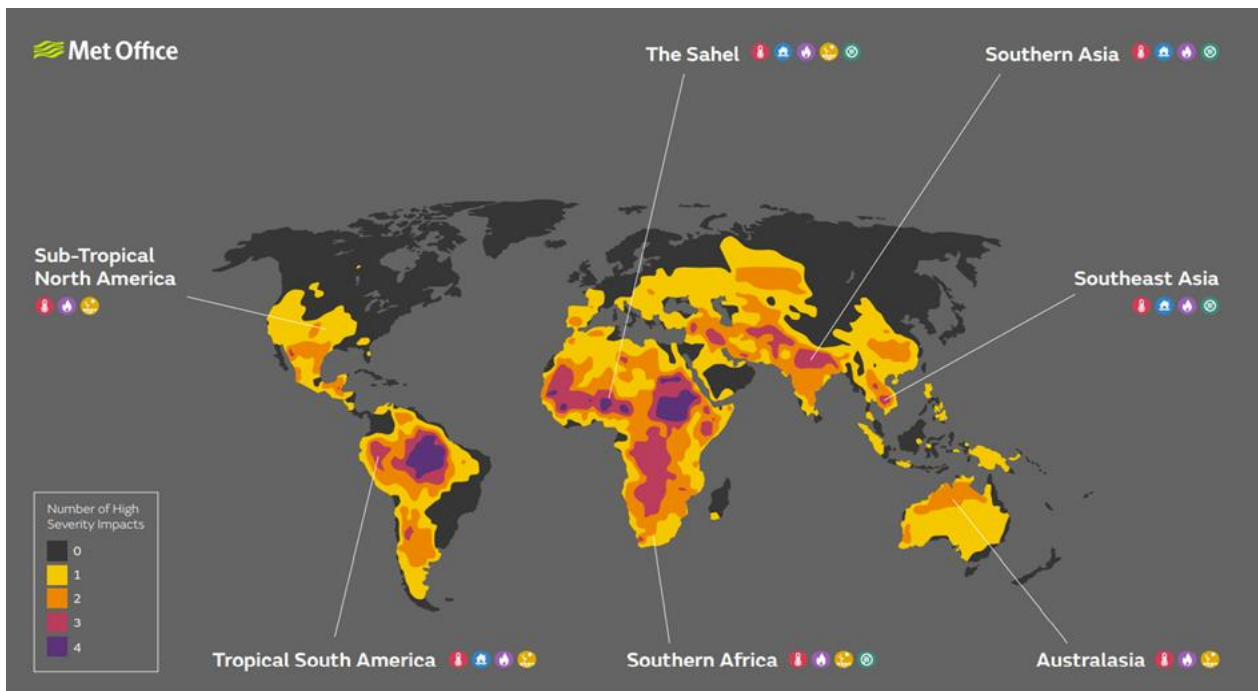
At the same time as **GHG** emissions arising from fossil fuel use have been increasing, **GHG** emissions from land-use appear to have been declining. This finding is recognised as requiring further work in the study.

Closer inspection of the **GCP** study (yet to be peer reviewed) indicates the importance of working with the **PRC** and India in accelerating the transition from the use of fossil fuels to produce electrical energy to renewable resources to produce electrical energy.

The graph below illustrates that the use of fossil fuel remains the default position.



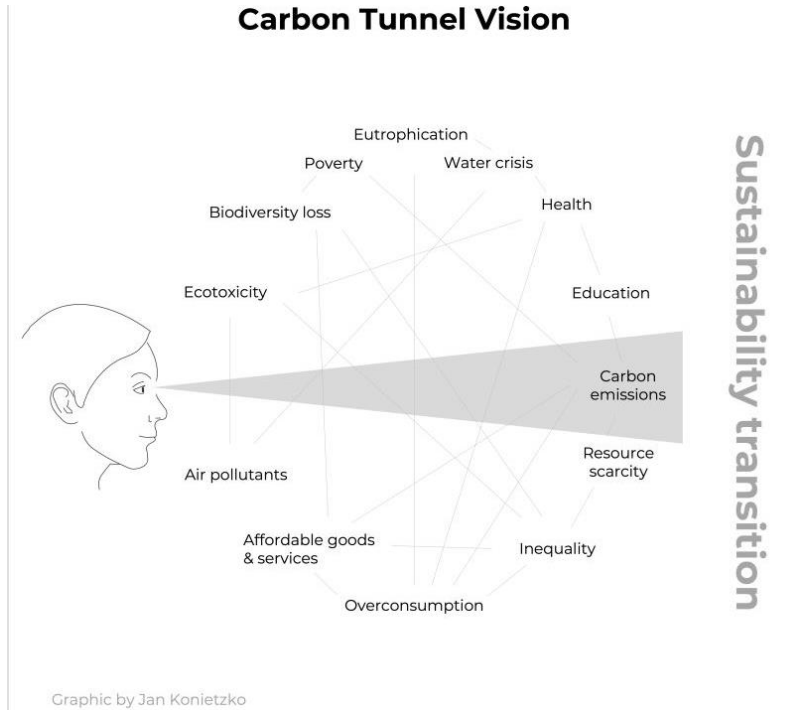
- Mass a mess:** On November 11, 2021, [The Washington Post](#) reported that there is likely to be undercounting of **GHG** emissions at a country level. The report emphasises the need for accurate monitoring, determination, and audit and verification. This is not a question of berating countries for not achieving targets; it is a means of ensuring that together **GHG** emissions are reduced. It is hoped that the implementation of the **Paris Rulebook** will allow effective monitoring, determination, audit and verification going forward.
- New Met Office study:** On November 9, 2021, the UK Met Office published a [new study](#). The headline from the study is that if the increase in average global temperatures increases by **2°C** above pre-industrial levels up to 1 billion people globally could face extreme heat stress. It is important to reflect that in average global temperatures have increased by **1.1°C** above pre-industrial levels.



Visualisation and Listening Platforms and Tools, and useful materials:

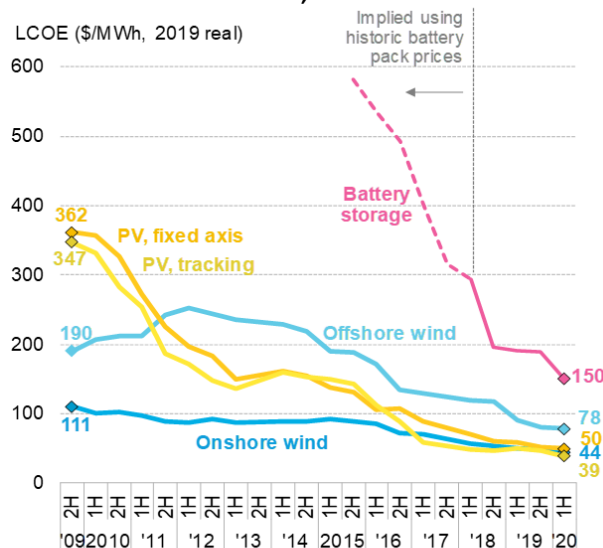
- **Carbon Tunnel Vision:** Since the start of September 2021, Low Carbon Pulse has focused on the issues and trends ahead of **COP-26**. As has been noted previously in Low Carbon Pulse, the purpose of Low Carbon Pulse is not to address progress towards achievement of the Sustainable Development Goals (**SDGs**) of the United Nations Environment Programme; rather its purpose is to monitor progress towards achievement of **NZE**.

On November 9, 2021, the author of Low Carbon Pulse came across a graphic by Mr Jan Konietzko which while not tied specifically to the **SDGs**, provides a helpful reminder that while our focus is on Carbon Emissions, and their reduction, and that this is the principal existential issue, it is necessary to have in mind the broader context of the reduction of **GHG** emissions, and in progressing to the achievement of **NZE** to seek to address **SDGs** on that journey.



- **Renewables are getting cheaper:** Edition 29 of Low Carbon Pulse included a graphic demonstrating that the cost of renewable electrical energy was the lowest in history. Continuing the theme, the cost of renewable electrical energy is getting cheaper. The following graph demonstrates this trend:

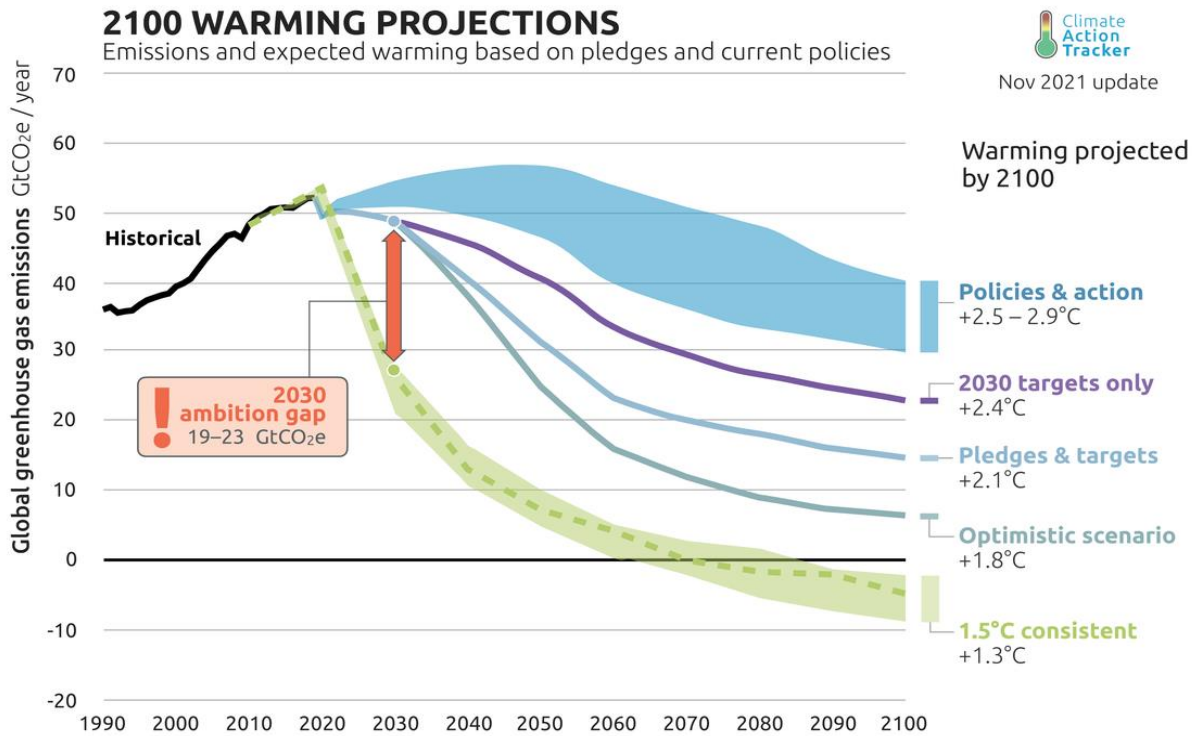
Figure 2: Global LCOE benchmarks – PV, wind and batteries



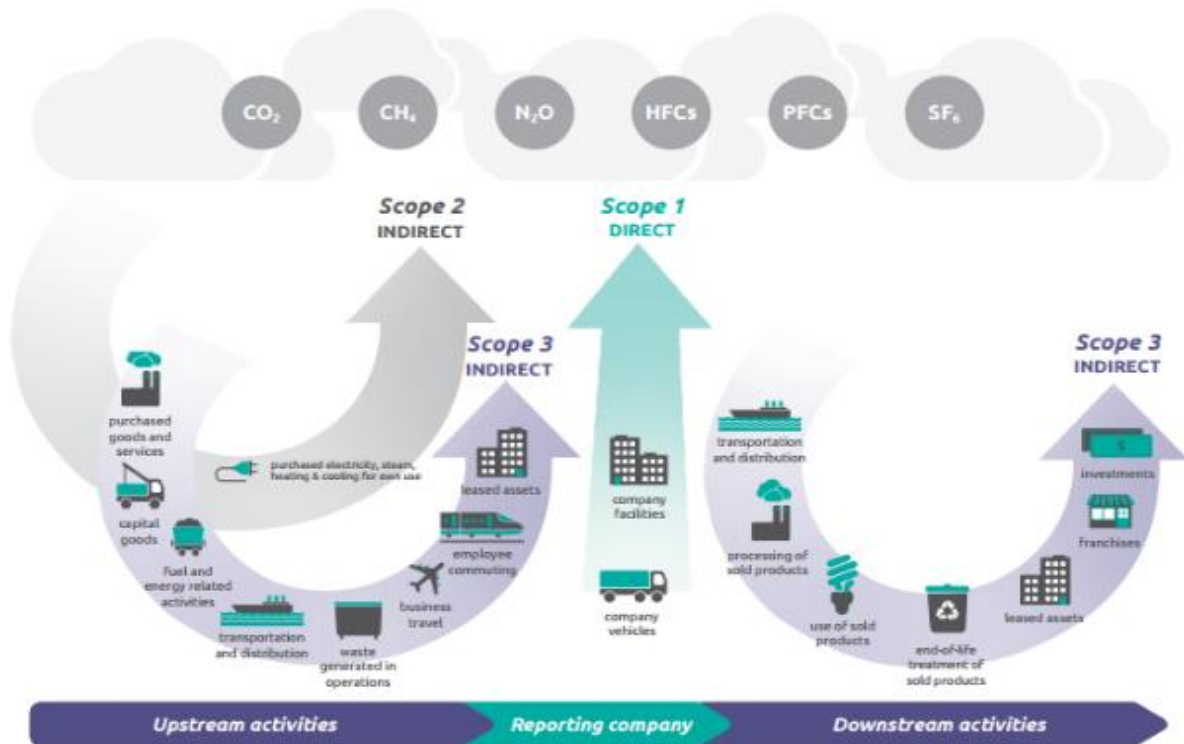
Source: BloombergNEF. Note: The global benchmark is a country weighted-average using the latest annual capacity additions. The storage LCOE is reflective of utility-scale projects with four-hour duration, it includes charging costs.

As noted on previous editions of Low Carbon Pulse (and sibling publications), the development and deployment of renewable electrical energy is at the core of achieving progress towards **NZE**.

- **Climate Action Tracker:** Previous editions of Low Carbon Pulse have included links to and graphics from the Climate Action Tracker. During **COP-26**, the good folk at Climate Action Tracker shared a powerful and sobering graph, which represents the data included in the thermometer graphic:



- **Scope 1, 2 and 3 emissions:** For details on Scope 1, 2 and 3 **GHG** emissions the authority is the [Greenhouse Gas Protocol](#) (mentioned in sibling publications of Low Carbon Pulse). To provide an understanding of each Scope at a glance, the following diagram is helpful:



IEA Statistics Report on GHG emissions from energy:

On November 11, 2021 the **IEA** released its report, [Greenhouse Gas Emissions from Energy, Statistics Report](#).

Consistent with recent reports from the **IEA**, the theme from the report is that the rate of development and deployment of renewable electrical energy capacity needs to increase. The Appendix to **Edition 34** of Low Carbon Pulse will include a detailed review.

Germany:

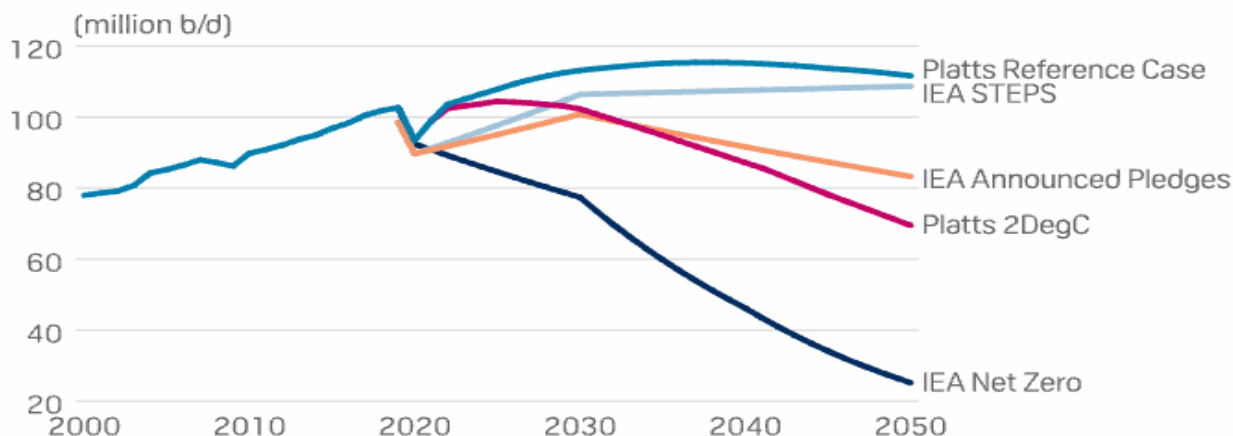
- **Blending begins:** On November 1, 2021, it was reported widely that Avacon (a subsidiary of energy giant E.ON) and the German Technical and Scientific Association for Gas and Water (**DVGW**) are to commence blending of hydrogen with natural gas, starting with a 10% hydrogen and 90% natural gas blend from December 2021, with a planned progression to a 15% to 85% mix during Q1 of 2022.
- **ISSB in Frankfurt am Main:** As noted above (under **Business and Industry Progress during COP-26 - Mark Carney posts**), the IFRS Foundation is establishing International Sustainability Board Standards (**ISSB**) to be headquartered in Frankfurt am Main, the German financial capital.
The purpose of the **ISSB** is to develop bases of disclosure and reporting that are comparable, of high quality and transparent on a par with the requirement for disclosure and reporting for the purposes of financial statements.
- **Germany and Scotland – Northern Green Giants:** On November 10, 2021, ScottishPower (one of the two giant Scottish energy companies, the other being [SSE plc](#)) made a [press release](#) contemplating collaboration between Germany and Scotland in the production of hydrogen in Scotland and export to Germany. The contemplated collaboration is outlined in the [Draft Hydrogen Action Plan](#) released by the Scottish Government (on November 10, 2021). The **Draft Hydrogen Action Plan** sizes the potential market at €20 billion.
- **RWE and Shell – Other North Green Giants: Editions 5 and 16** of Low Carbon Pulse reported at length (and over time) on the NorthH2 and the AcquVentus projects, both of which involve RWE and Royal Dutch Shell plc.
On November 11, 2021 RWE and Shell announced another major and significant combination of their cooperation, with the signing of a memorandum of understanding under which each corporation commits to advance jointly projects for the production, use and distribution of Green Hydrogen, and other decarbonisation projects, across Europe. While the focus is on Green Hydrogen, Blue Hydrogen may be produced, using CCS / CCUS.
See: [Green hydrogen and decarbonisation solutions: Shell and RWE want to drive energy transition forward](#)
- **RWE AG late news:** On November 15, 2021 (one day outside the two week news cycle for the rest of **Edition 30** of Low Carbon Pulse), RWE AG published its new strategy on **GHG** emissions to 2030 - €50 billion and 50 GW of renewable electrical energy capacity.

GCC countries update:

- **United Arab Emirates (UAE) Leadership:** On November 3, 2021, the **UAE** announced the establishment of a platform with **IRENA**, the Energy Transition Accelerator Financing (**Etaf**) platform.
The **Etaf** platform is intended to accelerate the transition to renewable electrical energy in developing countries. It is understood that the **UAE** has committed USD 400 million, to be provided by the Abu Dhabi Fund for Development.
See: [UAE and Irena plan to raise \\$1 billion for renewables innovation](#)
- **UAE Hydrogen Leadership:** On November 4, 2021, the **UAE** published its *Hydrogen Leadership Roadmap (H2LR)*, which includes five key means to enable clear legal and regulatory framework, and as clarity commercial development.
The **H2LR** has three core objectives: **1.** New sources of value creation through export of low carbon hydrogen and derivatives; **2.** Creating new opportunities through low carbon iron and steel, and **3.** Contributing to the **UAEs 2050 NZE** commitment (see **Edition 29** of Low Carbon Pulse).
Consistent with these three objectives, the **H2LR** is intended to provide the means to decarbonise domestic use of energy carriers and to provide the means to become a global hub for the production and export of clean hydrogen as a clean energy carrier.
The **UAE** is targeting a 25% share of the key clean energy carrier markets, including Germany, India, Japan, Republic of Korea, and East Asia, and Europe generally.
- **UAE and Germany mapping a way forward:** The relationship between the **UAE** and Germany continues to develop – on November 4, 2021 it was reported widely that a task force has been established to increase the levels of cooperation between the **UAE** and Germany.
This initiative builds on the role that Siemens fulfilled in the development of the first photovoltaic solar to hydrogen project and the [study](#) on the role of hydrogen in energy transition that was published in January 2021.
- **UAE and Pakistan aligning:** On November 9, 2021, it was announced that the **UAE** and Pakistan had signed a memorandum of understanding (**MOU**) to increase cooperation on climate change mitigation and environmental protection more broadly. The **MOU** was signed at **COP-26**.
- **Abu Dhabi plans additional 2 GW of PV solar:** On November 10, 2021, [energy & utilities](#), reported that Abu Dhabi is planning to deploy a further 2 GW of photovoltaic capacity (in two projects) in the near term.
It is reported that the Department of Energy (**DOE**) plans this deployment as one of nine clean energy initiatives within Abu Dhabi.
These nine clean energy initiatives include the two waste-to-energy plants in Abu Dhabi and Al-Ain, the tender process for which is underway. These projects are in line to follow the Emirates Waste to Energy Company (Bee'ah and Masdar) project in Sharjah, and the Besix, Hitachi Zosen Inova and Itochu Corporation project in Dubai.
The use of waste to energy in the **GCC** countries provides a means of effective disposal of waste, and the use of **BECCS** to capture and to store the **GHG** emissions that arise on combustion / thermal treatment of the waste.

- **Oman and Siemens mapping a way forward:** On November 11, 2021, the Oman Hydrogen Centre (**OHC**) signed a memorandum of understanding (**MOU**) with Siemens Energy Oman to collaborate on the development and deployment of hydrogen energy projects and on hydrogen initiatives in the Sultanate of Oman.
- **Fossil Fuel reduction:** On November 11, 2021, S&P Global Platts shared its perspective on the progress of the Kingdom of Saudi Arabia and the **UAE** towards **NZE** through the reduction in the production of oil. The following diagram demonstrates the dynamic of the required reductions in oil production to achieve the required reductions in **GHGs**:

GLOBAL OIL DEMAND SCENARIO DIVERGENCE



Note: Shows scenarios normalized to include oil liquids including biofuels

Source: S&P Global Platts Analytics, IEA

- **ACWA Power awarded 1.1 GW wind project in Egypt:** On November 11, 2021, [energy & utilities](#), reported that ACWA Power (leading power and utility corporation) was the successful tenderer to develop an onshore 1.1 GW wind farm, and had been awarded "a power purchase agreement ... by the Council of Ministers".
- **UAE location for COP-28:** On November 11, 2021, **UAE** as named as the host-nation for COP-28 in 2023. **UAE** hosting COP-28 may be regarded as clear recognition of the engagement of the **GCC** countries, and **UAE** in particular in progress towards the achievement of **NZE**, and critical role that each **GCC** country will play in progress towards **NZE**.

India:

- **One Sun, One World, One Grid (OSOWOG):** On November 2, 2021, Indian Prime Minister, Mr Narendra Modi, and the UK Prime Minister, Mr Boris Johnson, announced a transnational grid initiative – **OSOWOG**. In an ear-catching speech at **COP-26** Mr Modi noted:

"The One Sun, One World, One Grid and the [Green Grids Initiative](#) is an idea whose time has come. If the world has to move to a clean and green future, these interconnected transnational grids are going to be critical solutions".

- **Five prime commitments:** As noted above (under **NDCs and NZE**), the Indian Prime Minister, Mr Modi committed India to achieving **NZE** by 2050. Please click [here](#) for a transcript of Mr Modi's speech.

In addition, Mr Modi committed as follows: **1.** By 2030, India will increase its non-fossil fuel capacity to 500 GW (a 50 GW increase in this commitment); **2.** By 2030, India will satisfy 50% of its energy demand from renewable energy; **3.** By 2030, India will reduce its **GHG** emissions by 1 giga tonne (1 billion metric tonnes); and **4.** by 2030, India will reduce the carbon intensity of its economy to less than 45%.

Just as President Barack Obama stole the show in the second week of **COP-26**, Prime Minister Modi (with Prime Minister Mottley of Barbados) stole the show in the first week.

As has been noted in Low Carbon Pulse for some time, India is taking centre stage. This is critical globally, because the decarbonisation of India (as its population grows, the urbanisation of that population increases, and its economy develops), will be critical to the achievement of **NZE** globally.

- **USD 15 billion = 15 GW of Green Hydrogen Capacity:** The India Hydrogen Alliance (**IH2A**) (see [Editions 17](#) and [20](#) of Low Carbon Pulse) is leading and shaping thinking around the development of the hydrogen economy in India, and then its members are making that thinking a reality.

The **IH2A** estimates that the development of 15 GW of Green Hydrogen production capacity by 2030 will cost around USD 15 billion. The cost includes the development of electrolyzers that will require 30 GW of installed renewable electrical energy capacity. Using current technologies vital statistics, this deployment will allow the production of 3 million metric tonnes per annum of Green Hydrogen.

This estimate is contained in a [publication](#) from the **IH2A** that provides a digest of the developments in, and associated with, the development of the hydrogen economy in India. The publication is well-worth a read, and future editions of Low Carbon Pulse will include a link to it.

- **Adani to invest USD 70 billion:** On November 11, 2021, Adani (the world leading logistics-to-energy conglomerate) announced plans to invest USD 70 billion by 2030 in the development and deployment of renewable electrical energy. Adani intends to become the world's largest renewable electrical energy corporation.

The Adani investment plans include the development of giga-factories.

Further, by 2030, Adani intends to be the producer of the cheapest hydrogen globally.

See: Adani [website](#)

Indonesia:

It has been a busy time for policy setting in Indonesia.

In addition to the announcement of the commitment to the achievement of **NZE** by 2060 and the promise offered by Energy Transition Mechanism (**ETM**):

- On November 3, 2021, Indonesia announced that it is to regulate to price carbon through an carbon emissions trading scheme. Indonesia President, Mr Joko Widodo, announced the regulation at **COP-26**. (**Edition 21** of Low Carbon Pulse reported on the contemplated introduction of a carbon price based on an earlier draft of the regulation.) Corporations will be able to trade carbon permits / units, with the trading to take place on a bourse like platform. The Indonesian scheme will comprise a cap and trade scheme (see **Edition 12** of Low Carbon Pulse for explanation), under which a capped number of carbon permits / units will be issued, with corporations having to bid for those permits / units, and a carbon credit scheme.
- As noted above, on November 4, 2021, in statements surrounding the announcement of the **ETM** and the **NZE** by 2060 commitment, on a number of occasions, the [Long-Term Strategy for Low Carbon and Climate Resilience 2050](#) was mentioned.

PRC:

Everyday a range of interesting facts and stats emerge from news feeds and publications reviewed for the purposes of compiling Low Carbon Pulse. One of the more interesting facts of late is that the power demand for the iron and steel sector in **PRC** is equal to the power demand of Germany. It is worth sitting with this fact for a few minutes. The folk at IHS Market have provided a helpful [diagram](#) that indicates that the power demand in the **PRC** is driven by industry.

To manage the length of this **Edition 30** of Low Carbon Pulse, **Edition 31** will include new items from November 2021.

Japan:

• Pan-Pacific Panasonic:

- **Edition 18** of Low Carbon Pulse reported on Panasonic Corporation's plans to make its Kusatu fuel-cell factory a stand-alone plant powered by renewable electrical energy (**REE**) alone. Panasonic's plans are progressing, and Panasonic plan to commercialise the concept of a 100% **REE** fuel-cell factory by 2023. The 100% **REE** power supply for the fuel-cell factory involves the use of photovoltaic solar and lithium-ion battery electric storage systems, and fuel-cell technology to generate electrical energy from hydrogen.
- On November 6, 2021, it was reported that Panasonic Corporation and CIMC Enric (part of the China International Marine Containers or **CIMC**) had signed a memorandum of Understanding (**MOU**) to develop jointly hydrogen heat and power systems. It is understood that the fulfilment of the intent of the **MOU** will contribute to the development of an energy park pilot project, consistent with the plans of the Ministry of Science and Technology's plans outlined in 2020. See: [Panasonic in Hydrogen Power Talks with China's CIMC Enric](#)

- **Floating Off-shore Wind Group (FOW)**: On November 12, 2021, it was reported widely that Equinor, JGC Japan Corporation, OW Ocean Winds (a joint venture between EDP and Engie), Sumitomo Corporation Global Metals and TODA Corporation had established the **FOW**.

The stated purpose of the **FOW** is to promote actively the development and deployment of floating off-shore wind field capacity in the coastal waters of Japan. The **FOW** proposed three initial actions aligned with this purpose: **1.** To set a target of 2-3 GW of floating off-shore wind field capacity by 2030, and to set medium-term and long-term targets; **2.** To promote strategic development plans for large-scale development and domestic industrial use; and **3.** To create an attractive **FOW** business environment, and to accelerate it.

Australia:

- **Federal Government: Editions 28** and **29** noted the scrutiny to which the Federal Government of Australia is subject to, both from the international community and its own citizens. The Federal Government continues to share its view that technology, and not policy settings, will achieve reductions in **NZE** emissions. The consensus is that both are needed, because policy settings will drive the development and deployment of technology.

In the near term, Australia did not commit to the **Beyond Oil and Gas Alliance**, to the [Global Coal to Clean Power Transition Statement](#) or to the [Global Methane Pledge](#), but did commit to the [Glasgow Breakthroughs](#) and an emission technology development deal with the **ROK** – see below.

- **A Clean Energy Finance Corporation (CEFC) First**: On November 8, 2021, Australia's CEFC announced that it has committed funding to allow Orica (leading chemicals company) to update its processing plants to reduce **GHG** emissions arising from the production of ammonium nitrite, in particular to abate nitrous oxide (**N₂O**); one of the three principle **GHGs** with **CO₂** and **CH₄** (see **Edition 24** of Low Carbon Pulse).

This is a first for the CEFC in that it is the first direct investment in the manufacturing sector in Australia.

• State Governments:

• New South Wales:

Edition 4 of Low Carbon Pulse reported in the plans of the New South Wales Government to promote the development and deployment of renewable electrical energy in the State of New South Wales (**NSW**).

Edition 26 of Low Carbon Pulse reported on the level of interest in **New England Renewable Energy Zone** or **New England REZ**.

On November 1, 2021, it was reported widely that the NSW Government has invited registrations of interest for its third renewable energy zone (**REZ**) – the **South West REZ**.

There are three more **REZs** to come to market, the **Illawarra REZ** and the **Hunter-Central Coast REZ**. Please click [here](#) to view the NSW Government's electricity roadmap.

NSW REZs – THE STORY SO FAR ...

Central West Orana REZ – interest expressed by the private sector to develop 27 GW of renewable electrical energy capacity

New England REZ – interest expressed by the private sector to develop 34 GW of renewable electrical energy capacity

On November 11, 2021, [pv magazine](#), reported that Australia's first coordinated renewable energy zone is to be built in the central west of NSW, the **Central-West Orana REZ**.

The **Central-West Orana REZ** will deliver up to 3 GW of renewable electrical energy into the grid. The development of the **Central-West Orana REZ** is aligned with the NSW Government policy setting of the development and deployment of 12 GW of renewable electrical energy and 2 GW of **BESS** by 2030.

It is understood that the **Central-West Orana REZ** was preferred as the first **REZ** to be developed because of the level of investment in renewable electrical energy development already underway in the Central-West region.

It will be interesting to follow the developing of the NSW **REZ** development as Australia's most populous State progresses to the development and deployment of 12 GW of renewable electrical energy capacity across the State (see **Edition 4** of Low Carbon Pulse).

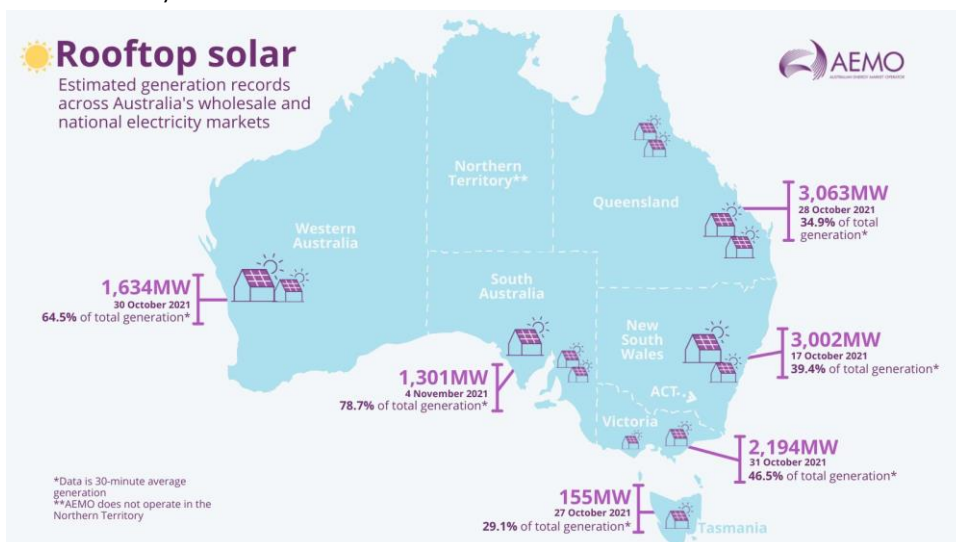
- **South Australia:** On October 29, 2021, the State of South Australia launched its [Hydrogen Prospectus](#) for the development of Three Hydrogen Hubs, at Cape Hardy / Port Spencer, Port Adelaide and Port Bonython.

Edition 3 of Low Carbon Pulse outlined the plans for the Hydrogen Hubs back in 2020.

As has been noted in previous editions of Low Carbon Pulse, the State and Territory Governments of Australia are trail blazing on the road to **NZE**, and each State Government recognises its role in facilitating the shift to hydrogen, and the value to its State of the shift. The Government of South Australia is in the vanguard of the States, and is leading the way with policy settings that will set a benchmark globally.

- **State by State – roof-top by roof-top:** Previous editions of Low Carbon Pulse have reported on the impact that matching load with dispatch of photovoltaic solar is having across Australia.

On November 9, 2021, the Australian Energy Market Operator (**AEMO**) published an insight piece with an accompanying map to show the current installed capacity across each Australian State and Territory. The levels and rates of installation of roof-top photovoltaic solar panels are a function of a number of factors, but critically the support offered by State and Territory Governments.



Republic of Korea:

- **ROK aligned with Australia:** During the **G20** Summit in Rome, Australian Prime Minister, Mr Scott Morrison, and **ROK** President, Mr Moon Jae-in, agreed that their countries would partner in the development and deployment of the development of technology to decarbonise industrial and transport activities.

The communique noted that Australia and **ROK** will: collaborate across existing and emerging low and zero emissions technologies, including technologies for clean hydrogen and clean ammonia supply; low emissions iron and steel; hydrogen fuel cell electric vehicles; hydrogen power generation; carbon capture, utilisation and storage; energy storage; solar; and critical minerals supply chain ...".

- **KEPCO and gencos to exit coal by 2050:** On November 10, 2021, [The Korean Herald](#), reported that Korea Electric Power Corp (**KEPCO**), and its six power generation subsidiaries (**Korea Hydro & Nuclear, Korea South-East Power, Korea Midland Power, Korea Western Power, Korea Southern Power** and **Korea East-West Power**), will phase-out coal, and will have ceased to use coal for the purposes of the generation of electrical energy by 2050.

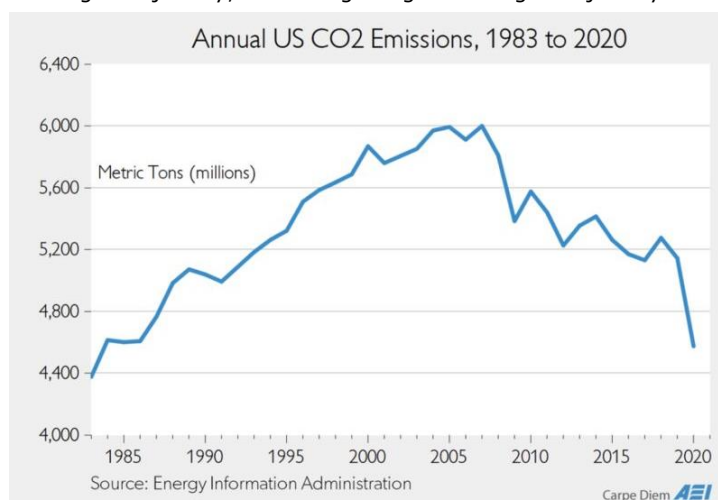
The activities of **KEPCO**, and its subsidiaries, give rise to around 37% of the **GHG** emissions arising in the **ROK** (or 270 million metric tonnes per annum of **GHG** emissions).

US:

- **While you were sleeping:** **Editions 23** and **25** of Low Carbon Pulse reported on the passing of the Bipartisan Infrastructure Deal (**Infrastructure Investment and Jobs Act**) by the US Senate.

On Saturday November 6, 2021 the White House released a [Fact Sheet](#) providing details of the Bipartisan Infrastructure Deal, the Deal having passed on Friday November 5, 2021.

- **While you were flying:** On November 10, 2021, the US [set](#) the goal of achieving net-zero **GHG** emissions from the US aviation sector by 2050. This follows the announcement in September of a reduction of 20% in **GHG** emissions by 2030, reflecting the shift to sustainable / synthetic aviation fuel (**SAF**).
- **The arc of US CO₂ emissions:** On November 11, 2021, the newly announced CEO of FFI North America, Mr Paul Browning, shared a graph showing the arc of US **CO₂** emissions from 1983 to 2020. While the information in the graph will not be new to many readers of Low Carbon Pulse, the key takeaway from the graph is that the US is on the right trajectory, and that getting on the right trajectory can be achieved quickly.



Bioenergy:

- **UK Biomass Policy Statement:** On November 4, 2021, the UK Government released its [Biomass policy statement: a strategic view of the role of sustainable biomass for net zero \(Biomass Strategy\)](#). The **Biomass Strategy** will be considered in detail in the **November and December Report on Reports**, to be published in the Appendix to the Second Edition of Low Carbon Pulse.
- **Low carbon whisky: Edition 23** of Low Carbon Pulse reported on the use of "green biogas" to power and to propel whisky delivery vehicles. On November 11, 2021, the Anaerobic Digestion and Bioresources Association (**ADBA**) reported on the approval of the development of Scotland's lowest-carbon grain distillery, St Boswells Distillery, in the rolling green and pleasant land of the Scottish Borders. St Boswell's is to use anaerobic digestion to take the spent cereal and convert the residual grain mulch into **CH₄** and residual material that can be used as a soil conditioner for crops.
- **Not low carbon enough ... not yet anyway:** Given the focus on Glasgow specifically, and Scotland generally, there has been an associated focus on the decarbonisation of the whisky industry in Scotland. While the industry is clearly making progress directionally to achieve **GHG** reductions and **NZE**, it is acknowledged by the industry that achieving **NZE** is going to be a challenge, and that it needs to do more.
- **More than a grain of truth:** On November 14, 2021, a piece came to the attention of the author of Low Carbon Pulse tying back to the use of the residual grain mulch. In Italy, Consorzio Italiano Biogas (**CIB**) is completing the development of a bioenergy production facility. The residual grain mulch is derived from the processing of the growth and cropping of native grains to produce flour and pasta. Like the spent cereal in the production of whisky, the residual mulch is subject to anaerobic digestion to derive biogas (a combination of **CO₂** and **CH₄**, and traces of other gases). The biogas is processed further to remove **CO₂** and traces of other gases, to upgrade the biogas to produce biomethane. The biomethane may be used to fire power generation or as pipeline gas to be delivered to the ultimate customer.

Blue and Green Carbon:

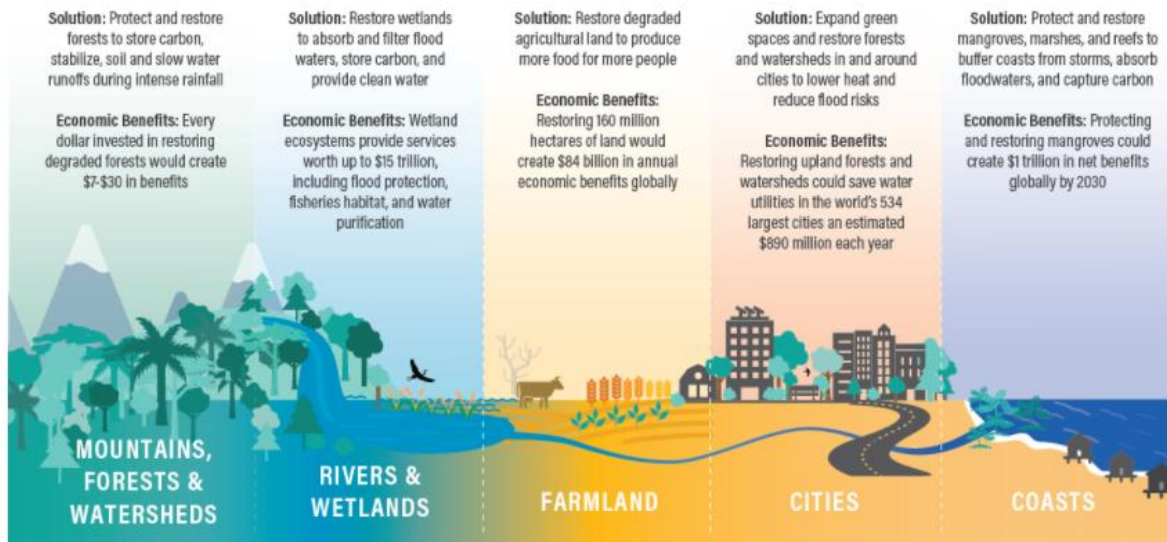
- **Great Green Wall (GGW):** On November 5, 2021, the European Commission (**EC**) extolled the virtues of the **GGW** project: the project is intended to restore degraded land across the Sahel Region of Africa, spanning 21 countries by the development of sustainable land management projects to form a 8,000 km "wall" across the width of Africa, covering an area of 100 hectares of degraded land. It is estimated that the restoration of the degraded land will provide a carbon sink into which 250 million tonnes of carbon may be sequestered. It is difficult to think of a project that illustrates more graphically the connection between the achievement of Sustainable Development Goals and land-use, and the connection of land-use to achieving progress towards the achievement of **NZE**. (The 21 countries are: Algeria, Benin, Burkina Faso, Cameroon, Chad, Cape Verde, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Ghana, Libya, Mali, Mauritania, Niger, Nigeria, Senegal, Somalia, Sudan and Tunisia). **See:** [The Great Green Wall \(GGW\)](#)
- **Energy Voice speaks to issues for Africa:** On November 5, 2021, [energyvoice.com](#), published an article entitled [Jobs, cash and power, it's all on the line for Africa's COP26 hopes](#). The article is excellent, noting that, "Africa is forecast to see more impact from climate change than others, even while going through its own critical energy access struggle".

For those on the continent, particularly in sub-Saharan Africa, a lack of electricity continues to be a major problem." (See **Edition 20** of Low Carbon Pulse.)

Consistent with the **GCP**, developed countries need to support African countries in the development and deployment of renewable electrical energy, the restoration of degraded land, and provide value to the use of land that allows for the maximisation of carbon removal and retention.

- **Green Carbon:** There has been an increasing focus on the use of nature based solutions to remove **GHG** emissions. **Edition 32** of Low Carbon Pulse (the *Magic Johnson Edition*) will cover Green Carbon and nature based solutions in full, but for the time being, this graphic is a good scene setter.

Nature-Based Solutions Can Deliver Big Economic Benefits



Source: Verdone and Seidl, *Roots of Prosperity* (Forests); Millennium Ecosystem Assessment (Rivers & Wetlands); A. Wu, *How Can Restoring Degraded Landscapes Deliver Financial Returns?* (Farmland); The Nature Conservancy, *Beyond the Source* (Cities); Global Commission on Adaptation, *Adapt Now* (Coasts).

WORLD RESOURCES INSTITUTE

BESS and HESS:

Long Duration Energy Storage Council (LDESC) established: On November 4, 2021, the **LDESC** was established to provide guidance to Governments to the transmission grid operators on the objective of working towards global deployment of 85 – 140 TWh of long duration energy storage by 2040.

The founding members of the **LDESCs** are (in alphabetical order): Alfa Laval, Ambri, Azelio, Baker Hughes, Breakthrough Energy, BP, CellCube, Ceres, Echogen Power Systems, EnergyDome, Enlighten, EOS, ESS, Inc., Ezinc, Form Energy, Greenko, Highview Power, Malta, Neom, Quidnet Energy, Redflow, Rio Tinto, Siemens Energy, and Stiesdal.

See: Long Duration Energy Storage Council [website](#)

CCS / CCUS:

- **Making CCS work:** On November 1, 2021, it was reported widely the Beach Energy Ltd and Santos Ltd took a final investment decision (**FID**) to sanction the development of a carbon storage project at the natural gas complex at Moomba, South Australia to store up to 1.7 million metric tonnes per annum (**mmtpa**) of **CO₂**.

CEO of Santos Ltd, Mr Kevin Gallagher, is reported to have stated that: "We forecast a full lifecycle cost of less than USD24 per tonne of **CO₂**, including cash costs in operation of USD6-8 per tonne of **CO₂**". Mr Gallagher went on to note that: "It is also an important milestone in our plan for Santos to achieve net-zero Scope 1 and 2 emissions by 2040".

It is understood that key to **FID** was the agreement of the Federal Government of Australia to issue carbon credits in respect of the **GHG** emissions avoided by the capture and the storage of **CO₂**, with the value of the carbon credits understood to be broadly equivalent to the development of the CCS project cost. The registration of the CCS project by the Clean Energy Regulator means that carbon credits will be issued over the 25 year period of the project.

The focus therefore is on the cash costs in operation of USD6-8 per tonne of **CO₂** – to the knowledge of the author the lowest cash cost of operation for CCS globally.

See: [Santos announces FID on Moomba carbon capture and storage project](#); [Beach and Santos announce FID on Moomba carbon capture & storage project](#)

- **Santos DACs:** On November 5, 2021, Santos Ltd announced that it was partnering with the **CSIRO** (Commonwealth [of Australia] Scientific and Industrial Research Organisation, being the national science agency of Australia) to develop low cost direct air capture technology.

The partnership intends to continue work to develop the CSIRO Carbon Assist™ technology. The technology will be tested at the natural gas complex at Moomba, South Australia, with the **CO₂** captured to be stored at the Moomba Carbon Storage project.

See: [Santos partners with CSIRO on development of new technology to negate carbon emissions](#)

- **UK Phase 2 of CCS Cluster Sequencing Process: Editions 23, 28 and 29** reported on Carbon Clusters and Hydrogen Hubs around the UK. As reported in **Edition 29** of Low Carbon Pulse, the UK Government selected the **East Coast Cluster** (comprising Net Zero Teesside and Zero Carbon Humber) and **HyNet North West** as the two CCS projects (each a **Track-1-Cluster**) that were to receive government support in the **Track 1 CCS Programme** (see **Edition 23** of Low Carbon Pulse), i.e., **Phase 1 of the Cluster Sequencing Process**: the policy setting provided for the selection of two CCS projects (as outlined in **Edition 23**). In addition to the **East Coast Cluster** and **HyNet North West**, the **Scottish Cluster** was announced as a reserve cluster.

On November 8, 2021, the UK Government called for submissions from organisations wanting to take part in **Phase 2 of the CCUS Cluster Sequencing Process**. Phase 2 is stated to be "open to Power, Industrial Carbon Capture and Hydrogen production projects which meet the technology specific eligibility criteria".

- **Oxy Low Carbon Hub expands:** On November 9, 2021, it was reported widely, that Occidental Petroleum Corporations Oxy Low Carbon Ventures LLC (OLVC) is to expand the Gulf Coast CCS Hub by the development of a new CCS Sequestration Hub in Southern Texas.

See: Oxy Low Carbon Ventures [website](#)

- **ExxonMobil and Petronas teaming: Edition 29** of Low Carbon Pulse reported on ExxonMobil's focus on South East Asia for the development of CCS. On November 9, 2021, it was reported widely that ExxonMobil and Petronas had signed a memorandum of understanding to explore jointly the potential to develop carbon capture and storage technology projects in Malaysia. It is understood that a key aim of the work will be to allow Malaysia to reduce **GHG** emissions arising from activities within the country.

- **Transitioning to CCS in Norway: Editions 27 and 28** reported on development of the sub-sea bed of Norwegian Continental Shelf for use for storage of **CO₂**. On November 12, 2021, Rex International Holding Ltd, through its 90% owned subsidiary, Lime Petroleum AS, has teamed with Nautilus Carbon Services AS to secure a **CO₂** storage site.

CO₂ and its use:

CO₂ liquefaction: Thunder Said Energy has released an interesting [paper](#) on the liquefaction of **CO₂** on a smaller scale. Because of the properties of **CO₂**, most importantly a triple point of 5-bar and -57°C, it is possible to liquefy **CO₂** using 100 kWh of electrical energy per tonne of **CO₂**. The paper is well-worth a read, exploring the industries that may benefit from the dynamics explained in the paper.

E-fuels / Future Fuels / Now Fuels:

- **Linde hopping along:** Previous editions of Low Carbon Pulse have reported on progress of various initiatives and projects of Linde (one of the Big Three industrial gas suppliers globally), including in respect of Leuna.

On November 2, 2021, Linde announced further progress with the development of a new 24 MW PEM (proton exchange membrane) electrolyser facility at the Leuna Chemical Complex in Leipzig-Halle, Germany. The PEM electrolyser to be installed at the facility will be manufactured by ITM Linde Electrolysis GmbH, a joint venture between ITM Power and the Linde. It is great to see these leading corporations working together.

Green Hydrogen produced at the facility will be supplied to industrial customers of Linde using the existing hydrogen network and will be liquified and distributed to provide fuel from the mobility / transport sector. The facility is scheduled to commence production of Green Hydrogen in 2022.

See: Linde [website](#)

- **Aman Green Hydrogen Project:** On November 4, 2021, the Islamic Republic of Mauritania and CWP signed The [Glasgow Declaration](#).

The commercial purpose of the **Glasgow Declaration** is to allow the development of the second phase of the Green Hydrogen project to be developed at Aman, using 30 GW renewable electrical energy from photovoltaic solar and wind sources to produce up to 10 million metric tonnes per annum of Green Ammonia. The scale of the Aman project is significant in a global context.

The form of the **Declaration** is significant because it recounts the **Glasgow Breakthroughs** in particular, "**to accelerate the development and deployment of green hydrogen as a critical tool for decarbonising heavy industry and transport**", the African Green Hydrogen Alliance, and its role in support of the Green Hydrogen Catapult. In other words, the **Declaration** recounts the growing framework for the development and deployment of Green Hydrogen projects.

- **Mid-West Pilot Project:** On November 4, 2021, APA Group, Pilot Energy and Warrego Energy announced the formation of a consortium to undertake, and to fund jointly, the development of a pilot Blue Hydrogen and CCS project in the Mid-West Region of Western Australia.

See: [Consortium to investigate delivery of low cost hydrogen](#); [Consortium formed to progress Pilot's Mid West blue Hydrogen and Carbon Capture & Storage \(CCS\) Project](#); Warrego Energy's [announcement](#)

- **Namibia perfectly placed: Edition 26** of Low Carbon Pulse reported on consideration of the development of a Green Hydrogen project in Namibia. On November 5, 2021, it was reported widely that Hyphen Hydrogen Energy had been selected by the Government of Namibia to develop a large-scale Green Hydrogen project (**NH2 Project**).

The **NH2 Project**, to be located in the Tsau / Khaeb national park, is to produce 300,000 metric tonnes of Green Hydrogen a year. It is reported that the renewable electrical energy for the **NH2 Project** will comprise 2 GW mixed photovoltaic solar and wind, and **BESS**, with a total capital cost of USD 4.4 billion.

The location in the Tsau / Khaeb national park is a function of: "*The Tsau / Khaeb national park [being] among the top 5 locations in the world for low-cost hydrogen production, benefiting from a combination of co-located onshore wind and solar resources near the sea and land export routes to market*".

The **NH2 Project** will be capable of expansion to 5 GW of renewable electrical energy and 3 GW of electrolyser capacity, with a total capital cost of USD 9.4 billion on expansion.

See: Hyphen Hydrogen Energy [website](#)

- **Ports connecting the dots:** On November 13, 2021, it was reported that the Namibian Ports Authority (**NPA**) had signed a memorandum of understanding (**MOU**) with the Port of Rotterdam Authority (**PORA**). The **MOU** contemplates that Namport, Namibia, will become the key export port of Green Hydrogen and Green Hydrogen-based fuels produced by the **NH2 Project**. Under the **MOU**, **NPA** and **PORA** will work together to connect Namibia with the Port of Rotterdam, and as such, provide a gateway to access European buyers of Green Hydrogen and Green Hydrogen based-fuels. The development of port capacity is key in the context of any Green Hydrogen Hub.
See: Port of Rotterdam [website](#)
- **Haldor Topsoe and Hyundai Oil Bank look for opportunities:** On November 8, 2021, Haldor Topsoe announced that it and Hyundai Oil Bank were working together to identify opportunities with Blue Hydrogen and Green Hydrogen, and waste plastic recycling, bio-refining and e-fuels.
As might be expected, they are also working on CCS and CCUS capacity development. This is an exciting combination, marking the likely convergence of the use of chemical technology to recycle waste plastics at scale.
See: [Haldor Topsoe and Hyundai Oilbank sign Memorandum of Understanding to develop green energy solutions](#)
- **Blue Hydrogen Power Project Progresses: Edition 21** of Low Carbon Pulse reported on the development of the 600 MW Blue Hydrogen fuelled power project at Keadby (**Keadby BH2 Power**): the Blue Hydrogen being produced from natural gas feedstock, with the **CO₂** arising to be captured and stored.
On November 2, 2021, Equinor (leading international energy corporation) announced that it has the pre-FEED contracts had been awarded for the development of the Blue Hydrogen production plant.
See: Equinor [website](#)
- **Patriot Energy to Clean the Kimberley:** On November 8, 2021, it was reported widely that Patriot Hydrogen is to supply **75 P2H** hydrogen generation units to Kimberley Clean Energy which intends to decarbonise the length of its value chain. It is understood that the generation units will create clean hydrogen, including from the use of biomass and waste.
See: Kimberley Clean Energy [website](#); Patriot Hydrogen [website](#)
- **Giants, Norsk Hydro and Shell break bread:** On November 9, 2021, Norsk Hydro and Shell signed a memorandum of understanding to identify projects for the development of Green Hydrogen capacity.
It is understood that Norsk Hydro's Green Hydrogen business, Hydro Havrand, will concentrate on the production and supply of Green Hydrogen – "produced from renewable [electrical energy] in hubs centred around Hydro and Shell's own business, and where they see strong potential for scaling production for customers in heavy industry and [mobility] transport".
See: [Hydro and Shell join forces to explore renewable hydrogen projects](#)
- **FFI humming along, this time in Argentina and PNG:**
 - **Pampas Facility:** On November 1, 2021, the first day of the **World Leaders' Summit** and the second day of **COP-26**, Fortescue Future Industries (**FFI**) announced plans to develop a 15 GW USD 8.4 billion Green Hydrogen production project (**GHPP** or **Pampas Facility**) in Rio Negro province, Patagonia, Argentina by 2030.
On development, **GHPP** will produce 2.2 million metric tonnes per annum of Green Hydrogen – sufficient to decarbonise the German iron and steel industry. The **GHPP** will be developed in stages, with the pilot phase (600 MW USD 1.2 billion) being completed by the end of 2024, followed by the progress phase (1.4 GW), with the final phase to be completed by 2030.
 - **PNG facilities:** On November 6, 2021, **FFI** signed a Master Development Agreement under which **FFI** is to undertake feasibility studies with a view to developing renewable energy projects in Papua New Guinea, and the development of Green Hydrogen attendant on the proving up project through those feasibility studies.
- **Norway considering State-Owned Hydrogen company:** On November 12, 2021, it was reported widely that the Norwegian Government is considering establishing a hydrogen energy carrier corporation, possibly in combination with Equinor (owned as to 67% by the Norwegian Government) or Statkraft (owned as to 100% by the Norwegian Government), or both of them.
Previous editions of Low Carbon Pulse have advocated that there is a role for Government in the development of hydrogen supply (most recently see **Edition 27** of Low Carbon Pulse). Norwegian Climate Minister, Mr Espen Barthe Eide said: "**The idea is ... [to] be an engine to drive large hydrogen investments in Norway**".
- **Woodside Energy progressing in Tasmania:** Previous editions of Low Carbon Pulse have reported on the plans of Woodside Energy Ltd (**WEL**) to develop a Green Hydrogen production facility in Bell Bay, Tasmania (please click [here](#) to view the Low Carbon Pulse Compendium). On November 12, 2021 it was reported widely that **WEL** had secured a site for the production facility, and planned to make a final investment decision during 2023.

Green Metals / Minerals, Mining and Difficult to Decarbonize industries:

- **Hydrogen at mine site:** On November 11, 2021, Unique Metals and Xodus announced that they had signed a memorandum of understanding to use hydrogen to power and to propel forklift trucks and to produce electrical energy at Unique Metals HyMetals Project.
See: websites of [Xodus](#) and [Unique Metals](#)
- **Investment required at mine site:** During **COP-26**, the author of Low Carbon Pulse read many articles on the level of investment required to achieve **NZE**. As noted in previous editions of Low Carbon Pulse, Low Carbon Pulse does not include estimates of costs, noting that the estimates change. This said, on November 11, 2021, an article in [Kitco News](#), authored by Mr Neils Christensen, struck a chord, and as such we are going to make an exception.
The article is well-worth a read, picking up on great report from Bank of America (published on November 8, 2021), in particular picking up on the conclusion that the mining industry "**needs to spend USD 72 billion annually out to 2030 just to prevent bottlenecks to achieving Net-Zero**". In context, the business as usual capital investment by the mining industry over the last decade has averaged around USD 99.5 billion annually.

Hydrogen - Cities, Clusters and Hubs, Giga-Factories, and Valleys:

- **Port of Newcastle:** On November 8, 2021, the Australian Renewable Energy Agency (**ARENA**) announced funding support for a study to assess the potential of the Port of Newcastle (still the world's busiest port for the export of coal). The Hunter Valley region has long produced and exported coal.

The Port of Newcastle has considerable potential as a location for a hydrogen hub (and as a possible carbon cluster).

See: [ARENA](#) website

- **ITM Power to develop second UK giga-factory:** On November 9, 2021, it was reported widely, that leading Green Hydrogen technology company, ITM Power intends to develop its second giga-factory in the UK (1.5 GW of capacity). The second giga-factory is to be located close to its first giga-factory, with both sites in Sheffield, South Yorkshire, England.

See: [Intention to Purchase Site in Sheffield for the Second UK Giga Factory Collaboration with University of Sheffield](#)

- **A new twinning:** As a young fella one of the games played on long car journeys was to observe the signs for each town and to see with which town it was twinned.

At **COP-26** a new twinning initiative was [launched](#), the H2 Twin Cities initiative. The purpose of the initiative is to connect cities and communities around the world to develop and to deploy clean hydrogen solutions.

- **Amsterdam Hydrogen Hub:** On November 11, 2021, it was reported widely that Amsterdam has launched a Hydrogen Hub (**AHH**). The **AHH** involves collaboration by the Port of Amsterdam, Amsterdam Airport, Schiphol, Vattenfall, Liander, NZKG, Gasunie, Oram Nobian and the province of North Holland and the municipalities of Amsterdam and Zaanstad. It is understood that the principal aim of the hub is to achieve the large-scale transition of the Amsterdam Area and North Sea Canal Area into a hydrogen economy by 2050 through the import and export of hydrogen.

Wind round-up:

- **Ørsted Hai Phong proposal:** On November 2, 2021, Ørsted proposed the development of a USD 11.9 to 13.6 billion 3.9 GW off-shore wind field (**OWF**) project off-shore Vietnam. The **OWF** will be located 14 km off Bach Long Vy Island, and around 100 km from the mainland. Ørsted has the backing of the Danish Government.

See: Ørsted [website](#)

- **Eastern Horizons in view:** On November 5, 2021, Dominion Energy (**DE**) submitted plans for approval by Virginia State Corporation Commission for the development of the 2.6 GW off-shore wind field project off of the US State of Virginia (**Coastal Virginia Offshore Wind** or **CVOW** project). The **DE** announcement follows the announcement by Siemens Gamesa (leading manufacturer of wind turbines) on its development of the US's first wind turbine blade manufacturing facility at the Port of Virginia.

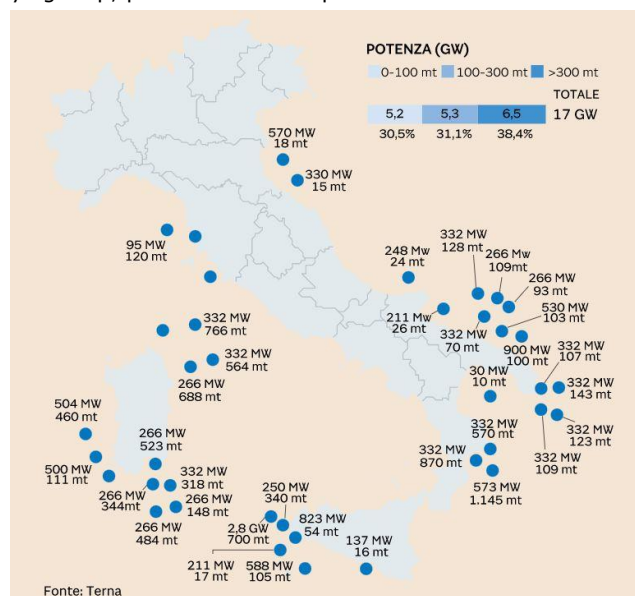
See: [Dominion Energy Continues to Advance Coastal Virginia Offshore Wind Project; Finalizes Selection of Major Offshore Suppliers; Global leadership grows: Siemens Gamesa solidifies offshore presence in U.S. with Virginia blade facility](#)

- **Northern Horizons expand:** On November 5, 2021, Aker Offshore Wind and Aker Clean Hydrogen, working in collaboration with **DNV**, announced plans to develop an off-shore wind field project to the north of the Shetland Isles off the north of Scotland with the renewable electrical energy generated to be used to power multiple floating installations that will produce Green Hydrogen to haulage to a net-zero refinery on Shetland. The Shetland refinery will liquefy the Green Hydrogen and use it as feedstock to produce Green Ammonia and other hydrogen-based fuels for use within the UK and globally. The project is called Northern Horizons.

See: [Northern Horizons: A Pathway for Scotland to Become a Clean Energy Exporter](#)

- **Italian off-shore wind set to boom: Editions 28 and 29** of Low Carbon Pulse have reported on progress in respect of off-shore wind field developments.

On November 9, 2021, Mr Gionvanni Battista Picotti published an insightful piece on the development of the off-shore wind fields with an accompanying map, please see the map below.



- **From the Balerics to the Baltic (again):** On November 8, 2021, global international energy giant, Iberdrola, announced plans to develop an off-shore wind field in the Baltic Sea, the 300 MW Windanker project. This will be the third off-shore project developed by Iberdrola, after the operational 350 MW Wikinger project, and the under-development 476 Baltic Eagle project.
See: [Iberdrola develops Windanker, its third offshore wind farm in the Baltic Sea, with €800 million planned investment](#)
- **Crown Estates eyes the horizon again:** On November 11, 2021, The Crown Estate outlined [plans](#) to develop up to 4 GW of off-shore wind field capacity in the Celtic Sea.
The Chief Executive at The Crown Estate, Mr Dan Labbad, noted the need to continue to work closely with the UK and Welsh Governments, regional authorities and the market as the plans become better defined.

Solar and Sustainable Energy Round-up:

In addition to other news items covered above in respect of solar and sustainable energy, the following news items are noteworthy:

- **France to build new nuclear:** In November, 2021, it was reported widely that French President, Mr Emmanuel Macron, had addressed the French people to announced that a formal decision was imminent about the development of further EPR reactors.
- **Chile proposes 15,000 km HVDC interconnector:** On November 14, 2021, Chile proposed the development of a High Voltage Direct Current interconnector to transmit electricity from renewable electrical energy production in South America to Asia.

Round-up on Land Transport:

Consistent with [Edition 29](#) of Low Carbon Pulse, this [Edition 30](#) of Low Carbon Pulse includes news items of Land Transport, Ports and Shipping and Airports and Aviation from both the new cycle for this [Edition 30](#) of Low Carbon Pulse and for [Edition 29](#) of Low Carbon Pulse.

As explained in [Edition 29](#) of Low Carbon Pulse, this approach was taken to manage the length of [Edition 29](#), while ensuring that all material and significant news items are covered.

- **Buses and Coaches (and ambulances):**
 - **Wrightbus:**
 - **Right technology:** On October 8, 2021, it was reported widely that Wrightbus' fuel cell technology (**FCT**) double-decker bus was to be show-cased at the Global Investment Summit (which took place on October 19, 2021, see [Edition 29](#) of Low Carbon Pulse).
 - **Right for Brighton:** On November 4, 2021, Go-Ahead Group plc ordered 20 fuel cell electric (**FCE**) buses from Wrightbus. The **FCE** buses are to be delivered and deployed during 2022.
 - **New Flyer:**
On October 14, 2021, it was reported widely that NFI Group (a leading bus and coach manufacturer) that Champaign-Urbana Mass Transit District (**MTD**), in Illinois, being:
"the first-in-America renewable transportation project"
was to use the fuel-cell Xcelsior CHARGE H2 buses manufactured by NFI Group company, New Flyer of North America Inc.
The buses are powered and propelled by **FCT** using renewable hydrogen.
 - **New coach for Brisbane:**
In late October 2021, it was reported widely that a coach manufactured by Hyzon Motor Inc., was operating in Brisbane, Queensland.
 - **NH2S:**
On November 2, 2021, it was reported widely, that the National Health Service in the UK (as part of the London Ambulance Service) is to trial the use of a **FCT** powered and propelled ambulance.
The ambulance being trialled has been developed by UK corporation, ULEMCo, is equipped with a fuel cell in the power train of the ambulance, and has a range of 300 miles (or 482 kms).
 - **Ballard abroad:**
On November 4, 2021, Ballard Power Systems Inc. announced an order for 40 FCmove™ HD (70kW) modules for use to power and to propel fuel cell electric buses (**FCEB**) across Europe and the UK during 2022.
 - **Long-distance coach travel:**
On November 12, 2021, a consortium comprising FlixMobility, Freudenberg Fuel Cell e-Power Systems and ZF Friedrichshafen AG announced plans to develop a long-distance coach for use across Europe - the HyFleet project.
The long-distance coach is planned to be developed and deployed by the end of 2024, and will travel up to 200,000 kms a year, and is capable of travelling 1,000 kms between refuelling.
- **Motor cars – the daily drive:**
 - **EV progress:**
During October, as the figures for sale of motor cars across Europe were compiled, it became apparent that September 2021 was the first month in which the best-selling motor car in Europe was an EV.

- **EV sales:** On November 9, 2021, Alessandro Blasi, Special Advisor to the IEA Executive Director shared a useful perspective on the development of the EV market, accompanied by a bar chart to demonstrate the sale of EV across selected markets:



- **Industrials:**

- **JCB – Green PRyze:** On October 20, 2021 JCB committed to accelerating the switch of its construction and works equipment to the use of hydrogen.

On November 1, 2021, it was reported widely that **FFI** (a subsidiary of Fortescue Metals Group Limited, established by Dr Andrew Forrest, AO) and JCB and Ryze Hydrogen had signed an agreement to supply Green Hydrogen for Ryze Hydrogen to distribute across the UK to match demand of customers across the UK.

A quick reminder: Dr Forrest has set the corporations that he established the target of producing 15 million metric tonnes per annum (**mmtpa**) of Green Hydrogen by 2030, moving to 50 **mmtpa** by 2040. As noted above, FMG is continuing to identify projects globally that will allow it to match its targets with production.

- **JCB – Main Prize:** On November, 2021, JCB was awarded the Royal Automobile Club's Dewar Trophy (a prestigious engineering award) for its hydrogen-fuel engine design.

- **Intermodal and Logistics:**

On October 13, 2021, Maersk Japan announced that it was piloting an intermodal transportation solution (**ITS**) in Japan. Among other things, the **ITS** involves the use of renewable diesel (to achieve immediate **GHG** emission reductions).

- **Trains:**

- **PRC testing fuel cell hybrid:** On November 3, 2021, hydrogenfuelnews.com, reported that the first hydrogen fuel cell hybrid locomotive developed in the **PRC** commenced pilot testing in the final week of October 2021. The hydrogen fuel cell hybrid train project is a joint venture between CRRC Datong Co., Ltd., (a subsidiary of the State Power Investment Corporation Limited (SPIC) and the Hydrogen Energy Co., Ltd.

- **Porterbrook – repurposing with promise:** On November 5, 2021, it was reported widely that Porterbrook has repurposed a locomotive, the HydroFLEX, the UK's first hydrogen-ready passenger train, using **FCT**, using Green Hydrogen, and oxygen to power and to propel the train.

See: HydroFLEX [website](#)

- **Alstom and Eversholt fast friends:** On November 10, 2021, [Global Railway Review](#), reported that Alstom and Eversholt Rail had signed an agreement for the delivery of 10 three car hydrogen multiple units (**HMUs**). The HMUs are to be designed, built and commissioned by Alstom, with the build to be undertaken in the UK.

- **Trucks:**

- **Daimler AGO-GO-GO:**

- **125 years ago:** On October 6, 2021, [Daimler Truck AG](#) published an article to note that it was the 125th anniversary of production of the first motorised truck.

- **eActros active:** On October 6, 2021, Daimler Truck AG announced that the Mercedes-Benz eActros has commenced operation with customers in Germany and the Netherlands.

- **Licensed to run:** On October 25, 2021, it was reported widely that Daimler Trucks is able to test its **FCT** trucks on public roads as a result of being licensed to do so. This may seem like an everyday, run-of-the-mill event, but it reflects the pace at which Daimler Truck is travelling in developing and deploying **FCT** to power and to propel **FCEVs**.

- **Building network:** On October 27, 2021, Daimler Truck AG announced that it and BP plan to develop and to deploy a hydrogen infrastructure network across the UK to allow the introduction of **FCEVs** onto UK roads.

See: [Daimler Truck AG and BP to pioneer deployment of hydrogen infrastructure, supporting the decarbonization of UK freight transport](#)

- **BEV and FCEV:** On November 4, 2021, Daimler Truck AG noted that it was developed **BEV** trucks and **FCEV** trucks. This dual track approach is noteworthy because it illustrates that Daimler AG anticipates a market of sufficient size and segmentation to support both technologies.
- **Licence to chill:** On November 4, 2021, Daimler Truck AG announced the development of fuel cells that will maintain the temperature of liquid hydrogen below its boiling point at minus 253°C. This is significant because the use of liquid hydrogen, rather than compressed hydrogen, allows **FCEV** trucks to carry a greater mass of hydrogen.
- **From reservoir to bowser:** On November 11, 2021, Daimler Truck AG and TotalEnergies signed a new agreement to work together to develop and to deploy ecosystems for heavy-duty truck / heavy-goods vehicles powered and propelled by hydrogen across Europe. The agreement sits alongside the work that each corporation is doing to source and to distribute, to delivery hydrogen to and to dispense hydrogen at hydrogen refuelling infrastructure.
- **Diesel to GO:**

On November 11, 2021, [electric & hybrid](#) , reported that the UK is to phase-out by 2040 the use of internal combustion engine (**ICE**) heavy good vehicles (**HGVs**) powered and propelled by diesel.

From the start of 2040, all new **HGVs** in the UK will have to be powered and propelled by a power source using a zero-emission technology. This commitment to phase-out **ICE HGVs** powered and propelled by diesel was given on Transport Day at **COP-26**.
- **Hyzon – taking the hy-road:**
 - **Hy-road in NZ:** On November 3, 2021, Hiringa Refuelling New Zealand commenced construction of the first of four high-capacity hydrogen refuelling infrastructure facilities in New Zealand, in partnership with Hyzon.
 - **The arc becomes a circle: Editions 22** reported on the commitment of Ark Energy Corporation to purchase **FCEV** trucks from Hyzon Motors Inc to be used to transport zinc from the Sun Metals Zinc Refinery in Townsville, Queensland (refinery being owned by Ark Energy's sibling corporation Sun Metals Corporation, Ark Energy and Sun Metals owned by Korea Zinc Company Limited, the largest zinc, and lead and silver, producer in the world).

On November 8, 2021, Australian Renewable Energy Agency (**ARENA**) announced that it has approved, conditionally, funding support for the deployment of a 1 MW electrolyser with hydrogen storage and refuelling infrastructure to produce Green Hydrogen to be used by the **FCEV** trucks to be supply by Hyzon to Ark Energy.

On November 8, 2021, Australia's Clean Energy Finance Corporation (**CEFC**) announced that it financed the purchase of the **FCEV** trucks, and the Green Hydrogen and the hydrogen storage and refuelling infrastructure.
- **Hyzon and Itochu focus on the mining sector:** On November 9, 2021, Hyzon Motors Inc and Itochu Corporation (leading Japanese trading house) announced that they have aligned to pursue jointly opportunities for the use of hydrogen opportunities across the metals and minerals sector.

It is understood that the alignment is focused on the development jointly of hydrogen supply chains and the development and deployment of **FCEV** and **FCT** across the sector.

- **Giga Carbon Neutrality (GCN) on the road:** On November 11, 2021, it was reported widely, that **GCN** had unveiled its range of zero-emission commercial vehicles. While early days, it is reported that **GCN** intends to bring its zero emission vehicles to market by 2024.
- **Mobility and Transportation:**
 - **H2X Sarawak:** On November 4, 2021, [hydrogencentral.com](#), reported that H2X is to commence the manufacture of **FCEVs** in Sarawak, Malaysia. SEDC Energy (a wholly-owned subsidiary of the Sarawak Economic Development Corporation (**SEDC**)) signed a memorandum of understanding with H2X Global to establish a joint venture to manufacture and to assemble **FCEVs** and to undertake strategic transport projects.

It is understood that the joint venture will manufacture and assemble the Warrego Pick up to City Buses and the H2X Hydrogen Powered Generators.
- **Eni and Air Liquide combine:** On November 4, 2021, Eni and Air Liquide have combined to invest in the development and deployment of hydrogen refuelling infrastructure across Italy so as to support the transition to the use of hydrogen in the mobility / transport sector.

Eni and Air Liquide have signed a letter of intent for these purposes, with Eni having existing distribution and retail capacity across Italy, and Air Liquide having expertise across the value supply chain for hydrogen.

See: Air Liquide [website](#)

- **Snam and Shell matched:** On November 5, 2021, Snam (a leading energy infrastructure corporation) and Shell Energy Italia (a subsidiary of Royal Dutch Shell, on the leading international energy corporations) signed a memorandum of understand (**MOU**).

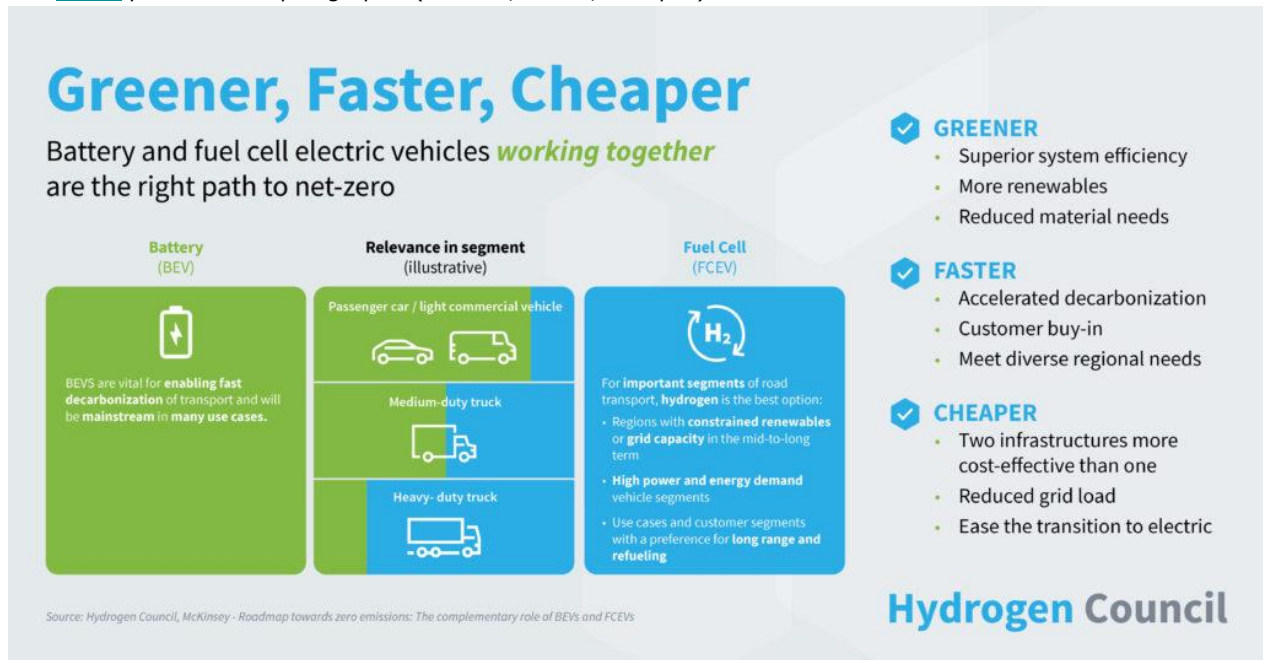
It is understood that the **MOU** provides for Snam and Shell Energy Italia to work together, domestically, within Italy, and internationally, to develop energy efficiency and sustainable mobility / transportation solutions.

The **MOU** contemplates that in working together Snam and Shell Energy Italia will identify projects that they may develop jointly, specifically projects for use of hydrogen by the industrial sector and the mobility / transportation sectors.

See: [Snam and Shell Energy Italia Sign Cooperation Agreement on Energy Transition](#); Shell [announcement](#)

- **Hydrogen Council abroad:** On October 27 2021, the Hydrogen Council issued an assessment of the use of a combination of battery and fuel cell technologies.

The [article](#) provides a helpful graphic (*Greener, Faster, Cheaper*):



Ports Progress and Shipping Forecast:

- **Global Energy Ventures and Wärtsilä:** On October 6, 2021, Global Energy Ventures Limited (**GEV**) announced that its compressed hydrogen (**C-H₂**) carrier, having a 430 metric tonne (**mt**) capacity, had received approval in principle (**AIP**) from the American Bureau of Shipping (**ABS**). The 430 mt **C-H₂** carrier has been described as a pilot hydrogen carrier project.

Edition 26 of Low Carbon Pulse reported on the **AIP** for the 2,000 mt **C-H₂** carrier. Each **C-H₂** carrier is to be powered and propelled using fuel cell technology.

On November 5, 2021, Wärtsilä's role in respect of the **AIP** was reported, with Wärtsilä having worked with **GEV** ship designer to develop an optimal power and propulsion system, using Wärtsilä dual-fuel engines to power two electric drive fixed-pitch propellers.

See: [Wärtsilä's decarbonisation focus emphasised with Approval-in-Principle for GEVs pilot hydrogen vessel](#); Global Energy Ventures [website](#)

Edition 19 of Low Carbon Pulse reported on the **Zero Emission Shipping Mission**, one of three **MI Missions**. Mission Innovation published something of a progress [check](#) (entitled Shipping out: **The challenges and opportunities of decarbonising the world's most global industry**) on October 6, 2021.

- **Solvang and Wärtsilä:** On October 20, 2021, it was reported widely that Wärtsilä (leading engine and power technology corporation) is to work with Solvang ASA (leading shipping company) to develop a carbon capture and storage system on board one of Solvang's ethylene carriers, the 2019 build Clipper Eos.

It is understood that the intention is to deploy the system on board the carrier by 2023.

See: [Wärtsilä and Solvang to collaborate on retrofitting carbon capture and storage system on Clipper Eos](#)

- **Hydrogen – sea port to sea port:** On November 6, 2021, the Ports of Antwerp and Zeebrugge and Chilean Ports have agreed to collaborate to make the transportation of Green Hydrogen from one continent to another a reality.

See: Port of Antwerp [press release](#); Port of Zeebrugge [press release](#)

- **Port of Gothenberg (PoG) to develop hydrogen production facility:** On November 3, 2021, the **PoG** announced plans to develop a hydrogen production facility with the port to produce hydrogen to be used to power and to propel land-side equipment within the port. While the scale of the planned hydrogen production facility may appear small, 4 MW to produce 2 metric tonnes of hydrogen a day, the approach being taken by the **PoG** reflects the need to balance supply with demand, and there is no better way to achieve this balance than to be the user of the producer, supplier and user of the hydrogen. As such, this plan is significant.

See: [Hydrogen production facility planned for the Port of Gothenburg](#)

- **Mitsui OSK and Vale sailing:** On November 8, 2021, Mitsui OSK Lines Ltd announced that it was working with Vale to conduct jointly a study to consider the installation of a wind propulsion system (Rotor Sail) on a 200,000 tonne in service bulk carrier (used principally for the carriage of iron ore).

While the principle will be understood, Mitsui OSK explains:

"The Rotor Sail produces propulsive force as the wind generates differential pressure around the slewing rotor while the vessel is underway. It offers high efficiency because the natural energy of the wind directly propels the vessel rather than being converted into electricity ..."

Regular readers of Low Carbon Pulse will recall that Wallenius Marine is developing a similar vessel, the Oceanbird.

See: [MOL, Vale International Announce Joint Study on Use of Wind Propulsion System 'Rotor Sail' on Bulk Carrier](#)

- **Mitsui OSK, MOL Drybulk and Japan Engine Corporation (J-ENG) hydrogen testing:** On November 9, 2021, Mitsui OSK Lines, MOL Drybulk and J-ENG announced that they are trialling a hydrogen-fuelled engine on an in-service vessel.

Mitsui OSK explained that this is a world first, with the low-speed, two-stroke hydrogen fuelled marine engine being trialled. J-Engine, working with Kawasaki Heavy Industries and Yanmar Power Technology, is the engine technology provider.

See: [MOL, MOL Drybulk, J-ENG Sign Agreement for Trial of Hydrogen-fueled Engine equipped Onboard](#)

- **Danish Maritime Authority pressing on:** On November 9, 2021, the Danish Maritime Authority (**DMA**) released a [summary](#) of the research of **DMA**, the Technical University of Denmark (**DTU**) and Oxford Research.

The research was commissioned by the **DMA** as part of its role in, and commitment to, the Zero-Emission Shipping Mission (**ZESM**): **ZESM** is intended to accelerate international public-private collaboration to scale-up and to deploy new green maritime solutions, with Governments of Denmark, Norway and the US leading **ZESM**, working with the **Global Maritime Forum** (see [Edition 19](#) of Low Carbon Pulse).

By way of reminder, **ZESM** has three principal goals: **1.** to develop, demonstrate and deploy zero-emission fuels, ships and fuel infrastructure in a coordinated fashion along the full value chain; **2.** by 2030, to have developed ships capable of running on hydrogen-based fuels (being zero-emission fuels) – such as Green Hydrogen, green ammonia, green methanol, and advanced biofuels – that make up at least 5% of the global deep-sea fleet, measured by fuel consumption; and **3.** by 2030, to have at least 200 of these "well-to-wake" zero-emission fuelled ships in service and utilizing these fuels across their main deep-sea shipping routes.

The summary provides four main conclusions in respect of readiness and innovation needed to progress to achieve the **ZESM** goals by 2030. The conclusions are that: **1.** The technologies to produce green fuels are available, but are not developed and deployed yet; **2.** A technology natural approach is to be preferred to stimulate further innovation; **3.** Three "cross-cutting" innovations are required: (a) demonstration plant development; (b) standards development; and (c) scale-up of the development and deployment of renewable electrical energy and develop further efficiency of technology; **4.** Fuel specific innovations are required in all three parts of the supply value chain: (a) fuel production; (b) bunkering infrastructure; and (c) vessel and fuel storage system design.

- **PORA pressing on, ever more quickly:** Previous editions of Low Carbon Pulse have reported on the progress being made by the Port of Rotterdam Authority or **PORA** (see [Editions 20, 23, and 25](#) of Low Carbon Pulse) to prepare for hydrogen and hydrogen-based fuels.

On November 9, 2021 **PORA** announced that the import of hydrogen would be feasible by 2025. This is based on a study conducted by **PORA**, with all areas within the Port of Rotterdam (from Pernis to Maasvlakte 2 having the ability to import hydrogen).

See: [PORA](#) website

- **AP Moller – Maersk to develop Green Methanol Tug:** [Edition 26](#) of Low Carbon Pulse reported (at length) on the order of ## container vessels to be powered and propelled by Green Methanol.

On November 9, 2021, AP Moller – Maersk and its towage subsidiary Svitzer announced the development of a tug to be powered and propelled using fuel cell technology, using Green Methanol as the fuel. This will be a world first.

See: [AP Moller-Maersk](#) website

- **FFI converting MMA Leveque to Green Ammonia:** On November 11, 2021, FFI announced that it is progressing the conversion of the MMA Leveque to be able to be powered and propelled by close to 100% Green Ammonia.

See: [FFI](#) website

- **Clydebank Declaration:** On November 10, 2021, the [Clydebank Declaration](#) was agreed at **COP-26**. The **Clydebank Declaration** emphasises the importance of limiting "the increase in global average temperature to **1.5°C** above pre-industrial levels", expressed great concern that if "no further action is taken, international shipping emissions are expected to represent 90% to 130% of 2008 emissions levels by 2050", and recognised that "a rapid transition in the coming decade to clean maritime fuels, zero-emission vessels, alternative propulsion systems, and the global availability of landside infrastructure to support these, is imperative for the transition to clean shipping".

In addition the signatories to the **Clydebank Declaration** commit to facilitate the development of **Green Corridors**, with at least six **Green Corridors** by "the middle of this decade ... [and] many more corridors ... by 2030". A **Green Corridor** is a route between two or more ports that are "zero-emission maritime routes".

The signatories to the **Clydebank Declaration** are: Australia, Belgium, Canada, Chile, Denmark, Fiji, Finland, France, Germany, Republic of Ireland, Italy, Japan, Republic of the Marshall Islands, Morocco, the Netherlands, Norway, Spain, Sweden the UK, and the US.

Airports and Aviation loop-round:

- **Rolls Royce flies on SAF:** On October 25, 2021, Rolls Royce tested an engine (one of four) fuelled by a sustainable / synthetic aviation (**SAF**) derived from liquid waste produced by World Energy (with the other three engines powered and propelled by conventional aviation fuel). On a test flight using the Rolls Royce Trent 1000 turbofan engine the **SAF** fuelled engine performed well on a test flight from Tuscan, Arizona, to Texas, and back to Tuscan.
- **Increased SAF safe:** On October 26, 2021, Airbus, Boeing, Dassault Aviation, GE Aviation, Rolls Royce, Safran and Go Beyond restated commitments to decarbonisation of the aviation industry, through developing aircraft and engine design, use of **SAF** and exploring the use of hydrogen, and continuing to develop technology so as to enable net-zero-carbon aviation.

Depending on the source of the feedstock for **SAF**, it is reported that the use of **SAF** 90% of **GHG** emissions arising from the aviation industry could be achieved on a net-basis. Key to making this progress is to allow fuel comprising 100% **SAF** to be used to power and to propel aircraft, increasing the current proportion of 50% conventional **SAF**, 50% fossil fuel sourced. If one were to pick a likely trend, it would be that hydrogen fuel cell technology will be used to power aircraft, and **SAF** will be used to propel them.

- **Zeroing in on first commercial flight:** On October 27, 2021, it was reported that Zero-Avia is planning the first commercial flight for its 19-seat aircraft in 2024 between London and Rotterdam and The Hague in 2024. On November 1, 2021, it was reported widely that ZeroAvia is to develop a 76-seat aircraft, working with Alaska Air Group to retrofit the engines on a De Havilland Q400 aircraft. This follows the announcement that Zero-Avia is planning the first commercial flight for its 19-seat aircraft in 2024 between London and Rotterdam and The Hague.
- **SAS to SAF:** On November 2, 2021, **SAS** (Scandinavian Airlines System) announced a partnership to supply **SAF**. On November 2, 2021, Vattenfall announced the exploration by Vattenfall, SAS, Shell and LanzaTech to produce **SAF** (or electro-fuel or an e-fuel) using the LanzaJet™ "Alcohol to Get" technology using "fossil free electricity and recycled carbon dioxide from district heating". Initial thinking is to produce 50,000 metric tonnes of **SAF** a year. As production of the **SAF** increased, SAS contemplates using this source to provide up to 25% of its demand for aviation fuel.
- **Airport supply and demand:** On November 5, 2021, Milan Malpensa Airport, Italy, announced that it intended to develop and to deploy a Green Hydrogen production facility to assure it of supply of Green Hydrogen. [International Airport Review](#) reported that Snam (a leading energy infrastructure corporation) had partnered with Milan Airports and SEA. It is understood that in the first instance the Green Hydrogen will be used to power and to propel land-side vehicles. The Green Hydrogen production facility and associated infrastructure will have funding support from [Horizon 2020](#) one of the European Union initiatives.

Low Carbon Pulse - Edition 31

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading later in the week, welcome to the Friday December 3, 2021 version of **Edition 31** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Monday November 15, 2021 to Sunday November 28, 2021 (inclusive of each day).

Please click [here](#) for the **First Low Carbon Pulse Compendium**, which comprises **Editions 1 to 28** of Low Carbon Pulse. Click [here](#) for the **Second Low Carbon Pulse Compendium**. Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

Edition 32 (*The Magic Johnson Edition*) of Low Carbon Pulse will be published on Friday December 17, 2021. **Edition 33** (*The Larry Bird Edition*) will be published on Tuesday January 23, 2021, after the Christmas and western New Year holiday season and before Lunar New Year.

Reflections on COP-26 after the dust has settled:

- **Down to earth:**

Expectations for the 26th session of the Conference of Parties (**COP-26**) of the United Nations Framework Convention on Climate Change were somewhere between heightened and sky high.

Before **COP-26**, the President of **COP-26**, Mr Alok Sharma, set out the four UK Government Goals for **COP-26** (**Four Pillars**).

The next page or so outlines progress made in respect of the **Four Pillars**.

Four Pillars: In the working week before **COP-26**, 2021, Low Carbon Pulse published five [COP-26 Countdown features](#) describing each of the **Four Pillars**.

In short hand, the **Four Pillars** were as follows:

1. Secure global net zero by mid-century and keep 1.5 degrees within reach (**First Pillar**);
2. Adapt to protect communities and natural habitats (**Second Pillar**);
3. Mobilise finance (**Third Pillar**); and
4. Work together to deliver, including the finalisation of the **Paris Rulebook** (**Fourth Pillar**).

On the face of it, progress was made on each of the **Four Pillars** (see [Edition 30](#) of Low Carbon Pulse for a summary of the outcomes from **COP-26**).

It appears that the importance of staying tethered to a **1.5°C** average increase in global temperatures is now well and truly understood.

If three words emerged from the coverage of, and articulated the needs and outcomes from, **COP-26**, they are: **ambitious, accelerated, and action**, best combined in the following sentence. "**More ambitious targets, and accelerated action to achieve them, is needed to avoid the worst effects of climate change.**"

Momentum developed ahead of, and at, **COP-26** in respect of more ambitious targets. The achievement of those more ambitious targets will limit the increase in average global temperature in a range of **1.8°C to 2.4°C** (see [Edition 30](#) of Low Carbon Pulse, under **In Summary**). The range needs to be towards **1.5°C** within **1.5°C to 2°C** (what Low Carbon Pulse has previously defined as the **Responsible Range**).

The science underpinning the **Paris Agreement** holds good.

- **Back to work:**

While those attending **COP-26** are taking a well-earned rest, there is a need to build on the **Four Pillars**. There is no doubt that the private sector is pushing on.

Building on the Four Pillars:

1. **First Pillar:**

"Countries are being asked to come forward with ambitious 2030 emission reductions targets, that align with reaching net zero by the middle of the century.

To deliver on these stretching targets, countries will need to:

- Accelerate the phase out of coal [in the event, becoming the phase-down of coal];
- Curtail deforestation;
- Speed up the switch to electric vehicles;
- Encourage investment in renewables."

A broader consensus arose before and during, and has consolidated after, **COP-26**: limiting the average increase in global temperatures to **1.5°C** is key to avoiding the worst effects of climate change on the climate system, and the achievement of the **Stretch Goal** is barely achievable. As was the case ahead of **COP-26**, acceleration of reductions in **GHG** emissions is critical, with greater ambition and commitment required ahead of COP-27 in Egypt.

The Administrator of the United Nations Development Programme (**UNEP**), Mr Achim Steiner, published a [summary](#) of **COP-26** on November 14, 2021, with the final paragraph containing the following: "The road to COP-27 begins now and it is vital that we accelerate the momentum provided by **COP-26**. With 1.5 degrees remaining barely within reach, **COP 26** must be a springboard for further commitments from countries in the immediate future".

The key outcome of **COP-26** is that achieving 1.5 degrees is the basis for policy setting. To achieve the **Stretch Goal**, and **NZE** by 2050, by 2030 **GHG** emissions must be reduced by 50%. There is a window, it remains open.

2. **Second Pillar:**

"The climate is already changing and it will continue to change even as we reduce emissions, with devastating effects. As **COP-26** we need to work together to enable and encourage countries affected by climate change to:

- Protect and to restore ecosystems; and
- Build defences, warning systems and resilient infrastructure and agriculture to avoid loss of homes, livelihoods and even lives".

Adaptation to climate change requires action by all countries, with some countries requiring more action than others. It is worth clicking-through on the link to the [46 Least Developed Countries \(LDCs\)](#), with a combined population of 1.1 billion people to get a sense of their location: of the 46 **LDCs**, 33 countries are African countries (including island states), four in East Asia (including Bhutan and Nepal), four in South East Asia (if one includes Timor-Leste), one in the Middle East (Yemen), and four Pacific Island nations of Solomon Islands, Tuvalu and Vanuatu, and in the Caribbean, Haiti.

Many, if not all, of the **LDCs** have contributed little, very little or not at all to climate change, yet the need for action in many of these countries is the greatest, and they are in need of the most assistance to take action to adapt. The United Nations Least Developed Country Expert Group (**LEG**), established and working under the auspices of the United Nations Framework Convention on Climate Change (**UNFCCC**), has been providing support to **LDCs** in respect of adaptation since 2001.

In Glasgow, the **LEG** reflected on 20 years of support for **LDCs** and looked forward. In looking forward, **LEG** reflected on the need for more coordination, but also on the need for **LDCs** and, other developing countries, to develop plans for adaptation, and to take those plans to developed countries, in particular the G-7 countries, and the European Union. The [third edition](#) of **Low Carbon Pulse – COP-26 Countdown** summarised what needs to be done in the near term.

3. **Third Pillar:**

"To deliver on our first two goals, developed countries must make good on their promise to mobilise at least USD 100 billion in climate change funding a year by 2020.

International financial institutions must play their parts and we need to work towards unleashing the trillions in private and public sector finance to secure global net zero".

While attention at **COP-26** was focused on the USD 100 billion climate funding commitment each year, and some progress was made (and more organisation and coordination is required – see the [fourth edition](#) of **Low Carbon Pulse – COP-26 Countdown**), following the conclusion of **COP-26**, the common consensus is that there was more progress (and in the words of the **UNEP-WCMC**), "more positive buzz around the redirection of trillions of \$ of private finance".

In this context, the [Glasgow Financial Alliance for Net Zero](#) has been welcomed warmly, and it is hoped that action will be taken "swiftly and fairly through transparent action plans and robust near-term targets".

4. **Fourth Pillar:**

"We can only rise to the challenges of the climate crisis by working together.

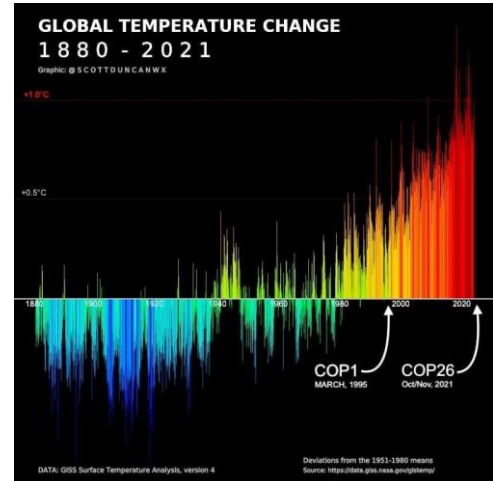
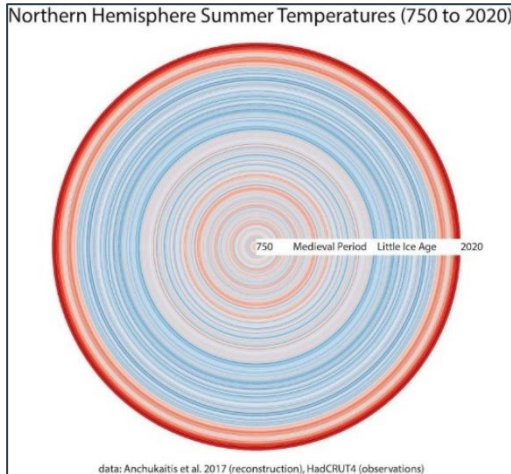
At **COP-26** we must:

- Finalise the Paris Rulebook (the detailed rules that make the Paris Agreement operational); and
- Accelerate action to tackle the climate crisis through collaboration between governments, businesses and civil society".

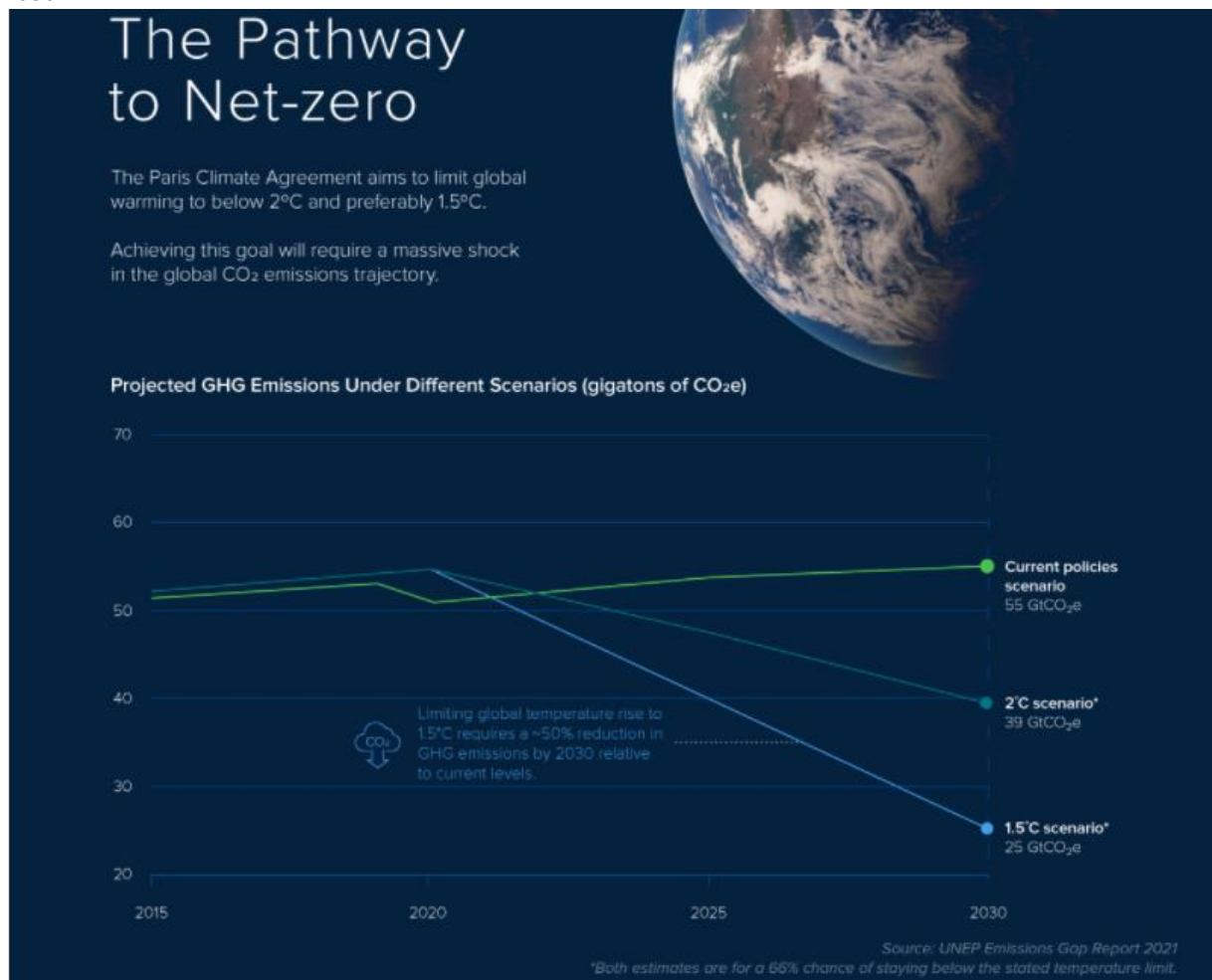
As noted in **Edition 29** of Low Carbon Pulse, the finalisation of the **Paris Rulebook** would be a mark of the success of **COP-26**. In a standalone article, to be published early in 2022, implementation of the **Rulebook** will be reviewed.

Climate change reported and explained:

- Data Rings True:** On November 26, 2021, UN Climate Change published a graphic developed by climate scientist, Mr Kevin Anchukaitis, University of Arizona, US. The graphic described as "dataviz "Warming Rings" represent the temperatures in the Northern Hemisphere from 750 to 2020.
- Global Temperature Change – 1880 to 2021:** In another visual representation of the context in which **COP-26** took place, the following graph provides a very clear message around the rate of climate change, COP-1 to **COP-26**:



- Pathways to Net Zero:** Previous editions of Low Carbon Pulse noted that to limit the increase in average global temperatures to **1.5°C** (and in so doing achieving **NZE**) it is necessary to reduce **GHG** emissions by between 46% and 50% by 2030. The graphic below provides an assessment that requires a 50% reduction in **GHG** emissions by 2030:



GCC Countries:

- **ADNOC aligns with Mitsui and GS Energy:** On November 15, 2021, it was announced by the Abu Dhabi National Oil Company (**ADNOC**) that Mitsui & Co. Ltd (leading Japanese trading company) and GS Energy (leading international energy corporation head quartered in Seoul, Republic of Korea), had agreed to partner with TA'ZIZ and Fertiglobe, to develop a world scale low-carbon blue ammonia project in the TA'ZIZ Industrial Chemicals Zone in Ruwais.

His Excellency Dr. Sultan Ahmed Al Jaber, the Minister of Industry and Advanced Technology for the United Arab Emirates (**UAE**) and Managing Director and Group CEO of **ADNOC**, said: "*The strategic partnerships with Mitsui and GS Energy, two of ... Asia's global energy champions, reflect ADNOC's commitment to increase the production of low-carbon hydrogen and ammonia.*"

See: [Mitsui and GS Energy to Join TA'ZIZ in World-Scale Low-Carbon Blue Ammonia Project](#);

- **NEOM floats into view:** On November 16, 2021, an octagonal shaped representation of a floating industrial complex appeared in many news feeds:



The floating industrial complex is to form part of Neom, the USD 500 billion renewable city being developed by the Kingdom of Saudi Arabia (**KSA**). The floating industrial complex (**OXAGON**) includes a number of renewable energy projects, including what will be the world's largest Green Hydrogen production facility, involving Air Products and ACWA (among others, see [Editions 28](#) and [29](#) of Low Carbon Pulse).

- **Emirates test flight on 100% SAF:** On November 18, 2021 it was reported widely that Emirates is preparing for a test flight using sustainable / synthetic aviation fuel (**SAF**) towards the end of 2022. The flight will use 100% **SAF** to power and to propel the aircraft being used.

- **UAE and Russia to collaborate:** The [Emirates New Agency](#) reported that the **UAE** and Russia had signed a memorandum of understanding (**MOU**) under which the countries are to explore how to work together to identify and to develop sustainable energy sources, i.e., developing hydrogen and hydrogen-based fuel projects.

The **MOU** is reported to have been signed by the Ministry of Industry and Advanced Technology for the **UAE**, and by the Ministry of Industry and Trade for Russia.

His Excellency Dr. Sultan Ahmed Al Jaber, the Minister of Industry and Advanced Technology said that: "*The MoU aligns with the strategic vision of our leadership – to build new and reinforce existing international collaboration in support of sustainable development*".

- **ADNOC closes financing for CCS and hydrogen production:** On November 21, 2021, [Energy&Utilities](#), reported widely that **ADNOC** had closed financing with the Japan Bank for International Cooperation (**JBIC**) for USD 2.1 billion, and with four Japanese commercial banks SMBC, Mizuho, MUFG, and the Tokyo branch of HSBC for USD 900 million. The USD 3 billion financing facilities are to be applied in the development and deployment of CCS / CCUS, and hydrogen and ammonia production, projects.

- **Hydrogen Projects and Production Prices:** On November 23, 2021, [futurenetzero](#) reported on new data provided by S&P Platts Analytics, which outlines that current planned hydrogen projects in the GCC countries are estimated to involve USD 44 billion in investment, with USD 35 billion to be invested in projects becoming operational by 2030.

S&P Platts Global Analytics has announced the launch of a daily information service detailing the cost of hydrogen produced in the **KSA**, Oman, Qatar and **UAE**. So far there have been no surprises – the cost of production of hydrogen derived and produced from **CH₄** in **KSA** and **UAE** is lower than the cost of production in Australia and the Netherlands.

As the supply of hydrogen develops in tandem with the development of demand, one can expect transparency of production cost and delivered cost becoming key to the development of a hydrogen market.

- **UAE and AUS Business Council press print:** On November 24, 2021, the **Australian UAE Business Council** released the **Final Report of its Working Group on Renewable and Alternative Energies**. The **Final Report** will be reported on in the **November and December Report on Reports** to be included contained in the Appendix to the Second Compendium of Low Carbon Pulse at the same time as the publication of **Edition 35**.

- **Masdar and Armenia:** On November 26, 2021, Masdar (Abu Dhabi Future Energy Company) signed an agreement with the Government of the Republic of Armenia to develop a 200 MW photovoltaic solar plant – the Ayg-1 project.

While the scale of the Ayg-1 project itself may not be regarded as significant, what is significant is that Masdar continues in its role as a "go-to" renewable energy developer and investor.

See: [Masdar signs agreement to develop Armenias largest solar power plant](#)

Japan and Republic of Korea:

- **Hydrogen and ammonia for power generation:** On November 16, 2021, [rechargenews](#) reported that the Government of the Republic of Korea intends to use hydrogen and ammonia as fuel for electrical energy generation. The Ministry of Trade, Industry and Energy (**MOTIE**) plans to combine hydrogen (30%) and natural gas (70%) at all gas-fired power stations by 2035, and to combine ammonia (20%) with coal (80%) at more than half coal-fired power stations as early as 2030. As reported by [rechargenews](#), the plans to use hydrogen and ammonia will amount to the use of each of 17.7 GW and 3.5 GW of hydrogen and ammonia fired electrical energy capacity.

Given the higher heating values of hydrogen and ammonia, the capacity factors of gas-fired and coal-fired generation 50% and 77% respectively, this will equate to 1.4 million metric tonnes of hydrogen and 3.8 million metric tonnes of ammonia (derived from 670,000 metric tonnes of hydrogen). By way of a point of reference, this equates to about 2 million metric tonnes of hydrogen production a year, or the entire output from the two 10 GW mega-hydrogen projects **AquaVentus** (see **Editions 16, 17** (in which described), **21, 23, 26** and **30** of Low Carbon Pulse) and **North2** (see **Editions 5** and **16** of Low Carbon Pulse). See under **E-fuels and Future Fuels (increasingly "Now Fuels")** below for an update on AquaVentus.

- **East-West Power and Equinor combine:** On November 17, 2021, it was reported widely that Korea East-West Power (one of the six power generation subsidiaries of Korea Electric Power Corp (**KEPCO**)) and Equinor (leading international energy corporation) had signed a memorandum of understanding (**MOU**) under which they will cooperate in the development of 3 GW off-shore wind field projects.

Given the intended location of the off-shore wind fields, floating off-shore wind development will be required, an area in which Equinor is highly experienced. It is reported that the **MOU** reflects plans to develop 3 GW shared by Equinor in Q2 of 2021, and is consistent with the broader USD 23 billion capital expenditure plans of Equinor for the five year period 2021 to 2026.

See: [Stepping up Korean offshore wind plans, 3 GW collaboration with EWP](#)

This is one of the many steps that **KEPCO**, and its six power generation subsidiaries (**Korea Hydro & Nuclear, Korea South-East Power, Korea Midland Power, Korea Western Power, Korea Southern Power** and **Korea East-West Power**), are taking in progress to achievement of **NZE**. **Edition 30** of Low Carbon Pulse noted the commitment to the phase-out of coal, with coal to ceased to be used for the generation of electrical energy by 2050.

- **Japan Decarbonising the Power Sector in Indonesia: Edition 18** of Low Carbon Pulse reported that:

- **Indonesia was on the road:**

- **Phasing out coal-fired power:** On May 27, 2021, Perusahaan Listrik Negara (**PLN**) announced its intention to shutter all of its coal-fired power plants by 2056. It is reported that the shuttering will be phased: conventional plants to be shuttered by 2035 (9 GWs), "supercritical" plants by 2040 (10 GWs) and "ultra-supercritical" by 2056. The shuttering is intended to be consistent with carbon neutrality by 2060.

The shuttering of the **PLN** coal-fired plants was viewed as the start of a broader move to new policy settings in Indonesia, and is certainly consistent with the decision not to develop any new coal-fired power stations.

See: [Indonesian state utility to retire coal power plants gradually](#)

- **Phasing in of renewable electrical energy and phasing out of coal-fired:** On May 27, 2021, it was reported widely that the Government of Indonesia would not approve the development of any new coal-fired power stations, recognising that coal-fired power stations under construction, and at the state of financial close, will proceed.

See: [No new coal plants in Indonesia in another bid to cut emissions](#)

Editions 20 and **25** of Low Carbon Pulse reported on the announcement by the Japanese Minister for the Ministry of the Economy, Trade and Industry (**METI**) to provide up to USD 10 billion dollars for the Asian Energy Transition Initiative to support ASEAN countries, and the proposed "acquire to retire" program, and the possible implications.

Edition 30 of Low Carbon Pulse reported on the announcement by the Asian Development Bank, Indonesia and the Philippines of the Energy Transition Mechanism (**ETM**) Southeast Asia Partnership (**SEAP**).

Edition 30 reported that Indonesia has committed to achieving **NZE** by 2060, and to reducing **GHG** emissions by 29% by 2030 (its pre-existing commitment), or by 41% by 2030 with support from developed countries.

On November 25, 2021, leading Japanese energy corporations Tokyo Power Company (**TEPCO**), TEPCO Power Grid, JERA and Tokyo Electric Power Services agreed to work together with the Japan International Cooperation Agency (**JICA**) to develop a proposed roadmap to decarbonise the power sector in Indonesia – the "Data Collection Survey on Power Sector in Indonesia for Decarbonisation".

The roadmap will identify measures that **JICA** may undertake in Indonesia to support the implementation of the roadmap.

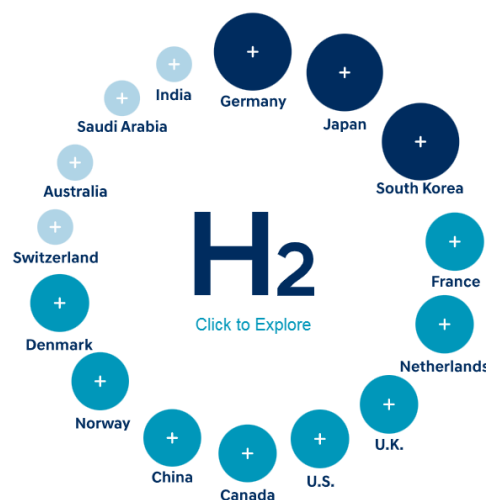
- **Republic of Korea demand for clean hydrogen by 2050:** On November 27, 2021, [S&P Platts Global](#) wrote that "South Korea will provide 27.9 million metric tonnes of "clean hydrogen" by 2050, all of which will be either green or blue hydrogen as [a] part of efforts to make it the country's number one energy source by 2050, replacing oil".

France and Germany:

- **France to fund hydrogen:** On November 16, 2021, the President of France, Mr Emmanuel Macron, announced that the French Government will provide funding in the amount of €1.9 (or USD 2.15 billion) for the further development of the hydrogen sector in France. This funding is part of the €30 billion "France 2030" industrial investment plan. As foreshadowed in **Edition 30** of Low Carbon Pulse, the hydrogen produced will be Pink Hydrogen predominantly, sourcing electrical energy from nuclear energy sources.
- **H2Wind within H2Mare: Editions 22, 23, and 25** reported on the three German flagship hydrogen projects to develop off-shore wind field hydrogen production and storage capacity. If hydrogen can be produced and stored at sea, the cost of submarine pipelines and beach-head connection can be avoided. In this context, the Federal German Ministry of Education and Research (**BMBF**) has provided funding to support research to be undertaken by the Fraunhofer Institute for Machine Tools and Reforming Technology (**IWU**) to develop robust electrolyzers and storage systems capable of operating conditions off-shore. The research by **IWU** is scheduled to continue until 2025.

Investing in the Hydrogen Economy:

Bloomberg is reported to have assessed in detail the commitment and investment of 15 countries to the development of hydrogen capacity. The following graphic provides Bloomberg's assessment as things stand at the moment, before the initiatives in the lead up to **COP-26**, and since:



Australia:

- **Queensland continuing to deliver:** In November 2021, the Queensland Government released [Consultation on the model for QREZ design and access – Delivering Queensland Renewable Energy Zones](#). The consultation is being undertaken to develop the models for the delivery of the three Queensland Renewable Energy Zones (**QREZs**), Northern, Central and Southern, with the delivery of the **QREZs** being aligned with the achievement of Queensland's commitment to reduce **GHG** emissions by 50% by 2030. There has been a good deal of comment about the consultation paper, with an apparent consensus that more than 3.3 GW of renewable electrical energy contemplated will be required. The **November and December Report on Reports** (to be included the Appendix to the Second Compendium of Low Carbon Pulse at the same time as publication of **Edition 35** of the Low Carbon Pulse) will consider the **QREZs**.
- **ANU reports on Blue and Green:** On November 10, 2021, the Australian National University published a [paper](#) on the comparative **GHG** emissions and costs of the production of Blue and Green Hydrogen. The report will be considered in detail in the **November and December Report on Reports** to be included in Appendix to the Second Compendium of Low Carbon Pulse at the time of publication of **Edition 35** of Low Carbon Pulse.
- **South Australia:**
 - **goes positive:** On November 16, 2021, the South Australian Government welcomed, in the most positive of terms, the decision of the Japanese Government to provide funding support to Marubeni Corporation in respect of the development of a pilot project to produce Green Hydrogen for export to Japan. In welcoming the decision of the Japanese Government, the South Australian Government noted that the pilot project had been "show-cased" by the Japanese Ministry of the Environment at **COP-26** in a presentation entitled, **Building global supply chain of Green Hydrogen to support the energy transition toward a decarbonised society**.
 - **goes more positive still:** On November 18, 2021, it was reported widely that a new 6 GW renewable energy and Green Hydrogen Project had been proposed – the **Moolawatana Renewable Hydrogen Project** - to be located at Moolawatana Station, around 570 km to the north of Adelaide, South Australia's capital city.

- goes negative:** On Sunday November 21, 2021, roof-top solar capacity resulted in two negative demand events in South Australia – reportedly a world first for a GW scale grid system. Between 12.20 and 12.50 pm and 13.25 and 13.50, demand across the SA grid was "negative" within the State, with export of electrical energy inter-state. It is understood that full effect of the "synchronous condensers" (see [Edition 29](#) of Low Carbon Pulse) is now being realised: the synchronous condensers mean that synchronous generation (provided by 240 MW of gas-fired power generation), has been scaled back to 120 MW and now to 80 MW, allowing the dispatch of more renewable electrical energy to the grid in South Australia.

On Saturday November 27, 2021 for a 72 hour rolling-period, renewable electrical energy accounted for 101% of electrical energy dispatched to the grid in South Australia. Again, reportedly a world first for a GW scale grid system.
- NSW:**

 - Blends Green Hydrogen with Natural Gas:** On November 18, 2021, it was reported widely that Jemena was blending hydrogen with natural gas, with the blended gas being hauled and stored across the Jemena gas distribution network.

The Green Hydrogen is blended at Jemena's Western Sydney Green Hydrogen Hub, co-funded by the Australian Renewable Energy Agency (**ARENA**)
 - Legislates in support of Green Hydrogen Capacity development:** On November 19, 2021, the New South Wales legislature passed the Energy Legislation Amendment Bill providing the legislative means to give effect to the [NSW Hydrogen Strategy](#).
- Victoria goes off-shore:** On November 23, 2021, the State of Victoria and the Star of the South (Australia's first off-shore wind field project – see [Editions 13](#) and [16](#) of Low Carbon Pulse), entered into a partnership agreement under which the State of Victoria agreed to provide funding to allow pre-construction development work to be undertaken.

In addition to the Star of the South, the Victorian Government has agreed to provide funding support for a Macquarie Group 1 GW Bass Coast off-shore wind field project, and for a Flotation Energy project.
- Australia to go off-shore:** On November 25, 2021, the Senate of the Australian Federal Parliament passed off-shore electrical energy legislation. The legislation will be subject of coverage from the Ashurst Energy Team in Australia, but in short the legislation comprises: the [Offshore Electricity Infrastructure Bill 2021](#) and the [Offshore Electricity Infrastructure \(Regulatory Levies\) Bill 2021](#).

[Reneweconomy's](#) live [map](#) identifies the 13 offshore wind field projects that may now develop under the offshore electrical energy legislation.
- Australia and Germany on the same page:** In the lead up to **COP-26**, Low Carbon Pulse parked coverage of the HySupply State of Play Report ([The Case for an Australian Hydrogen Export Market to Germany: State of Play Version 1.0](#)) released as a consultation paper, choosing rather to wait for the final form.

On November 23, 2021, Australia and Germany committed to strengthen bilateral cooperation on hydrogen technology (please click [here](#) for the official announcement from the Australian Government). The Australian Renewable Energy Agency (**ARENA**) is to take a lead role in a "hydrogen innovation and technology incubator", **HyGATE**, which will support a pilot project, and trial, demonstration and research projects for the purposes of the development of a hydrogen supply chain.

The Australian Federal Government has announced that **ARENA** and the Ministry of Education and Research (**BMBF**) of the Federal German Government will open the funding support initiative in Q1 of 2022.

US:

- Back on track: Edition 25** of Low Carbon Pulse reported on the progress of the [Infrastructure Investment and Jobs Act \(IIAJA\)](#) as follows:

 - "US Bipartisan Infrastructure Deal Done: Edition 23** of Low Carbon Pulse reported that the US infrastructure investment package (**IIP**) was nearly done. On August 10, 2021, the **IIP** "got done": by a vote of 69 to 30, the US Senate passed the [Infrastructure Investment and Jobs Act \(IIAJA\)](#).
 - What next for the IIAJA?** From the US Senate, the **IIAJA** has made its way to the House of Representatives for adjustment to some of its provisions, those adjusted provisions to be returned to the US Senate for consolidation by the Senate before the **IIAJA** is presented to President Joe Biden for signature."

On November 15, 2021, President Joe Biden signed the **IIAJA**.
- Key aspects of IIAJA in context of projects to NZE:**

USD 9.5 billion in funding support (over five years) to lower the costs of clean hydrogen and to commercialise its use, with funding to support the development and deployment of electric vehicles (**EVs**) and carbon capture and sequestration.
- Hydrogen Gets Big Billing:** [World Energy](#) reports that the largest hydrogen program in the **IIAJA** will provide the US Department of Energy (**DOE**) with USD 8 billion to provide support for at least four hydrogen hubs that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen.

The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.

The balance of the USD 9.5 billion comprises USD 1 billion in funding to lower the cost of producing Green Hydrogen with the goal of achieving a cost of USD 2 per kg by 2026, and USD 500 million to allow the award of grant funding for the purposes of research, development and demonstration (**RDD**) to develop and deliver clean hydrogen production, delivery, storage and use technologies.

The **IIAJA** contemplates the development of a national hydrogen strategy and roadmap to facilitate large-scale, and wide-spread, production, delivery, storage and use of clean hydrogen.

- **Clean Hydrogen Gets Big Tax Credit:** On November 22, 2021, [rechargenews](#) reported on the clean hydrogen tax credit of up to USD 3 per kg of clean hydrogen.

The **Build Back Better Bill** (as distinct from the **IIAJA**) passed by the House of Representatives on November 19, 2021, includes a ten-year production tax credit (**PTC**) scheme under which producers of clean hydrogen are able to benefit from a USD 3 per kg tax credit. It is important to note that the **Build Back Better Bill** has yet to progress through the US Senate, and as such there is a risk that the **PTC** may not eventuate.

The tax credit scheme provides a higher tax credit for cleaner hydrogen as follows in respect of clean hydrogen projects in respect of which construction commences before 2029:

CLEAN HYDROGEN TEN YEAR TAX CREDIT SCHEME		
CO ₂ -e per kg of H ₂	Tax Credit of full tax credit	Impact per kg of H ₂
0.45 – 1.5	33.4%	USD 1.00
1.5 - -2.5	25%	USD 0.75
2.5 – 4.0	20%	USD 0.60
4.0 – 6.0	15%	USD 0.45

Finland:

- **Finland in focus: Edition 4** of Low Carbon Pulse included a piece on Finland as follows:

"Business Finland (a public organisation directed by the Finnish Ministry of Employment and Economy) has published a **National Hydrogen Roadmap for Finland**.

The **Roadmap** is clear as to historical, current and future uses:

"Hydrogen has been used as an industrial chemical for more than 100 years. Today ... used to manufacture ammonia, and ... fertilizers, as well as methanol and hydrogen peroxide, both vital feedstocks for a wide variety of different chemical products ... Producing hydrogen via low or totally carbon-free ways, and using this "good" low-carbon hydrogen to replace hydrogen with a larger carbon footprint, we can reduce carbon emissions"

Hydrogen is seen as playing a key role in Finland's national goal of carbon neutrality by 2035. The **Roadmap** does not contain policy settings, rather it, and each initiative contemplated by it, is intended to provide a "knowledge base for further work" including shaping policy settings for Finland, and "determining the role of hydrogen in the national energy and climate policy".

As with the **DOE Hydrogen Program Plan**, the Finnish **National Hydrogen Roadmap** provides a good analysis of the role that hydrogen can play across sectors, and the scale of the demand side of the prospective market for hydrogen, and in the case of the **Roadmap** the role that Finnish business can play across the hydrogen value chain."

See: [Hydrogen Roadmap for Finland](#)

- **European Commission funding for CCS:** On November 17, 2021 the European Commission committed funding support, from the newly established €1.1 billion Innovation Fund, for the production of clean-hydrogen at a refinery at Porvoo, Finland, with the capture of **CO₂** and its storage in the North Sea in geological formations below the seabed, with the electrical energy required being produced by renewable sources.
- **Momentum accelerating:** On November 22, 2021 it was reported widely that Finland is progressing to develop a number of initiatives that will make it a leading hydrogen economy. One initiative involves the development and deployment of large-scale hydrogen production capacity around the Gulf of Bothnia and the Baltic Sea, with the Gulf of Bothnia regarded as highly prospective for hydrogen production, storage and use and transportation.

Sweden - European Commission Funding for Green Steel:

Previous editions of Low Carbon Pulse have reported on and described at length the Green Steel initiatives using fossil fuel free hydrogen in Gallivare and Oxelosund, Sweden.

On November 17, 2021 the European Commission committed funding support, from the newly established €1.1 billion Innovation Fund, for scale development of Green Steel production in Gallivare and Oxelosund.

Scotland:

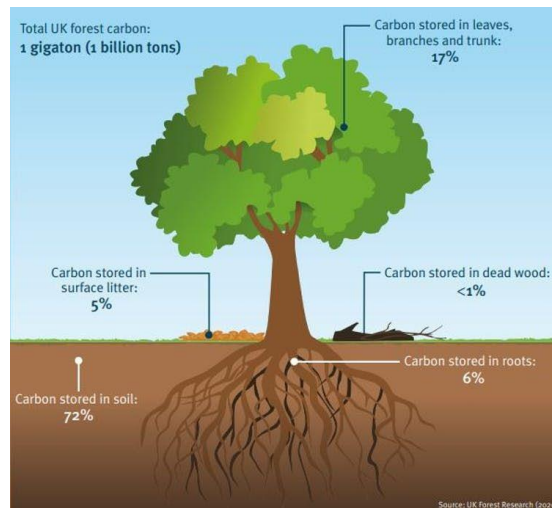
Scotland has made and continues to make considerable progress to achieving **NZE**.

The **BBC** has reported recently that the load for electrical energy across Scotland is being matched, or is close to being matched, by the dispatch of renewable electrical energy sources.

And yet Scotland is continuing to develop sources of renewable electrical energy, allowing the export of renewable electrical energy, and the use of renewable electrical energy to produce Green Hydrogen. The potential for Scotland to be an exporter of both renewable electrical energy and Green Hydrogen is regarded as huge.

Blue and Green Carbon:

- **A helpful picture:** UK Forest Research has developed a pictorial representation of the use of flora to absorb **CO₂**, and the role of soil and root systems.

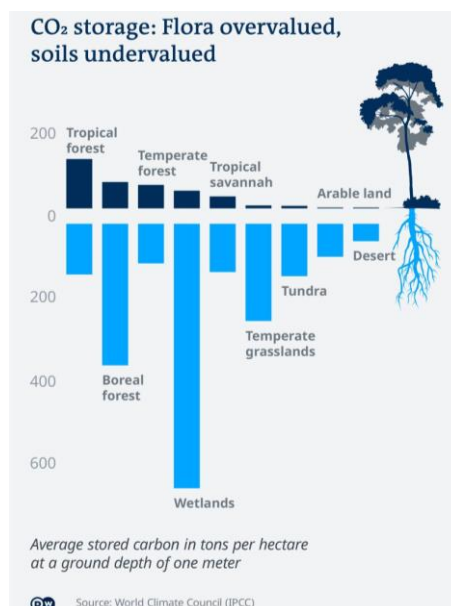


While the percentages of absorption will depend on the climate and the flora, this is a helpful picture in that it emphasises the importance of restoration of eco-systems following deforestation, and the benefits of afforestation and reforestation.

- **TotalEnergies committed to Green Carbon:** On November 19, 2021, TotalEnergies announced that it has signed an agreement with the Government of Suriname, South America, to provide support for Suriname's national strategy to reduce **GHG** emissions by preserving the forests of Suriname. The support includes a carbon credit exchange agreement.
- **A not so helpful finding:** On November 23, 2021, the [New Scientist](#), reported on a study of an area of tropical forest. The study finds that flora within the area of the study grew at a slower rate during years when nights are warmer than average or when dry-season days are unusually warm to hot. If taken as general findings, the implications are that as average temperatures increase the ability of tropical forests to absorb **CO₂** may lessen.
- **Saudi Green Initiative – Plant 100 million mangroves:** One of the less reported aspects of the Kingdom of Saudi Arabia's Green Initiative is the plan to plant 100 million mangroves. As reported in previous editions of Low Carbon Pulse, mangrove forests / swamps provide a significant opportunity to restore and to improve the health of both land and sea. It is estimated that the Kingdom's plan to plant 100 million mangroves will result in the removal of 96 million tonnes of **CO₂** from the climate system.

Continuing the theme of mangroves and Blue Carbon, and straddling the next news item, the following link is to the new Ramsar Convention on Wetlands guidance publication [The contribution of blue carbon ecosystems to climate change mitigation](#) providing for scaling up Blue Carbon.

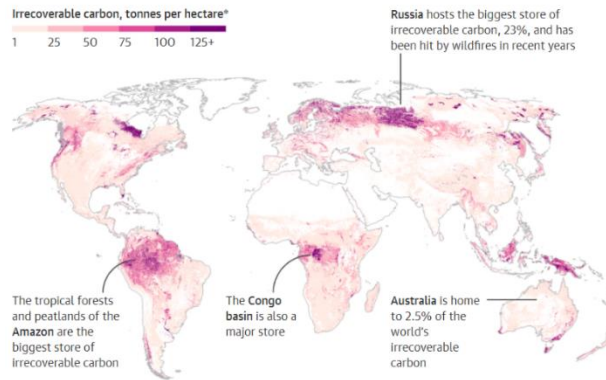
- **Grasslands, Peatlands, and Wetlands – lands of hope and glory:** Wetlands International has published a **CO₂** storage graphic which illustrates the ability of grasslands, peatlands and wetlands to absorb **CO₂**.



While the author of Low Carbon Pulse has not verified the information conveyed by the graphic, it is consistent with other information read by the author.

- **Irrecoverable carbon:** A new [study](#) published in Nature Sustainability has mapped what it has termed **irrecoverable carbon**, being carbon sinks that need to be preserved. The study finds that half of the **irrecoverable carbon** is in carbon sinks located on 3.3% of the world's land mass: 57% of **irrecoverable carbon** is flora, and 43% is in soils and peatlands, with peatlands storing more carbon than tropical and sub-tropical forests.

New mapping shows the carbon-rich areas humanity cannot afford to destroy if climate catastrophe is to be avoided



Guardian graphic. Source: Nature Sustainability. *to 30cm depth for forests and grasslands and to 100cm depth for peat and wetlands (reflecting the different depths of typical disturbance for different ecosystems)

Bioenergy:

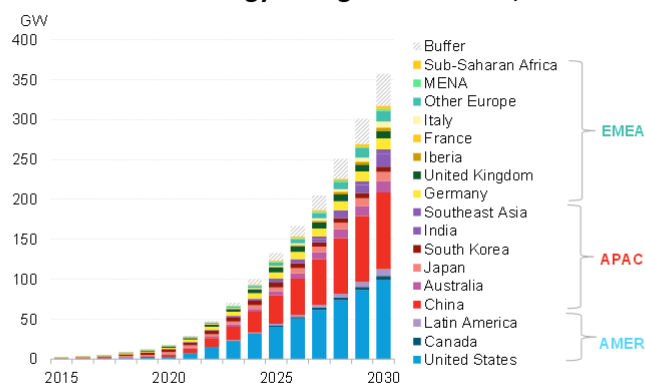
- **Australia has a bioenergy roadmap:** On November 18, 2021, the Australian Renewable Energy Agency (**ARENA**) published a [bioenergy roadmap](#) for Australia. On Friday November 18, 2021, ARENA announced funding support to help implement that roll-out of the bioenergy roadmap. This funding is in addition to funding support provided to date by the Australian Federal Government. The ARENA bioenergy roadmap will be considered in detail in the **November and December Report on Reports** to comprise the Appendix to **Edition 35** of Low Carbon Pulse.
- **PGNiG – oil and gas to biogas and biomethane:** On November 26, 2021, [World Biogas Association](#), reported that Polish state-owned oil and gas corporation, Polskie Gornictwo Naftowe i Gazownictwo (**PGNiG**) is to develop the biogas and biomethane sector. It is reported that the **PGNiG** has agreed to take responsibility for coordinating work to develop bio-LNG, bio-CNG and biomethane, with the biomethane to be distributed using the gas distribution network as pipeline gas.

BIOENERGY	
Biomass: organic matter arising from the life-cycle of any living thing, flora or fauna.	Bioenergy: energy derived or produced from biomass, whether in gaseous, liquid or solid form.
Biogas: a mixture of CH₄ and CO₂ , arising from the decomposition of organic matter, including derived or produced from anaerobic digestion.	Biomethane: CH₄ in near pure form, derived or produced from upgrading Biogas or gasification of biomass. Biogas and Biomethane are Biogases.
Bio CNG: Biogas or Biomethane that is compressed.	Bio LNG: Biomethane that is liquified.

BESS and HESS (and now CAESS):

- **Boom in BESS and HESS:** On November 15, 2021, [BloombergNEF](#) forecast (in its [Global Energy Storage Outlook](#) report) that the 2020s would be a boom decade for the installation of energy storage – "the energy storage decade", with 1 TWh of energy storage capacity to be installed by 2030.

Figure 1: Global cumulative energy storage installations, 2015-30



Source: BloombergNEF. Note: MENA = Middle East & North Africa. Buffer represents markets and use-cases that we are unable to forecast due to lack of visibility.

The **Global Energy Storage Outlook** will be reported on in detail in the **November and December Report on Reports** to comprise the Appendix to **Edition 35** of Low Carbon Pulse.

- **World's Largest HESS:** On November 17, 2021, Hefei Sinopower Technologies Co. Ltd announced that on November 13, 2021, plans to develop the Zhangjiakou 200 MW / 800 MWh HESS were progressing with the production of preliminary design for the project.

See: Hefei Sinopower Technologies Co. Ltd [website](#)

- **Whitelee Windfarm – first of a kind - HESS: Edition 14** of Low Carbon Pulse reported on the Whitelee Windfarm, East Renfrewshire, Scotland. On November 22, 2021, [BBC](#) News reported that the UK Government is to provide funding support to allow the development and deployment of a Green Hydrogen production and storage facility to provide Green Hydrogen for public transport in Glasgow. The Green Hydrogen production and storage facility is being developed by BOC, ITM Power and Scottish Power, and involves the deployment of the UK's largest electrolyser yet, and the UK's first **HESS** (hydrogen energy storage system).

The UK's Energy and Climate Change Minister, Mr Greg Hands said: "*This first-of-a-kind hydrogen facility will put Scotland at the forefront of plans to make the UK a world leading hydrogen economy ... helping to decarbonise local transport ...*".

- **ARENA for BESS:** On November 22, 2021, it was reported widely that during December 2021, the Australian Renewable Energy Agency (**ARENA**) is to launch a funding round to allow the fast-tracking of the development and deployment of grid-scale **BESS** to continue the progress being made to ensure that by 2025 the Australian east-coast grid system is able to support the dispatch of 100% renewables to match load.

See: ARENA [website](#)

- **Long Duration Energy Storage:** One of the organisations established or launched at **COP-26** was the [Long Duration Energy Storage Council \(LDESC\)](#), comprising, among others, BP, Rio Tinto and Siemens.

LDES is **BESS** (typically using lithium-ion technology), that provides eight hours or more of electrical energy storage to nameplate output. While the need for **LDES** is known, both for use behind the meter and grid-scale, it remains the case that the roll-out of **LDES** is taking time.

Edition 13 of Low Carbon Pulse reported on the development of thinking around **LDES** as follows:

"In the recent **Energy Storage Summit USA 2021**, these issues were discussed, as were the factors that will inform the size of **BESS** by location, including the energy density per square kilometre. In this context, "long-range" **BESS**, having capacity to supply for over 6 hours, is likely to be used less in areas of higher energy density than areas of lower energy density because in areas of higher energy density land use and value is likely to be at a premium. Given these dynamics, it is apparent that a broad range of multi-faceted **BESS** solutions are likely to be developed, on grid, and off-grid, at meter, and behind the meter, including micro-grids.

In this brave new world of **BESS**, **BESS** storage of 10/12/24 hours is being contemplated for business users, and up to **72** hours for telecommunications companies, including to guard against the consequences of land-borne weather events."

The **LDESC** is seeking to mobilise the development of **LDES**.

On November 23, 2021, the **LDESC** and McKinsey & Co published a [report](#) on **LDES (LDES Report)**. The reported headline from the **LDES Report** is that to achieve net-zero across power grids by 2040, **BESS** nameplate capacity of 1.5 to 2.5 TW, with **LDES** output capacity of 85 – 140 TWh of **LDES** would be required.

The **LDES Report** is well-worth a read, and will be reported on in detail in the **November and December Report on Reports** to be contained in the Appendix to **Edition 35** of Low Carbon Pulse.

- **CAESS (Compressed Air Energy System Storage): Editions 20** and **21** of Low Carbon Pulse reported on the storage of energy using compressed air technology, and **Editions 13** and **25** of Low Carbon Pulse have reported on long-duration energy storage (**LDES**).

On November 24, 2021, it was reported widely that Hydrostor is contemplating the development of a USD 800 million 400 MW / 3200 MWh **LDES CAESS**. The Hydrostor business model and technology involves the compression of air using off-peak, and surplus electrical, energy from the grid, to derive heat and to compress air (with the compressed air stored at a constant pressure), with compressed air and heat recombined to produce energy to drive a turbine to produce electrical energy for dispatch to the grid.

As noted in previous editions of Low Carbon Pulse, the vital statistics of 400 MW / 3,200 MWh mean that the contemplated **LDES CAESS** will be able to supply 400 MW of electrical energy for up to 8 hours.

Hydrostor is reported to have applied to the Californian Energy Commission, with the intention to commence commercial operation of the **LDES CAESS** by 2026.

- **BESS at Loy Yang Power Station:** On November 26, 2021, it was reported widely that AGL Energy (one of Australia's Big Three energy corporations) had received approval for a 200 MW / 800 MWh **BESS** to be developed at the site of AGL's Loy Yang power station (**Loy Yang BESS**) in the Australian State of Victoria.

In the land of the Big Battery, the development of the **Loy Yang BESS** will provide further strengthening of grid system integrity and stability as the grid system in Australia continues to progress to a 100% renewable electrical energy network, transitioning over time from coal-fired generation capacity.

It is understood that the development of the **Loy Yang BESS** is part of the roll-out by AGL Energy of 850 MW of "grid-scale" **BESSs**, including the 250 MW / 1000 MWh **BESS** being installed at Torrens Island, South Australia, and the approved 50 ME / 100 MWh **BESS** at Broken Hill, New South Wales and the planned 150 MW **BESS** at Liddell Power Station, in New South Wales' Hunter Valley.

See: [AGL firms up capacity with grid-scale battery in Victoria](#)

CCS / CCUS:

- **Freeport LNG, Storegga and Talos Energy combine:** On November 16, 2021, [The Houston Chronicle](#), reported that Talos Energy had plans to develop the first carbon capture and storage facility on the Gulf Coast, in partnership with Freeport LNG and Storegga Geotechnologies. The Gulf Coast CCS would capture **CO₂** arising at the Freeport LNG liquefaction and export facility, and other sources of **CO₂**.
- **Summit Carbon progresses proposed CO₂ pipeline:** On November 17, 2021, it was reported widely that Summit Carbon Solutions is progressing the proposed development of a **CO₂** pipeline in the US State of Iowa, with a longer term intention to develop a **CO₂** pipeline system across five US States. It is to be expected, that **CO₂** pipelines will be developed to haul **CO₂** to points of storage and use.
See: Summit Carbon Solutions [website](#)
- **SK Energy and Honeywell combine:** On November 22, 2021, it was reported widely that SK Innovation and Energy (part of the leading chaebol SK Energy) and Honeywell (leading technology solutions corporation) are to undertake a feasibility study to retrofit carbon capture units to capture **CO₂** arising from an SK hydrogen production facility, located at SK's refining facilities in Ulsan, Republic of Korea. The use of carbon capture units would capture up to 400,000 metric tonnes of **CO₂** a year, with the captured **CO₂** reportedly to be injected into depleted natural gas reservoirs.
See: [SK Innovation to Use Honeywell Technology for Carbon Capture And Sequestration Feasibility Study In Korea](#)
- **Air Liquide and BASF combine:** On November 22, 2021, Air Liquide (one of the big three industrial gas producers globally) and BASF (leading chemical producer) announced plans to develop what has been described as the "world's largest cross-border Carbon Capture and Storage (CCS) value chain".
Air Liquide and BASF will develop jointly the Kairos@C project at the chemical facilities of BASF located in Antwerp, Belgium: at its core Kairos@C will capture **CO₂**, liquefy it, transport and store it in sub-surface structures below the sea-bed of the North Sea. As with the SK Energy / Honeywell combination, Kairos@C will retrofit existing production facilities with carbon capture units. The European Union Innovation Fund is to provide funding support for Kairos@C.
See: [Air Liquide and BASF welcome support from European Innovation Fund for joint CCS project](#)
- **An IEA perspective on CCS:** On November 24, 2021, the International Energy Agency (**IEA**) released a commentary entitled [Carbon capture in 2021: Off and running or another false start?](#) The commentary is well-worth a read, providing a focused and pithy overview of the current state of play in CCS / CCUS.
The commentary notes that in 2021 more than 100 CCS / CCUS projects have been announced and that "the global project pipeline for CO₂ capture capacity is on track to quadruple".
Consistent with other **IEA** publications (and ongoing Low Carbon Pulse narratives), the importance of CCS / CCUS is again emphasised: " ... without CCUS we would have limited or no solutions for tackling emissions from heavy industry sectors, including cement. CCUS also provides a key option to address emissions from existing energy assets, to support a cost-competitive scaling up of low-carbon hydrogen production, and to remove carbon from the atmosphere".
- **Norwegian Continental Shelf in demand: Edition 27** of Low Carbon Pulse reported on the process underway in respect of use of geological formations on the Norwegian Continental Shelf for carbon storage. The Norwegian Continental Shelf is regarded as highly-prospective in scale for the development of carbon storage.
On November 24, 2021, Storegga Geotechnologies announced that it had entered into an agreement with Sval Energi to explore jointly opportunities for carbon storage on the Norwegian Continental Shelf.
- **Northern Lights gets green light:** Previous editions of Low Carbon Pulse have reported extensively on the size and scope, and progress, of the Longship Project, which includes the Northern Lights project (see **Editions 2, 11, 16, 17, and 19**).
On November 26, 2021, the Northern Lights Project was included in the European Commission's proposed fifth list of Projects of Common Interest (**PCIs**). **PCI**'s are key infrastructure projects intended to achieve the European Union's climate objectives. The Northern Lights Project, as a **PCI**, is a **CO₂** capture, transportation and storage project.
See: Northern Lights JV [website](#)

Carbon credits and markets and Hydrogen markets:

- **Woodmac on the money:** On November 25, 2021, the ever excellent Wood Mackenzie's, The Edge, included an article entitled [Carbon Markets' COP-26 breakthrough – Why tighter rules on carbon credits will boost prices](#). In the article, the Chairman, Chief Analyst and author of The Edge, Mr Simon Flowers, outlines the key points of a conversation with Head of Carbon Research at Wood Mackenzie, Ms Elena Belletti, to discuss the significance of agreement on Article 6 of the Paris Agreement (see **Editions 27 and 30** of Low Carbon Pulse).
The views shared are "on the money", and are driving thinking of a number of countries with high-quality resources, now determined to achieve "gold-standard" carbon credits for sale globally. The article is well-worth a read.
Before the end of February 2022, the author of Low Carbon Pulse will publish a stand-alone article on carbon credits and Article 6 of the Paris Agreement and the **Paris Rulebook**.
- **Hydrogen market coming into focus:** In the two weeks since the end of **COP-26**, and possibly a little before, commentary in articles and new items has started to provide an early narrative around the development of a hydrogen market.
The high-water mark of this and related narratives has been provided by five position papers from Hydrogen Europe:
 1. European Trading System;
 2. Phasing out of ETS free allowances and Phasing in Carbon Border Adjustment Mechanism (**CBAM**);
 3. The ETS and Aviation;
 4. New separate ETS for the Building and Transport Sector; and
 5. Energy Taxation Directive from Hydrogen Europe, **under H2zero Net Zero – Hydrogen Europe Position Papers – Reforming carbon markets to enable a liquid sustainable and affordable hydrogen market**.

While the Papers focus on Europe, the thinking is clear and definitional. The **November and December Report on Reports** will consider each position paper, and other materials in the context of both carbon and hydrogen markets. The **November and December Report on Reports** will comprise the Appendix to **Edition 35** of Low Carbon Pulse.

E-fuels and Future Fuels (increasingly "Now Fuels"):

- **Brugg, Switzerland goes mobile:** On November 15, 2021, it was announced that Axpo is to develop a Green Hydrogen production facility co-located with its Wildegg-Brugg hydro-electric power plant. It is reported that the Green Hydrogen production facility will produce up to 2,000 metric tonnes of Green Hydrogen per annum, and that Axpo has contracted with off-takers of the Green Hydrogen for use in the mobility / transport sector.

See: [Axpo plans new green hydrogen production plant in Swiss town of Brugg](#)

- **Hornsea Two to power 100 MW electrolyser:** On November 15, 2021, it was reported widely that ITM Power, Ørsted, Phillips 66 and Element Energy (participants in the **Giga-stack Project**) have published a report on the progress in the development to deployment of Green Hydrogen production capacity, with a final investment decision (**FID**) expected within the next 18 months, and assuming a positive **FID**, achievement of commercial operation by 2025.

In summary, Hornsea Two is the world's largest off-shore wind field, and it will provide the renewable electrical energy to the Phillips 66 Humber Refinery to displace fossil fuels currently being used to power its heaters.

- **AquaVentus joined by a further 8 corporations: Editions 16, 17, 21, 23, and 26** have reported on and described in detail the AquaVentus project - the 10 GW off-shore wind field to hydrogen project.

On November 16, 2021 the AquaVentus consortium announced that it had been joined by a further eight corporations in various capacities, including GICON®-Großmann Ingenieur Consult GmbH, Heerema Marine Contractors SE, Neptune Energy, Noordgastransport B.V. (NOGAT BV and NGT BV), Ptx Development BmbH, Ramboll and Saipem.

See: AquaVentus [website](#)

- **Proposed 1.3 GW hydrogen export facility in Sarawak, Malaysia:** On November 16, 2021, [pvmagazine](#), reported that H2X and Thales New Energy (both Australian based corporations) had signed a memorandum of understanding (**MOU**) with the Sarawak Economic Development Corporation subsidiary, SEDC Energy.

It is reported that the **MOU** contemplates the establishment of an incorporated joint venture to develop the Samalaju Hydrogen Production Facility, with a reported capacity of 1.3 GW and as such the ability to produce as much as 170,000 metric tonnes of hydrogen a year, or 970,000 metric tonnes of ammonia.

- **Shelling out for Largest Green Hydrogen Facility:** On November 19, 2021, [hydrogen central](#) reported that Shell wants to develop the largest Green Hydrogen production facility in the world at Maasvlakte. The design of the facility is what has captured the headlines.



- **Vision and Energy:** On November 22, 2021, it was reported widely that Vision Hydrogen and Virya Energy have been granted approvals to develop a Green Hydrogen production facility in the Port of Terneuzen, the Netherlands. It is understood that initially the production capacity of the facility will be 26 MW (3,500 metric tonnes of Green Hydrogen a year) with the intention to increase the production capacity to 75 MW (10,500 metric tonnes of Green Hydrogen a year).

See: [Vision Hydrogen And Virya Energy Awarded Permits For Scalable 25-75 MW Green Hydrogen Production Facility](#)

- **Indian Oil Corporation Limited (IOCL) to green refining:** On November 22, 2021 it was reported widely that **IOCL** (state-owned oil and gas corporation) is to procure Green Hydrogen production facilities to be located at its refineries at Mathura, Uttar Pradesh and Panipat, Haryana. One of the principal uses of grey hydrogen produced currently is for the purposes of refining oil.

See: IOCL [website](#)

- **Redefining recycling thinking:** On November 23, 2021, it was reported widely that Shell is to develop and to deploy a pyrolysis upgrader unit to take plastic waste as feedstock to derive chemicals. While this technology is proven, its use to apply pyrolysis may be regarded as progress. It is reported that that the pyrolysis upgrader unit is part of a broader development to establish a Shell Energy and Chemical Park in Singapore.

The development of the Shell Energy and Chemical Park, and bio-based fuels and feedstocks to be derived and produced there, reflects the Sustainable Jurong Island [initiative](#) published by the Singapore Economic Development Board on November 23, 2021. The initiative includes the capture of 2 million metric tonnes of carbon capture by 2030. It would be wonderful for a partnership or a series of partnerships to develop between Shell and Governments to target the collection of plastics for use as feedstock.

See: [Investment in Shell Energy and Chemical Park Singapore to Bring Circular Chemicals to Asia Pacific Customers](#)

- Rehyned thinking:** On November 24, 2021 the Rehyn project (among others, see [Editions 21](#) and [22](#) of Low Carbon Pulse) reported on economic findings and policy setting thinking following the development and deployment of 10 MW electrolyser at the Shell Refinery.

The core of the published findings are of no surprise: "Electrolysers face a trade-off-between high fixed cost and low load factors and high electricity cost at high load factors".

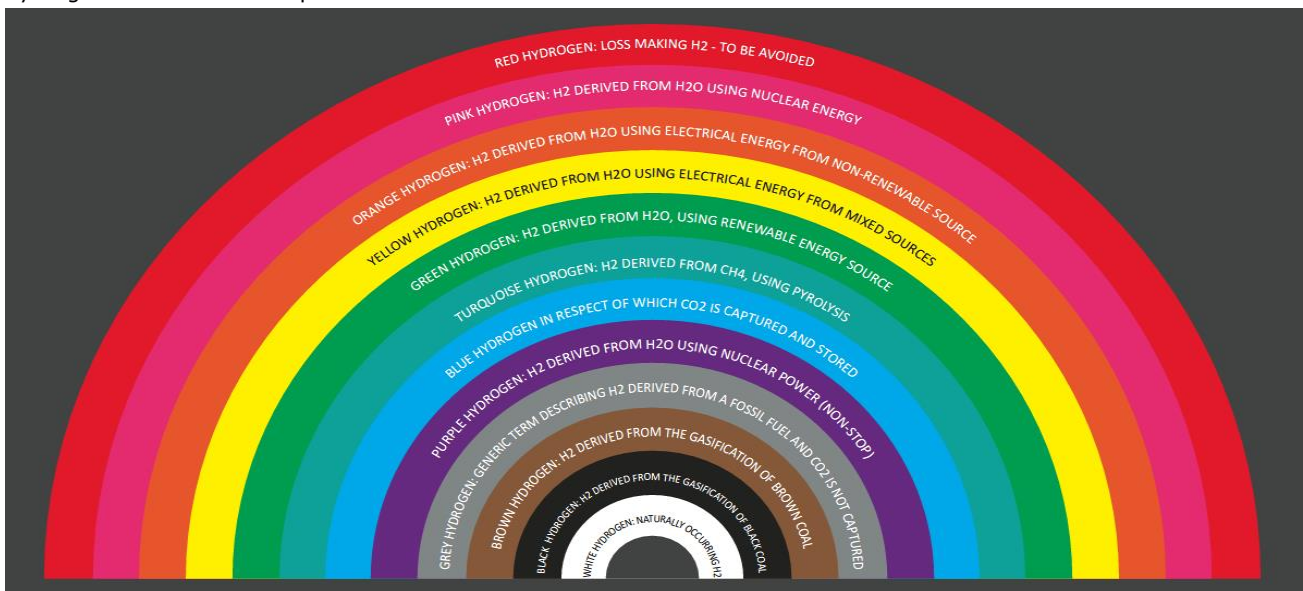
The central conclusion is that for the economics of an electrolyser to be sustainable the electrolyser must be able to run at base load to be able to achieve a €4 per kg of hydrogen produced (assuming zero levy or tax on the electrical energy used).

See: [Brief summary report on initial policy implications of the bulk electrolyser model](#)
- Edify and Port of Townsville:** On November 24, 2021, it was reported widely that Edify (leading renewable energy project developer) and the Port of Townsville had signed a memorandum of understanding (**MOU**) for the purpose of working together to investigate the export of hydrogen.

It is expected that the work under the **MOU** will concentrate on the export of Green Hydrogen produced by Edify's proposed, and recently approved, 1 GW electrolyser, with capacity to produce up to 150,000 metric tonnes per annum of Green Hydrogen (see [Edition 17](#) of Low Carbon Pulse). Edify's Green Hydrogen production facility is to be located in the Lansdown Eco-Industrial Precinct, 46 km south of Townsville.

See: [Edify's MoU with Port of Townsville to advance Hydrogen Export](#); [Hydrogen Export Plans Boost for Jobs](#)
- UK considering hydrogen from nuclear:** As noted under, [Hydrogen Gets Big Billing](#), above, the US is to use nuclear power and likely steam to produce hydrogen.

On November 26, 2021, [H2-view](#), reported that the UK is considering the introduction of "nuclear derived hydrogen" in the context of policy setting decisions to be made on the role of hydrogen in buildings (ambient and water heating). The National Nuclear Laboratory (**NNL**) and DNV are working together to discern the basis on which nuclear derived hydrogen could be scaled up the GW scale.



Ashurst Hydrogen Rainbow ©Ashurst 2021

[**Note:** Some authors / commentators use Purple Hydrogen to refer to the production of hydrogen using coal or petcoke gasification using CCS to capture the CO₂ arising.

In South Australia, White Hydrogen is being referred to as Gold Hydrogen, reflecting the rush to acquire exploration licenses]

- EQTEC and Wood ink blue:** Previous editions of Low Carbon Pulse have reported extensively on projects to derive and to produce hydrogen and natural gas, and sibling publication, [Hydrogen for Industry \(H24I\) Feature 1: Hydrogen from Waste](#), outlined the use of waste and waste water to derive and to produce hydrogen. As noted in the [H24I](#) feature, waste (and waste water) provides a viable source of feedstock for the derivation and production of hydrogen and biogas (and further processed biomethane).

On November 26, 2021, it was reported widely, that EQTEC and Wood had concluded a strategic collaboration agreement to pursue waste-to-hydrogen and waste-to-synthetic natural gas (**SNG**) developments.

See: EQTEC [website](#); Wood [website](#)
- Tokyo Gas and Mitsubishi Corporation combine:** On November 26, 2021, [hydrogen central](#), reported that Tokyo Gas Co. Ltd. (**TG**) and Mitsubishi Corporation (**MC**) had announced that they were exploring joint feasibility in the procurement and supply of synthetic methane, i.e., synthetic natural gas. It is understood that **TG** and **MC** are focusing on the feasibility of synthetic methane produced using the combination of Green Hydrogen and **CO₂**.

The background to this is policy based: for Japan to achieve **NZE** by 2050, among other things, the heating industry needs to be decarbonised. In this context, Japan's Strategic Energy Plan contemplates the replacement of natural gas with synthetic methane. Of course, while the production of synthetic methane may be **GHG** emission free (depending on the source of the **CO₂**), the combustion / oxidation of synthetic methane is not **GHG** emission free.

Green Metals / Minerals, Mining and Difficult to Decarbonize industries:

Miners pursue green coals: In November 2021, TotalEnergies posted [Saft magazine # 42 – Sustainable Mining](#). A link to the Saft article is attached.

The article focuses on the role, in fact the increasing role, of energy storage systems at mine sites, and the progress towards the displacement of diesel generation capacity.

Hydrogen - Cities, Clusters and Hubs, Giga-Factories, and Valleys:

- **Hydrogen Hub at the Port of Newcastle:** On November 15, 2021, it was reported widely that Macquarie Group (through its Green Investment Group), Jemena and Snowy Hydro are considering the feasibility of the development of a Green Hydrogen Hub in the New South Wales, Australia, City of Newcastle.

It is understood that the feasibility study will assess the viability of the development of a Green Hydrogen Hub, using a 40 MW electrolyser in the first instance, but assessing expansion of Green Hydrogen production capacity of up to 1 GW by 2030. The Australian Renewable Energy Agency (**ARENA**) is providing funding support for the feasibility study.

- **Aberdeen to be world's first 100% hydrogen powered city:** On November 19, 2021, [energyvoice](#) reported on plans to make Aberdeen the world's first hydrogen powered city by 2030. Gas network corporation, SGN, has published a roadmap outlining the role that clean-fuel can play in decarbonising energy, and sets out an accelerated pathway for Aberdeen.

- **Ballard, Caterpillar and Microsoft combine:** On November 22, 2021, it was reported widely that Ballard Power Systems, Caterpillar Inc and Microsoft are to demonstrate a back-up power system that will use fuel cell technology to provide reliable and sustainable back-up power systems for data-centres.

Ballard Power will provide the fuel cell technology, Caterpillar the control systems and Microsoft the data-centre design team.

See: [Ballard teams up with Caterpillar & Microsoft to demonstrate megawatt-scale hydrogen fuel cell backup generator system for datacenters](#); [Caterpillar to Launch Demonstration Project Using Hydrogen Fuel Cell Technology for Backup Power at Microsoft Data Center](#)

Off-shore wind round-up:

- **Morro Bay, California designated for OWF:** Edition [23](#) of Low Carbon Pulse reported on the likely designation of Morro Bay, California for the development of off-shore wind field development.

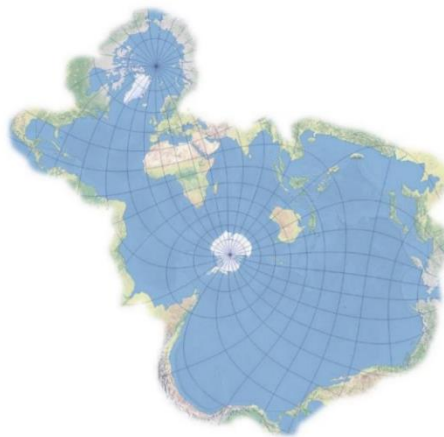
On November 15, 2021, the Bureau of Ocean Energy Management (**BOEM**) designated an area of 376 square miles in Morro Bay for the purposes of the development of off-shore wind field capacity. The area is around 20 miles off the coast of California.

- **Italy awash with floaters:** Edition [30](#) of Low Carbon Pulse reported on the highly prospective off-shore wind field resources in Italian waters.

On November 22, 2021, it was reported widely that the Ministry of Ecological Transition had received 64 expressions of interest (**EOI's**) to develop and to deploy off-shore floating wind field projects. It is reported that 55 **EOI's** were received from corporations, three from environmental protection organisations, and seven from other organisations.

- **71,000 GW opportunity:** On November 23, 2021, the author of Low Carbon Pulse came across a representation conveying the scale, and the size of the prize, of the development of off-shore wind capacity.

The headline accompanying the graphic is: "**When you work in #Offshorewind the world looks like this: 115 countries with a 71,000 GW opportunity to combat #climatecrises!**".



- **Singapore Enterprise Energy energizes overseas:** On November 22, 2021, it was reported widely that Singapore based off-shore wind field developer, Enterprise Energy, intends to develop a USD 10 billion wind field off the Republic of Ireland.

- **Germany to increase offshore wind field development:** Edition [23](#) of Low Carbon Pulse reported that during 2021, installation of off-shore wind field capacity had stalled.

On November 24, 2021, the new coalition government (comprising Social Democrats, Greens and Free Democrats) announced plans to increase the targets for the installation of offshore wind field development as follows: 30 GW by 2030 (an increase of 10 GW from the previous 20 GW), 40 GW by 2035, and 70 GW by 2045.

In addition to offshore wind field capacity development, 200 GW of photovoltaic solar is planned by 2030, and 2% of the land mass of Germany is to be designated for onshore wind farm development.

- **Thor Offshore Lottery:** On November 25, 2021, the Danish Energy Agency (**DEA**) announced that the award of the 1 GW Thor offshore wind field (**Thor OWF**) project will be decided by a lottery.

It is understood the multiple bidders, including heavy weight consortiums, Copenhagen Infrastructure Partners and SSE, Iberdrola and Total Energies, Ørsted and RWE, Swan Wind (Eneco and European Energy) and Vattenfall, are to draw lots for the award.

The **Thor OWF** project is to be developed by the winner of the lottery without any Government support in the form of a subsidy. The **DEA** announced that: "*More than one bidder has offered to build Thor offshore wind farm with a capacity of 1,000 MW at the minimum price of Dkr0.10 / MWh, and the tender will therefore, in accordance with the tender conditions, be decided by drawing lots*".

The drawing of lots will take place on December 1, 2021 – see **Edition 32** of Low Carbon Pulse.

- **Second US Off-shore approval:** On November 25, 2021, it was reported widely, that the US Department of the Interior (**DOI**) has approved the construction and the operation of Ørsted Offshore North America and Eversource's 132 MW South Fork off-shore wind field project, off the coast of Rhode Island (see **Edition 8** of Low Carbon Pulse). The Record of Decision (**ROD**) issued by the Bureau of Ocean Energy Management (**BOEM**) contains the terms of the decision to approve South Fork.

In March 2021, the **DOI** approved the first off-shore wind field – the 804 MW Vineyard Wind 1 project (see **Editions 12** and **13** of Low Carbon Pulse), and on November 19, 2021 was reported to have held a ground breaking ceremony, at Covell's Beach, Barnstable.

While noted before in Low Carbon Pulse that the US is not as progressed as some other countries in off-shore wind field development this appears to be changing, at a rate of knots: US Secretary of the Interior, Ms Deb Haaland is reported to have said:

"Just one year ago, there were no large-scale off-shore wind projects approved in federal states of the United States. Today there are two, with several more on the horizon".

Solar and sustainable:

- **EDF afloat in Laos:** On November 16, 2021, [pvmagazine](#) reported that EDF (leading energy cooperation head-quartered in France) intends to develop a 240 MW floating photovoltaic solar farm to be located on the largest hydroelectric dam in Laos, providing water for the Nam Theun hydro-electric power station. The 240 MW photovoltaic project, the Nam Theun 2 Solar Project, will cover an area of 3.2 km² less than 1% of the area of the water dammed.
- **Buffett and Gates go nuclear: Edition 19** of Low Carbon Pulse reported on the plans of industry and investment titans Warren Buffet and Bill Gates to develop a nuclear power plant in Kemmerer, Wyoming. Subject to obtaining all approvals, TerraPower is to develop a USD 4 billion 345 MW nuclear power plant, about 130 miles northeast of Salt Lake City, Utah. The nuclear power plant, deploying a relatively small Sodium reactor, based on the technology used in nuclear submarines, will have a short build period, be cheaper to build, and both cheaper and safer to operate than larger conventional nuclear power plants.
- **ADB and PetroVietnam alignment:** On November 18, 2021, [vietnamplus](#) reported that the Asian Development Bank (**ADB**) and the Vietnam Oil and Gas Group (**PetroVietnam**) had signed a Memorandum of Understanding (**MOU**) to establish a strategic partnership, covering the period 2021 to 2024, to promote clean and renewable energy development and deployment, and in so doing assist **PetroVietnam** achieve **GHG** emission reduction targets, principally **NZE** by 2050.
- **Geothermal – A Summary:** In November, 2021, the Global Geothermal Alliance, IDB and IRENA published, [Geothermal: The Solution Underneath](#). The publication provides a useful summary. The publication will be summarised in the **November and December Report on Reports**, to be contained in the Appendix to **Edition 34** of Low Carbon Pulse.
- **A mix of Oil and Sun:** On November 23, 2021, [Africanews](#), reported that TotalEnergies is to develop 500 MW of photovoltaic solar capacity in Libya, working with the Libyan Government.
- **Enel to add 84 GW of renewables by 2030:** On November 24, 2021, Enel (leading international renewables corporation) announced that it was to invest around €70 billion (USD 78 billion) to scale up its renewable electrical energy and **BESS** portfolio by 2030, and in doing so develop 84 GW of new renewable capacity, such that by 2030 Enel will have a total of 129 GW of renewables capacity. Of the additional 84 GW of new renewable capacity, 43 GW is to be photovoltaic solar, with 9 GW of **BESS**.

See: [Enel, the road to 2030 in the 2022-2024 Strategic Plan: powering investments towards zero emissions with focus on the electrification of customer energy demand](#)

- **Vinci verges green: Edition 14** of Low Carbon Pulse reported on plans in the **ROK** to develop photovoltaic solar facilities along linear transport routes. On November 24, 2021, Vinci Group announced plans to install photovoltaic solar facilities along unused areas for land along freeways / motorways in France. It is reported that Vinci Group will partner with Tryba Energy to develop and to deploy the facilities.

As with the initiative in the **ROK**, the Vinci Group initiative is significant in that land is being used to generate renewable electrical energy, and the development and deployment of like initiatives consistently along linear transport routes more broadly will deliver significant additional renewable energy capacity at speed.

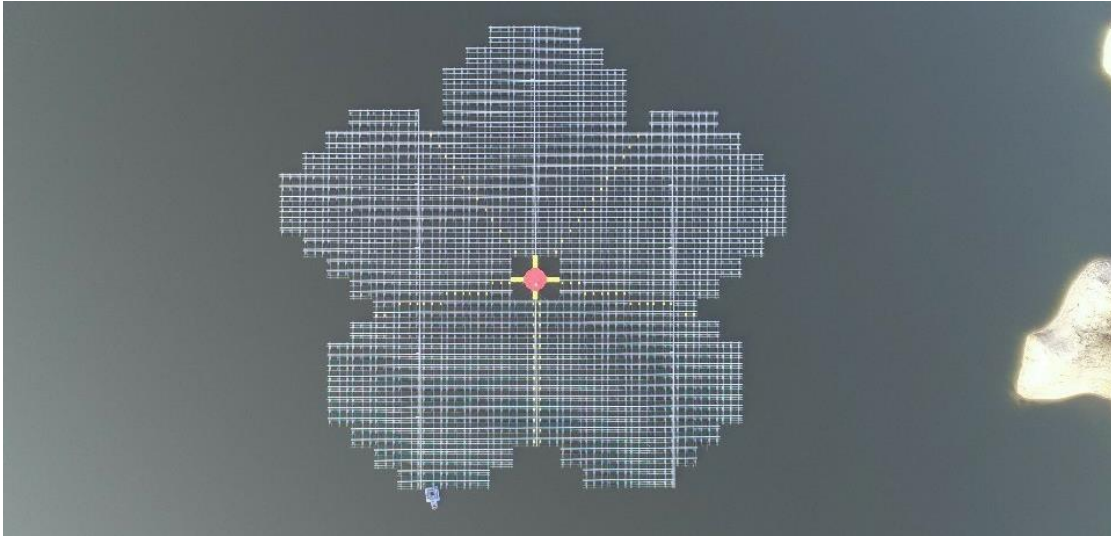
See: Vinci Autoroute [website](#)

- **Scotra flowers: Edition 12** of Low Carbon Pulse reported on the development of floating photovoltaic solar projects across the **ROK**.

On November 26, 2021, [pv magazine](#), reported that South Korea's largest floating photovoltaic solar facility had come on line. Scotra (the South Korean developer), using solar modules provided by Hanwha Q-Cells, has deployed the 41 MW floating photovoltaic solar facility. The floating facility is configured in the shape of a flower – see previous page.

The floating flower facility is the largest floating facility deployed in the **ROK**. Scotra developed the 24 MW floating photovoltaic solar facility on a reservoir in Goheung county, Jeollanam-do, and the 500 kW pilot floating facility on Hapcheon.

- **BASF Goes Green:** On November 26, 2021, [rechargenews](#), reported that BASF has formed its own renewables business to allow effective management of its projected increased demand for green energy / power.
- **Continued electrification:** One of the tensions that exists around the achievement of progress towards **NZE** is that at the same time that renewable electrical energy capacity is being developed and deployed to displace existing fossil fuel capacity and to allow the production of Green Hydrogen and hydrogen-based fuels, the population of the world



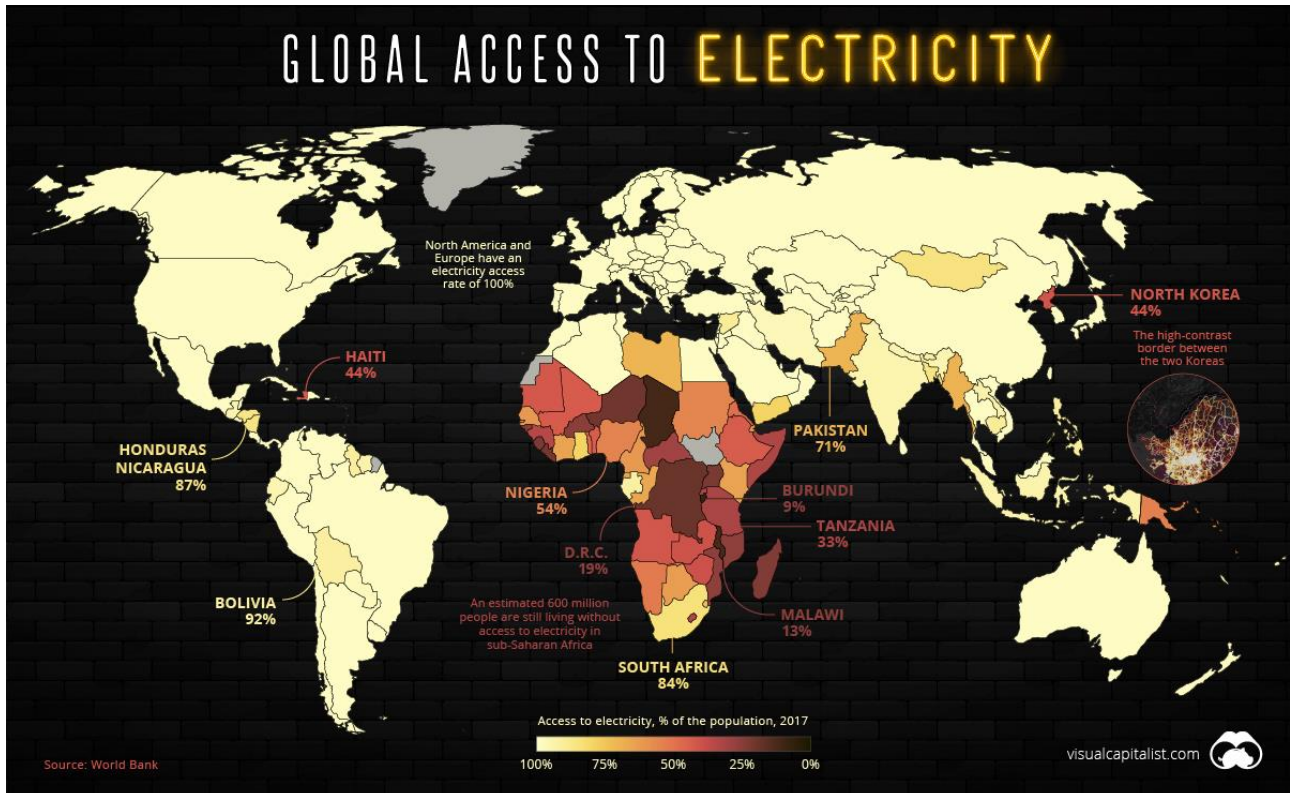
continues to increase and to urbanise.

While confronting, it is often helpful to reflect upon the scale of the task to develop renewable electrical energy capacity:

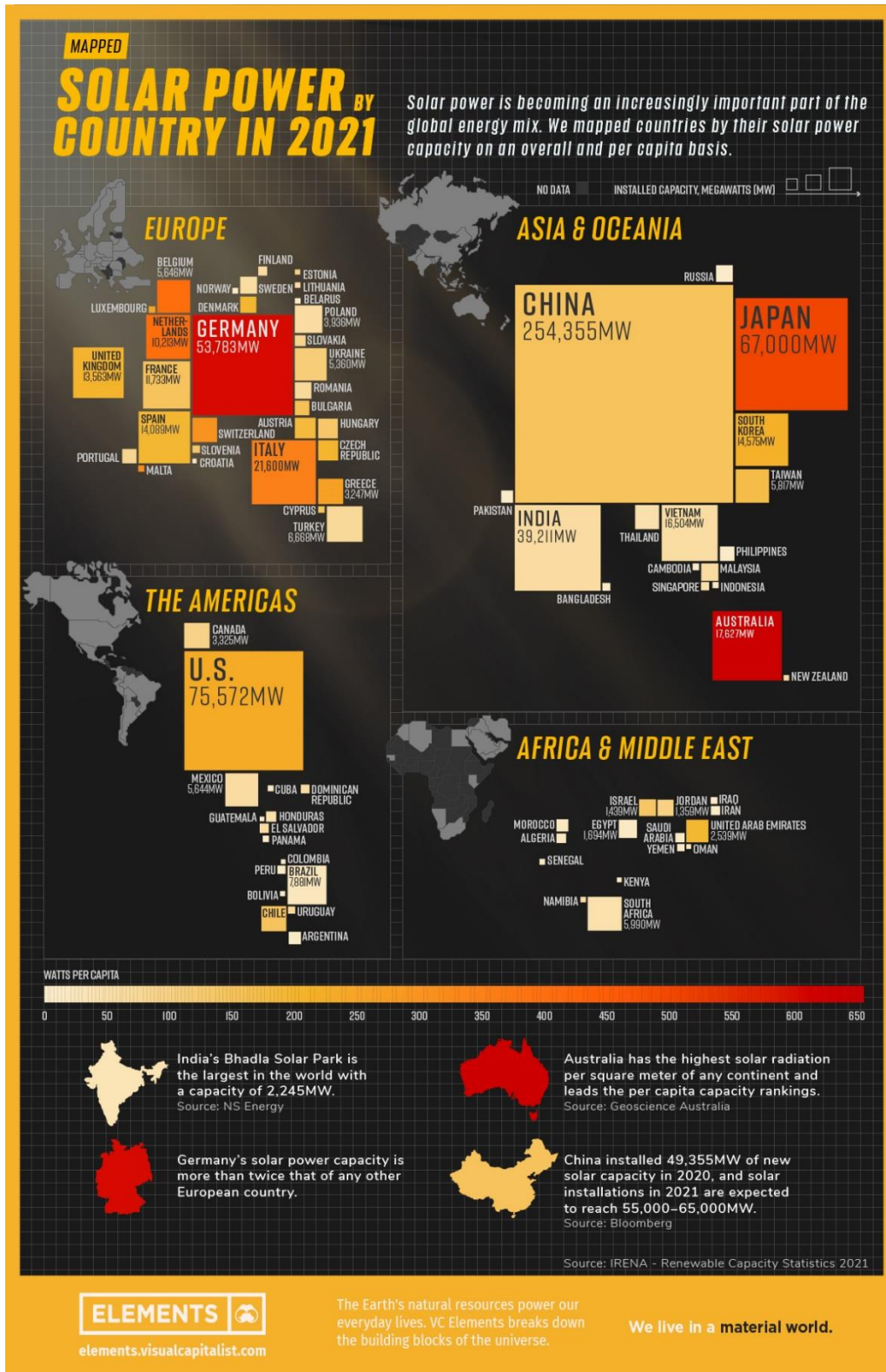
1. to retire fossil fuelled power generation capacity and to replace it with renewable electrical energy capacity;
2. to develop and to deploy renewable electrical energy to derive and to produce hydrogen and hydrogen-based fuels; and
3. to develop and deploy renewable electrical energy to those in the world that currently do not have it.

With the increase in population, the number of people without access to electrical energy will increase. At the moment, there are a number of estimates of how many people currently do not have access to electrical energy with a range of between 800 million to 1.2 billion from different sources.

Without wishing to debate the actual number of people, the graphic below provides a fair representation of the geographical spread of the global population without electrical energy.



- **Photovoltaic solar mapped by country:** In one of the clearest and cleverest graphics from the good folk at the Visual Capitalist, the following map graphic provides a summary of the photovoltaic solar capacity installed by countries in 2021.



- **Progress check around the world on photovoltaic solar installation and plans:**
 - The new coalition Government in Germany has indicated that it intends to develop and to deploy an additional 143.5 GW of photovoltaic solar capacity by 2030;
 - The Polish research institute, Instytut Energetyki Odnawialnej, has estimated that Poland will have developed and deployed 30 GW of photovoltaic solar capacity by 2030;
 - In the first nine months of 2021 around:
 - 2 GW of photovoltaic solar capacity has been deployed in France; and

- 2.82 GW of photovoltaic solar capacity has been deployed in the Republic of Korea; and
- In Belgium, the EnergyVille, has reported that the potential for roof-top photovoltaic solar is close to 100 GW.
- **Community Energy Toolkit:** In November 2021, the International Renewable Energy Agency (**IRENA**) published a paper, entitled [Community Energy Toolkit: Best practices for broadening the ownership of renewables](#) that outlines how communities may participate actively in energy decision-making around the world, and in so doing harness the benefits of the energy transition.

NZE Waste:

- **The concept of NZE Waste:** Edition **29** of Low Carbon Pulse introduced the concept of **Net Zero Emission Waste** or **NZE Waste**, being waste that: "*arises from the extraction, manufacture, transportation and use of equipment and infrastructure developed for the purposes of reducing GHG emissions, including on the extraction of metals and minerals used in the manufacture of solar panels and wind towers and turbines, and energy storage systems (including BESSs) on the manufacture of those panels, towers and turbines, and systems, and on recovery and recycling of resources from them at the end of their life-cycles, and the means of disposal of any material that cannot be recovered or recycled*".

While **NZE Waste** is not yet as recognised as a term of art, and named as such, the need to develop an effective **NZE Waste** management system is recognised. In recognition of the need to develop an effective **NZE Waste** management system, this edition (and future editions of) Low Carbon Pulse will include a section on **NZE Waste**.

While it is unlikely that the **NZE Waste** section of Low Carbon Pulse will contain the same level of content as other sections, it is nevertheless important – if you will, book-ending the news items on green mining and giga-factories.

- **The Dark Side of Solar Power:** In June 2021, the Harvard Business Review, contained an insightful article from authors Atalay Atasu, Serasu Duran and Luk N. Van Wassenhove, with the article entitled [The Dark Side of Solar Power](#). The article offers a clear perspective, and it is well-worth a read. Among, other things, the article refers to the International Renewable Energy Agency Report (**IRENA**) from 2016 that anticipated the need to address the [End-of-life management Solar Photovoltaic Panels](#). Of course the effective waste management of photovoltaic solar panels, is but one part of the effective management of **NZE Waste**.
- **Northvolt recharging:** In November 15, 2021, it was announced that Northvolt produced a lithium-ion battery using recycled metal. Northvolt has announced that it is able to recover up to 95% of metals from a battery, and in so doing reducing demand for newly mined metals.

See: [Northvolt produces first fully recycled battery cell – looks towards establishing 125,000 ton/year giga recycling plant](#)

- **Aker Offshore Wind recycling wind-blades:** On November 24, 2021 it was announced that a pilot project is to commence to provide the UK with its first wind blade turbine recycling plant.

Aker Offshore Wind, working with researchers from the Advanced Composites Group and Lightweight Manufacturing Centre at the University of Strathclyde (part of the National Manufacturing Institute Scotland Group) and trade body Composites UK, are to oversee the development of a viable solution that can be implemented commercially at scale. The oversight group will work with other partners from Cubis (composite part manufacturer), GRP Solutions (composite distributor), Nottingham University and global waste management company SUEZ.

Land Mobility and Transport:

- **California Energy Commission (CEC) backs Hydrogen Infrastructure:** On November 16, 2021, the CEC approved a USD 1.4 billion funding support plan to allow the development and deployment of zero-emission mobility / transport infrastructure and manufacturing with hydrogen as the focus. Among other things, the funding support is intended to enable California to achieve its recharging and refuelling targets by 2025.

Ports Progress and Shipping Forecast:

- **Shoreham aligns with Getech:** On November 15, 2021 it was announced that Shoreham Port, UK had contracted with Getech subsidiary, G2 Green, with G2 Green to develop all of the port-based hydrogen and ammonia production and storage facilities, and associated renewable electrical energy capacity at the Port of Shoreham.

See: Shoreham Port [website](#)

- **Yara first:** On November 19, 2021, the Yara Birkeland departed for its maiden voyage – the Yara Birkeland is the first container vessel to be powered and propelled by electric technology. CEO of Yara, Mr Svien Tore Holsether said: "[Yara is] proud to be able to show case the world's first fully electric and self-propelled container ship. It will cut 1,000 tonnes of CO2 and replace 40,000 trips by diesel-powered trucks a year".

The Yara Birkeland was developed in collaboration with Kongsberg Group and was built by VARD, and will transport mineral fertiliser between Porsgrunn and Brevik.

See: [Yara to start operating the world's first fully emission-free container ship](#)

- **Shanghai Port first:** On November 25, 2021, it was reported widely that Shanghai Port has commenced trials of the first mobile crane powered and propelled using hydrogen fuel cell (**FC**) technology.
- **Port of Narvik first:** On November 25, 2021, it was reported widely that the Port of Narvik, Norway, is seeking to work with project partners to develop a high-speed workboat powered and propelled by **FC** technology from TECO 2030 and built by Grovfjord Mekaniske Verksted.
- **Gaussin and Nexport moving goods south:** Edition **1** of Low Carbon Pulse reported as follows: "*The French corporation, Gaussin, has unveiled two new vehicles for use in logistics ports – the ATM-H2 and the APM-H2. Vehicles used in logistics and port hubs are viewed as being more than likely to transition from the use of fossil fuels to hydrogen. The ATM-H2 has a towing capacity of 38 tonnes (for use in logistics hubs) and the APM-H2 has a pulling capacity of 75 tonnes (for use in the movement of containers at container terminals). These vehicles use a fuel cell that combines hydrogen with oxygen to produce electrical energy.*"

On November 25, 2021, it was reported that GAUSSIN and Nexport had signed a joint venture agreement to allow exclusive licensing and manufacturing to supply of zero-emissions vehicles (**ZEVs**) and systems and technology into the Australian and New Zealand markets, including **ZEVs** to be supplied for use at airports, logistics hubs and terminals and at port terminals.

- **Reflections on COP-26 for the Shipping Sector:** On November 26, 2021, Head of Regulatory Affairs at the Mærsk Mc-Kinney Møller Center for Zero Carbon, Mr Jan-Christoph Napierski published [Global decarbonisation after the COP – new hope for zero by 2050?](#), detailing the four central take-aways from COP:

1. Global zero as a new target for IMO;
2. The continued activity of private stakeholders in the shipping sector, reflecting in the activity before COP, including the [Getting to Zero Coalition](#), and the [Cargo Owners for Zero Emission Vessels](#);
3. The [Clydebank Declaration](#) (see **Edition 30** of Low Carbon Pulse); and
4. The broader engagement of the shipping sector with particular progress around the Zero Emission Shipping Mission within the framework of Mission Innovation (see **Editions 19** and **30** of Low Carbon Pulse).

As with all thought-leadership from Mærsk Mc-Kinney Møller Center for Zero Carbon, the reflections of Mr Napierski are clear and direct, including the following summary:

"COP 26 in Glasgow was a landmark for the decarbonization of shipping. The formal agreement may seem thin but many other initiatives have created a global momentum that cannot be ignored anymore. This creates hope, also for the heavy discussions on Market Based Measures going on right now in the IMO's 77th session in the Marine Environment Protection Committee".

- **A.P. Moller – Maersk looks to hydrogen:** **Edition 26** of Low Carbon Pulse (under **A.P. Moller – Maersk: fleet of foot**) reported, in detail, on the decision by A.P. Moller-Maersk to procure container vessels powered and propelled by dual fuel engines, fuel oil and low-carbon methanol.

On November 26, 2021 it was reported widely that A.P. Moller-Maersk was seeking to secure supplies of Green Methanol (noting that **Edition 26** stated that the supply of low-carbon methanol was critical), and is assessing the use of hydrogen as a fuel to power and to propel vessels in its fleet.

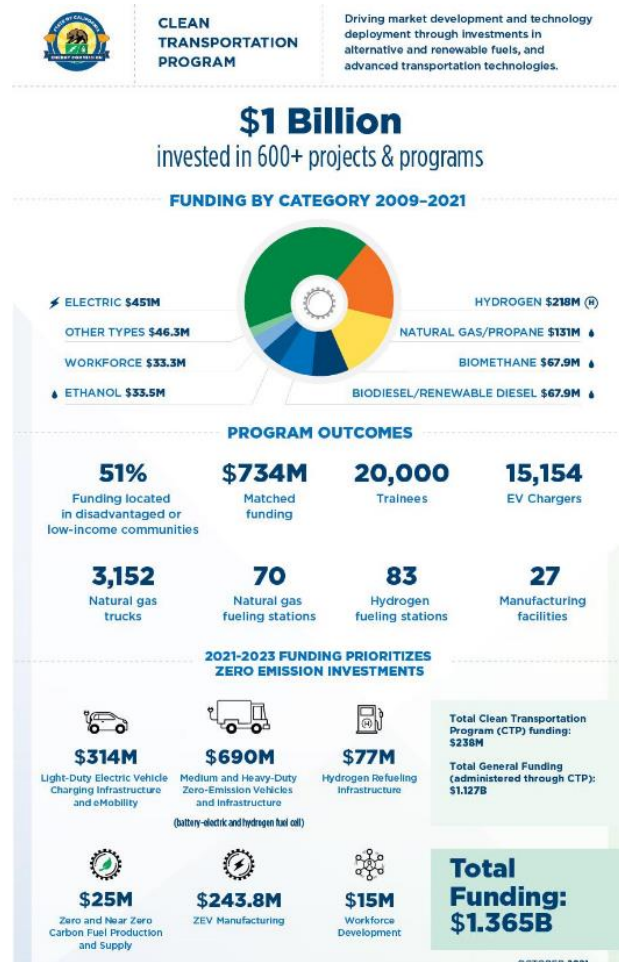
Head of Future Fuels at A.P. Moller-Maersk, Ms Maria Strandesen, noted that Green Methanol remained the decarbonisation fuel of choice, and that hydrogen could be used for certain vessels: *"We are looking at our vessels that have a maximum roundtrip of 2,000 km – we don't have many of those – but we do have a few there [and] we are ... looking [at] whether hydrogen could be used as fuel."*

For longer activities hydrogen by deep-sea going vessels hydrogen is not regarded as a viable option because the energy density of hydrogen is such that it will take up valuable cargo space. Ms Strandesen noted that hydrogen would take up as much as 15 times the tankage of current fuels.

Land Mobility and Transport and Airports and Aviation lite:

As has been the case in respect of other editions of Low Carbon Pulse, while there are news items relating to **Land Mobility and Transport** and **Airports and Aviation** in the period covered by this **Edition 31** of Low Carbon Pulse, in order to manage the length of this **Edition 31**, **Edition 32** will combine those news items with news items arising to December 16, 2021, the date on which **Edition 32** will be published.

This said, the diagram on the right struck the author of Low Carbon Pulse as helpful.



Low Carbon Pulse - Edition 32

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to **Edition 32** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the 18 day period from Monday November 29, 2021 to Thursday December 16, 2021 (inclusive of each day).

Please click [here](#) for the **First Low Carbon Pulse Compendium**, which comprises **Editions 1 to 28** of Low Carbon Pulse. Click [here](#) for the **Second Low Carbon Pulse Compendium**, and click [here](#) for the **Anniversary Edition** of Low Carbon Pulse. Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

This is the final edition of Low Carbon Pulse for calendar year 2021. **Edition 33** (*The Larry Bird Edition*) will be published on Monday January 17, 2021, after the Christmas and western New Year holiday season. The Appendix to **Edition 33** will comprise the Report on Reports for November and December.

Reflections on calendar year 2021 and thoughts about 2022:

Background: It may be regarded as customary for publishers of periodicals to look back to reflect on events of the past 12 months, and look forward to the coming 12 months. Given that 2021 has been the first full year of Low Carbon Pulse (28 editions if the Anniversary Edition is counted), and given progress in 2021, it seems appropriate to follow custom.

In looking back (pages 2 to 7), the events and matters included are those that were significant of themselves, or reflected a significant trend in a general sense. With limited exceptions, corporations are not referenced. This is not to discount the significance of achievements, decisions and plans of individual corporations, rather it recognises that greater significance is to be found in policy settings and themes and trends.

In looking forward (pages 7 to 10), the observations included tend to reflect themes and trends that have emerged, and appear likely to continue or to become more significant during 2022.

Why name Editions 32 and 33 after 1980s basketball players? From August 13, 2021 to December 13, 2021, the author of Low Carbon Pulse was located in Papua New Guinea (**PNG**). While located in PNG, the author rediscovered a passion for basketball (long dormant). With the rediscovery of passion, and, more importantly, muscle memory, the satisfying sound of the *swish* returned (as the basketball touched "nothing but nylon"), so the capacity to "switch -off" was rediscovered.

With rediscovery, the author has rediscovered on "you-tube" the achievements of Earvin "Magic" Johnson and Larry Joe Bird (after whom the Twitter logo is named). No doubt reflective of the decade in which the author played basketball, Magic Johnson and Larry Joe are the author's favourite basketball players. Always have been, always will be! This does not mean that the author regards either of them as the GOAT, that accolade rests with Michael Jordan.

Both played for one franchise during their careers; Magic played No 32 for the Los Angeles Lakers and Larry Joe played No 33 for the Boston Celtics. Each franchise retired their numbers on their retirements. On the court, they were the fiercest of competitors. Off the court, they were the best of friends. They remain the best of friends.

To me, Messrs Johnson and Bird remain the embodiment of authenticity, manifest in their genuineness, and their hard fought success, wrought in application and hard work, two folk who played for their teams, cut no corners, and shared 8 championships during the 1980's. Different times, different values, well-before COP-1.

- **Looking back on 2021:**

- **Quarter 1:**

- **January** (covered in **Editions 6, 7, 8** and **9** of Low Carbon Pulse):

Cheapest electrical energy in history: The new calendar year started with news of record low tariffs for photovoltaic solar projects in the United Arab Emirates (**UAE**) and India, and progress of the South Fork Wind Farm in the US (the second scale off-shore wind project in the US).

Oldest first term US President in history: On January 20, 2021, US President, Mr Joe Biden, was inaugurated (marked by **Edition 7** of Low Carbon Pulse), most memorable for [The Hill We Climb](#) by Ms Amanda Gorman. The afternoon of January 20, 2021, was memorable as President Biden signed executive orders, including one under which the US was to re-accede to the Paris Agreement, which occurred on February 19, 2021.

The "pick of publications" for January were the **Hydrogen Council's [Hydrogen decarbonisation pathways](#)**, Shell with Deloitte's [Decarbonising Road Freight: Getting Into Gear](#), and Shell's [Decarbonising Road Freight: Shell's Route ahead](#).

- **February** (covered in **Editions 9, 10** and **11** of Low Carbon Pulse):

Long winded: The shortest month was long on news about off-shore wind tender outcomes and off-shore wind field (**OWF**) plans: in North Asia, the Republic of Korea (**ROK**) announced plans to install 8.2 GW of **OWF** by 2030, the European Union (**EU**) plans to install 60 GW of **OWF** by 2030 continued to take shape (including plans outlined by France to procure 8.75 GW of **OWF** capacity by 2028), and the UK awarded leases for 8 GW of **OWF**.

North Asia priced and regulated: During February the design and definition of the Peoples Republic of China (**PRC**) emission trading scheme (**ETS**) became clear, "going live" on February 1, 2021. Also in the first week of February, the design and definition of **ROK's** Hydrogen Law became clear as it came into effect.

Texas outages: During mid-February, the Lone Star State was impacted by power outages (see **Editions 9, 10** and **17** of Low Carbon Pulse reported on the power outages and the causes of them). As many organisations reflected on the year, one of the more helpful reflections has come from Wood McKenzie with its article [Learning the right lessons from the Texas crisis](#) (published on December 3, 2021).

The "pick of the publications" for February were the **Hydrogen Council** and **McKinsey & Co's [report](#)** on the state of the development of the global hydrogen economy. This report appears likely to be published every six months or so: with the report for July 2021 included for convenience below. Mr Bill Gates' book, **How to Avoid a Climate Disaster** was released, providing a clear plan for the way forward to net-zero **GHG** emissions, including that reliance on renewable electrical energy alone will not allow us to reach **NZE**.

- **March** (covered in **Editions 11, 12** and **13** of Low Carbon Pulse):

PRC ETS size and shape: During March the scope and size of, and the timing of trading under, the **PRC ETS** became clear still: first, the proposed commencement of trading nationwide in respect of emissions quotas, with quotas to be registered for trading (and transferred) overtime to allow an orderly commencement to trading, and secondly, the extension of the **PRC ETS** to include enterprises undertaking activities not included in the initial iteration of the **PRC ETS**.

UK half way to NZE: On March 18, 2021, it was reported that the **GHG** emissions arising in the UK were at 51% of 1990 levels, and at their lowest levels since 1879. In other words, the UK was half way to meeting its target of net-zero **GHG** emissions by 2050.

Elsewhere, more to do: The good news from the UK contrasted with a United Nations [report](#) which concluded that the nationally determined contributions (**NDCs**) of Parties to the Paris Agreement would result in less than a 1% reduction in **GHG** emissions from 2010 levels by 2030. UN Climate Chief, Ms Patricia Espinosa stated: "What we need to put on the table is much more radical and much more transformative than we have been being until now". This became the recurring theme of 2021 – including before **COP-26**, and after.

- **Quarter 2:**

- **April** (covered in **Editions 13, 14, 15** and **16** of Low Carbon Pulse):

KAS - electrical energy cheaper still: In the first week of April, the Kingdom of Saudi Arabia (**KAS**) announced the results of tenders in Round 2 of its National Renewable Energy Program. The results included a winning bid on one of seven project awards of a little over 1 cent per kWh (see **Edition 14** of Low Carbon Pulse).

EU - 55 by 30: On April 21, 2021 the the European Commission (**EC**) welcomed provisional agreement on the **European Climate Law** reflecting **55 by 30**, i.e., a 55% **GHG** emissions reduction by 2030 across the **EU**.

Global Leaders: On April 22 and 23, 2021, the Leaders' Summit was held (see **Edition 15** of Low Carbon Pulse for Summary), bringing together 40 world leaders to the Leaders' Summit, and a further 63 world leaders involved in "listening sessions". The Leaders' Summit marked the hoped for re-emergence of US leadership, and continued alignment (including on the need to reduce **CH₄** emissions), with the **PRC** and Russia involved in the Summit.

Germany – NZE by 45: As the Leaders' Summit took place, the German constitutional court determined that German legislation was unconstitutional because it did not deal with reductions in **GHG** emissions after 2030. In response to this determination, the German Federal Government announced: 65% **GHG** emission reductions by 2030 and 85-90% by 2040, both compared to 1990 **GHG** emissions, and net-zero **GHG** emissions by 2045.

- **May** (covered in **Editions 16, 17, 18** and **19** of Low Carbon Pulse):

All action IEA: The **International Energy Agency (IEA) [Net-zero by 2050: A Roadmap for the Global Energy Sector \(IEA Roadmap\)](#)** was published on May 18, 2021, providing a clear sense of scale and scope of what is needed to hold the increase in average global temperature to **1.5°C** (with its key finding to be found at the end of **Edition 18** of Low Carbon Pulse). The **IEA Roadmap** has been a reference point for each **IEA** publication since, and has become something of a reference guide or tool-kit.

All action judiciary: On May 26, 2021, the District Court in The Hague, in the Netherlands, delivered its judgment in a case brought against Royal Dutch Shell plc (**RDS**) by Milieudefensie (et al). This judgment requires

RDS to reduce the net **CO₂** emissions of the **RDS** group by at least 45% by 2030, compared to 2019. (**RDS** has appealed.)

All action shareholder bases: The **RDS** judgement was handed down in the same week that CVX and IOM were taken by surprise by shareholder activism at board level (see **Edition 18** of Low Carbon Pulse).

- **June** (covered in **Editions 19, 20** and **21** of Low Carbon Pulse):

IRENA joined IEA: The International Renewable Energy Agency (**IRENA**) World Energy Outlook (**WETO**) was published at the end of June. The **WETO** is summarised in **Edition 21** of Low Carbon Pulse, in the Report on Report in **Edition 23** of Low Carbon Pulse, and is compared with other reports in **Edition 28**.

A role of natural gas: The role of natural gas was coming into ever sharper focus (see **Edition 11** of Low Carbon Pulse – **Natural Gas as a transition fuel**, and **Edition 20** of Low Carbon Pulse – **The Role of Natural Gas**), including in light of the pathways suggested by both **IEA Roadmap** and **WETO**, and **EU** thinking around clean hydrogen, not at that time in the context of energy security.

The following table provides a high-level overview of the **IEA Roadmap** and the **WETO**. It is important to note that each is intended to achieve **NZE** while ensuring that the increase in average global temperatures are limited to **1.5°C** above pre-industrial levels. As 2021 progressed, the criticality of this became a key theme.

IEA ROADMAP AND WETO – SIX AND SEVEN PILLARS	
IEA Roadmap	The seven pillars of the IEA Roadmap are: 1. Energy efficiency; 2. Behavioural change; 3. Electrification; 4. Renewables; 5. Hydrogen and hydrogen-based fuels; 6. Bioenergy and land use change; and 7. Carbon capture, utilisation and storage.
WETO	The six pillars of the WETO are: 1. Energy Conservation and efficiency; 2. Renewables (power and direct uses); 3. Electrification of end use (direct); 4. Hydrogen and its derivatives; 5. CCS and CCUS in industry; and 6. BECCS and other carbon removal measures.

Note: By the end of Q2, the format of Low Carbon Pulse reflected the subject matter and the number of news items arising,. Country and global developments, CCS / CCUS and BECCS and BECCUS, BESS and HESS, Future / E-fuels (including Green Hydrogen and Hydrogen Based Fuels), Green Metals and Minerals, Green Hydrogen Hubs (and Carbon Clusters), Valleys, and Cities, Uses of **CO₂**, Wind and Solar and Sustainable round ups, Land Transport, Ports and Shipping and Airports and Aviation.

Quarter 3:

- **July** (covered in **Editions 21, 22** and **23** of Low Carbon Pulse):

Fit for 55: The **Fit for 55 Package** was published by the **EC** (see **Edition 22** of Low Carbon Pulse for detailed review), providing the means for the **EU** to reduce **GHG** emissions by **55% by 2030**, including direct and indirect use of the **EU ETS**.

PRC ETS trades: The **PRC ETS** commenced trading, with 4 giga-tonnes (i.e., 4 billion metric tonnes) of **GHG** emissions covered by the **PRC ETS**, and the prospect of the application of the **PRC ETS** to be expanded to cover 8 giga-tonnes.

Two of three reasons to be cheerful around mid-2021.

What a difference six months makes: As noted above, **Edition 10** of Low Carbon Pulse reported on the **Hydrogen Council** and **McKinsey & Co** report, dated February 17th, 2021 (**February Report**). On July 15, 2021, the **Hydrogen Council** and **McKinsey & Co** published their second report (**July Report**).

The table below shows the increased level of activity over the six month period, February to July 2021.

HIGH LEVEL COMPARISON, FEBRUARY TO JULY			
Large Scale Projects (February)	230	Large Scale Projects (July)	359
Total Investment Amount (Feb)	USD 300 billion	Total Investment Amount (July)	USD 500 billion
30% of Total Investment Amount was firm at USD 80 billion		30% of Total Investment Amount is firm, at USD 150 billion	

In November 2021, the Hydrogen Council and McKinsey & Company published **Hydrogen for Net Zero**; Chapter 3 containing the headline grabbing **Large Scale Projects > 520**, and **Total investment amount USD 540 billion**. The **November and December Report on Reports** will cover **Hydrogen for Net Zero**, and the Hydrogen Council's **Policy Toolbox for Low Carbon and Renewable Hydrogen** publication in detail (the **Report on Reports** comprising the Appendix to **Edition 35** of Low Carbon Pulse).

2°C increase not fit for purpose: On July 21, 2021, BloombergNEF published **New Energy Outlook, 2021 (NEO)**. **NEO** provided another perspective on achieving **NZE** by 2050, placing it in the context of the carbon budget that is available before reaching a **2°C** increase in average global temperatures compared to pre-industrial times, rather than **1.5°C** under the **IEA Roadmap** and the **WETO**. Based on current trends, **NEO** noted that a **2°C** increase in average global temperatures would arise by 2044.

Orthodoxy and reality has taken thinking back to the criticality limiting the increase to a **1.5°C** increase or, in the words of **COP-26** "keeping a **1.5°C** increase within reach". This thinking is no doubt underlined by the extreme weather events experienced during the months of July through September globally.

On July 22, 2021, the **IEA** published a report entitled **Empowering Cities for a Net Zero Future- Unlocking resilient, smart, sustainable urban energy systems (Smart Cities Report)**. The **Smart Cities Report** is likely to be one of those reports that becomes more influential over time. It is one of the stand-out reports of 2021. It is summarised in the Appendix to **Edition 23** of Low Carbon Pulse.

- **August** (covered in **Editions 23, 24, 25** and **26** of Low Carbon Pulse):

Call for more action: On August 1, 2021, Ms Allegra Stratton, Climate Spokesperson for No. 10 Downing Street, said that achieving **NZE** by 2050, is "**too far away**", "**the science is clear**", and the UK must reduce its **GHG** emissions "**right now**".

Ms Stratton encouraged people to "**feel the fierce urgency of now**". Ms Stratton was right. (Revelations during the week-beginning December 6, 2021 do not lessen the power of her words in August 2021.)

At the time, Low Carbon Pulse noted that this may be regarded as one of the most telling and timely phrases of 2021: for the UK, leading the way to **NZE**, and as such acting on the science, to consider that acceleration was needed, resonated, resoundingly, and it still does. This assessment was, and remains, clear headed.

Clear need for more action: The **Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report – Climate Change 2021, The Physical Science Report (2021 Report)** was published, with the key conclusions being that: "It is more likely than not that the earth will be **1.5°C** warmer in 2050 than it was in the 19th century". The **2021 Report** finds, unequivocally, that the reason for the increase in average temperature globally is the emission to the climate system of "well-mixed greenhouse gases" (being **CO₂**, **CH₄** and **N₂O**) arising from human activities.

The **2021 Report** is summarised in **Edition 24** of Low Carbon Pulse. The science is clear.

Call heeded in India: From the end of Q1, there was a marked increase in activity in India, at Government (including state-owned corporations) and private sector corporation level. Executive Director of the International Energy Agency (**IEA**) Dr Fitoh Birol said that: "*India is a leading country in terms of renewable energy investments ... the country has great plans to be a driver of clean energy transitions ...*". This is a good thing.

On August 15, 2021, India celebrated the commencement of the 75th year after its founding on August 15, 1947. Indian Prime Minister, Mr Narendra Modi, took the opportunity to announce the National Hydrogen Mission for India (**NH2M**) in his Independence Day Speech. Prime Minister Modi was to steal the show at **COP-26**.

Call not heeded on NGHGEIs: The need to remove **CO₂** from the climate system (in addition to the reduction in **GHG** emissions) is core to the Paris Agreement (recognised in Article 4). From the start of Q2, the means to the achievement of removal of **CO₂** using **net negative gas house gas emission initiatives**, received increased coverage, including in news item in Fortune magazine, under **Net zero isn't enough. We need to get to net negative**. While awareness has increased, more needs to be done. **COP-26** did not move the dial significantly.

- **September** (covered in **Editions 26, 27** and **28** of Low Carbon Pulse):

Global Methane Pledge: As noted in the **Anniversary Edition** of Low Carbon Pulse, one of the most significant areas of progress from October 2020 to September 2021 was (and since has been) the recognition of the need to reduce **CH₄** emissions. **Edition 26** of Low Carbon Pulse noted, that:

*"While there is more than 200 times more **CO₂** than **CH₄** at large in the climate system, and each **CH₄** molecule remains in the climate system for an average of ten years (not hundreds of years), **CH₄** molecules absorb and retain more radiative heat, which means that **CH₄** can have up to 84 times the global warming potential of **CO₂**. This is why in recent Government to Government engagement and reports, there has been a focus on the reduction in **CH₄** emissions: it is estimated that up to 57% of **CH₄** could be reduced by 2030, reducing the impact on the climate system by 0.25°C by 2050, and 0.5°C by 2100".*

On September 17, 2021, the EC and the US signed the **Global Methane Pledge** to reduce **CH₄** emissions by one third by 2030. Since September, 110 countries have signed the **Global Methane Pledge** (with the details of the countries that have pledged listed at www.globalmethanepledge.org).

Global Levy on shipping proposed: On September 13, 2021, the International Chamber of Shipping (**ICS**) proposed the introduction of a global levy on **GHG** emissions from shipping activities (**ICS Proposal**). On September 13, 2021, **ICS** issued a **press release** in respect of the **ICS Proposal**. The **ICS Proposal** would be mandatory in respect of vessels trading globally having gross tonnage exceeding 5,000 tonnes. The amount of the global levy would provide funding for the **IMO Climate Fund**.

Global get together: The week beginning September 20, 2021, saw the United Nations General Assembly in full-session. The UN General Assembly of 2021 was the first since 2014 to have the benefit of an assessment report from the Intergovernmental Panel on Climate Change (**IPCC**) - the **2021 Report**. Some speeches from world leaders to the General Assembly were inspiring, contributing to heightened expectations ahead of **COP-26**.

Global leaders focused: In light of the **2021 Report** and the approach of **COP-26**, the business of the United Nations General Assembly focused on climate change, and for the first time in 40 years, there was a leader-lead meeting under the auspices of the United Nations General Assembly (the **UN High-Level Dialogue on Energy**).

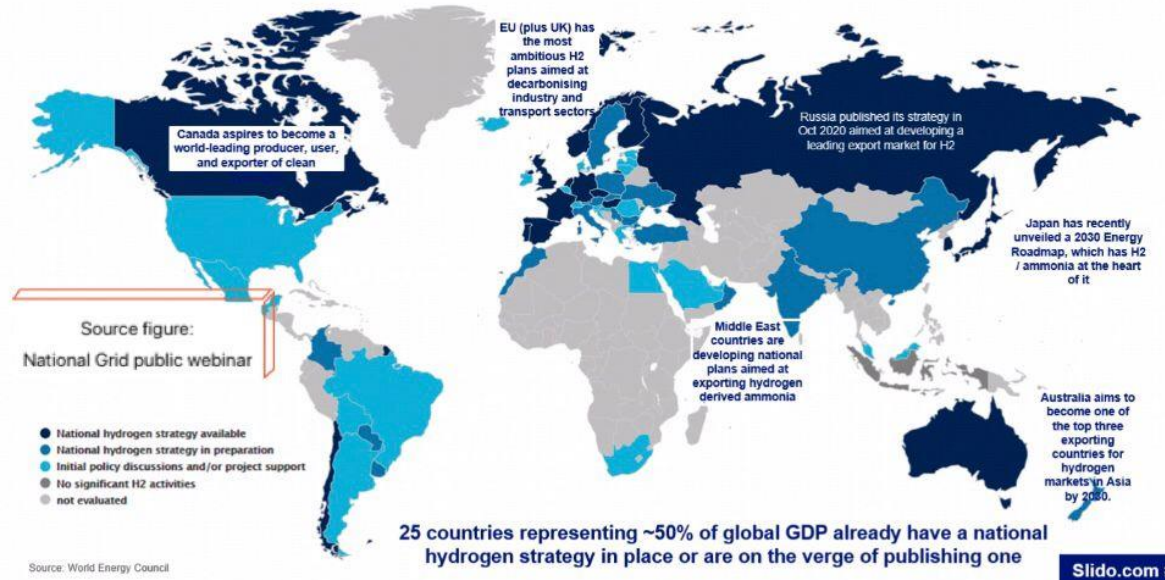
There was some good news from the UN General Assembly, with the **PRC** announcing cessation of support for the development of coal-fired power stations (under One-Belt-One-Road (**OBOR**)), and Turkey announcing that it was to ratify the Paris Agreement, which the Turkish Parliament did during the first week of October. (On ratification by Turkey, all G20 countries had ratified the Paris Agreement.)

After the UN General Assembly, the great and the good met in Rome, Italy in late September.

Edition 29 of Low Carbon Pulse noted that by the end of September the expectations for **COP-26** were somewhere between heightened and sky-high.

By the end of Q3 hydrogen plans, roadmaps and strategies were receiving increased coverage. The graphic below sets out the state of play at the end of Q3:

Status of current National H2 Strategies / Plans (Q3 2021)



Quarter 4:

- **October** (covered in **Editions 28** and **29** of Low Carbon Pulse):

Mind the gap: After a busy September, and increasing optimism, two reports focused minds ahead of **COP-26**: the United Nations Framework Convention for Climate Change (**UNFCCC**) **NDC Synthesis Report** – reporting on the impact on climate of the implementation of **NDCs** committed to as at the end of July 2021, and the United Nations Environmental Program (**UNEP**) **Production Gap Report** – reporting that in setting **NDCs** countries had not taken account of planned increases in fossil fuel production and use.

The **NDC Synthesis Report** informed the UN Secretary General, Mr Antonio Guterres' use of the phrase "the **Catastrophic Pathway**" of a **2.7°C** increase in average global temperature. Mr Guterres' used the phrase in his speech to the UN General Assembly in September, and repeated it in his speech at **COP-26**.

The **Production Gap Report** informed a considerable amount of news coverage, and debate, a good deal of it well-informed and constructive, no doubt as a result of the excellence of the **Report**. Talking of excellent publications, the **IEA** published its **Global Hydrogen Review** during October. (The Appendix to **Edition 30** of Low Carbon Pulse reports on the core findings of the **Review**.)

The findings in the **Production Gap Report** were underscored by US EIA's **Internal Energy Outlook** which projected a 47% increase in total final energy usage by 2050, with natural gas and oil remaining the largest sources of total final energy by 2050.

Reduce methane: The curtailment and reduction in **CH₄** continued to capture the attention of the news feeds, as awareness of the **Global Methane Pledge**, and its significance continued to increase, and no-doubt better informed by the **IEA** **Curtailling Methane Emissions from Fossil Fuel Operations**.

Increase NDCs and commitments to NZE: In addition to publications dropping thick and fast ahead of **COP-26**, countries made announcements ahead of **COP-26**, including commitments by the United Arab Emirates (**UAE**) and the Kingdom of Saudi Arabia (**KSA**) to achieve **NZE** by 2050 and 2060 respectively, and the **ROK** committed to increasing its **NDC** to a 40% reduction in **GHG** emissions by 2030 (from 26.3%).

Ever increasing green power: The UK committed to having all green electrical energy by 2035. The **Sixth Strategic Energy Plan** was adopted by Japan, providing for a doubling of renewable electrical energy capacity to up to 38% by 2030, with nuclear electrical energy accounting for up to a further 22% by 2030.

A borrowed motto: By the end of October, leading into **COP-26**, **Edition 29** of Low Carbon Pulse borrowed the extended Olympic motto "Faster, Higher, Stronger, Together" motto proposed by the President of the Olympic Committee, Mr Thomas Bach, earlier in 2020 as indicative of the action required (Mr Bach having proposed the inclusion of "Together"): "The rate of reduction in, and the rate of removal of, **GHG** emissions need to be faster and higher, and commitment stronger, together."

[**Note:** Following **Edition 28** of Low Carbon Pulse, the **Anniversary Edition** of Low Carbon Pulse was posted on October 19, 2021, five pieces were published on each working day before **COP-26** and **Edition 29** of Low Carbon Pulse covered the 26 day period to October 30, 2021. As a result two editions of Low Carbon Pulse were published during October 2021, but with a good deal of accompanying narrative ahead of **COP-26**.]

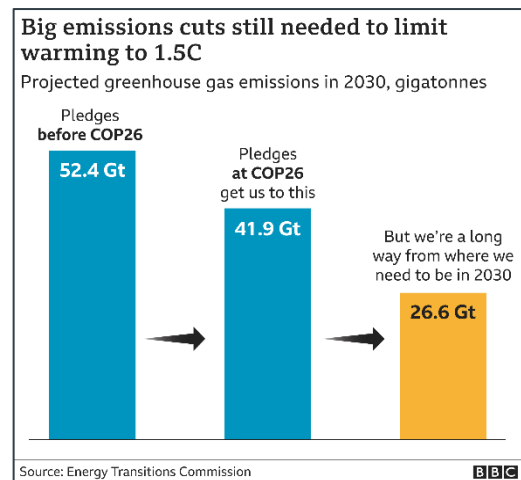
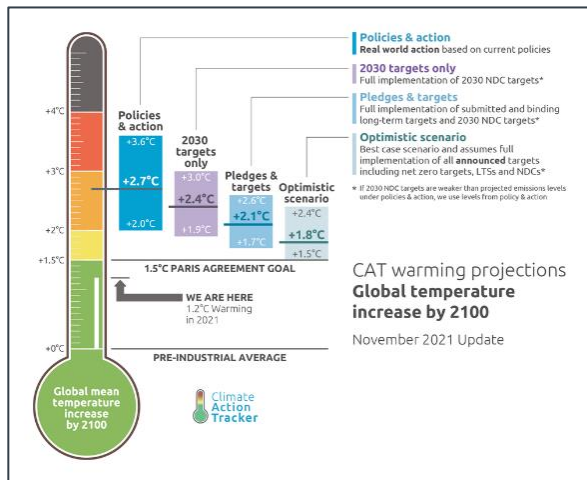
- **November** (covered in **Editions 30** and **31** and this **Edition 32** of Low Carbon Pulse):

A measure of success: From Sunday October 31, 2021 to Saturday 13 November, 2021, **COP-26** took place in Glasgow, Scotland.

For the author, while not all of the hoped for outcomes were achieved, the key indicia of success for **COP-26** was achieved – reaching agreement on the **Paris Rulebook**. (An article on the **Paris Rulebook** and agreement in respect of Article 6 of the Paris Agreement, will be written by the author of Low Carbon Pulse during the southern hemisphere summer holiday for release early in 2022.)

- An increased measure of engagement:** Delegates from nearly 200 countries met at **COP-26**. For those in attendance that had attended previous COPs, there was a reported sense of urgency around what may now be regarded as a climate change emergency, and a marked increase in engagement by the private sector. **Edition 30** of Low Carbon Pulse reported on the key outcomes from **COP-26**, and that reporting is not repeated here.

Graphic stories: Two telling graphics emerged during **COP-26** (each included in **Edition 30**), and are repeated here - indicate that if the combined **NDCs** of each country (as they stood during **COP-26**) were to be implemented, this would provide a pathway limiting increases in average global temperatures to **1.8°C**.



While this is good news, bringing us within the Responsible Range (of between **1.5°C** and **2°C**), it is not enough, progress needs to be made to limit average temperature increases to a **1.5°C** increase by mid-century, and ideally lower by the end of the twenty first century. Average global temperatures have increased by **1.1°C** since pre-industrial times, and the rate of increase has been accelerating (ever faster) since 1990.

The gap remains: Reductions of 45 to 50% in **GHG** emissions are required by 2030 to stay within the global carbon budget, and to achieve **NZE** by 2050. The modelled gap between **NDCs** and what is required is likely to remain. Action is required to close the gap, with a clear focus on the 45 to 50% reduction.

Reasons to be cheerful: As November progressed, the level and range of activity across all sectors increased, key features including increased off-shore wind field developments, planned and progressing, photovoltaic solar electrical energy continuing to be rolled-out, with the roll-out gaining pace (some may say apace), increased progress around CCS and CCUS, and **BESS** and **HESS** (and seemingly compressed air storage systems at scale), an increasing level of understanding, and definition, around both carbon credits and markets, and the prospect of a hydrogen market, a clear understanding and increasing commitment globally to green steel production, progress in the shipping industry towards decarbonisation, and the long anticipated take-off in the commitment to, and use of, **SAF** (sustainable / synthetic aviation fuel) in the aviation industry.

- December** (covered by this **Edition 32** of Low Carbon Pulse, to December 16, 2021. December 17 to December 31, 2021 is covered by **Edition 33**):

Reasons not to be complacent: As reported in **Edition 27** of Low Carbon Pulse, the **CSIRO** (the Commonwealth Scientific and Industrial Research Organisation, Australia's premier research institute) determined that the bushfires in Australia (elsewhere, termed wildfires) during the southern hemisphere summer of 2019 / 2020 resulted in the emission of over 715 million metric tonnes of **CO₂** to the climate system (around 1.5% of global **GHG CO₂-e** emissions annually) – a mass of **CO₂** equivalent to the **GHG** emissions arising from anthropogenic activities in Germany each year.

While much of the flora in Australia has evolved to grow back after bushfires (and as such absorb **CO₂**), what could not have been predicted was that up to 80 % of the **CO₂** emissions from those bushfires was absorbed by ocean algal blooms off the east- and south coasts of the island continent (principally two blooms in the Pacific Ocean and Southern Ocean, covering an area twice the size of Australia).

On December 6, 2021, the **EU's** Copernicus Atmosphere Monitoring Service **reported** (**Copernicus Report**) that around 1,760 million metric tonnes (or 1.76 giga-tonnes) of **CO₂** were released to the climate system from wildfires during 2021. Stated another way, that is a little over 3.5% of global **GHG CO₂-e** emissions annually, or, stated another way, closing-in on two and a half times the **GHG** emissions of Germany annually. The global carbon budget does not make allowance for **CO₂** arising from the effects of climate change!

There is a solution to most things: The **Copernicus Report** is well-worth a read, not least because it illustrates the widespread nature of the wildfires. The **Copernicus Report** read side-by-side with the **2021 Report** make salutary reading. If one were involved in managing global carbon budgeting, one would see value in accelerating global negative **GHG** initiatives to remove **CO₂**, in the near, medium and long term.

GCC countries: During the first part of December news continued to flow about decarbonisation initiatives and plans of the Gulf Council Cooperation (**GCC**) countries, and their National Oil Companies (**NOCs**).

As noted in **Edition 27** of Low Carbon Pulse, decarbonisation, and, more broadly, progress to achieving **NZE** needs **NOCs** (and international oil companies (**IOCs**)). This may be an inconvenient truth to many folk, but it is the truth.

More than this, there is an imperative for **NOCs** (and **IOCs**) to drive progress towards the achievement of **NZE**: their continued existence rests squarely with their ability to transition from producers of energy carriers derived

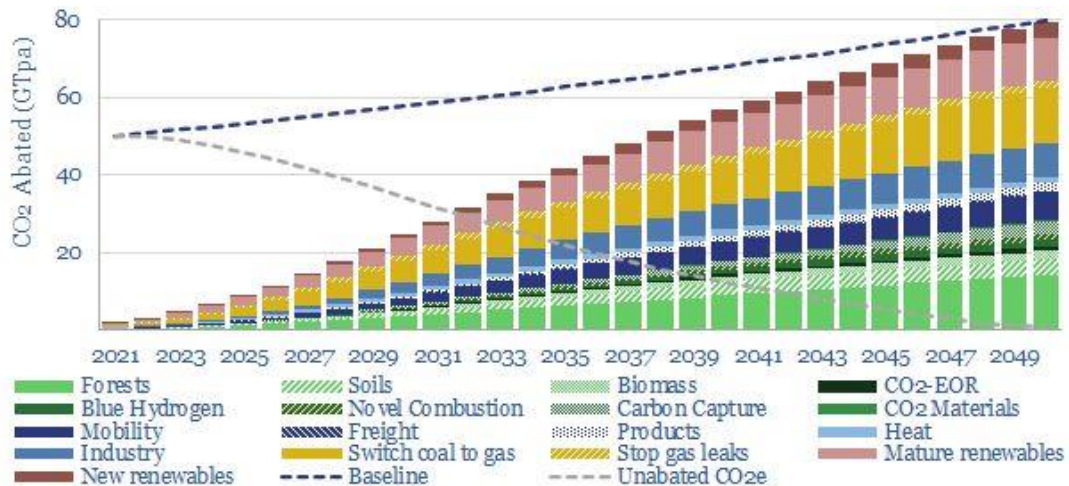
and produced from fossil fuels, to becoming producers of energy carriers derived and produced from hydrogen and hydrogen-based fuels, producers of biofuels from renewable resources (and associated carbon capture and storage and carbon capture and use), and producers of bio-feedstocks to produce bio-plastics.

Festive / Holiday Season Cheer: Not known for positively charged news streams, the [IEA Renewables 2021 Report](#) (see next news item, **under Themes and trends that emerged during 2021**) revised up its five year forecast (from 2020 on a comparative basis) for the installation of renewable electrical energy for the five years to the end for 2026.

This upward revision is a result of stronger policy settings and more ambitious Nationally Determined Contributions (**NDCs**) arising in the context of **COP-26**. The **IEA** considers that the renewable electrical energy roll-out will continue at an increased rate, notwithstanding record commodity prices that have increased the cost of development and deployment of both photovoltaic solar and wind projects.

On December 16, 2021, the ever excellent **Thunder Said Energy** published a graphic representation of the mix and means to achieving **NZE** by 2050. The associated narrative is that:

"The entire global economy can be decarbonized by 2050 at an average cost of USD40/ton ... momentum is getting exciting in five key areas: efficiency gains, under-supplied commodity bottlenecks, power-electronics, CCS and nature-based **CO₂** removals".



- **Themes and trends that emerged during 2021:**

The [Anniversary Edition](#) of Low Carbon Pulse, provided an assessment of, and reflection on, matters covered in **Editions 1 to 28** (October 6 2020 to October 5 2021), ahead of **COP-26**, and as such sought to frame thinking ahead of **COP-26**. This section does not repeat the content of the [Anniversary Edition](#), although it does emphasise a number of matters covered in the **Anniversary Edition**.

- **More renewable energy installed than ever before, but not enough:** It is estimated that up to 290 GW of renewable electrical energy capacity will be commissioned during 2021, including 160 GW of photovoltaic solar capacity.

This cheering fact is reported by the **IEA** in its [Renewables 2021 – Analysis and Forecasts to 2026 – Fuel report \(Renewables 2021 Report\)](#), published on December 1, 2021. Also attached is a link to the [executive summary](#) of the **Renewables 2021 Report**.

The [Renewables 2021 Report](#) will be reported on in detail in the **November and December Report on Reports** (comprised in the Appendix to **Edition 34** of Low Carbon Pulse), but for the time being the key headlines are:

- renewable electrical energy will be installed at a rate of around 300 GW a year over the next five years, as a main case, with between an additional 40 to 100 GW as an accelerated case;
- renewable electrical energy will account for around 95% of new electrical energy capacity installed over the next five years;
- installed renewable electrical energy will increase by 60% over the next five years, reaching 4,600 GW in 2026;
- the **PRC** will continue lead the way in the installation of renewable electrical energy capacity, with 43% of installed capacity over the next five years, followed by Europe, India and the US, with the **PRC**, Europe, India and the US accounting for 80% of the renewable electrical energy to be installed over the next five years; and
- if current rates of progress are maintained in the **PRC** and Europe, both will over-shoot their targets, and as such achieve those targets earlier than committed.

The most powerful finding from the [IEA Renewables 2021 Report](#) is that while there is positive news year on year from 2020, photovoltaic solar and wind roll-out needs to accelerate to close the gap between the actual rate of roll-out and the required rate of roll-out.

- **The natural solar and wind, geothermal and hydro resources exist:** The resources are matched by existing technology, albeit technology that will develop. During 2021, atlases were released or updated ([pumped storage](#), [solar](#) and [wind](#)) outlining the extent of renewable resources.

The scale and scope of renewable resources is clear; the time-frame within which a proportion of them must be harnessed to produce electrical energy is known; aligning the two is the challenge.

- **Exporting sun and wind:** One of the trends that has emerged during 2021 has been the development (so far, mostly proposed development) of high voltage direct current (**HVDC**) interconnectors to deliver renewable electrical energy from countries rich in renewable resources to countries that are not (including because they simply do not have the land mass).

In mid-June 2021, the Norway to UK **North Sea Link** (the Statnett and National Grid project) commenced transmission – the longest submarine **HVDC** in the world at around 750 km. It is to be expected that more **HVDC** projects will be developed within Europe, on-shore and submarine, with the **Greenlink** project from the Republic of Ireland to the UK progressing.

During 2021, Cyprus, Greece and Israel have progressed plans for a submarine electrical energy interconnector (the **EuroAsia Interconnector**) to enhance efficiency across grids and to allow each country to optimise renewable electrical energy capacity, particularly solar, so as to allow each country to move towards net-zero **GHG**, and to minimise the need to maintain non-renewable electrical energy. The **EuroAsia Interconnector** has achieved **EU** status as a Project of Common Interest (an **EPCI**).

The most high profile **HVDC** projects being progressed to development are the **AAPowerLink** (or **Sun Cable Project**) (700 km on-shore, 3,800 km sub-sea), from the Northern Territory of Australia to Singapore (currently contemplated as a 17 to 20 GW project), and the **Xlinks** project (3,800 km) from Morocco, North Africa to Devon, England, and to Pembroke, Wales (currently contemplated as a 10.5 GW project).

On June 24, 2021, the Australian Financial Review revisited the suggestion of the **PRC** President, Mr Xi Jinping (made to the United Nations) of a "global energy internet" or "submarine super-grids" using ultra-high-voltage direct current (**UHVDC**) transmission lines. While **UHVDC** projects are progressing to development are submarine projects, **UHVDC** projects are to be developed in the **PRC**. It seems likely that more of them will be **UHVDC**.

On December 6, 2021, Bloomberg reported on a USD 300 billion plan to bring green power to the **PRC's** megacities, over thousands of kilometres of **UHVDC** transmission infrastructure. The development and deployment of **UHVDC** is an area that is likely to develop, not least because of its relative simplicity. If one reflects that by 2030 the **PRC** will have installed 1,200 GW of renewable electrical energy in the form of solar and wind capacity (equivalent to the load of the US), there is sense in leveraging the ever-increasing scale. The **PRC** has 30 functioning **UHVDC** lines. It seems likely that there are many more to come.

- **There is a need to "crack on":** In reflecting on **COP-26**, Executive Director of the Hydrogen Council, Mr Daryl Wilson reflected that "*the strongest sentiment for [him was] the need to "crack-on" with actual implementation of climate solutions*".

In the context of implementation, renewable electrical energy is core to implementation, followed by hydrogen:

"Hydrogen is not a panacea or silver bullet ... but it's a key solution [among] many that needs to be acted on fast ... Hydrogen for Net Zero, indicates hydrogen can make up 22% of final energy use by 2050 and deliver 85 giga-tonnes of decarbonisation along the journey to that date. That is one fifth of the job that needs to be done – a significant chunk of work".

If hydrogen and hydrogen based fuels are to make this level of contribution, more needs to be done to increase demand for hydrogen as an energy carrier / vector. This is particularly the case in respect of the development of demand for Green Hydrogen and Green Ammonia.

On December 6, 2021, it was reported that the Executive Director of the **IEA**, Dr Fitoh Birol had noted that: "*The relative lack of demand for green hydrogen makes [the] sector's progress uncertain*". The perspective of the **IEA** on this point is explored further in a [Recharge article](#) (dated December 6, 2021) an article that is worth reading.

European Hydrogen Week (**EHW**) took place in the week beginning November 29, 2021. European Union President, Ms Ursula von der Leyen, opened **EHW** outlining the basis to build on the [EU Hydrogen Strategy](#) in a compelling [speech](#) (for further detail see under **Europe** below).

To the author of Low Carbon Pulse, the way to increase demand for Green Hydrogen is not to make the cost of other energy carriers more expensive, rather the way forward is, and always has been, to reduce the cost per kg of Green Hydrogen. If this proposition is accepted, the focus of policy settings should be how best to increase the supply and reduce the cost of Green Hydrogen. In this context, those developing and implementing policy settings should not be confined by existing targets. For an up to the moment assessment, on December 8, 2021, Wood Mackenzie provided an [analysis](#), the headline from which is that producing Green Hydrogen for USD "1/kg is achievable in some countries by 2030".

- **While there is a need crack on globally, the EU is progressing towards achievement of targets:** On November 29, 2021, Vice-President of the European Commission, Mr Frans Timmermans said the **EU** countries and neighbouring countries are likely to exceed the installation target of 80 GW of electrolyzers powered by renewable electrical energy.

Mr Timmermans said that:

" ... our aim [is]: 40 GW of renewable electrolyzers in Europe and 40 GW in Europe's neighbourhood with export to the EU. I think it's realistic to say we will probably out-perform that by 2030".

The issue now is the rate of acceleration in the development and deployment of Green Hydrogen, critically the policy settings that will accelerate ahead of the target. To many policy setting watchers, if it is possible to see that if a target will be achieved nine years out, that policy setting is unlikely to have been ambitious enough in the first instance, and it should be accelerated and extended.

- **There is a need for Government involvement:** There is an identified need for the development of renewable energy capacity, including to produce energy carriers, critically, hydrogen and hydrogen based fuels.

The cost of capital to the Governments of many developed countries is lower than the capital costs of the private sector, and the basis of investment by the government of developed countries is different that the basis for investment of the private sector.

While many Governments are providing funding support for the private sector (both within their borders and outside them), there is an argument for government-to-government cooperation, i.e., for governments to coordinate the development of infrastructure to accelerate supply and to accelerate demand.

If it is accepted that the supply and demand sides of hydrogen and hydrogen-based fuels need to be accelerated, there is a role for Governments, certainly "book-ending" sourcing water (including possibly using desalinated water or processed and treated waste water in fresh water scarce environments) and port storage and delivery infrastructure (in the host country) and the port receiving and storage infrastructure and pipeline distribution systems (in the import country).

Historically and currently, many countries have invested in infrastructure to allow the development of industry, in most instances being circumstances in which there was not an existential concern, simply to achieve the multiplier effect of developing an industry.

- **Carbon Credits, Article 6 and the Paris Rulebook:** In contrast to the slower growth in demand for hydrogen and hydrogen-based fuels (in particular Green Hydrogen), the demand for carbon credits appears to be increasing at pace, in particular in the Voluntary Carbon Market / Voluntary Carbon Credit Market.

In a publication entitled, [Why was it so significant that COP-26 completed the Paris Rulebook?](#), a high-level summary of the significance of the **Paris Rulebook** is provided:

The infographic is divided into six panels, each with a background image and a text box:

- Panel 1 (Top Left):** Title: "Why was it so significant that COP26 completed the Paris Rulebook?". Background: Paris skyline with the Eiffel Tower.
- Panel 2 (Top Middle):** Title: "The Paris Rulebook sets out the guidelines for how the Paris Agreement is implemented, including...". Background: Aerial view of a city street.
- Panel 3 (Top Right):** Title: "1. A common approach for countries to report their emissions and track progress on action and support, to ensure:". List:
 - transparency
 - accountability
 - confidence in the system
 Background: Dark blue with icons of a person and a bar chart.
- Panel 4 (Bottom Left):** Title: "2. Clear rules for international carbon markets that are robust and contribute to our climate goals." Background: Sunset over water.
- Panel 5 (Bottom Middle):** Title: "3. Common time frames for emission reduction commitments (NDCs), to compare countries' targets and track implementation more effectively." Background: Dark blue with a white lightning bolt icon.
- Panel 6 (Bottom Right):** Title: "This will now make the Paris Agreement fully operational, allowing for delivery of the landmark accord, with the goal of keeping 1.5°C alive." Background: A stone archway in a park.

In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions (and, in the longer term, **NZE** on the basis of carbon neutrality). Previous editions of Low Carbon Pulse have covered the uses of words and phrases in this context, but ultimately, decarbonisation takes time, and needs to be achieved across Scope 1, 2 and 3 emissions. To buy the time, while still reducing **GHG** emissions on a net-basis, corporations buy carbon credits.

In a stand-alone article to be published during the early part of 2022, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues.

• **A look ahead to 2022 (and beyond):**

- **Addressing adverse pricing consequences and bottlenecks:** The **IEA Renewable Market Report** has identified increased costs of photovoltaic solar panels experienced during 2021 as likely to continue to during 2022. This becomes a problem if the rate of installation of photovoltaic solar renewable electrical energy capacity is slowed as a result of the higher costs or the bottlenecks associated with supply not being able to keep pace with demand, or both. The continued roll-out, and its rate, is critical to reducing **GHG** emissions.

At the moment, by and large, the market is being left to itself, and we owe a debt of gratitude to the photovoltaic solar manufacturers, critically those in the **PRC**.

The **IEA Renewables 2021 Report** outlines the cost pressure points that have prevailed since the beginning of 2020: the price of photovoltaic grade polysilicon has increased over four-fold, the price of steel by more than

50%, aluminium by more than 80%, copper by more than 60%, and wait for it, freight costs have increased six-fold.

This is not a matter that can be ignored: the **IEA** estimates that up to 100 GW of roll-out may be delayed if commodity price shocks occur. Consistent with the continued narrative, roll-out needs to accelerate, not slow.

- **Renewable electrical energy roll-out will continue, and increase over time:** The **IEA Renewable Energy Market Update 2021** is timely because it demonstrates both the rate of roll-out, and that an increased rate of roll-out is required.

As will be apparent from **Wind Round-up** below, a number of countries are increasing the roll-out of renewable electrical energy, aiming to progress to achieve their respective commitments to reduce **GHG** emissions by 2030 (and in some instances before), and to continue to make progress to be in position to progress to **NZE** by 2050.

While no more than a hope, ideally, countries will accelerate to **NZE** well-head of 2050, in some instances by 2035. Any early indications of this will likely take shape during 2022.

- **The rate of energy transition in GCC countries is key, both for them and for the rest of the world:** The **GCC** countries will continue to develop Blue Hydrogen and Green Hydrogen projects as they accelerate their progress towards the achievement of **NZE**, both at a country level and leveraging the benefits of world class renewable energy resources at a global level.

As a general statement, the **GCC** countries have the means and motivation to achieve energy transition that allows them to transition from Black Gold to Blue / Green Gold, making use of world class resources, and the ability to develop photovoltaic solar projects to provide the lowest cost electrical energy in history. Blue and green molecules are worth more than green electrons.

- **Australia, Chile, the PRC and Spain to continue to lead:** Along with the **GCC** countries, four countries rich in solar resources appear likely to lead in the development of the hydrogen economy over the next five years (and beyond) – Australia, Chile, the **PRC** and Spain. (Low Carbon Pulse has recognised the roles of Australia, Chile and Spain in editions of Low Carbon Pulse under "Net Zero Heroes".)

Each country is blessed by geography to allow production of Green Hydrogen and Green Hydrogen-based fuels (supply) and to export Green Hydrogen and Green Hydrogen based-fuels in the case of Australia, Chile and Spain to match demand overseas, and to domestic demand / use in the case of the **PRC**. Each country is also blessed by leadership, whether political or in the private sector, or both.

- **The key is to the Cities:** Ahead of, and since **COP-26**, there has been an increased focus on the greening of cities, those built and those to be built, and the buildings within them. The urban environment has become an area of greater awareness, and increasing focus: 25 mega-cities are responsible for 52% of **GHG** emissions arising in an urban setting, critically Beijing, Handan, Shanghai, Tokyo, and Moscow.

By 2030, it is estimated that there will be 43 cities globally with populations of more than 10 million. Amongst other things, with urbanisation comes waste heat. Ideally urban areas should be designed so as to become heat sinks. This involves the greening of the urban environment.

As noted above, the **Smart Cities Report** from the **IEA** appears likely to increase awareness and action:

"Cities account for more than 50% of the global population, 80% of global GDP, two-thirds of global energy consumption and more than 70% of annual global carbon emissions".

It is anticipated that decarbonising cities will become a key focus.

- **Increasing NDCs during 2022 ahead of COP-27:** At **COP-26** the High Ambition Coalition COP-26 Leaders' Statement [announced](#) that they were committed to increasing the **NDCs** to align with holding the increase in average global temperatures to **1.5°C (Stretch Goal)** for the purposes of commitments to be made before or at COP-27 (to be held in Egypt in 2022).

Further, all countries have agreed to update their **NDCs** ahead of COP-27. It is to be expected that countries will update their **NDCs**, and, in the case of many, it is hoped that they will stretch their **NDCs**, including to a level that is aligned to an increase in average temperatures that is lower than the **Stretch Goal** and that gets to **NZE** as soon as possible before 2050, not by 2050.

- **Final words on the look back and the look forward:**

For the author of Low Carbon Pulse, three quotes from **COP-26** are the quotes of 2021:

"Two degrees is a death sentence [for small island states]."

Prime Minister of Barbados, Ms Mia Mottley (watch Ms Mottley's speech [here](#))

"What is stopping any other heavy, hard to abate industries from doing the same [i.e., doing what FMG is doing]?"

Nothing. Just the will to make it happen!

CEO of Fortescue Future Industries, Ms Julie Shuttleworth (watch Ms Shuttleworth's speech [here](#))

"We are still knocking on the door of climate catastrophe ... it is time to go into emergency mode – or our chance of reaching net-zero will itself be net zero"

*United Nations Secretary-General, Mr Antonio Guterres on the final day of **COP-26***

The quote of the year has to go to Ms Julie Shuttleworth, in particular the need for **"the will to make it happen"**. What Ms Shuttleworth said is totemic, explanatory, speaking to the application of the individual and collective will to reduce **GHG** emissions to **NZE** to achieve what Mr Bill Gates has described as, **"the hardest thing humanity's ever done"**.

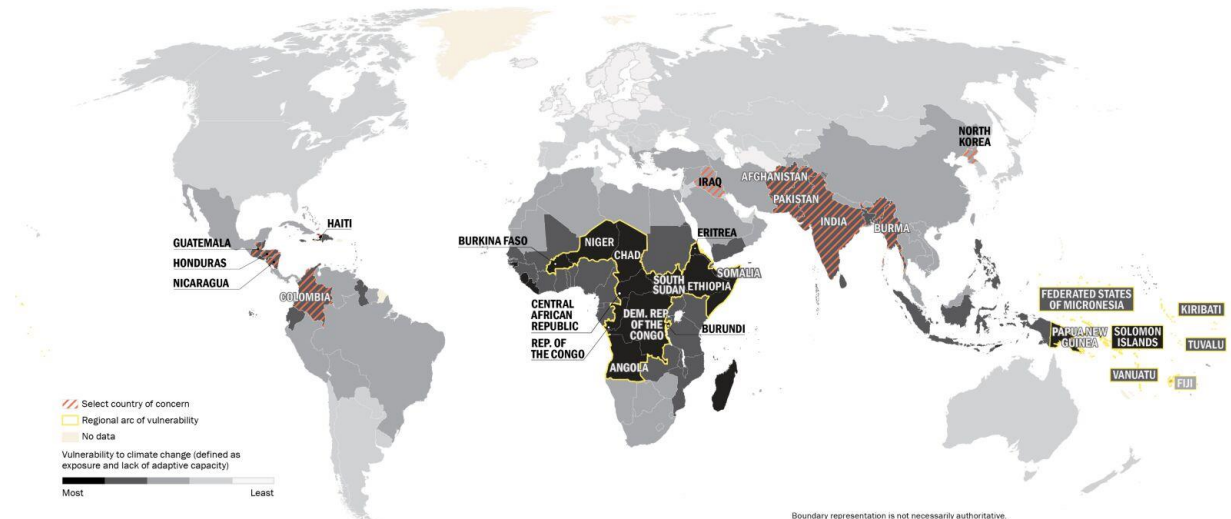
For the author, Ms Shuttleworth joins Messrs Johnson and Bird as the embodiment of authenticity, manifest in genuineness, and hard fought success, wrought in application and hard work, playing for the team, cutting no corners.

Climate change reported and explained:

- **Most vulnerable countries:** The following map provides a summary of the countries that are most at risk from the impact of climate change:

Climate Change in Select Highly Vulnerable Countries of Concern

The IC identified 11 countries and two regions of great concern from the threat of climate change. Building resilience in these countries and regions would probably be especially helpful in mitigating future risks to US interests. Two regional arcs also stand out because these groups of countries are clustered together, are relatively poor, and have little capacity to assist their neighbors.



As will be apparent, Afghanistan, Colombia, Guatemala, Haiti, Honduras, India, Iraq, Myanmar, Nicaragua, the People's Republic of Korea (North Korea) and Pakistan are considered to be the most vulnerable countries from the broader effects of climate change. The [report](#) from which the graphic is sourced, the Office of the Director of National Intelligence, outlines that climate change may result in increased political instability that may impact security.

On November 29 and 30, 2021, [CNBC](#) reported on the findings that underpin this graphic, and the fact that in some of these countries the impact of climate change on sources of energy, food, and water, and the impact on health, gives rise to the risk of prolonged instability. The solution is to work with each of these countries to allow them to adapt to climate change, and its consequences. Given the regimes in some of these countries, for some the concept of providing help may be regarded as a challenge, but help is needed nevertheless, and help should be given.

- **Most recent National Oceanic and Atmospheric (NOAA) report:** In previous editions of Low Carbon Pulse, findings from the [monthly report](#) of the **NOAA** were reported. Over the October and November editions of Low Carbon Pulse, this reporting was missing so as to manage the length of each edition. On December 10, 2021, the **NOAA** reported that November 2021 was the seventh warmest, eighth driest November on record for the US.

GCC Countries:

- **Emirates Global Aluminium and GE decarb plan:** On November 29, 2021, it was reported that Emirates Global Aluminium (**EGA**) and General Electric are developing a plan to decarbonise **EGA's** activities. In January 2021, the **EGA** contracted with the Dubai Electricity & Water Authority (**DEWA**) for the supply of renewable electrical energy from the Mohammed bin Rashid Al Maktoum Solar Park (see [Editions 8](#) and [18](#) of Low Carbon Pulse). The focus of the work to be undertaken by **EGA** and GE is to repurpose the current natural gas turbines to take and to use blended natural gas and hydrogen.

See: General Electric [press release](#); Emirates Global Aluminium [press release](#)

- **Masdar and Engie alliance:** On December 3, 2021, [Masdar](#) (Abu Dhabi Future Energy Company) and Engie (global leading energy company) announced a strategic alliance to explore the co-development of a **UAE** located Green Hydrogen hub. Masdar and Engie are contemplating the development and deployment of 2 GW of electrolyser capacity by 2030, at an anticipated cost of USD 5 billion. The strategic alliance agreement was signed by Dr Sultan Ahmed Al Jaber, UAE Minister of Industry and Advanced Technology, ADNOC Managing Director and Group CEO, and Masdar Chair, and Ms. Catherine MacGregor, ENGIE CEO.

See: [ENGIE and Masdar form US\\$5 billion strategic alliance to drive UAE's green hydrogen economy](#); [Masdar and ENGIE form US\\$5 billion strategic alliance to help drive UAE's green hydrogen economy](#)

- **Saudi Aramco and French corporations:** On December 4, 2021, Saudi Aramco announced that it signed agreements with leading French corporations as it continue to progress towards decarbonisation of its activities.

It is reported that the agreements involve Saudi Aramco: **1.** Having agreed to work with Gaussin (leading clean and intelligent transport corporation) to develop on-road and off-road vehicle solutions; **2.** Having signed an memorandum of understanding (**MOU**) with Air Liquide to develop "low carbon-hydrogen and ammonia production, logistics and back cracking technology", and an **MOU** to evaluate "carbon capture and sequestration opportunities"; **3.** Having signed an **MOU** with Alteia to develop "advanced artificial intelligence-driven geospatial imagery interpretation and

processing capabilities"; and **4.** Having signed an **MOU** with Axens "to explore the local manufacturing and maintenance services and furnaces and fired heaters".

See: [Aramco announces collaboration with French companies](#)

- **ADNOC and TotalEnergies:** On December 5, 2021, it was reported widely that **ADNOC** and TotalEnergies had signed a strategic alliance to work together to develop low-carbon hydrogen and carbon capture and storage projects, and to explore the development of upstream oil and gas opportunities within Abu Dhabi. The strategic alliance agreement was signed by Dr Sultan Ahmed Al Jaber, **UAE** Minister of Industry and Advanced Technology, ADNOC Managing Director and Group CEO, and Masdar Chair, and Mr Patrick Pouyanne, TotalEnergies CEO.
- **Air Products and thyssenkrupp write large:** On December 13, 2021, it was reported widely that Air Products had contracted with thyssenkrupp for the supply of 2 GW of electrolyzers for Air Products' USD 5 billion Green Hydrogen production project to supply Green Hydrogen to Neom to be powered by 4 GW of renewable electrical energy. While Low Carbon Pulse does not tend to cover contracts for supply of goods and services in respect of projects underway, this is a landmark contract for a landmark project for a landmark city of the future.
See: [Air Products and thyssenkrupp sign exclusive strategic cooperation agreement for world-scale electrolysis plants to generate green hydrogen](#); [One of the Largest Green Hydrogen Projects in the World: thyssenkrupp Signs Contract to Install Over 2GW Electrolysis Plant for Air Products in NEOM](#)
- **Emirates Water and Electricity Company (Ewec) – good day sunshine:** On December 13, 2021 [energy&utilities](#) reported that **Ewec** has stated procurement preparation for a 1 to 1.5 GW world-scale photovoltaic solar project to be delivered under an independent power producer (**IPP**) model.
This will be the third photovoltaic solar IPP, the first being the 1.17 GW Noor Abu IPP (that came on line in July 2019) and the 2 GW Al Dhafra IPP (that was awarded in 2020 at a then world-record low US cents 1.32/kWh).

India and Indonesia:

- **India Hydrogen Alliance – November 2021:** Attached is the link to the November edition of [India H2 Monitor – November 2021](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the context of the **India H2 Monitor**. Some of the news items have already been covered in **Editions 29, 30 and 31** of Low Carbon Pulse because they relate to reported news items from Government and corporations.
- **Indonesia and FFI combine:** On December 10, 2021, [H2view](#), reported that Fortescue Future Industries (**FFI**) has signed an agreement with North Kalimantan Provincial Government of the Republic of Indonesia to explore the development of Green Hydrogen production capacity.
- **India's Journey to 500 GW:** On December 15, 2021 the **IEA** held a webinar titled [India's Journey to 500 GW: Reaching the Capacity and Investment Targets \(India's Journey to 500\)](#).
The background to India's Journey to 500: At **COP-26**, the Indian Prime Minister, Mr Nahendra Modi committed India to achieving **NZE** by 2050. Please click [here](#) for a transcript of Mr Modi's speech.
In addition, Mr Modi committed as follows: **1.** By 2030, India will increase its non-fossil fuel capacity to 500 GW (a 50 GW increase in this commitment from 450 GW); **2.** By 2030, India will satisfy 50% of its energy demand from renewable energy; **3.** By 2030, India will reduce its **GHG** emissions by 1 giga tonne (1 billion metric tonnes); and **3.** by 2030, India will reduce the carbon intensity of its economy to less than 45%.
As has been noted in Low Carbon Pulse for some time, India is taking centre stage. This is critical globally, because the decarbonisation of India (as its population grows, the urbanisation of that population increases, and its economy develops), will be critical to the achievement of **NZE** globally.
- **The headlines from India's Journey to 500:** On December 15, 2021, the **IEA** and the CEEW Centre for Energy Finance, held a webinar for 90 minutes. The author attends many webinars, some of which are worth it, some not. This was worth attending, click [here](#) to view a recording of the webinar.

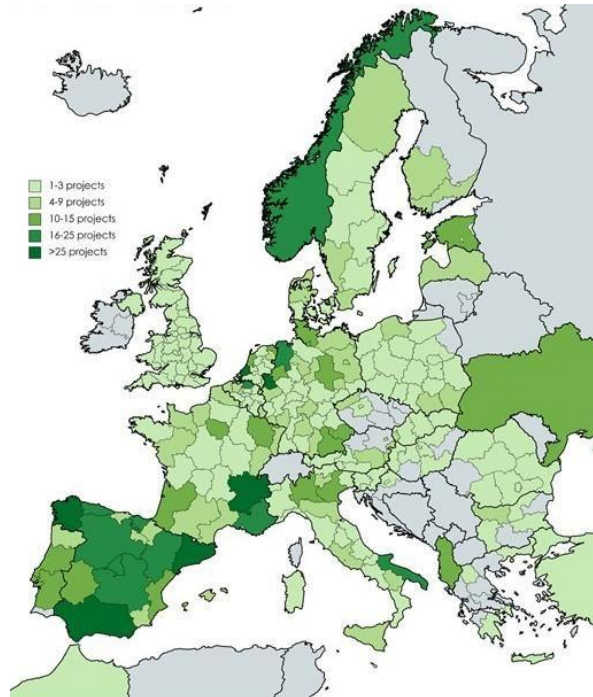
Japan and Republic of Korea:

- **Size and Shape taking shape:** On December 1, 2021, [Recharge](#) reported that **ROK** is getting to grips with the size and shape of the supply and demand for hydrogen and hydrogen-based fuels across its economy by 2050. The Government of **ROK** has outlined (in a strategy paper), that it expects to have annual demand of 28 million metric tonnes of hydrogen, with 60% of demand being sourced from Green and clean hydrogen produced overseas.
"Hydrogen will become [ROK's] largest single energy source in 2050, which will account for 33% of the total energy consumption [within ROK]".
See **Edition 31** of Low Carbon Pulse for details of plans to blend hydrogen and natural gas to fire gas-fired power plants and to blend ammonia with coal to fire coal-fired power plants.
The strategy paper will be considered in detail in the **November and December Report on Reports** to be included in the Appendix to the Second Compendium of Low Carbon Pulse.
- **Reforming Korea's Electricity Market for Net Zero:** On December 9, 2021, the **IEA** and the Korea Energy Economics Institute published **Reforming Korea's Electricity Market for Net Zero**. The report is excellent.
- **Third Off-shore Wind Auction:** On December 10, 2021, Japan opened its third auction process for off-shore wind field capacity under the Renewable Sea Area Utilization Law. The auction will select a developer for up to 356 MW of installed capacity in the Happo-Noshiro zone off-shore of the Akita prefecture. The auction process will close on June 10, 2022, with the preferred bidder expected to be announced in December 2022.
By way of reminder, the Japanese Government plans to develop and to deploy 10 GW of off-shore wind field capacity by 2030, and 45 GW by 2040.
- **Another FCT power plant:** Previous editions of Low Carbon Pulse have reported on the use of fuel cell technology in the **ROK** to generate electrical energy (see **Editions 4 and 9** of Low Carbon Pulse).

On December 13, 2021, [fuelcellworks](#) reported that Doosan Fuel Cell has now provided the technology for the world's two largest fuel cell technology power stations, the Shinincheon Bitdream Fuel Cell Power Plant (see **Edition 23** of Low Carbon Pulse) and the Western Incheon Fuel Cell Phase 4.

Europe:

- **ECHA maps H2 Europe:** On December 1, 2021, the European Clean Hydrogen Alliance (**ECHA** – see **Edition 5** of Low Carbon Pulse) provided an overview of prospective hydrogen projects across Europe, comprising over 750 projects across the supply / value chain, including 446 hydrogen production projects, 163 hydrogen transmission and disruption projects, 172 hydrogen for industrial application, 240 hydrogen for transport application, 143 hydrogen for energy application and 77 hydrogen for building projects. Spain is the country with the most prospective projects across Europe.



The **ECHA** was established at the same time as the [EU Hydrogen Strategy](#) in July 2020 ([A hydrogen strategy for a climate-neutral Europe](#)). The **ECHA** is a forum in which civil society, industry and public authorities come together to coordinate investment initiatives.

- **AccionaPlug map Iberian Peninsula:** On November 30, 2021, Acciona (leading infrastructure developer and investor) and Plug Power (leading hydrogen technology company) announced that they had established a joint venture to develop and to deploy Green Hydrogen production facilities across the Iberian Peninsula, both co-located with customers and stand-alone. In addition, the joint venture, AccionaPlug, will develop hydrogen supply and value chains across the Peninsula.

See: [ACCIONA Energía and Plug Power launch AccionaPlug to address green hydrogen market in Spain and Portugal](#); [Plug Power and Acciona Energía Launch Accionaplug to Address Green Hydrogen Market in Spain and Portugal](#)

- **EU maps carbon capture plans:** On December 1, 2021, [Reuters](#) reported that **EU** plans to capture 5 million metric tonnes per annum of **CO₂**, and create an **EU** system to certify **CO₂** removal. The plans were published formally on December 15, 2021: [press release](#) from the **EC** under **European Green Deal: Commission proposals to remove, recycle and store carbon sustainably**, reporting on the adoption by the EC of a [Communication on Sustainable Carbon Cycles](#).

Executive Vice-President for the European Green Deal Mr Frans Timmermans said:

"Today, we set out the main principles and objectives of our work to prepare the necessary rules. These rules will ensure carbon removals are credible and have the desired effect, and help to create new business opportunities in carbon farming for, foresters, and other land managers".

By the end of 2022, the **EC** will propose a regulatory framework for the certification of carbon removal based on transparent carbon accounting and monitoring rules, allowing verification of carbon removal. The **EC** will launch a call for evidence during January 2022.

As noted above, in January 2022, the author of Low Carbon Pulse will post a stand-alone article on Carbon Credits, Article 6 and the **Paris Rulebook**, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues. The stand-alone article will cover the carbon removal in the context of carbon credits and off-sets in the context of the **EU**.

- **Distribution map to be developed:** On December 3, 2021 it was reported widely that DNV will lead the Ready4H2 Project, which will assess how best to develop the pipeline network across Europe so as to facilitate the distribution of hydrogen across the continent.

DNV will work with 80 corporations and organisations across Europe for this purpose. At a policy setting level it is recognised that the distribution system needs to be developed so as to facilitate the development of the use of hydrogen, and to avoid any slow-down in the development.

See: [DNV to lead study on potential of European hydrogen distribution networks](#)

- **EU Green Taxonomy:**

- **EU Green Taxonomy adopted:**

On December 9, 2021, the first climate delegated act (the [EU Taxonomy Climate Delegated Act](#)) was approved by the **EC**, and will become law on January 1, 2022, thereby confirming the adoption of the **Technical Screening Criteria**.

Among other things, the **EU Green Taxonomy** provides:

1. a basis by reference to which corporations may report; and
2. **CO₂-e** intensity benchmarks for the energy sector (that are neutral as to technology) of 100 g **CO₂-e**/kWh as making a substantial contribution to climate mitigation, and 250 g **CO₂-e**/ kWh giving rise to significant harm.

- **What does not this mean and what is its practical application?**

The effect of the **EU Taxonomy Climate Delegated Act** is that the **EC** must use the **EU Green Taxonomy** to assess climate change adaptation and climate change mitigation activities, including to do no significant harm across environmental objectives.

Effectively, the **EU Green Taxonomy** does not define what technology must be used (hence it is neutral as to technology), but the technology used for the purposes of prescribed activities will be assessed against the **Taxonomy**, including the benchmarks.

The positions of participants and stakeholders has informed the "debate" around the **CO₂-e** intensity benchmarks for some time, including around the use of natural gas and nuclear energy sources (including as sources for the production of hydrogen and hydrogen-based fuels) in the context of the **EU Green Taxonomy**.

The **EC** has not acknowledged formally that the **EU Green Taxonomy** might include natural gas or nuclear energy sources. The role of natural gas and nuclear is clear, but in the words of Mr Frans Timmermans: " ... nuclear and transition gas play a role in energy transition ... [but] that does not make them green". The **EC** will determine how to badge natural gas and nuclear energy by the end of 2021.

(A link is attached to the ec.europa.eu [website](#) that contains relevant materials under **EU taxonomy for sustainable activities**.)

- **A busy day in Brussels:** In addition to the adoption by the **EC** of a **Communication on Sustainable Carbon Cycles**, on December 15, 2021, the **EC** outlined the role of clean gases (including hydrogen) in delivering the [Green Deal](#). The proposals presented by the **EC** include legislation on the decarbonisation of gas markets and hydrogen, and establishment of a market for hydrogen, building on the [EU Hydrogen Strategy](#) from July 2020 (**A hydrogen strategy for a climate-neutral Europe**).

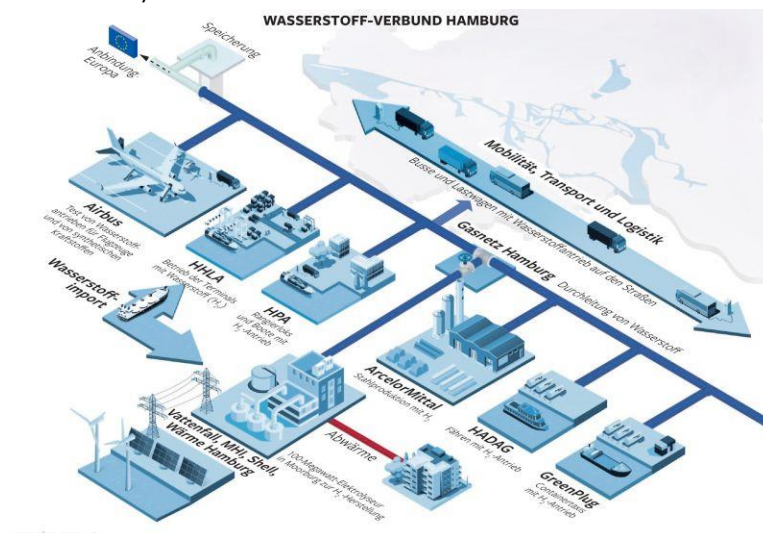
The attached [link](#) provides a two page overview of the proposal from the **EC**.

Scotland and Germany:

Edition 30 of Low Carbon Pulse reported on November 10, 2021, ScottishPower (one of the two giant Scottish energy companies, the other being [SSE](#) plc) made a [press release](#) contemplating collaboration between Germany and Scotland in the production of hydrogen in Scotland and export to Germany. The contemplated collaboration is outlined in the [Draft Hydrogen Action Plan](#) released by the Scottish Government (on November 10, 2021). The **Draft Hydrogen Action Plan** sizes the potential market at €20 billion.

On November 29, 2021 it was reported in [Hamburg News](#) that City of Hamburg and the Government of Scotland had signed a Declaration of Intent to collaborate on Green Hydrogen production.

As reported in **Editions 18** and **20** of Low Carbon Pulse, the inland Port of Hamburg and the City of Hamburg want to develop as a centre of hydrogen and become a European Green Hydrogen Hub. The Hamburg News feature is well-worth a read, providing background to the dynamics that have resulted in the Declaration of Intent.



France and Germany:

On December 1, 2021, the **IEA** released [France 2021 – Analysis](#). The report provides a helpful analysis of the policy settings in France, and the progress that remains to be made in France to achieve **NZE** by 2050.

The report will be considered in more detail in the **November and December Report on Reports** will be included in the Appendix to the Second Compendium of Low Carbon Pulse.

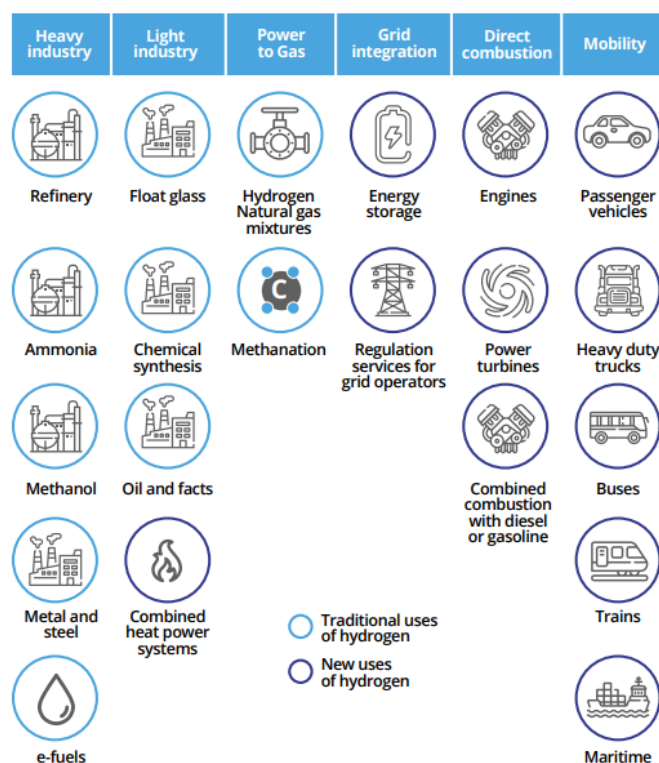
Mexico and Germany:

In December, 2021, **Green Hydrogen in Mexico: towards a decarbonization of the economy** (Volumes [I](#), [II](#), [III](#) and [IV](#)) was published (**GH2 Mex**). The report is the work of Alianza Energética Energiepartnerschaft – México – Deutschland and Cooperación Alemana – Deutsche Zusammenarbeit.

While each Volume **of GH2 Mex** is well-worth a read, Volume [I](#) sets a new benchmark for excellence in analysis of a highly prospective market, and the hydrogen industry generally. **GH2 Mex** complements the [IEA Global Hydrogen Review](#).

GH2 Mex will be considered in more detail in the **November and December Report on Reports** to be included in the Appendix to Second Compendium of Low Carbon Pulse. While to be included in the **Report on Reports**, the following diagrammatic representation of the uses of Green Hydrogen is worth including here:

Figure 1-9. Traditional and new uses of hydrogen (Hinicio, 2020)



Australia:

- **Western Australia to Northern Europe:** On December 2, 2021, the Government of Western Australia and Port of Rotterdam announced that they had signed a memorandum of understanding (**MOU**) to develop a supply chain from Western Australia to the Port of Rotterdam, the Netherlands.

Editions 17, 20, and 21 have reported on the forward thinking nature of Port of Rotterdam Authority in the development of facilities and infrastructure for the import and storage of hydrogen and hydrogen-based fuel. The signing of the **MOU** may be regarded as a significant development that under-scores the clear development of supply chains from Australia to Europe.

- **New South Wales two new REZ:** Most recently, **Edition 30** of Low Carbon Pulse reported on the Renewable Energy Zones (**REZs**) in New South Wales, Australia's most populous state. On December 3, 2021, the NSW Government sought expressions of interest for the development and deployment of new solar and wind and energy storage projects on the Central Coast and Hunter Regions of New South Wales.

The New South Wales Government announced its **REZs** plans in 2020 (see **Edition 4** of Low Carbon Pulse), and has been progressing those plans since then. The **REZ** plans, and the policy settings supporting them, are aimed at ensuring that New South Wales halves its **GHG** emissions by 2030, and achieves **NZE** by 2050.

- **Federal Government of Australia:** On December 3, 2021, the Federal Government of Australia [announced](#) its Hydrogen Technology Cluster Australia program, with clusters to be located Townsville, Queensland, and in Gascoyne and Midwest regions of Western Australia.
- **Guarantee of Origin (GOO) Scheme to be tested and trialed:** On December 10, 2021, it was announced that the Federal Government of Australia is to start to work with participants in the hydrogen industry to test the design of its **GOO** Scheme.

Key to the assurance of origin of hydrogen and any hydrogen-based fuel is monitoring and verifying the **GHG** emissions that arise from the production of hydrogen and hydrogen-based fuels.

The Federal Minister for Industry, Energy and Emissions Reduction, Mr Angus Taylor noted that: "*Continuing our close work with industry through design and trials is critical to ensuring that an Australian Guarantee of Origin scheme is fit for purpose to support industry growth and attract investment.*"

- **State of Hydrogen 2021:** On December 10, 2021, the Department of Industry, Science, Energy and Resources (**DISER**) published [State of Hydrogen 2021](#), reporting on the state of the hydrogen industry in Australia. The **DISER** report is both informative and welcome.

The **DISER** report will be considered in the **November and December Report on Reports** to be included in the Appendix to the Second Compendium of Low Carbon Pulse.

- **Victoria's Renewable Energy Zones:** On December 13, 2021, [reneweconomy](#), under [Victoria seeks 1.5 GW of new wind and solar in first renewable zone tender](#), reported that the Victorian Government had received more than 30 proposals in response to expressions of interest to provide new renewable electrical energy and innovative solutions to strengthen the grid.

UK and US:

- **Largest NZE procurement:** On December 8, 2021, the President of the United States, Mr Joe Biden, signed an executive order directing the Federal Government to achieve **NZE** by 2050, 100% carbon pollution-free electricity by 2030, and 100% zero-emission vehicle acquisition by 2035. Here is a [link](#) to the Executive Order.
- **United States Hydrogen Alliance established:** On December 7, 2021, it was announced that the Western States Hydrogen Alliance had been expanded to become the United States Hydrogen Alliance. This may be expected to result in more active engagement by participants and stakeholders in the hydrogen and hydrogen-based fuel sector.
- **Off-shore wind knows no limits:** On December 16, 2021, the UK opened for applications in the fourth round of its off-shore wind field procurement process under which contracts for differences (**CFDs**) will be allocated (**fourth CFD allocation round**). Further details of the 12 GW **fourth CFD allocation round** are to be found at a press release from the UK Government, titled [Biggest ever renewable energy support scheme opens](#).

The headline for the press release is that off-shore wind will be supported by funding of GBP 200 million a year, and while fixed-bottom off-shore wind is the focus of the funding, there is specific allocation for floating off-shore, tidal. Also photovoltaic and on-shore wind is included.

By way of reminder, on February 6, 2021 HM Treasury announced the successful tenderers in the third round **CFD** allocation round (see **Edition 9** of Low Carbon Pulse). Early in 2022 the successful tenderers in the **ScotWind Leasing Scheme** are to be announced (see **Edition 22** of Low Carbon Pulse). (**Edition 33** of Low Carbon Pulse reports on the outcome of the **ScotWind Leasing Scheme**.)

Blue and Green Carbon:

- **UN Biodiversity – 5 Blue Forests:** UN Biodiversity under the auspices of the UN Environment Programme has shared an article, [5 "blue forests" that are vital to life on Earth](#). The article is well-worth a read, identifying as it does, mangroves, salt marshes, seagrass meadows, rockweed, and kelp forests as the 5 "blue forests".

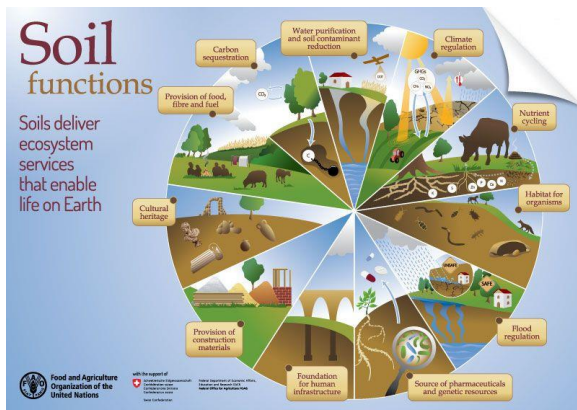
On December 1, 2021, the **UNEP-WCMC (UN Environment Programme World Conservation Monitoring Centre)** shared a [piece](#) from earlier in 2021 about the importance of mangroves in Cambodia. It is well-worth a read.

On December 5, 2021, **ADNOC** announced its [Seeds of Legacy program](#) dedicated to preserving and planting more mangroves.

- **South Ocean – crucial carbon sink:** On December 3, 2021, a [study](#) published in Science, and supported by NASA (and the National Science Foundation and **NOAA**), reported on the importance of the South Ocean in absorbing **CO₂**. The study is well-worth a read.

The key findings arise from airborne measurements, with the key finding being: "*that the Southern Ocean is a stronger carbon sink than previously thought, playing a significant role in mitigating the impact of greenhouse gases*".

- **World Soil Day:** One learns something new every day: December 5 is World Soil Day. To mark 2021 World Soil Day the Executive Secretary, Convention of Biological Diversity, Ms Elizabeth Maruma Mrema issued a [statement](#) that provided a timely reminder of the importance of the health of soil: "*Soil biodiversity underpins the functioning of ecosystems that provide essential functions and services to sustain food and water security and deliver multiple benefits to ... all facets of sustainable development ... More sustainable management of soil resources through the conversation, restoration and sustainable use of soil biodiversity can play an important role in transforming our food systems*".



- **How long does it take to create a few centimetres of soil?** In the words of the song, it takes a thousand years. The European Commission (EC) introduced some of its coverage of the [EU Data Crunch Soil Strategy](#) in this way. The [EU Data Crunch Soil Strategy](#) is short, at six pages, but conveys a sense of the importance of soil. As the [EU Data Crunch Soil Strategy](#) says, soil is a magic carpet beneath our feet. (This has stuck with the author of Low Carbon Pulse.)

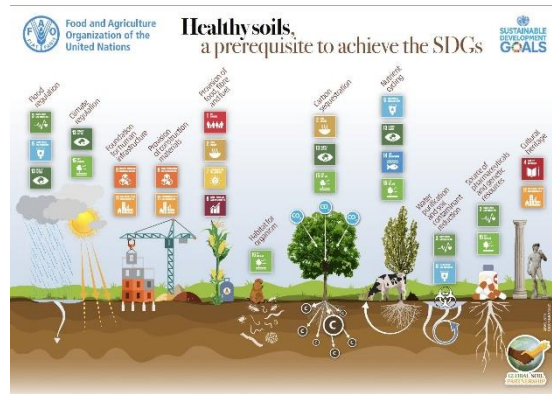
A (bad) pun (in particular for Liverpool Football Club fans) that nearly did not make it through editing: "It is important to remember that while we may walk on loam, we never walk a loam".

- **Planting trees is not the answer:** On December 8, 2021, an article was published by [physorg](#) that makes it clear that achieving carbon neutrality is not the target for which to aim; the target has to be decarbonisation. The article notes that plants and soil are absorbing considerable **CO₂**, and that in the case of rainforests there is a risk that they are at, or are reaching, saturation point.

The most telling sentence in the article is: "relying on the biosphere to store fossil carbon is ... daft when we may well need all the nature-based solutions we can find just to keep the carbon content of the biosphere stable". It is expected that this sentence will gain wide acceptance over time.

Since 1850 human activities have released 2,400 billion tonnes of **GHG** emissions to the climate system. There is around 460 billion tonnes of **GHG** emissions left in the carbon budget before average global temperatures increase by **1.5°C**. There is no short cut, decarbonisation needs to be achieved in short-order.

- **Planting sea-weed is not the answer:** [A Research Strategy for Ocean-Based Carbon Dioxide Removal and Sequestration](#) finds that current levels of **CO₂** emissions exceed greatly the ability of nature to remove it from the environment. The safest and soundest way to address levels of carbon in the climate system is to remove 10 gigatonnes of **CO₂** every year by 2050.



Bioenergy:

- **Bio-LNG in Tassie:** On November 29, 2021, Optimal Group and BOC / Elgas (a subsidiary of one of the big three industrial gas corporations, Linde), announced that they had signed a memorandum of understanding to explore jointly the development of the first bio-LNG production project in Australia at BOC/Elgas' Westbury LNG Plant, in Tasmania, Australia. Optimal and BOC/Elgas will explore the potential for Optimal to develop a waste to biogas facility. **See:** [Optimal Group and BOC sign agreement to focus on development of Australia's first bioLNG facility](#); [BOC and Optimal Group sign agreement to focus on development of Australia's first bioLNG facility](#)
- **Waste-to-H2 in Bulgaria:** On November 30, 2021, [H2view](#) reported that the City of Simtli has signed a letter of intent with Hydrogen Utopia International to develop a hydrogen production plant (the Powerhouse Energy Distributed Modular Gasification Plant), with the plant to use waste as feedstock to produce biogas and to derive hydrogen from that biogas.
- **TotalEnergies embraces Clean Energy:** On November 30, 2021, [Energy Connects](#) reported that TotalEnergies and Clean Energy are developing their first biomethane production facility, with biomethane produced intended for use in the mobility / transport sector, and compressed natural gas. The biomethane production facility is located at the Del Rio Dairy farm, with the feedstock for the biomethane production sourced from manure supplied by the farm.
- **Power-to-X plant:** On December 6, 2021, Copenhagen Infrastructure Partners (**CIP**, leading renewable energy project developer and investor) announced that it was to develop one of the world's first commercial Power-to-X plants, to produce Green Methanol from **CO₂** derived from waste incineration. **CIP** will develop the Power-to-X plant with Aalborg Forsyning and Reno-Nord. The Power-to-X plant is to be located in Aalborg, and will take up to 180,000 metric tonnes of **CO₂** a year from Reno-Nord, and produce 130,000 metric tonnes of Green Methanol. **See:** [CIP announces plans to build Europe's largest Power-to-X-facility, with the support of market leaders within the agriculture and shipping industries](#)
- **WasteFuel not wasting time:** [Edition 27](#) of Low Carbon Pulse reported that Maersk had invested in WasteFuel (a start-up backed in part by Mr Warren Buffett through Berkshire Hathaway subsidiary NetJets). At that time it was understood that WasteFuel processes agricultural and municipal solid waste to provide synthetic biofuel, bio-methanol for sale into the Americas and into Asia. It is becoming increasingly clear that Maersk could purchase all biofuel produced by WasteFuel, but WasteFuel sees the size of the market for biofuel as providing biofuel producers the opportunity to grow to the size of some international oil companies in a relatively short period of time.
- **Biomethane Declaration:** On December 7, 2021, the European Biogas Alliance announced that 28 corporations from across Europe presented the [Biomethane Declaration](#) to the European Commissioner for Energy, Kadri Simson. The Biomethane Declaration is worth a read.

BESS and HESS:

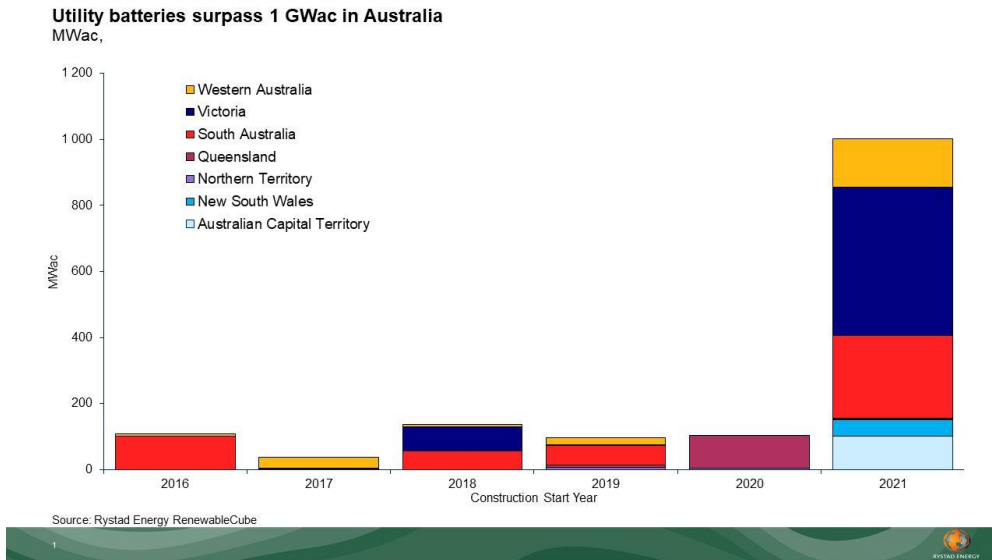
- **HypSTER project progressing:** The first **EU** supported hydrogen energy storage system (**HESS**) project (**HypSTER**) is proceeding in France, using salt caverns. Storenergy (a subsidiary of global leading energy company, Engie) will develop the **HypSTER** project, with partners, Armines, Axelera, Ecole Polytechnique, Element Energy, ESK GmbH, Howden, INERIS and INVYN.

Among other things, the **HypSTER** project will assess the position of storage in the hydrogen value chain.

See: [HypSTER website](#)

For an article providing some background on **HESS** see [Power – Hydrogen – Want Long-Term Energy Storage? Look to Hydrogen](#).

- **Hornsedale BESS four years on:** On December 1, 2017, the Hornsdale **BESS** was launched in South Australia. Since the launch of the Hornsdale **BESS**, **BESS's** have become a future across Australia and globally.
- **What a difference five years makes!** Set out below is a bar chart demonstrating that **BESS** has come along way since the outages in South Australia in Q3 of 2016.



- **Hazelwood BESS:** Engie and Macquarie Group's Green Investment Group are to develop and to deploy a 150 MW / 150 MWh BESS at Hazelwood, Victoria.
- **GIGA Storage Buffalo Battery:** On December 7, 2021 it was reported by [DNV – Energy](#) that GIGA Storage (a Dutch technology corporation) has achieved financial close in respect of its Buffalo Battery, the largest BESS in the Netherlands that will operate in a smart grid in the Renewable Energy Hub Flevoland.
- **Victorian Big Battery officially opened:** On December 8, 2021, the Biggest **BESS** in Australia opened officially – the Victorian Big Battery (**VBB**) – the 300 MW / 450 MWh **BESS**. The Neoen **VBB** has been developed and deployed in around 12 months.

As noted in [Edition 23](#) Low Carbon Pulse, from contract to connection was achieved in record time. (Also see [Editions 5](#) and [11](#) of Low Carbon Pulse for details of the progress of **VBB**.)

On December 14, 2021, Neoen announced that construction had commenced on its 100 MW / 200 MWh BESS close to Canberra, Australian Capital Territory – the Capital Battery.

- **North Territory – Katherine BESS:** On December 13, 2021 it was reported that Hitachi has been selected to provide a **BESS** for the iconic town of Katherine, Northern Territory, Australia (for which the author's eldest daughter is named).

The Northern Territory Government Minister for Renewables and Energy, Ms Eva Lawler, explained that: "The award of the [Katherine] **BESS** tender is a huge step in our plan for 50% renewables by 2030 – it is the cornerstone of our Darwin-Katherine System Plan".

- **US – record Q3:** During the week beginning December 13, 2021, it was reported widely that during Q3 of calendar year 2021, 1.463 GW / 3.487 GWh of **BESS** capacity was installed in the US.
- **New South Sales – Wallerawang BESS:** [Edition 17](#) of Low Carbon Pulse reported that: "Greenspot plans to make use of the existing generation hall and related infrastructure at the decommissioned Wallerawang coal-fired power station just outside Lithgow, Central Western, New South Wales, Australia, to house a big battery. The AU\$500 million **Wallerawang 9 Battery BESS Project** will have **BESS** capacity of 500 MW / 1,000 MWh".

On December 15, 2021, it was reported widely that Greenspot had submitted a development application to permit it to develop and to deploy a 500 MW / 1000 MWh **Wallerawang 9 Battery BESS Project**.

BECCS / BECCUS and CCS and CCUS:

- **CCS Break-even point:** On December 1, 2021, Reuters reported that the Vice President for Global CCS Solutions at Equinor, Mr Torbjørn Fossum, had stated:

"[Equinor believes] that there is a potential break even at 100 euros per tonne [of CO₂] ... Today there is a gap between what it costs to emit [the CO₂] and what it costs to implement CCS. [Equinor believes that gap is closing within the next ten years]."

In the European context the cost of emission is a function of the cost of emissions trading permits under the **EU ETS**: on December 1, 2021, €76 an emissions trading permit.

What this means in practice is that Governments should continue to develop and to implement policy settings that allow CCS to develop, while at the same time managing (down) the number of emissions trading permits (and as such lowering caps).

Critical to allowing CSS to develop is continued funding support to develop the supply of CCS capacity and services. The Northern Lights project and the **CCUS** (cluster sequencing) **Programme** in the UK, are great examples.

- **Kasawari CCS project progresses:** On December 6, 2021, it was reported widely that Petronas' Kasawari CCS project is on the pathway to a final investment decision in 2022 with Petronas having invited bids to the award of front-end engineering and design contracts from two consortiums – Malaysia Marine & Heavy Engineering and Ranhill Worley and Hyundai Heavy Industries and Aker Solutions. Some heavy-weight players for a heavy-weight project.
- **Bifrost and Greensand Green lighted:** On December 8, 2021, [offshoreenergy](#) reported that the Danish Energy Agency (**DEA**) agreed to provide funding support for two CCS projects in the Danish sector of the North Sea. The TotalEnergies operated Bifrost, and the INEOS lead Greensand. It is well-worth clicking through to the article.
- **Polaris to progress:** On December 10, 2021 it was announced that Equinor ASA, Horisont Energy AS, and Vår Energi had entered into an agreement to collaborate on the development for the carbon transportation and storage project, Polaris off the coast of Northern Norway (see **Editions 25** and **27** of Low Carbon Pulse).
The Polaris storage project is expected to have **CO₂** storage capacity of 100 million tonnes of **CO₂**, or stated another way, twice the mass of **GHG** emissions arising from activities in Norway each year. As noted in previous editions of Low Carbon Pulse, the Polaris storage project is key to the development of the **Barents Blue** project in Finnmark – Europe's first world-scale carbon neutral ammonia production plant.
As reported in **Edition 25** of Low Carbon Pulse, Equinor ASA, Horisont Energy AS, and Vår Energi entered into a cooperation agreement for Barents Blue earlier in 2021.
See: [Horisont Energi, Equinor and Vår Energi enter joint development agreement on Polaris Carbon Transport and Storage Project](#); [Vår Energi enters the Barents Sea Polaris CO₂ storage joint partnership](#); Equinor ASA [website](#)
- **CCS round-up:** On December 11, 2021, [oilprice](#) published [Carbon Capture Innovations Will Play A Key Role in Net-Zero Ambitions](#). The article is worth a read, providing a clear sense of the role of CCS, including touching on the announcement by the Climate Change Committee in the UK that the use of reservoirs in the North Sea for CCS will provide the most effective means of achieving CCS in that part of the world.
- **CDR – the difference between DAC+S and CCS:** On December 15, 2021 the good folk at Climeworks posted a four page flyer clarifying DACS and CCS. A [link](#) is included for those interested in a high-level description.

Carbon credits and markets Hydrogen Markets and Trading:

Hydrogen Trading: On December 7, 2021, it was reported widely that RWE and Novatek has signed a memorandum of understanding (**MOU**) to cooperate in the supply of low-carbon and carbon-free fuels. It is reported that the **MOU** contemplates the supply of low-carbon ammonia and hydrogen. Novatek is the largest independent producer of natural gas in Russia. To produce low-carbon ammonia and hydrogen (Blue Ammonia and Blue Hydrogen), it will be necessary for it to develop carbon capture and carbon storage facilities.

E-fuels and Future Fuels (increasingly "Now Fuels"):

- **BP tees-up:** On November 29, 2021, BP announced that it plans to develop a large-scale Green Hydrogen production facility by 2025 (**HyGreen Teesside**). The **HyGreen Teesside** facility will be located on the east coast of England. BP is leading the Net Zero Teesside projects and the Northern Endurance Partnership (**NEP**) as part of the East Coast Cluster (see **Editions 22** and **23** of Low Carbon Pulse).
- **Total Eren swoops to develop H2 Magallanes:** On December 2, 2021, it was reported widely that Total Eren (a leading renewable energy corporation part owned by TotalEnergies) plans to develop a 10 GW on-shore wind project to supply renewable electrical energy to power Green Hydrogen and Green Ammonia production facilities in the Magallanes region of southern Chile (**H2 Megallanes**): it is reported that **H2 Megallanes** will comprise a desalination facility, 8 GW of electrolyser capacity, and ammonia production facilities. First production is expected by 2027, with the expectation that **H2 Megallanes** will produced 800,000 metric tonnes of Green Hydrogen a year, and 4 million metric tonnes of Green Ammonia.
See: [Total Eren Secures Lands and Launches Studies Aiming to Develop a Large-scale Green Hydrogen Project in Chile's Magallanes Region](#)
- **FFI Canadian Projects:** On December 2, 2021, Fortescue Future Industries (subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, OA) signed agreements with three Canadian Indigenous nations with a view to assessing the viability of the development of three Green Hydrogen projects.
As reported in previous editions of Low Carbon Pulse, **FFI** has contracted in many countries for the development of Green Hydrogen production facilities, and continues to do so.
See: [Fortescue Future Industries and Indigenous leaders in Canada collaborate on green hydrogen projects](#)
- **Acciona to supply renewable energy to Stanwell CQ-H2:** On December 2, 2021, Acciona Energia announced that it has signed a memorandum of understanding with Stanwell Corporation for the supply of renewable electrical energy from Acciona Energia's Aldoga photovoltaic solar facility via a direct connection (rather than grid connection) to the Stanwell led Central 3 GW Queensland Hydrogen Project (**CQ-H2**) – see **Edition 19** of Low Carbon Pulse (there batted the **Gladstone 3G** or **G3G** within the Gladstone State Development Area (**GSDA**)).
See: [ACCIONA Energía signs agreement to supply clean energy to a 3GW green hydrogen plant in Queensland](#)
- **Woodside Stateside:** On December 6, 2021, Woodside Energy Limited announced that it was developing a hydrogen production project at Westport Industrial Park, Ardmore County, Oklahoma (**H2OK**), a major node on the US road freight network. **H2OK** will deploy an initial 290 MW electrolyser capable of producing 90 metric tonnes of hydrogen a day. The hydrogen will be liquified and will be used by the heavy mobility / transport sector. Woodside announced that it had signed an MOU with Hyzon Motors for the off-take.
As Woodside notes, **H2OK** joins **H2 Perth** and **H2TAS** as its third significant hydrogen project.
See: [Woodside Expands Hydrogen Portfolio to the United States](#)
- **Trafigura pulls out in traffic:** On December 9, 2021 it was reported widely that leading Swiss metals and oil trading trader, Trafigura Group, is planning to develop a USD 540 million Green Hydrogen production facility is Port Pirie, South Australia.

- **Desert Bloom pulls H₂O out of air:** On December 13, 2021, it was reported widely (and enthusiastically) that the Desert Bloom Green Hydrogen production facility project in the Northern Territory, Australia, had been given Major Project Status.

In any Australia State or Territory in Australia, Major Project Status allows for coordination of approvals and permitting, and in so doing increases the rate at which a project is able to progress to development and deployment. Project proponent, Aqua Aerem (water air in Latin), has indicated that Major Project Status will allow a 8 MW pilot to commence in 2022, ahead of the planned 10 GW, AUS 10.75 billion, staged development.

On completion the Desert Bloom Green Hydrogen production facility will produce 410,000 metric tonnes of Green Hydrogen a year at a projected cost of less than USD 2/kg.

Desert Bloom is a game changer because it uses "air-to-water" technology: some areas of the world with world class solar resources are areas that are also subject to water stress, and as such require the use of desalinated sea-water or process and treat waste water to provide the H₂O feedstock for the production of Green Hydrogen using electrolyzers, adding cost, both capital and operating. The "air-to-water" or "water-from-air" technology will allow arid environments to be developed for Green Hydrogen production.

Aqua Aerem is majority owned by Sanguine Impact Investment.

- **South Africa continues to buzz:** On December 15, 2021, it was announced that an ammonia production plant is to be developed on Nelson Mandela Bay. The USD 4.6 billion ammonia production project is to be developed by Hive Hydrogen and Linde Africa (Linde being one of the three industrial gas giants globally, with Air Liquide and Air Products), and it is understood on completion, will produce up to 780,000 metric tonnes of ammonia a year.

See: [World's Largest Green Ammonia Plant for Nelson Mandela Bay, South Africa](#); Linde [website](#)

- **Macquarie and Nobian – giants combine:** On December 15, 2021, it was reported widely that Macquarie Group's Green Investment Group, and Nobian (leading chemicals corporation) have formed the Hydrogen Chemistry Company (**H2CC**) to focus on supply to the difficult to decarbonise industries, including the chemical and petrochemical and iron and steel industries, and to the aviation sector.

It is understood that the **H2CC** is to develop and to deploy up to 400 MW of electrolyser production capacity to produce Green Hydrogen, including a 250 MW electrolyser to be located in Rotterdam, the Netherlands, a 100 MW electrolyser proximate to Amsterdam, and a 60 MW electrolyser dedicated to the production of Green Hydrogen to be used as feedstock to produce methanol and aviation fuel.

See: [Nobian and GIG join forces to launch leading green hydrogen company HyCC](#); Nobian [press release](#)

Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

- **Possible pivot:** On December 1, 2021, the ever excellent BloombergNEF published an article on the prospects for, and costs of, decarbonising the iron and steel production industry globally by 2050, together with an accompanying report. Both the [article](#) and the [report](#) are well-worth a read.

- **Iberdrola and H2 Green Steel combine:** On December 2, 2021, Iberdrola (leading international energy company) and H2 Green Steel (**H2GS**, and see [Editions 11, 12, 13](#), and [20](#) of Low Carbon Pulse) announced plans to develop a Green Hydrogen production facility on the Iberian Peninsula to provide Green Hydrogen for use in the production of Green Steel (which with the use of Green Hydrogen gives rise to 95% less **CO₂** emissions).

The planned Green Hydrogen production facility would be the world's largest with electrolysis capacity of 1 GW. To provide sufficient renewable electrical energy to power the electrolyser, Iberdrola plans to invest around €800 million, with the total cost estimated at around €2.3 billion. It is understood that the intention is for production of Green Steel to commence in 2025 to 2026.

See: [Iberdrola and H2 Green Steel sign 2.3 billion euros green hydrogen deal](#); [H2 Green Steel and Iberdrola announce €2.3 billion Green hydrogen venture](#)

- **BSL and Shell combine:** [Edition 25](#) of Low Carbon Pulse reported that Bluescope Steel Limited (**BSL**) announced that it is committed to **NZE** for its Scope 1 and Scope 2 emissions. **BSL** indicated that it would achieve its **NZE** commitment using renewable electrical energy, and Green Hydrogen, rather natural gas (**CH₄**), whether alone or blended with hydrogen.

On December 6, 2021, **BSL** announced that it had signed an MoU with Shell to develop and to deploy a renewable hydrogen pilot project at **BSL's** Port Kembla Steelworks, and to explore, with other organisations, the development of an Illawarra Hydrogen Hub (aligned with the recent policy settings of the New South Wales Government).

See: [BlueScope and Shell join forces to develop renewable hydrogen projects in the Illawarra](#)

- **Firm commitments:** On December 8, 2021, [De Tijd newspaper](#) reported on the signing of a Declaration of Intent by ArcelorMittal and the Federal Government of Belgium and the Government of Flanders in respect of the investment of €1 billion to produce Green Steel (**Ghent Declaration of Intent** or **GDOI**).

The **GDOI** provides that the two blast furnaces at ArcelorMittal's Ghent steel works will be replaced by direct reduced iron (**DRI**) facilities which will provide **DRI** / sponge to the electric arc furnaces. (Low Carbon Pulse has reported previously on the investment of €700 for the purposes of Joint Venture Finocas.)

Hydrogen – Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

- **Geelong Hydrogen Hub:** On November 30, 2021, it was reported widely that Geelong Port, Victoria, Australia, is to develop the Geelong Hydrogen Hub (**GHH**).

The **GHH** is to involve the development and deployment of a biomass gasification project from which biogas will be produced from biomass, and that biomass will be used to derive clean hydrogen (see [Hydrogen For Industry \(H241\) Feature 1: Hydrogen from Waste](#)), using technology developed by CAC-H2.

See: [GeelongPort establishes the Geelong Hydrogen Hub](#)

- **Blending State-wide:** On December 6, 2021, it was reported widely that APA Group (leading Australia natural gas transmission and distribution pipeline owner and operator) is developing the first blue-print for state-wide hydrogen blending in the State of Victoria across the Victorian Transmission System. Rightly, APA CEO and Managing Director, Mr Rob Wheels said: "*This landmark study proposes to assess the Victorian gas transmission network to transport safely hydrogen blends, which could put Victoria in the box seat to achieve the least cost, fastest, and most efficient transition to a low-carbon future*".

See: [Developing Australia's first blueprint for state-wide hydrogen blending](#)

- **AGL Energy and FFI to develop the Hunter Energy Hub:** On December 8, 2021, AGL Energy and **FFI** announced plans to develop an energy hub at the sites occupied by the AGL Energy Liddell coal-fired power station (that is to close in 2023) and Bayswater coal-fired power station.

The detail of the plans will become clearer over time, but this is an exciting development for AGL Energy and for **FFI**, and for the Hunter region of New South Wales, Australia.

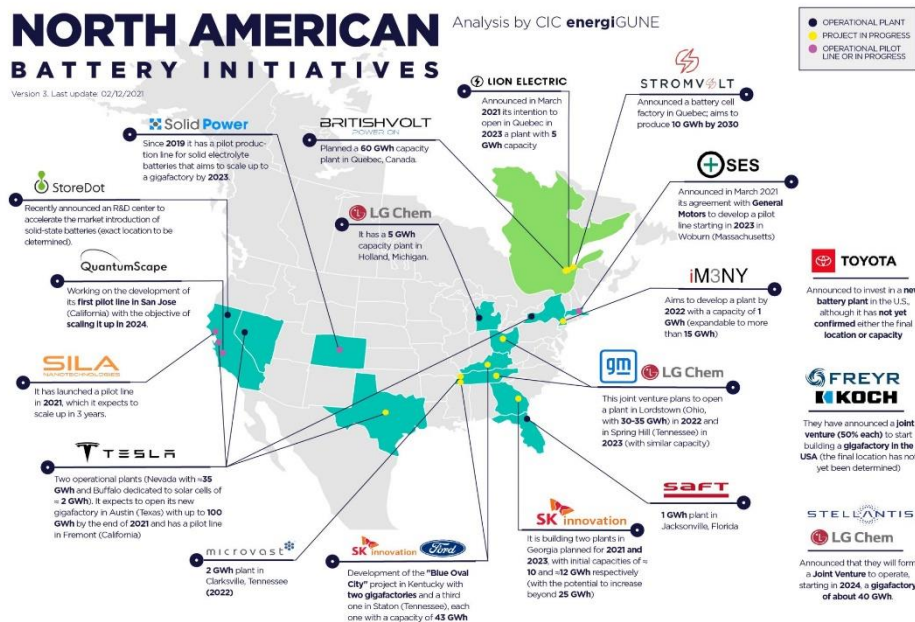
- **The new UK Hydrogen Hubs – Southampton and Inverness:** On December 8, 2021, it was announced that ExxonMobil, Macquarie Groups Green Investment Group (**GIG**) and SGN are contemplating the development of Southampton Hydrogen Hub, to decarbonise industrial activities being undertaken in the region.

In the days since the announcement, news items have covered the proposed development in more detail with **rigzone** reporting that the three corporations have signed a memorandum of understanding under which they will explore the use of hydrogen and carbon capture to reduce **GHG** emissions in the industrial cluster around Southampton.

An initial feasibility study undertaken by **GIG** and SGN is reported to have indicated the hydrogen demand may be up to 37 TWh in electrical energy equivalent terms.

On December 14, 2021, it was reported that H2 Green (a Getech business) and SGN had agreed to progress with plans for the development of Green Hydrogen production facilities; SGN to use its former gas-holder site.

- **Battery of factories:** The map below details the development of battery factories across the US:



Wind round-up, on-shore and off-shore:

- **MunmuBaram licensed:** On November 29, 2021, it was reported widely that the joint venture, **MunmuBaram** (80% Shell Overseas Investment B.V. and 20% CoensHexicon Co. Ltd see **Edition 26** of Low Carbon Pulse for coverage of the joint venture) had been granted an Electricity Business Licence (**EBL**) for the floating off-shore wind field project off the coast of Ulsan, **ROK**.

The **EBL** allows **MunmuBaram** to progress with the first stage (420 MW), of the three stage (1.3 GW), project (generating up to 4.2 TWh a year).

See: [Munmubaram Secures Electricity Business License for Floating Offshore Wind Project in South Korea](#)

By way of reminder: **Edition 26** of Low Carbon Pulse reported that: "On September 1, 2021, Shell Overseas Investment B.V. announced it has combined in joint venture with CoensHexicon Co. Ltd, with Shell a 80%, CoensHexicon, a 20% equity participant, to develop and then to operate the 1.4 GW Ulsan **OWF** project (the **MunmuBaram Project**)."

It is understood that the **MunmuBaram Project** plans to apply for the Electricity Business Licence (**EBL**) during this month, September 2021."

- **RWE and Ulsan City aligned:** On November 29, 2021, it was reported that Ulsan Metropolitan City (major manufacturing city in the **ROK**) and RWE (leading international energy corporation) had signed a memorandum of understanding under which Ulsan City and RWE are to cooperate to develop up to 1.5 GW of floating off-shore wind field renewable electrical energy.

See: [South Korea: RWE and Ulsan City cooperate in floating offshore wind](#)

- **High Wind in Turkey:** On November 29, 2021, [Daily Sabah](#), reported that for the first time the largest source of dispatched electrical energy across the grid in Turkey (operated by the Turkish Electricity Transmission Corporation (TEIAS)) was dispatched from wind farms, with 22.6% of load matched by electrical energy from wind farms. This was a record.
- **New Zealand looking off-shore:** On December 1, 2021, the [taranaki daily news](#), reported that BlueFloat Energy (a leading off-shore wind field corporation), Energy Estate (established renewable energy project developer) and Elemental Group (a pioneer in the New Zealand off-shore wind field sector).
- **"Luck of the Thor":** Edition 30 of Low Carbon Pulse reported that on December 1, 2021, the successful tenderer would be determined by the drawing of lots, with the successful tenderer to develop the 1 GW Thor off-shore wind field.

On December 1, 2021, the Danish Ministry of Climate, Energy and Utilities and the Danish Energy Agency announced that Thor Wind Farm I/S (owned by RWE AG, RWE Renewables GmbH, and RWE Renewables Management UK Limited) was the successful tenderer.

See: [Success in offshore auction: RWE secures concession for 1,000-megawatt wind farm off the Danish coast](#)

On December 8, 2021, [S&P Global Platts](#) provided a perspective of the competitive nature of some off-shore wind field projects.

The by-line is:

"It's no longer enough to bid zero for offshore wind concessions – now you have to pay for the privilege of securing valuable sea acreage".

While the concept of no subsidiary is not new, the competitive nature of off-shore and on-shore renewable energy projects in some parts of the world is becoming challenging for some participants.

- **Ørsted takes FIDs:** On December 1, 2021, Ørsted announced that it had taken final investment decisions (FIDs) on two German off-shore wind field developments – Gode Wind 3 (242 MW) and Borkum Riffgrund 3 (900 MW), which together will comprise 1.142 GW of installed capacity.

The FID decisions are supported by the power purchase agreements that Ørsted has concluded with Amazon, BASF, Covestro, Google and REWE Group.

See: [Ørsted takes final investment decision on two German offshore wind farms](#)

- **Dogger Bank C Banked:** Editions 4 and 5 of Low Carbon Pulse reported on FID for Dogger Bank C and financial close of Dogger Bank A and B. Construction of Dogger Bank A and B is underway.

On December 2, 2021, financial close of Dogger Bank C was reported widely. Total investment in Dogger Bank A, B and C is projected to be around GBP 9 billion.

See: [Equinor](#) website; [eni](#) website; [SSE](#) website

- **RWE cements further relationship with Asia Cement Corporation:** On December 6, 2021, RWE announced that it had reinforced its strategic partnership with Asian Cement Corporation (ACC) to develop fixed bottom and floating off-shore wind field projects off Taiwan, in waters off Hsinchu, Taichung and Changhua.

See: [Taiwan: RWE reinforces strategic partnership with ACC](#)

- **Dutch off-shore wind progress:** During the second week of December 2021 it was reported that the Dutch Government intends to expand its off-shore wind capacity, possibly through the development of a further 10.7 GW by 2030, from 11.5 GW to 22.2 GW, with newly designated zones in 1, 2 and 5-East (to accommodate an additional 8 GW), the Ijmuiden Ver North (2 GW) and Hollandse Kust (700 MW).

The development of this further capacity would align with the EU's commitment to reduce GHG emissions by 55% by 2030.

- **Denmark off-shore wind progress:** No sooner had the hammer fallen on the Thor drawing of lots(!), than the Government of Denmark committed to procure a further 3 GW of off-shore wind field capacity to be installed before 2030. Currently Denmark is committed to adding 7.2 GW of off-shore wind field capacity by 2030.

CURRENT PLANNED DEVELOPMENT OF OFF-SHORE WIND

North Sea Energy Island – 3 GW	Baltic Sea Energy Island – 2 GW	Hesselo (Baltic Sea) – up to 1.2 GW	North Sea Thor – 1 GW
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A number of players have asked that the process for the additional 3 GW does not include the drawing of lots next time around.

- **Alinta Energy power to Portland:** On December 7, 2021, it was reported widely that Alinta Energy has proposed the development of a 1 GW off-shore wind field, off the coast of Victoria, Australia, to provide 100% renewable electrical energy to the Alcoa alumina smelter at Portland, Victoria (the **Spinifex Off-shore Wind Project**).

See: Alinta [Website](#)

- **Vattenfall Vesterhav FID:** On December 14, 2021, it was reported widely that Vattenfall (leading European energy corporation) had taken a final investment decision in respect of its Vesterhav €769 million North and South off-shore wind field complex off the coast of Denmark.

See: [Vattenfall has taken the final investment decision for Vesterhav Syd and Vesterhav Nord adding 344 MW of fossil free electricity capacity to the Danish energy system towards 2023](#)

Solar and Sustainable:

- **World -scale dedicated Photovoltaic Solar Project:** On November 30, 2021, it was reported widely that Sinopec (one of the big three PRC oil and gas corporations) is to develop and to deploy a world scale photovoltaic solar project dedicated to the production of Green Hydrogen.

Located in Kuqa City, in the north western region of Xinjiang, the 300 MW photovoltaic solar facility will supply renewable electrical energy to allow the production of up to 20,000 metric tonnes of Green Hydrogen a year.

It is reported that the Green Hydrogen production facility will have a 210,000 m³ hydrogen storage tank, and will have a hydrogen pipeline with capacity of hauling 28,000 m³ of hydrogen an hour.

See: Sinopec [website](#)

- **Greentailing in Australia:** On December 6, 2021, it was reported widely that global leading renewable energy corporation, Enel Group has been granted an energy retail licence and intends to offer a "green-tailer" product within the Australian market, combining the supply of renewable electrical energy, virtual power plants and EV charging facilities to customers.

See: [Enel launches 'greentailer' business in Australia backed by Enel Green Power and Enel X](#)

- **Solar Power – the Fastest Growing Energy Source:** So declares a [slide deck](#) from Statkraft. While the article does not tell us anything that we do not know, the covering piece on LinkedIn grabs the attention:

"Every year, the Earth received 15,000 times more energy than the entire global population consumes".

While it is possible only to recover a relatively small proportion of that energy, there is sufficient energy that is capable of capture to generate sufficient renewable electrical energy from the sun.

NZE Waste:

Edition 31 of Low Carbon Pulse introduced a section titled **NZE Waste**. To manage the length of this **Edition 32** of Low Carbon Pulse, **Edition 33** of Low Carbon Pulse will include news on **NZE Waste** from Monday November 29, 2021, to Sunday January 16, 2022.

In addition, **Edition 33** of Low Carbon Pulse will include detail on Giga-Factories.

Land Mobility / Transport:

• Cars:

- **Nissan charging on:** On November 29, 2021, it was reported widely that Nissan Motors (leading vehicle manufacturer) is to invest GBP 13 billion over the next five years, with a view to having developed 23 "electric vehicle" models by 2030, with 15 of those vehicle models being electric, and 8 of those vehicles being hybrid. This investment is consistent with the plans of Nissan to sell electric vehicles 75% in Europe, 55% in Japan, and 40% in PRC by 2026, and 40% in the US by 2030.

See: Nissan Motors [website](#)

- **Toyota taking the hy road:** On December 2, 2021, it was reported widely that Toyota Motor Corporation had adapted the internal combustion engine (**ICE**) of a Yaris to combust hydrogen rather than motor spirit.

The adapted **ICE** is reported to give rise to "almost zero emissions", "while retaining the acoustic and sensory sensations of" an **ICE**. This adaption is for use in motorsport, at least for the time being.

See: [Toyota showcases experimental hydrogen-powered GR Yaris](#)

• Industry and Trucks:

- **Hyzon to Foshan:** On December 2, 2021, Hyzon Motors Inc (leading supplier of zero-emission fuel cell vehicles) announced that it had delivered eight dump trucks to the Foshan Dump Truck Association, with the intention being to lease the trucks to the Association on completion of successful trials of them.

Foshan Municipality is located in Guangdong Province is a designated "Hydrogen Energy Demonstration City" for the purposes of the United Nations Development Program.

See: [Hyzon Motors delivers eight dump trucks to trial customers in Foshan Municipality](#)

- **Hyzon to Shanghai:** On December 8, 2021, Hyzon Motors Inc announced that it had delivered 29 fuel cell technology trucks to the PRC, through Shanghai Hydrogen HongYun Automotive Co.

See: [Hyzon Motors delivers 29 hydrogen fuel cell electric heavy duty trucks to reduce carbon emissions in the steel industry](#)

- **Hyzon to Taiwan:** On December 13, 2021, it was reported widely that Hyzon Motors Inc and MiTac-Synnex Group (a leading industrial conglomerate) had signed a memorandum of understanding (**MOU**) to develop jointly hydrogen-powered commercial vehicles for the Taiwan market.

- **Giga Carbon Neutrality (GCN) mega order:** On December 13, 2021, clean commercial transportation and technology corporation, Giga Carbon Neutrality (**GCN**) announced that it is to supply 200 hydrogen and electrical vehicles to the **PRC**, together with associated engineering equipment and machinery.

The order for the supply is from the Peoples' Government of Ejin Horo Banner, and administrative division of Ordos City, in the Inner Mongolia Autonomous Region in the **PRC**.

Regular readers of Low Carbon Pulse will recall Ordos City. **Editions 18** and **19** of Low Carbon Pulse reported on the development of hydrogen production facilities in the cities of Baotou and Ordos City, Inner Mongolia. On August 18, 2021, it was reported that the development of renewable electrical energy projects (1.85 GW of solar photovoltaic and 370 MW of wind) will provide the electrical energy to allow the production of up to 66,900 **tpa** of Green Hydrogen. With construction to commence in October 2021, it expected that first Green Hydrogen will be produced in 2023 (see **Edition 25** of Low Carbon Pulse).

- **Switzerland setting a pace:** Switzerland was a first mover in the import and use of hydrogen fuel cell technology trucks (**FCT**) (see **Editions 1, 18, 22** and **23** of Low Carbon Pulse). By the end of 2021, around 50 **FCTs** will be in use, with nine hydrogen refuelling stations. By the end of 2022 around 20 hydrogen refuelling stations will be deployed. By the end of 2025 it is anticipated that 1,500 **FCTs** will be in use.

• Trains:

- **Giants combine:** On November 29, 2021, it was reported widely that Alstom (global leader in sustainable mobility technology) and Liebherr Aerospace & Transportation SAS (see **Edition 20** of Low Carbon Pulse) had signed a

collaboration agreement to optimise fuel cell technology, in particular to optimise hydrogen fuel cell systems, including to improve durability and reliability of fuel cells and increasing energy density.

See: [Alstom and Liebherr sign a collaboration agreement, in order to optimise hydrogen fuel cells](#)

- **Alstom and MOL on track to explore:** On December 3, 2021, it was reported widely that Alstom and MOL (the leading oil and gas company in Hungary) had signed a memorandum of understanding (**MOU**) to explore the use of hydrogen technology in rail transportation.

The **MOU** may be regarded as part of the decarbonisation of the rail transport network in Hungary, certainly to displace trains powered and propelled using diesel.

See: [Alstom and MOL sign agreement to explore use of hydrogen technologies for rail transport in Hungary](#)

- **CZ Loko:** Czech locomotive manufacturer, CZ Loko, is developing a fuel cell technology locomotive.

- **More giants combine:** On December 14, 2021, it was reported widely that BNSF Railway, Caterpillar and Chevron had signed a memorandum of understanding to develop a demonstration locomotive powered and propelled by fuel cell technology.

For each corporation, the demonstration locomotive project provides an outcome aligned with its broader progress in decarbonising activities, and the role that each corporation sees for itself in energy transition.

Ports Progress and Shipping Forecast:

• **First methanol-fuelled towboat:**

On November 29, 2021, [Marine Log](#), reported that the M/V Hydrogen One (being developed by ABB, the Elliot Bay Design Group and e1 Marine), will be available for charter from 2023 to meet the increasing "demand for sustainable towboat operations". The M/V Hydrogen One will be IMO 2030 compliant and have an operational range of 500 miles between refuelling.

• **Switch presses on:**

Editions 19 and **26** of Low Carbon Pulse have reported on the development and prospective deployment, and testing, of the hydrogen powered and propelled ferry in San Francisco Bay Area - the Sea Change.

On November 30, 2021, it was reported by Switch Maritime that in commissioning and trials of the ferry, that refuelling had been undertaken successfully. Also it was reported that BAE Systems was the supplier of the propulsion system for the Sea Change.

The fuel cell technology for Sea Change is supplied by Zero Emission Industries, and the BAE propulsion system will interface with the fuel cell technology, providing an all-electric powered and propelled vessel.

See: BAE Systems [website](#); Zero Emission Industries [website](#)

• **Puerto San Antonio to use Green Hydrogen:**

On December 1, 2021, it was reported that Puerto San Antonio, Chile, is to work with [Solek Group](#) (a leading renewable energy corporation) to develop Green Hydrogen production facilities at the port.

It is expected that renewable energy facilities will be developed and deployed to provide electrical energy for the port, and for the Green Hydrogen production facilities, with the Green Hydrogen being used to power vehicles used at the port.

See: Puerto San Antonio [website](#); Solek [website](#)

• **Fuel Cell and Ammonia Cracker approved:**

On December 1, 2021, it was reported that DNV had provided Approval in Principle (**AiP**) for the ZeroCoaster ammonia fuelled cargo ship designed by AFC Energy.

The technology approved is an alkaline fuel cell with ammonia cracker and fuel storage.

The design approved will allow the use of green ammonia in the shipping industry.

See: DNV [website](#); AFC Energy [website](#)

• **Fuel cell powered drivetrain passes test:**

On December 2, 2021, it was reported that Kongsberg Gruppen (Norwegian engineering corporation) had achieved a world first in testing a hydrogen fuelled fuel cell powered drivetrain propulsion system as part of its HySeas program developing hydrogen propulsion systems for vessels.

• **Panama Canal announces GHG emission fee:**

On December 3, 2021, [splash.247.com](#) reported that the Panama Canal Administrator had announced plans for a green vessel classification system that will include a **GHG** emissions fee. The **GHG** emissions fee will be applied to make the operations of the Panama Canal carbon-neutral.

As reported, the green vessel classification system will classify all vessels with an overall length exceeding 38.1 metres by reference to their energy efficiency, applying three factors:

1. The vessel's Energy Efficient Design Index score;
2. The vessel's use of efficient operational measures; and
3. The vessel's use of biofuels or carbon neutral fuels.

• **Port Authority of Valencia paves the way:**

On December 6, 2021, [fuelcellworks](#) reported that the Head of Strategic Planning and Innovation at the Port of Valencia (**PAV**), Mr Juan Manuel Diez, announced that the **PAV** would be the first port in Europe to incorporate hydrogen technologies to reduce the environmental impact of terminal machinery operations.

• **Kawasaki Heavy to transport light:**

On December 3, 2021 it was reported widely that the MV "Suiso Frontier" (see **Editions 2, 8, 10** and **17** of Low Carbon Pulse) built by Kawasaki Heavy Industries Limited (**KHI**), and owned by HySTRA is likely to travel to Australia during December 2021.

The MV "Suiso Frontier" will load, transport and deliver to Kobe, the first cargo of liquid hydrogen (**LH2**) as the Hydrogen Energy Supply Chain project progresses (see **Editions 10** and **12** of Low Carbon Pulse).

The development and scale-up of **LH2** carriers will be key to the development of the hydrogen export industry.

Managing Director of Capra Energy Group, Mr Tamir Druz, posted photographs of the Methane Pioneer (the first LNG carrier) and the Suiso Frontier (the first LH2 carrier). The photographs are included, as are the vital statistics for those involved in the sale and purchase of LNG and **LH2**, MMBtu of the cargo.

Methane Pioneer in 1959
1st Commercial LNG Carrier



Suiso Frontier in 2021
1st Commercial Liquefied H₂ Carrier



Carrying Capacity (cubic meters)	5,000 m ³ LNG	1,250 m ³ liquid H ₂
Cargo Size (mmbtus)	116,900 mmbtus	11,900 mmbtus

Edition 17 of Low Carbon Pulse noted that **KHI** is developing **LH2** carriers with a 40,000 m³ containment system, i.e., tank, with the intention of **KHI** to develop **LH2** carriers with four such tanks, i.e., 160,000 m³ of capacity (by volume).

Airports and Aviation:

- **History made:** On December 1, 2021, United Airlines made history by completing the first passenger flight using sustainable (or synthetic) aviation fuel (**SAF**). While Federal Aviation Authority regulations in the US allow use of a blend of 50% of **SAF** and 50% fossil fuel, approval and clearance for take-off were required to use 100% **SAF**.

See: United Airlines CEO Scott Kirby's LinkedIn [Post](#)

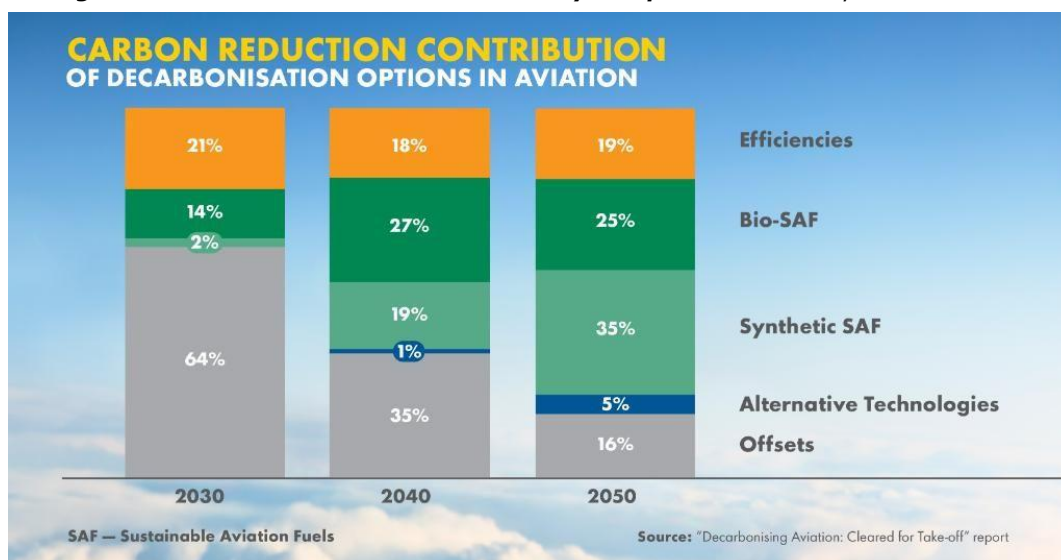
Research by the US Department of Energy (**DOE**) Bioenergy Technologies Office helped to develop the 100% **SAF** (derived and produced from biofuel). While a quiet achiever, the US biofuel industry continues to lead the world.

As ever with many if not most news items relating to progress towards decarbonisation and **NZE**, one does not have to look too far for the involvement of Government, research and funding support for the most part, to understand the critical role that Government has to play.

- **American Airlines and Aemetis aligned:** On December 1, 2021, it was reported widely that American Airlines and Aemetis had agreed a **SAF** supply agreement, with Aemetis to produce **SAF** at its Riverbank **SAF** production facility.
- **British Airways and Phillips 66 aligned:** On December 3, 2021, it was reported widely that British Airways and Phillips 66 had agreed a **SAF** supply agreement, with Phillips 66 to produce **SAF** at its Humber Refinery.

See: [British Airways and Phillips 66 Agree First Ever UK Produced Sustainable Aviation Fuel Supply](#); [British Airways, Phillips 66 Limited sign sustainable aviation fuel supply agreement](#)

- **Shell Aviation ... continued narrative:** **Edition 30** of Low Carbon Pulse contained the **September and October Report on Reports** (included the Appendix to the Second Compendium of Low Carbon Pulse), which reported on **Decarbonising Aviation: Cleared for Take-off – Industry Perspectives** from Royal Dutch Shell.



On December 7, 2021, Shell Aviation posted a short, but interesting piece on the carbon reduction options for the aviation industry, including the role of carbon credits, and their importance through 2030.

- **Aerospace Technology Institute UK flying hy:** On December 6, 2021, it was reported widely that the UK's Aerospace Technology Institute is to undertake a project (the **FlyZero Project**) that will allow the use of hydrogen to power and to propel an aeroplane to any global location with one stop.

The aeroplane is a concept aircraft of 279 passengers (with a range of 5,250 nautical miles), that will use a range of advanced technologies, including storage of liquid hydrogen in the fuselage, rather than in the wings (i.e., a dry winged aircraft), cryogenic hydrogen tanks and fuel systems and fuel cells to provide electrical energy to power the power systems (as opposed to the propulsion systems), and hydrogen gas turbines.

Consistent with the theme of Government involvement, the **FlyZero Project** is backed by the UK Government.

- **Air New Zealand perspective:** On December 8, 2021, the CEO of Air New Zealand, Mr Greg Foran, provided a perspective that is a helpful contrast with that provided by Shell Aviation, effectively that decarbonisation of the carbon footprint is the aim of Air New Zealand, rather than the use of carbon credits as a means to offset **GHG** emissions.
- **Airbus article of assurance:** As noted in previous editions of Low Carbon Pulse, Airbus aims to develop the first zero-emission commercial aircraft by 2035. On December 10, 2021, Airbus published an article [How to store liquid hydrogen for zero-emission flight](#). The article is well-worth a read.

The article outlines the challenges of use of hydrogen as an energy carrier: " ... storing hydrogen on board an aircraft poses several challenges. Hydrogen may provide more energy by mass than kerosene fuel, but it delivers less energy by volume." It is all a matter of energy density.

The liquefaction of hydrogen (at a temperature of minus **253°C**) increases the energy density by volume: in liquified form 4 litres of hydrogen is equivalent to 1 litre of kerosene (in liquid form at normal temperature and pressure). The development of cryogenic storage tanks is fundamental to the development of an aircraft that is able to use hydrogen to power and to propel that aircraft.

Low Carbon Pulse - Edition 33

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading later in the week, welcome to the Friday January 28, 2022 version of **Edition 33 (The Larry Bird Edition)** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Friday December 17, 2021 to Sunday January 23, 2022 (inclusive of each day). This **Edition 33** is a little later than advertised to allow it to report on the **ScotWind Leasing Scheme** outcomes and the end of **EU Green Taxonomy** consultation phase.

Edition 34 will be published on Tuesday February 8, 2022, covering the period from Monday January 24, 2022 to Sunday February 6, 2022, and will include the Report on Reports for November and December 2021.

Please click [here](#) for the landing page of Low Carbon Pulse, which contains links for **Editions 29 to 32**. Please click [here](#) for the **First Low Carbon Pulse Compendium**, which comprises **Editions 1 to 28** of Low Carbon Pulse. Click [here](#) for the **Second Low Carbon Pulse Compendium**.

Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

This is the first edition of Low Carbon Pulse for calendar year 2022.

Reminder of why Editions 32 and 33 are named for 1980s basketball players? From August 13, 2021 to December 13, 2021, the author of Low Carbon Pulse was located in Papua New Guinea (**PNG**). While located in **PNG**, the author rediscovered a passion for basketball (long dormant). With the rediscovery of passion, and, more importantly, muscle memory, the satisfying sound of the swish returned (as the basketball touched "nothing but nylon"), and so the capacity to "switch -off" was rediscovered.

With rediscovery, the author (re)discovered, on "you-tube", the achievements of Earvin "Magic" Johnson and Larry Joe Bird (after whom the Twitter logo is named). No doubt reflective of the decade in which the author played basketball, Magic Johnson and Larry Joe are the author's favourite basketball players. Always have been, always will be!

Both played for one franchise during their careers; Magic played No 32 for the Los Angeles Lakers and Larry Joe played No 33 for the Boston Celtics. Each franchise retired their numbers on their retirements. On the court, they were the fiercest of competitors. Off the court, they were, and remain, the best of friends.

To the author, Messrs Johnson and Bird remain the embodiment of authenticity, manifest in their genuineness, and hard fought success, wrought by application and hard work, two folk who cut no corners, and shared 8 championships during the 1980's. Different times, different values, well-before COP-1.

The year ahead:

This section of Low Carbon Pulse considers events that appear to the author likely to influence progress to **NZE** during 2022.

In each edition of Low Carbon Pulse during 2022, the news items that appear likely to be key over the coming two weeks will be identified: this approach was taken during the middle-months of 2021 until the focus turned to the 26th session of the Conference of Parties (**COP-26**) of the United Nations Framework Convention on Climate Change.

Background:

Among other things, **Edition 32** of Low Carbon Pulse outlined **Themes and trends that emerged during 2021** and provided a **Look forward to the coming 12 months**. In this context, the adoption of decisions relating to Article 6 of the Paris Agreement were touched upon in passing (under **Carbon Credits, Article 6 and the Paris Rulebook**).

Edition 32 noted that a stand-alone article is to be published during the early part of 2022 to provide an outline about Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and land-use generally comes to the fore. This stand-alone article is in the works.

Ahead of the publication of this article, and in any event, the author thought that it would be helpful (see **Timeline for 2022 - February to September**) to provide a summary of the work that still needs to be done by the Intergovernmental Panel on Climate Change (**IPCC**) to produce the first comprehensive assessment report since the report that informed the development and adoption of the Paris Agreement in 2015 (**IPCC's Sixth Assessment Report**). Among other things, the **IPCC's Sixth Assessment Report** will include the synthesised findings from among other things the **Sixth Assessment Report – Climate Change 2021, The Physical Science Basis (2021 Report)**.

As noted below, the **IPCC's Sixth Assessment Report** will be the key publication of 2022, to be published in advance of the 27th session of the Conference of the Parties (**COP-27**). The finalisation of the **IPCC's Sixth Assessment Report**, in particular the **Synthesis Report**, will run in parallel with work arising from **CMA 12a, 12b** and **12c** adopted at the Conference of Parties serving as the meeting of the Parties to the Paris Agreement at its third session (**CMA 3**) in the context of Article 6.

In addition, the **Timeline for 2022** identifies events that appear to the author likely to influence progress to **NZE** during 2022.

Content of this Edition 33:

As the length of each edition of Low Carbon Pulse has increased (likely to continue at around 20 pages each edition), it has become apparent that a contents page might assist the reader.

Pages 2 to 4: Timeline for 2022; Page 4: Key Theme for 2022; Page 4 and 5: Legal and Regulatory Highlights; Pages 6 and 7: A Big Week For Wind; Page 8 and 9: Climate change reported and explained; Pages 9 and 11: GCC Countries; Page 11: Africa; Page 11 and 12: India and Indonesia; Page 12 and 13: PRC and Russia; Page 13: Europe and UK, France and Germany, Germany and South Africa; Page 14: Americas; Page 14 and 15: Australia; Page 15 and 16: Blue and Green Carbon Initiatives and Biodiversity; Page 16 and 17 Bioenergy and Heat Recovery; Page 17 and 18: BESS and HESS (and other energy storage); Page 20 to 22: Carbon Accounting, Carbon Capture, Carbon Capture and Use and CDR; Page 22: Carbon Credit and Hydrogen Markets and Trading; Page 20 to 23: E-fuels and Future Fuels; Pages 27 to 30: Wind round-up, on-shore and off-shore; Pages 30: Solar and Sustainability; Page 28: NZE Waste; Pages 30 and 31: Land Mobility and Transport; Pages 31 and 32: Ports Progress and Shipping Forecast; and Page 32: Airports and Aviation.

Timeline for 2022:

The events identified are not all of the events that may influence or impact progress to **NZE**, but they are events on the radar of the author as likely to do so. Each event will be covered in Low Carbon Pulse.

- **TBA: Fifth United Nations Conference on Least Developed Countries (LDC5)** is to be held: see **Edition 31** of Low Carbon Pulse for background on the 46 countries (Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Yemen, Zambia) that are considered the least developed (**LDCs**).

LDCs are home to around 13% of the global population and 40% of the poorest people globally. It is understood that **LDCs** will include a high-level thematic round-table to discuss the issues faced by **LDCs** and the need of **LDCs** for support.

- **February 28 to March 3: Inaugural Middle East and North Africa Week**, organised under the auspices of the United Nations Framework Convention on Climate Change (**UNFCCC**) will be held. The **Middle East and North Africa Week** is to be hosted by the United Arab Emirates (**UAE**).

The role of the **UAE** is becoming ever more prominent and important – as marked by the successful World Future Energy Summit held from January 17 to 19, 2022. Likewise the Kingdom of Saudi Arabia (**KSA**) and the Sultanate of Oman are taking lead roles.

- **February to September:** The **IPCC** will progress finalisation of its first comprehensive assessment report (**IPCC's Sixth Assessment Report**) since the **IPCC's** Fifth Assessment Report. The Fifth Assessment Report, among other things, informed the development and adoption of the Paris Agreement in 2015.

The **IPCC's Sixth Assessment Report** will comprise contributions from three Working Groups, I, II and III detailed as follows:

- the findings of **Working Group I** (Physical Science Basis) as to the physical impact of climate change in the **2021 Report** (published in August 2021, and reported on in **Edition 24** of Low Carbon Pulse);
- the assessment of **Working Group II** (Impacts, Adaptation and Vulnerability) on the impact of climate change; and
- the assessment of **Working Group III** (Mitigation of Climate Change) on mitigation of the effects of, and progress to limit emissions causing, climate change.

By mid-February, it is expected that the **Summary for Policymakers** contained in the **2021 Report** will be pretty much finalised: the **2021 Report** comprised a **Summary of Policymakers** in draft (feedback was sought on it): see **Edition 24** of Low Carbon Pulse that summarises the key findings. The report of **Working Group II** will be published at the **end of February 2022**, and the report of **Working Group III** will be published in **early April 2022**.

In **September**, the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** is the last of the major reports from the **IPCC's** sixth assessment cycle (with the core writing team meeting January 25 to 29, 2022 to continue the development of the **Synthesis Report**). The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each Working Group, and in three Special Reports (**Global Warming of 1.5°C, Climate**

[Change and Land](#) and [The Ocean and Cryosphere in a Changing Climate](#)). The **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**. Neither part of the **Synthesis Report** will be anywhere near the length of each Working Group Report and each Special Report.

The **Synthesis Report** will be published well-ahead of the 27th session of the Conference of the Parties (**COP-27**) which will take place in Sharm El-Sheikh, South Sinai, Egypt (see below under **November 7 to 18: COP-27**).

By way of reminder, **Edition 32** of Low Carbon Pulse covered the **UNFCCC NDC Synthesis Report**, reporting on the impact on climate of the implementation of **NDCs** to which Parties had committed as at the end of July 2021, and the United Nations Environmental Program (**UNEP**) **Production Gap Report** reported that in setting **NDCs** countries had not taken account of planned increases in fossil fuel production and use.

The **NDC Synthesis Report** informed the UN Secretary General, Mr Antonio Guterres' use of the phrase "the **Catastrophic Pathway**" of a **2.7°C** increase in average global temperature.

The **Production Gap Report** informed a considerable amount of news coverage and debate, a good deal of it well-informed and constructive, no doubt as a result of the excellence of the **Report**.

The **NDC Synthesis** and **Production Gap Reports** contributed considerably to the understanding of the need for increased **NDCs** well-ahead of **COP-27**. The progress to increased **NDCs** will be covered by Low Carbon Pulse.

- **March 7 to 12: The IUCN Africa Protected Areas Congress (APAC)** will be held, being the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on the need to progress action to establish and to preserve protected areas. The **APAC** will take place in Kigali, Rwanda.

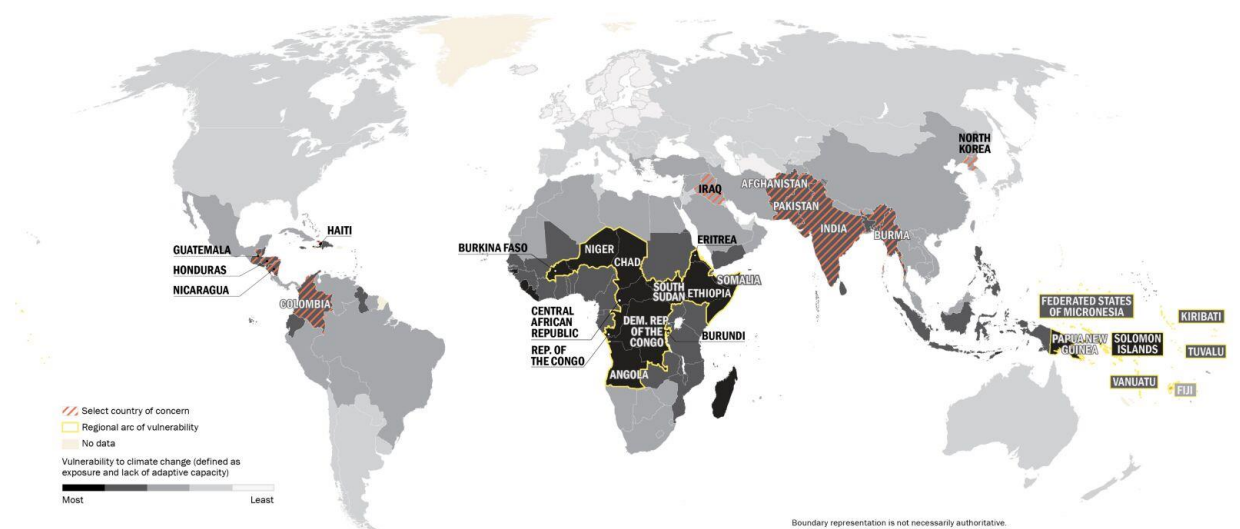
At **APAC** the role for, and the importance of, protected areas will be discussed, in particular the role in conserving nature, delivering services to vital life-supporting ecosystems, safeguarding Africa's wildlife, and promoting sustainable development while conserving the cultural heritage and traditions of each country.

The role of protected areas in the promotion sustainable development illustrates the balance that needs to be struck to allow the 54 countries in Africa (including 33 of the 46 **LDCs** in Africa) to develop economically, allowing for projected population growth and increased urbanisation, while at the same time conserving and restoring the environment.

In addition to Africa having 33 of the 46 **LDCs**, Africa has countries highly vulnerable to the impact of climate change.

Climate Change in Select Highly Vulnerable Countries of Concern

The IC identified 11 countries and two regions of great concern from the threat of climate change. Building resilience in these countries and regions would probably be especially helpful in mitigating future risks to US interests. Two regional arcs also stand out because these groups of countries are clustered together, are relatively poor, and have little capacity to assist their neighbors.



As will be apparent, a number of African countries (Angola, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Niger, Eritrea, Ethiopia, Republic of Congo, Somalia and South Sudan, each an **LDC**) are identified as most likely to be vulnerable to climate change by reference to their ability to adapt to climate change.

- **April 25 to May 8: The UN Biodiversity Conference (or COP 15)** will be continue in Kunming, Peoples Republic of China (**PRC**).

The first part of the **UN Biodiversity Conference** was held in October 2021, setting the scene for the second part through the adoption of the [Kunming Declaration](#) and the establishment of the [Kunming Biodiversity Fund](#).

The second part of the **UN Biodiversity Conference** is expected to progress thinking around policy settings with the adoption of a framework to achieve 21 points / targets and 10 milestones by 2030, together with net-improved outcomes by 2050, and as such reset thinking, and in some cases, provide a framework for thinking on policy settings.

While it is possible that the second part of **COP 15** may be delayed, there is a clear expectation that an agreement will be reached, emphasised by the members of the **Convention on Biological Diversity working group** which has carriage of the drafting and finalisation of the agreement.

- **May 2 to 6:** The **XV World Forestry Congress** will be held in Seoul, Republic of Korea (**ROK**) under the theme of **Building a Green Healthy and Resilient Future with Forests**. The **XV World Forestry Congress** will consider six sub-themes.

For the author of Low Carbon Pulse, the progress made at the **Congress** will be key, both for forestry and land use. Already in the first month of 2022, there has been a clear uptick in interest in the role that land-management and optimal land-use can have on increased absorption of **CO₂**, i.e., its negative **GHG** emission impact.

- **May 9 to 21:** The **15th United Nations Conference on Diversification** will be held in the Côte d'Ivoire. Consistent with **LDC5**, the **UN Biodiversity Conference** and the **XV World Forestry Congress**, the overarching theme that may be expected to emerge will be how to address deforestation, reforestation, afforestation, and land restoration, and land-management and land-use generally.
- **June 2 and 3:** The **Stockholm+50** conference will be held in Sweden. The conference will mark the 50th anniversary of the world's first conference on the environment - **United Nations Conference on the Human Environment** held in Stockholm, Sweden, June 5 to 16, 1972, which gave rise to the establishment of the UN Environment Programme (**UNEP**) and the concept of sustainable development, as captured in the [Stockholm Declaration](#).
- **June 26 to 28:** The **G7 Summit** will take place at Schloss Elmau, Bavaria, Germany, reflecting the Presidency of Germany. It is to be expected that climate change will dominate the agenda.
- **June 26 to 30:** The **World Urban Forum 11** will take place in Katowice, Poland under the theme **Transforming our Cities for a Better Urban Future**.
- **June 27 to July 1:** The **UN Ocean Conference** will take place in Lisbon, Portugal. The **UN Ocean Conference** will be the second time that the United Nations has convened a conference on the impact of climate change (and loss of natural habit and pollution) on the oceans.
The oceans (blue carbon) and flora (green carbon) are increasingly being regarded as the lungs of the planet, both essential to mitigating the impact of climate change on the climate system, and both susceptible to the impact of climate change.
- **August 22 to 24:** The [World Conference on Climate Change & Sustainability](#) will take place in Frankfurt, Germany. The [World Conference on Climate Change & Sustainability](#) is regarded as the foremost global forum for multilateral discussion about climate change.
- **September 13 to 27, 2022:** The **77th session of the UN General Assembly** will take place in New York City, New York State, the United States. As has become the tradition, **Climate Week NYC** will take place at the same time, and will be a pre-**COP-27** meeting.
- **October 30 and 31:** The **17th G20 Summit** will take place in Bali, Indonesia, reflecting the Presidency of the Republic of Indonesia. As with the **G7 Summit** in June 2022 it is expected that climate change will be a key agenda item ahead of **COP-27**.
- **November 7 to 18:** **COP-27** will take place in Sharm El-Sheikh, South Sinai, Egypt, and represents an opportunity to assess and develop thinking to address the impacts of climate change in Africa.
For the purposes of framing thinking about the impacts of climate change in Africa, the World Meteorological Organization (**WMO**) and its partners, have developed the [State of the Climate in Africa 2020](#), which is a helpful starting point for framing and understanding the impacts of climate change.

Key Theme For 2022:

If there was one key theme before, during and after **COP 26**, it was the need to **Increase NDCs during 2022 ahead of COP-27**: At **COP-26** the High Ambition Coalition **COP-26** Leaders' Statement [announced](#) that they were committed to increasing the **NDCs** to align with holding the increase in average global temperatures to **1.5°C (Stretch Goal)** for the purposes of commitments to be made before or at **COP-27**.

In addition, at **COP-26**, all countries agreed to update their **NDCs** ahead of **COP-27**. It is to be expected that countries will update their **NDCs**, and, in the case of many, it is hoped that they will stretch their **NDCs**, including to a level that is aligned to keep the increase in average temperatures at a level that is lower than the **Stretch Goal** and that gets to **NZE** as soon as possible before 2050, not by 2050.

Legal and Regulatory highlights:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.

- **EU policy settings to achieve 55 by 30:** **Edition 32** of Low Carbon Pulse reported that on December 15, 2021, a package of legislation and policy settings was released by the European Commission (**EC**) providing a framework to decarbonise gas markets, to promote hydrogen production and use, and to reduce **CH₄** emissions.

This framework is provided in a regulation and a directive - see links to each: [Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal markets for renewable and natural gases and for hydrogen](#) and [Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules the internal markets in renewable and natural gases and in hydrogen](#).

The reaction to the framework has been mixed, primarily arising from the continued balancing of natural gas as a transition fuel by Governments and achieving energy transition so as to progress to **NZE**, and the perspective of many in the renewable electrical energy sector who use of natural gas as a transition fuel as amounting to the preservation of the natural gas industry.

To the author of Low Carbon Pulse, the position is more nuanced, but the conclusion is that natural gas is needed, and certainty is required to ensure energy security and sustainable energy prices, at the same time as the use of natural gas is phased out. The best way, and quickest way, to phase out natural gas is through the acceleration of the development and deployment of renewable electrical energy capacity and e-fuel production capacity, and the use of bioenergy.

- **EU Green Taxonomy: Edition 32** of Low Carbon Pulse reported on the adoption of the **EU Green Taxonomy** and that its adoption and application may mean. The text is repeated again to provide context.
 - **"EU Green Taxonomy adopted:**

On December 9, 2021, the first climate delegated act (the [EU Taxonomy Climate Delegated Act](#)) was approved by the **EC**, and will become law on January 1, 2022, confirming the adoption of the **Technical Screening Criteria**. Among other things, the **EU Green Taxonomy** provides:

 1. a basis by reference to which corporations may report; and
 2. **CO₂-e** intensity benchmarks for the energy sector (that are neutral as to technology) of 100 g **CO₂-e/kWh** as making a substantial contribution to climate mitigation, and 250 g **CO₂-e/ kWh** giving rise to significant harm.
 - **What this does not mean and what is its practical application?**

The effect of the **EU Taxonomy Climate Delegated Act** is that the **EC** must use the **EU Green Taxonomy** to assess climate change adaptation and climate change mitigation activities, including to do no significant harm across environmental objectives.

Effectively, the **EU Green Taxonomy** does not define what technology must be used (hence it is neutral as to technology), but the technology used for the purposes of prescribed activities will be assessed against the **Taxonomy**, including the benchmarks.

The positions of participants and stakeholders has informed the "debate" around the **CO₂-e** intensity benchmarks for some time, including around the use of natural gas and nuclear energy sources (including as sources for the production of hydrogen and hydrogen-based fuels) in the context of the **EU Green Taxonomy**.

The **EC** has not acknowledged formally that the **EU Green Taxonomy** might include natural gas or nuclear energy sources. The role of natural gas and nuclear is clear, but in the words of Mr Frans Timmermans: " ... *nuclear and transition gas play a role in energy transition ... [but] that does not make them green*". "

(A link is attached to the ec.europa.eu [website](#) that contains relevant materials under **EU taxonomy for sustainable activities**.)"
 - **Badging natural gas and nuclear energy: Edition 32** of Low Carbon Pulse noted that: "**The EC will determine how to badge natural gas and nuclear energy by the end of 2021**".

At the time of publication of **Edition 32** of Low Carbon Pulse, the suggestion that the **EU Green Taxonomy** may include natural gas or nuclear energy, or both, had been the cause of considerable activity, comment and speculation, including around divisions between key **EU** countries, France and German.

On January 1, 2022, the **EC** began consulting with the Member States Expert Group on Sustainable Finance and the Platform on Sustainable Finance in respect of the draft text of a **Taxonomy Complementary Delegated Act** covering natural gas and nuclear activities (see **EC** press release entitled [EU Taxonomy: Commission begins expert consultations on Complementary Delegated Act covering certain nuclear and gas activities](#)).

The **EC** stated on January 1, 2022, that:

"The EU Taxonomy guides and mobilises private investment in activities that are needed to achieve climate neutrality in the next 30 years ... The Taxonomy provides for energy activities that enable Member States to move towards climate neutrality ... Taking account of scientific advice and current technological progress, as well as varying transition across Member States, the Commission considers that there is a role for natural gas and nuclear [power] as a means to facilitate the transition towards a predominantly renewable-based future [the EC Position]. Within the Taxonomy framework, this would mean classifying these energy sources under clear and tight conditions (for example, gas must come from renewable sources or have low emissions by 2035), in particular as they contribute to climate neutrality".

The Member States Expert Group on Sustainable Finance and the Platform on Sustainable Finance are required to be consulted on all Delegated Acts under the Taxonomy Regulation, reflecting the expert role of each under the Taxonomy Regulation.

In the original press release of January 1, 2022, the **EC** contemplated that Member States Expert Group on Sustainable Finance and the Platform on Sustainable Finance Platform on Sustainable Finance would have until January 12, 2022 to provide contributions. January 12, 2022 became Friday January 21, 2022. The **EC** will analyse the contributions received on or before January 21, 2022, ahead of the adoption formally of the Complementary Delegated Act.
 - **How a technical rulebook unleashed a political storm over EU green energy** (updated to January 14, 2022 – 17.24) is the title of an article from [Euronews.com](#). The article provides a very helpful summary of the road travelled (covered in various editions of Low Carbon Pulse) to the current form of the **EU Green Taxonomy**.

The storm of comment directed against the **EC Position** was seeded by a leaked draft (ahead of being shared by the **EC** to the Member States) that contemplates a road for gas installation to December 31, 2030, and nuclear sites to December 31, 2045, subject to complying with "clear and tight conditions" including 270 grams of **CO₂** per kilowatt hour for natural gas installations.

The **EU Green Taxonomy** is important in the **EU** context, and is likely to be important globally, because it is likely to be followed by countries around the world. Unless there is a change in position from the **EC**, as a practical matter, the Taxonomy **Complementary Delegated Act** will progress, and is likely to be in place by the end of January 2022.
 - **Denmark making mark:**
 - **Danish Hydrogen Strategy:** On December 17, 2021 the Danish Government published a paper titled [Power-To-X and Hydrogen Opportunities in Denmark](#).

The Danish Government's plans will be considered in detail in the **November and December Report on Reports** to be included in the Appendix to the Second Compendium of Low Carbon Pulse.

- **Denmark and Virginia collaborate:** On January 11, 2022, [State of Green](#) (a Danish Government website) reported that Denmark had signed an energy cooperation agreement with the US State of Virginia under which Denmark is to share insights and know-how for the purposes of assisting the State of Virginia implementing its off-shore renewable energy plans, including the development of a world scale 2.6 GW off-shore wind field (the **Coastal Virginia Offshore Wind Project**).

Under the Virginia Clean Economy Act, Virginia plans to derive 100% of its energy from clean sources by 2045.

- **Polish Hydrogen Strategy:** On January 7, 2021, [hydrogen-central.com](#) reported that the Council of Ministers approved the Polish Hydrogen Strategy to the year 2030, with an outlook to 2040.

The Polish Hydrogen Strategy will be considered in detail in the **January and February Report on Reports** to be included the Appendix to the Second Compendium to Low Carbon Pulse on the publication of **Edition 37** of Low Carbon Pulse.

A Big Week For Wind:

- **ScotWind Leasing Scheme:**

- **Final Stage of ScotWind Leasing Scheme:** On January 17, 2022, the [Crown Estate Scotland](#) announced the successful tenderers ScotWind Seabed Leasing auction process (**ScotWind Leasing Scheme**).

The **ScotWind Leasing Scheme** process commenced on January 15, 2021 (see **Edition 8** of Low Carbon Pulse), with the deadline date for the submission of applications being July 16, 2021 (see **Editions 20, 21** and **22** of Low Carbon Pulse), having been extended from March 31, 2021.

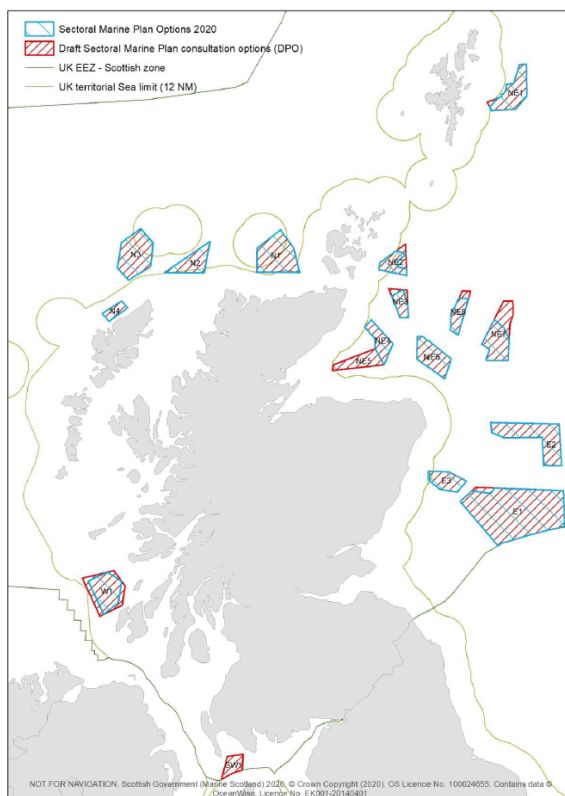
The **ScotWind Leasing Scheme** was the first auction process since the management of off-shore wind rights was devolved to Scotland.

- **Fifteen lease areas:** As noted in **Edition 22** of Low Carbon Pulse, the [Crown Estate Scotland](#) ran the auction process for 15 off-shore areas: Aberdeenshire (three areas - E1, 2 and 3), Argyll (W1), Moray Firth (five areas - NE 2, NE 3, NE 6, NE 5 and NE 7), Islay (N4), Lewis (N4), Orkney (three sites off the west of Orkney, into the outer Hebrides, N1, N2, and N3), and Shetland (NE1).

The 15 off-shore areas the subject of the ScotWind Leading Scheme are detailed in the map below (to the left). The off-shore areas the subject of successful tenderers (see the table on the next page) are detailed in the map below (to the right).

- **Size and shape of the areas:**

Edition 8 of Low Carbon Pulse reported on the **ScotWind Leasing Scheme** process and reported that the total area of the 15 sites is 8,600 km² or 3,320 miles².



Edition 22 of Low Carbon Pulse reported that 74 applications had been made by the July 16, 2021 deadline.

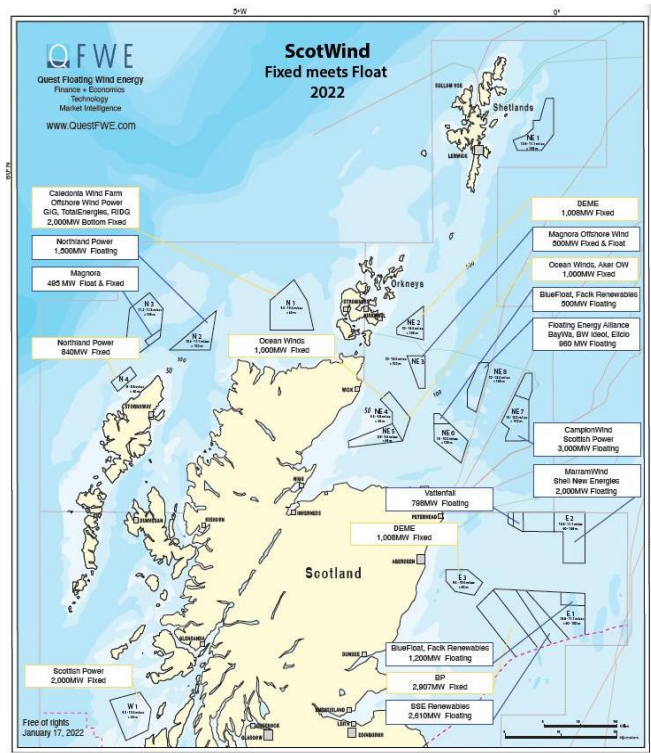
- ScotWind Leasing Scheme successful applicants tabled:**

On January 17, 2022, the [Crown Estate website](#) published a table detailing the successful applicants for off-shore wind leases.

Out of the 74 applications made, seventeen projects have been successful, and those successful projects cover a little over 7,000 km² of the 8,600 km² available for award.

The aggregate amount bid by the successful projects being a little under GBP 700 million. Each of the successful proponents / bidding consortia was covered in **Edition 22** of Low Carbon Pulse (under **Applicants for off-shore wind leases**).

The development of the seventeen projects will have direct and immediate benefits for the Scottish economy, and the broader UK economy. Proponents of each successful project procure goods and services to commence: **(1)** to undertake and to complete on-shore infrastructure (including at ports) and factories to allow the manufacture and fabrication of the footings, towers and turbines to allow the development of the projects; **(2)** to develop on-shore infrastructure to allow the connection to the transmission network in Scotland; and **(3)** to develop on-shore infrastructure to use the renewable electrical energy generated off-shore, including the development of Green Hydrogen production facilities as Scotland develops into a major producer of Green Hydrogen, including for the purposes of the export of Green Hydrogen to continental Europe (see **Editions 31** and **32** of Low Carbon Pulse).



- Successful tenderers:**

MAP REFERENCE	LEAD APPLICANT	OPTION FEES	TECHNOLOGY	TOTAL CAPACITY (MW)
1	BP Alternative Energy Investments	£85,900,000	Fixed	2,907
2	SSE Renewables	£85,900,000	Floating	2,610
3	Falck Renewables	£28,000,000	Floating	1,200
4	Shell New Energies	£86,000,000	Floating	2,000
5	Vattenfall	£20,000,000	Floating	798
6	DEME	£18,700,000	Fixed	1,008
7	DEME	£20,000,000	Floating	1,008
8	Falck Renewables	£25,600,000	Floating	1,000
9	Ocean Winds	£42,900,000	Fixed	1,000
10	Falck Renewables	£13,400,000	Floating	500
11	Scottish Power Renewables	£68,400,000	Floating	3,000
12	BayWa	£33,000,000	Floating	960
13	Offshore Wind Power	£65,700,000	Fixed	2,000
14	Northland Power	£3,900,000	Floating	1,500
15	Magnora	£10,300,000	Mixed	495

16	Northland Power	£16,100,000	Fixed	840
17	Scottish Power Renewables	£75,400,000	Fixed	2,000
Totals		£699,200,000		24,826

• **By the end of February 2022:**

• **Carbon Credits, Article 6 and the Paris Rulebook:**

In contrast to the slower growth in demand for hydrogen and hydrogen-based fuels (in particular Green Hydrogen), the demand for carbon credits appears to be increasing at pace, in particular in the Voluntary Carbon Market / Voluntary Carbon Credit Market.

In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions (and, in the longer term, **NZE** on the basis of carbon neutrality). Previous editions of Low Carbon Pulse have covered the uses of words and phrases in this context, but ultimately, decarbonisation takes time, and needs to be achieved across Scope 1, 2 and 3 emissions. To buy time, while still reducing **GHG** emissions on a net-basis, corporations buy carbon credits.

In the stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and as there appear to be increasingly calls for the regulation of the **Voluntary Carbon Market / Voluntary Carbon Credit Market**.

By way of reminder, **Edition 32** of Low Carbon Pulse noted that a publication entitled, [Why was it so significant that COP-26 completed the Paris Rulebook?](#) Contained a high-level summary of the significance of the **Paris Rulebook** as follows:



Climate change reported and explained:

This section considers news items within the news cycle of this **Edition 33** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.

• **2021 in numbers:**

- On December 27, 2021, **The Economist** provided a reflection of [2021 in numbers](#). The first number is 49.6°C, being the temperature recorded in Lytton, British Columbia, Canada, resulting in a wildfire that burned Lytton to the ground. Similar conditions impacted the Pacific Northwest. These conditions are extreme weather events. As noted in **Edition 26** Low Carbon Pulse, an extreme weather event is "an event that is rare at a particular place and time of year, normally rare means rarer than the 10th or 90th percentile of a probability density".

The Economist reflected that on December 8, 2021, the price of carbon in the **EU** was €88.88 per tonne of **CO₂**, approaching the USD 100 per tonne, with this higher price of carbon in part related to the increased use of fossil-fuels across the **EU** (which increased use resulted in an increase of over 600% in natural gas prices during 2021).

The balance of the new items informing **The Economist 2021 in numbers** were covered in the **Reflections on calendar year 2021** contained in **Edition 32** of Low Carbon Pulse (published in December 17, 2021), i.e., there was alignment between **The Economist** and Low Carbon Pulse!

- On January 7, 2022, **The Guardian** provided a reflection on [2021 in numbers](#) (under [More than 400 weather stations beat heat records in 2021](#)).

The Guardian article, based on excellent source material from Maximiliano Herrera, is well-worth a read for those interested in getting a sense of the range and spread of the impact of climate change across the globe.

- The January 2022 edition of **National Geographic** provides detailed coverage climate change, and a cogent summary:

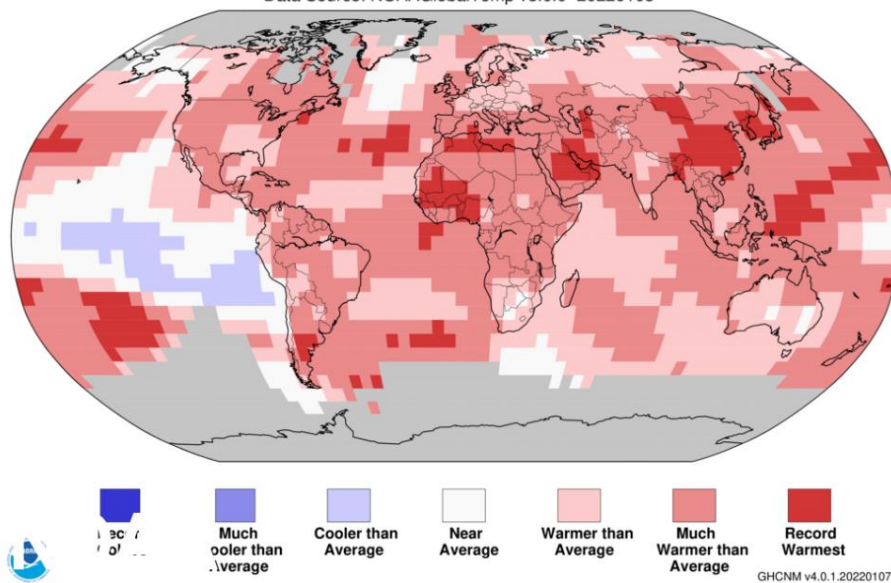
"[2021] was the year of Texas' deep freeze in February, Canada's highest temperatures in recorded history in June, and Germany and Belgium's lethal flash flooding in July".

- On January 10, 2022 **Copernicus Climate Change Services (C3S)** released its [annual findings](#) for 2021. The key findings that grabbed the headlines were that the last seven years have been the warmest on record, and that 2021 was the fifth-warmest on record. At a more granular level, 2021 was a year of extreme temperatures in Europe, heatwaves in the Mediterranean, and unprecedented high temperatures in North America. In addition, the [Copernicus Climate Change Service \(#C3S\)](#) report for December 2021 is well-worth a read and a view. With December 2021 being the sixth-warmest December on record.

Land & Ocean Temperature Percentiles Jan–Dec 2021

NOAA's National Centers for Environmental Information

Data Source: NOAAGlobalTemp v5.0.0–20220108



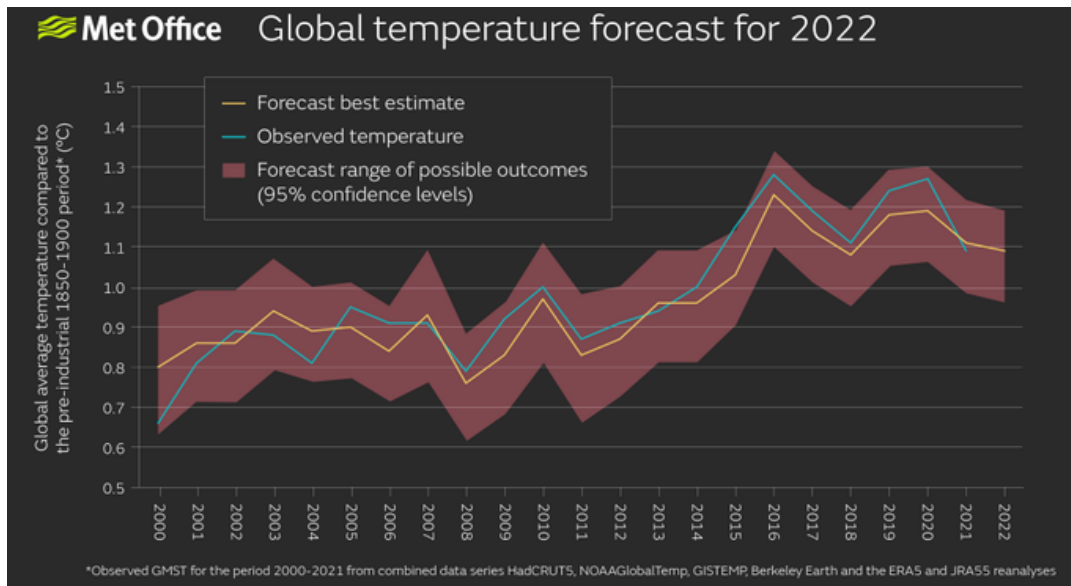
- On January 13, 2022 the **National Oceanic and Atmospheric Administration (NOAA)** published its [analysis](#) (under **2021 was the world's 6th-warmest year on record**).

The **NOAA** notes that **C3S** annual findings rank 2021 as the fifth-warmest year on record, compared to its finding of 2021 as being the sixth-warmest on record.

What both **C3S** and the **NOAA** find is that the last seven years have been the warmest on record. For those wishing to take a deeper dive, there is broad alignment across the findings of **C3S** and the **NOAA**.

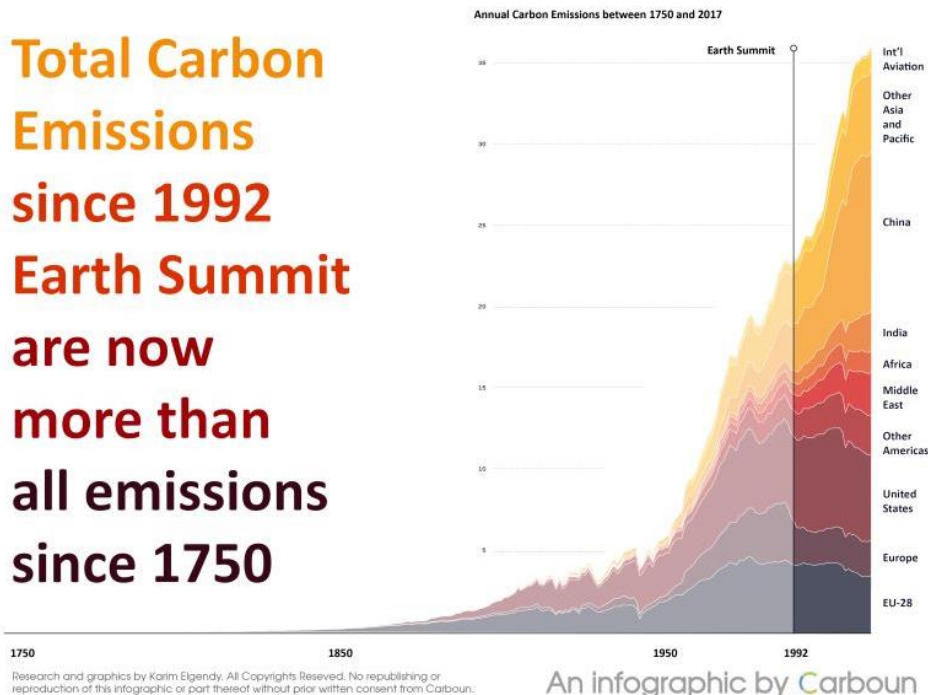
- 2022 in numbers:** On December 29, 2021, the UK Met Office released its [forecast](#) for average global temperatures during 2022:

"The average global temperature for 2022 is forecast to be between 0.97°C and 1.21°C (with a central estimate of 1.09°C) above the average for the pre-industrial period (1850-1990) ... : the eighth year in succession when temperatures have exceeded 1.0°C above pre-industrial levels".



- **1750 to 2021 in graphic:** Mr Karim Elgendy posted a graph on LinkedIn showing that:
"we have caused more damage to the climate since we recognised what we were doing, than we did ... before."

Total Carbon Emissions since 1992 Earth Summit are now more than all emissions since 1750



GCC Countries:

This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.

- **KSA spree:** On December 17, 2021, solarquarter.com, reported that by 2030 the **KSA** plans to spend USD 293 billion on renewable energy projects and related transmission and distribution infrastructure.
- **Hyport Duqm:** On December 26, 2021, the [Oman Daily Observer](https://oman-daily-observer.com) provided an update on the **Hyport Duqm Project** (see [Editions 18, 22, 25](#), and [26](#) of Low Carbon Pulse), in particular the size and shape of the Project shared by Mr Anwar al Battashi (**OQ** Project Lead) and Mr Jean-Baptiste De Cuyper (DEME Concessions Project Lead).

The **Hyport Duqm Project** is to be developed in phases, with the aim for Phase 1 to have 300,000 metric tonnes of Green Ammonia production capacity a year, and on completion to have production capacity of 1 million metric tonnes of Green Ammonia a year.

Hyport Duqm Project is a partnership between **OQ** (the global integrated energy group of the Sultanate of Oman) and DEME Concessions (renewable energy and off-shore marine infrastructure business of DEME Group of Belgium).

- **ACWA powers ahead:** On December 27, 2021, energy-utilities.com reported that a consortium, led by ACWA Power (leading developer, investor and owner operator of power and water assets), had achieved financial close for the USD 1.33 billion Red Sea Utilities project, a public-private partnership (**PPP**) project, under which the Red Sea Tourism Development Company (**TRSDC**) is procuring the development of utilities and related infrastructure.

It is understood that the **PPP** project includes the provision of power generation and potable water production, sewage treatment and solid waste management and treatment. The **TRSDC** is owned by the Public Investment Fund (**PIF**), with **PIF** providing a guarantee in respect of the offtake of utilities entered into between the **TRSDC** and the consortium.

The consortium comprises ACWA Power, Saudi Tabreed District Cooling Company and SPIC Huanghe Hydropower Development Company. It is understood that the project-financing was secured from Al-Rahji Banking and Investment Corporation, Banque Saudi Fransi, Saudi British Bank, Arab Petroleum Investment Corporation, Standard Chartered Bank and Riyadh Bank.

- **Aramco to produce hydrogen vehicles:** On January 7, 2022 (or thereabouts), it was reported that Aramco is considering whether, and, if so, how best, to produce vehicles using hydrogen fuel cell technology. While Aramco has the resources to produce vehicles, it may be that this initiative will result in the development of vehicle production capacity within the **KSA** undertaken by established vehicle manufacturers.

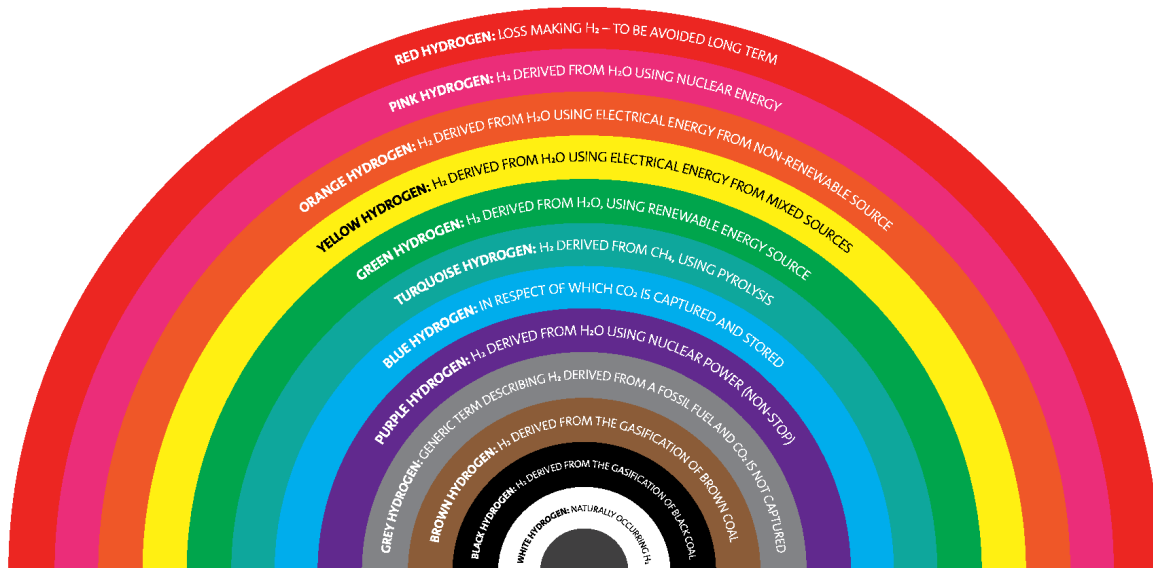
See: Aramco [website](#).

On January 22, 2022, The Siasat Daily (siasat-com.cdm) reported (under **Saudi Arabia to develop hydrogen fuel cell-based transport**) that Saudi Arabia had signed eight memoranda of understanding on January 20, 2022, with a number of corporations to implement pilot projects for hydrogen fuel-cell buses, cars and trains, and transportation applications generally, and sustainable / synthetic aviation fuel (**SAF**) in selected areas of the Kingdom.

The Minister of Energy, Prince Abdulaziz bin Salman said that:

"This step is taken simultaneously with drafting the hydrogen strategy, which arises from the integrated energy strategy that lays out the objectives, road map, and implementation timeline".

- **Aramco sponsors hydrogen vehicle:** Before and during the Paris – Dakar rally, [YouTube](#) was replete with videos of the Aramco sponsored Gaussin Group engineered hydrogen racing truck – Sherazade (Queen of the Desert). To the uninitiated the videos may appear to be sight only, not sound. This is not an error: Sherazade is zero GHG emission and zero noise emission vehicle. Sherazade completed the rally.
- **Aramco, Ministry of Energy and SABIC CO₂ capture and use:** On January 11, 2022, [Saudi Green Initiative](#) posted news that Aramco, the Ministry of Energy for the **KSA** and SABIC (leading chemical corporation) are combining efforts to scale-up carbon capture technology and to use **CO₂** captured to produce chemicals and sustainable / synthetic fuels, with the initial focus being the production of methanol.
- **Emirates Nuclear Energy Corporation (ENEC) targets hydrogen production:** On January 12, 2022, [english.alarabiya.net](#) reported that **ENEC's** Barakah nuclear power plant is considering the extent of its potential to create one million metric tonnes of hydrogen per year. See **Ashurst Hydrogen Rainbow** below for explanation of the colours of hydrogen.



Ashurst Hydrogen Rainbow ©Ashurst 2021

[Note: Some authors / commentators use Purple Hydrogen to refer to the production of hydrogen using coal or petcoke gasification using CCS to capture the CO₂ arising]

- **UAE and ROK extend energy partnership:** On January 17, 2022, [The Korea Herald](#) reported that **ROK** President, Mr Moon Jae, in a three day visit to **GCC Countries**, had said that: "Korea and the UAE will expand energy corporation into the hydrogen sector, a core energy source in the age of carbon neutrality".
The importance of the energy partnership is emphasised by the fact the President Moon was accompanied by the Minister of Trade, Industry and Energy, Mr Moon Sung-wook, and the CEOs of each of KNOC, the Korea International Trade Association, Hyundai Motor Group, GS Energy, SK Gas and Doosan Fuel Cell.
- **Oman and BP committed to multiple GWs:** On January 17, 2022, [pv-magazine](#) reported (under **Oman partners with bp on multi-gigawatt renewables, green hydrogen development**) that the Oman Ministry of Energy and Minerals had signed an agreement with BP (leading international energy corporation) to progress with the development of a combined renewable electrical energy and Green Hydrogen production project by 2030. In the near term, BP will assess the solar and wind resources in a 8,000 km² area of land that would be used to locate photovoltaic solar and wind generation capacity to provide renewable electrical energy for the production of Green Hydrogen.
- **Masdar continues to lead the way:** On January 18, 2022, [energy-utilities.com](#) reported (under **Masdar targets 200GW of clean energy capacity**) that Masdar (Abu Dhabi Future Energy Company) is targeting the development and deployment of 200 GW of clean energy capacity.
While there is no stated timeline for reaching this target, in the medium term Masdar intends to have 50 GW of installed capacity by 2030. The renewable energy business of Masdar will certainly have the right shareholder base to achieve the longer term target, with Taqa holding 43%, Mubadala 33% and ADNOC 24% of the equity in Masdar.
- **Masdar, Siemens and TotalEnergies to develop a SAF plant:** On January 19, 2022, [h2-view.com](#) reported that Masdar, Siemens and TotalEnergies intend to develop a demonstration sustainable / synthetic aviation fuel (**SAF**) production plant in Masdar City, Abu Dhabi, with front-end engineering and design to commence during 2022.
The **SAF** production plant would provide an off-taker for Green Hydrogen as a feedstock for the production of **SAF**.
- **Masdar and Engie and Fertigllobe align to develop Green Hydrogen production facility:** On January 19, 2022 (or thereabouts), Masdar and Engie announced that they had signed a collaboration agreement with Fertigllobe (a joint venture between ADNOC and OCI NV, the world's largest seaborne exporter of urea and merchant ammonia) to assess together whether and if so how to develop together a Green Hydrogen production facility in the **UAE** developing an electrolyser with capacity of up to 200 MW.

See: [Masdar](#) and [Engie](#) announcements

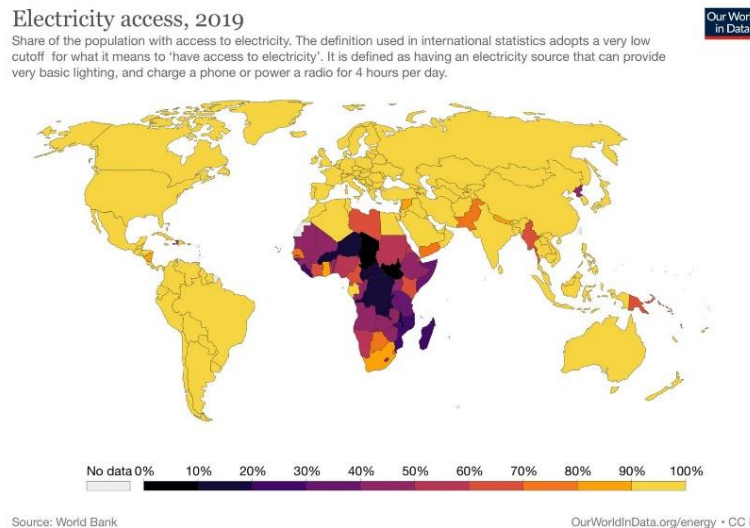
Mangrove restoration progressing in UAE: On January 20, 2022, an [engie](#) press release (under **Mangrove Rehabilitation Project – Environment Agency Abu Dhabi and Engie complete Phase II of the Mangrove Rehabilitation Project**) announced the success of the second phase of the Blue Carbon Environmental and Social Responsibility project (**Mangrove Seeding Project**).

The **Mangrove Seeding Project** involved the use of drone planting technology to plant more than 35,000 mangrove seeds in the Mirfa lagoon, Abu Dhabi. **Edition 31** of Low Carbon Pulse outlined the **CO₂** absorption capacity of mangroves.

Africa:

This section considers news items within the news cycle of this **Edition 33** of Low Carbon Pulse relating to Africa. Africa remains the continent with most developing countries, the most **LDCs** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.

- **Electrification globally:** On December 27, 2021, Mr Alessandro Blasi, Special Advisor to the **IEA** Executive Director (Dr Fitoh Birol) posted an Our World in Data graphic, providing a summary of the percentage of electrification globally by country. The graphic is included below:



The graphic is telling, the retelling of a journey into the heart of darkness (after Joseph Conrad).

India and Indonesia:

This section considers news items within the news cycle of this **Edition 33** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.

- **Long arms, with giant handshake:** On December 18, 2021, thismoney.co.uk, reported that Octopus Energy (leading UK energy supplier) had contracted with Sterlite Power (leading Indian infrastructure giant) under which Octopus Energy will supply green power to millions of homes in India.
- **Bloom Energy and NTPC Limited make progress:** On December 20, 2021, businesswire.com, reported that Bloom Energy (leading electrolysis technology corporation) had been selected by NTPC Limited (the largest energy corporation in India) to provide solid-oxide electrolyzers and hydrogen fuel cells for the first hydrogen energy storage system (**HESS**) project
- **Deep pockets needed:** On December 21, 2021, energyvoice.com, reported that the Government of Indonesia estimates that a total of USD 1,043 billion (or USD 1.043 trillion) is needed to develop 707.7 GW of renewable electrical energy to achieve **NZE** by 2060.

The Secretary of the Directorate General of New, Renewable Energy and Energy Conservation, Mr Sahid Junaidi stated in November 2021 that Indonesia has clean energy potential of 3,685 GW, with 3,285 GW of solar, 95 GW of hydropower, 57 GW of bioenergy, 155 GW of wind, 24 of geothermal, and 60 MW of marine.

As such, the issue for Indonesia is not sufficient renewable resources, it is sufficient funding.

- **India Hydrogen Alliance – December 2021:** Attached is the link to the [December](#) edition of [India H2 Monitor – December 2021](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the context of the **India H2 Monitor**.
- **BPCL outlines USD 3.36 billion plan:** On January 7, 2022, it was reported widely that Bharat Petroleum Corporation Ltd (**BPCL**) plans to invest in a diversified renewable energy and green portfolio, including photovoltaic solar, wind, biomass and hydroelectric.

The plan is to develop 1 GW of renewable and green electrical energy capacity by 2025, and 10 GW by 2040, at the latest. As reported, it is expected that the 1 GW of renewable electrical and green energy capacity by 2025 will comprise 800 MW of photovoltaic solar and 100 MW of wind, with the balance being provided by smaller scale biomass and hydroelectric projects.

- **India On track for NZE by 2070:** On January 9, 2022, Dr Fatih Birol (Executive Director of the **IEA**) continued his positive outlook for the decarbonisation of the Indian economy (see **Edition 23** of Low Carbon Pulse for earlier positive outlook). Dr Birol wrote: "As a developing economy with over 1.3 billion people, India's energy and climate goals are not just transformational for India but for the whole planet".

Dr Birol directs us to an "op-ed" in [The Times of India](#) authored by the CEO of NITI Aayog (Government of India Agency, that serves as the apex public policy think tank) Mr Amitabh Kant and Dr Birol outlining the policy goals and settings for India.

- **India aligned with IEA and IRENA:** On January 18, 2022, [h2-view.com](https://www.h2-view.com) reported (under **India Boosts commitment with IRENA agreement**) that the Indian Ministry of New and Renewable Energy is combining with the International Renewable Energy Agency (**IRENA**) to accelerate progress in scaling up the renewable energy and clean energy development and deployment to allow the development of Green Hydrogen production capacity. It is reported that the agreement was signed on January 16, 2022, and it is considered that the progress hoped for will contribute to the achievement of the [National Green Hydrogen Mission](#).

Japan and Republic of Korea (ROK):

This section considers news items within the news cycle of this **Edition 33** Low Carbon Pulse relating to Japan and **ROK**, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.

- **ROK allocates 2.2 GW in PV tender:** On January 5, 2022, [pv-magazine.com](https://www.pv-magazine.com), reported that the **ROK Energy Agency** announced the results of the second photovoltaic tender of 2021. The **Energy Agency** announced that it had allocated the entire 2.203 GW of photovoltaic solar capacity the subject of the tender, with the average price of the allocated capacity being a little below USD 0.12 per kWh, with all allocated capacity awarded a 20 year contract to supply renewable electrical energy. It is understood that capacity was allocated in respect of 5,393 projects in total. The average price is a little higher than for the previous tender to allocate 2.050 GW of photovoltaic capacity. **ROK** will tender for a further 4.2 GW of photovoltaic solar capacity during 2022.
- **Japan and Australia partner for export:** On January 7, 2022, it was reported widely that Japan and Australia had signed a partnership under which AUS \$150 million will be made available to support trade in clean hydrogen, with funding support to develop clean hydrogen and clean hydrogen derived fuels, including ammonia.
- **ROK and LH2 shipbuilding:** As noted in previous editions of Low Carbon Pulse (see **Editions 2, 6, 10, 17, 32** and this **Edition 33**) Kawasaki Heavy Industries is progressing the development of LH2 carriers. On January 12, 2022, Hyundai Heavy Industries subsidiary, Korea Shipbuilding & Offshore Engineering Co. Ltd (**KSOE**) announced that it expects to have developed technology to allow the scalable carriage of liquid hydrogen by 2025. To date, **KSOE** reports that it has developed containment tanks able to transport 20,000 m³ of liquid hydrogen per tank.

PRC and Russia:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the **PRC** and Russia, being countries that give rise to the most and the fourth most **GHG** emissions.

- **Wenzhou Taihan Floating Photovoltaic Solar connects to East China Grid:** On December 20, 2021, [offshore-energy.biz](https://www.offshore-energy.biz) reported that the 550 MW Wenzhou Taihan Floating Photovoltaic Solar (**WTFPS**) project had connected to the East China Grid to provide renewable electrical energy to the Southern Zhejiang Industrial Cluster. The **WTFPS** project comprises nearly 1.5 million photovoltaic panels covering 4.7 km².
- **Dezhou Dingzhuang Floating Photovoltaic enters operation:** On January 5, 2022, [rechargenews.com](https://www.rechargenews.com) reported that Huaneng had linked the 100 MW of reservoir-based floating photovoltaic solar to 8 MWh of **BESS**, and to the wind capacity in the Dezhou Dingzhuang Integrated Wind and Solar Energy Storage project in Shandong province. It is reported that the installed capacity of the Dezhou Dingzhuang Integrated Wind and Solar Energy Storage project is 320 MW.
- **World's largest pumped storage facility goes live:** On January 4, 2022, [cleantechnica.com](https://www.cleantechnica.com) reported (under **Largest Pumped-Hydro Facility in World Turns on in China**) that State Grid Corporation (the largest grid operator globally, and long-standing proponent of use of pumped storage for grid integrity and stability) had commissioned its 3.6 GW Fengning pumped storage facility in Hebei province. At the moment, the **PRC** has 30 GW of installed pumped storage capacity, with that plan to have 65 GW installed by 2025 and 120 GW by 2030. One of the clear advantages for the **PRC** is that State Grid Corporation (as state-owned corporation) has committed (consistent with being a long-standing proponent) to develop pumped storage capacity in tandem with the development and deployment of intermittent renewable electrical energy capacity across the **PRC**. The use of pumped storage has been part of plans of State Grid for at least the last 15 years, with pumped storage long being viewed as the most effective means of storage of electrical energy.
- **PRC to invest up to USD 75 trillion:** On January 11, 2022, [asiatimes.com](https://www.asiatimes.com) published an article entitled **Study forecasts China investment of \$75 trillion in carbon neutrality**. While Low Carbon Pulse does not tend to include new items that report on the level of investment required to achieve **NZE**, this article, and the study to which it relates (from the **Research Group of the Green Finance Committee of China Society For Finance and Banking**) is noteworthy. The 200 page study was prepared under the direction of Ma Jun, President of the Beijing Institute for Finance and Sustainability, coming under the auspices of the Beijing Municipal Bureau of Financial Work.
- **PRC installed 53 GW of photovoltaic solar in 2021:** On January 22, 2022, [pv-magazine.com](https://www.pv-magazine.com) (daily.newsletter@pv-magazine.com) reported that the National Energy Administration (**NEA**) reported that newly installed photovoltaic capacity in the **PRC** market reached 53 GW in 2021. Of this capacity, around 29 GW is from distributed generation projects.
- **PRC to reach 500 GW of module capacity by the end of 2022:** On January 20 and 21, 2022, it was reported widely that Asia Europe Clean Energy (Solar) Advisory (**AECEA**) estimates that by the end of 2022 the **PRC** will have developed 500 GW of module production capacity.

Europe and UK:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to countries within the European Union (**EU**) and the **EU** itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards **NZE**. In combination, countries comprising the **EU** give rise to the most **GHG** emissions after the Peoples Republic of China (**PRC**) and the US. The UK is a top-twenty **GHG** emitter, but has been a front-runner in progress towards **NZE**.

- **UK CCS and CCUS business model update:** On December 21, 2022, the UK Government, Department for Business, Energy & Industrial Strategy published updates on the proposed commercial frameworks for transport and storage, power and industrial carbon capture business models – [Transport and storage business model: January 2022 update](#) and [Transport and Storage – heads of terms: January 2022 update](#).
- **Rewilding land in the UK:** On January 6, 2022, [The Guardian](#), reported that farmers in the UK will be encouraged to rewild land. To effect rewilding, the UK Government is inviting bids for between 10 and 15 pilot projects covering at least 500 hectares and up to 5,000 hectares. The awards are expected in respect of pilot projects by summer 2022. The Guardian reports that by 2028 it is expected that the UK Government will provide between GBP 700 and 800 million a year for re-wilding. In the long term, by 2040 the UK Government aims to rewild around 300,000 hectares – stated another way, an area the size of the author's home county of Lancashire, England.
- **Expansion of European Hydrogen Backbone (EHB):** Editions [14](#), [20](#) and [Report on Reports](#) of Low Carbon Pulse have covered the development of the **EHB**. On January 18, 2022, it was announced that the **EHB** had welcomed six new members from Bulgaria, Croatia, Latvia, Lithuania, Norway and Portugal. The **EHB** comprises gas infrastructure corporations working together to develop a pan-European dedicated hydrogen infrastructure system, now covering 27 European countries.



- **UK Government backs Britishvolt Blyth build:** On January 21, 2022, the UK Government [announced](#) (under **Government backs Britishvolt plans for Blyth Gigafactory to build electric vehicle batteries**) that it has given an "in principle offer" to Britishvolt to provide funding support through the Automotive Transformation Fund for the purposes of the development of a giga-factory in Blyth, Northumberland.
- **UK Government receives applications for funding to develop Track 1 Clusters:** On January 21, 2022, a number of corporations announced that they had made applications to the UK Government Department of Business, Energy and Industrial Strategy (**BEIS**). **Edition 34** of Low Carbon Pulse will include details of applications made.

France and Germany:

This section considers news items within the news cycle of this **Edition 33** of Low Carbon Pulse relating to France and Germany.

- **Increased funding support:** During December 2021, the cabinet of the Federal German Government, led by Chancellor Mr Olaf Scholz, decided to increase funding support by €60 billion for the existing Energy and Climate Fund (**EKF**).
- **H2Global approved:** On December 20, 2021 it was reported widely that the **EC** had approved a €900 million Federal German Government scheme providing funding support for the development of Green Hydrogen production capacity outside the **EU (H2Global)**.

Under **H2Global**, funding support will be provided through competitive tenders, with successful tenderers required to provide, sell and buy side prices in a double auction model under which the lowest price for hydrogen supply and the highest price for hydrogen purchase will be successful, minimising the amount of funding support required.

Germany and South Africa:

Edition 32 of Low Carbon Pulse covered the GH2 Mex report [**Green Hydrogen in Mexico: towards a decarbonization of the economy** (Volumes [I](#), [II](#), [III](#) and [IV](#))], continuing the ever increasing number of countries with which Germany is developing collaborative relationships to allow the development of Green Hydrogen production capacity (see [Editions 2](#), [4](#), [12](#), and [13](#) of Low Carbon Pulse).

On January 18, 2022, [h2-view.com](#) reported that (under **South Africa, Germany to collaborate on developing a hydrogen economy**) that the German Government, through the German Development Agency (Deutsche Gesellschaft für Internationale Zusammenarbeit or GIZ), will provide financial support to support the development of a Green Hydrogen eco-system in South Africa.

Americas:

This section of considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.

- **Mandated photovoltaic solar and batteries:** On December 17, 2021, it was reported widely that the US State of California updated its Build Energy Efficiency Standards (see the [2022 Build Energy Efficiency Standards](#)) to require photovoltaic solar and battery electric storage systems to be incorporated into future commercial buildings and structures.
- **100% by 2050:** On December 20, 2021, [popsci.com](#) (popular science) reported on a paper published in Renewable Energy (**Zero air pollution and zero carbon from all energy at low cost and without blackouts in variable weather throughout the US with 100% wind-water-solar and storage**) that supported the scenario that the US could run reliably on clean energy by 2050. The report and the paper are well-worth a read providing a clear line of sight to achieving 100% renewable electrical energy across the US on a number of bases.
- **Office of Clean Energy Demonstrations announced:** On December 22, 2021, the US Department of Energy (**DOE**) announced the establishment of the Office Of Clean Energy Demonstration to oversee funding support of around USD\$ 21.5 billion for clean energy projects, with a fair proportion of this funding support earmarked for the development and deployment of clean hydrogen projects – see **Edition 31** of Low Carbon Pulse.
The funding support is part of [Infrastructure Investment and Jobs Act \(IIAJA\)](#) covered in **Edition 31** of Low Carbon Pulse, with around USD 9 billion of the USD\$ 21.5 billion earmarked to support the development of Green Hydrogen (shading to renewable hydrogen) capacity.
- **Canada 2022: Energy Policy Review:** On January 13, 2022, the **IEA** published [Canada 2022: Energy Policy Review](#). The **Review** will be considered in detail in the **January and February Report on Reports** to be included in the Appendix to the Second Compendium of Low Carbon Pulse with publication of **Edition 37** of Low Carbon Pulse.

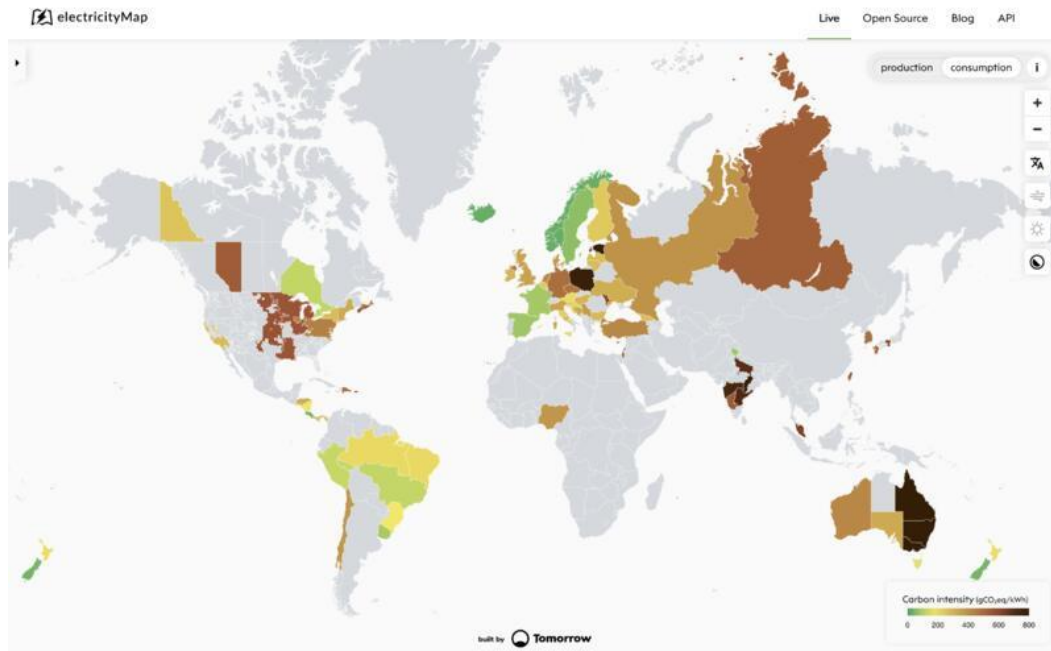
Australia:

This section of considers news items that have arisen within the news cycle of this **Edition 33** Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita. And yet Australia is making progress to achieving **NZE** at a faster rate than many other developed countries, and, along with the **GCC Countries**, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.

- **Five Release Areas for CCS:** In December 2021 the Department of Industry, Science, Energy and Resources (**DISER**) announced the release of [five areas for exploration](#) for use for off-shore **GHG** storage.
The five areas are off-shore in the Northern Territory (two release areas in the Bonaparte Basin) and the State of Western Australia (one release area in the Browse Basin, and two release areas with the Northern Carnarvon Basin). Bids can be submitted between March 4, 2022 and March 10, 2022.
- **CSIRO GenCost Consultation:** On December 17, 2021, the Commonwealth Scientific and Industrial Research Organisation (**CSIRO**), [published](#) for consultation its annual assessment of GenCost.
The headline from the [consultation draft](#) is that photovoltaic solar and on-shore wind are the lowest cost sources of new electrical energy generation, well below the cost of fossil fuels and a fraction of the cost of the generation of electrical energy from nuclear sources. This is not new news, but it confirmatory of other studies in Australia and globally.
- **South Australia ends 2021 in record territory:** Throughout 2021 Low Carbon Pulse reported on various renewable electrical energy dispatch records set in South Australia (see **Editions 6, 9, 12** and **28** of Low Carbon Pulse).
On January 12, 2022, [reneweconomy.com.au](#), reported that for a period of 6.5 days ending on December 29, 2021, the renewable electrical energy dispatched within South Australia mismatched load for 156 consecutive hours.
- **South Australia and New South Wales to develop interconnector:** On January 14, 2022, [pv-magazine-australia](#) reported that the construction of the electricity interconnector between the States of South Australia and New South Wales (**EnergyConnect**) will commence early in 2022.
The development of the electricity interconnector will allow each State to progress more readily and speedily to the decarbonisation of electrical energy production. Further, **EnergyConnect** is considered likely to unlock / to accelerate more than AUS\$ 20 billion of renewable electrical energy investment across the two States.
- **Kawasaki Heavy to transport light:** **Edition 32** of Low Carbon Pulse reported that it was likely that the MV "Suiso Frontier" (see **Editions 2, 8, 10** and **17** of Low Carbon Pulse) built by Kawasaki Heavy Industries Limited (**KHI**), and owned by HySTRA, would travel to Australia during December 2021 to load, to transport and to deliver to Kobe, the first cargo of liquid hydrogen (**LH₂**) as the Hydrogen Energy Supply Chain (**HESC**) project progresses (see **Editions 10** and **12** of Low Carbon Pulse).
The development of **LH₂** carriers is key to the development of the hydrogen export industry. As many commentators have noted, the unit cost of transportation of **LH₂** in **LH₂** carriers as currently configured and sized needs to fall, with the development of **LH₂** carriers with containment systems (tanks) able to transport a mass of **LH₂** that has a heating value comparable with that of a **LNG** carrier. As reported in Low Carbon Pulse previously, **KHI** is making progress in this regard, including developing a 40,000 m³ tank, and contemplating the development of **LH₂** carriers with four such tanks.
On December 24, 2021, the **Suiso Frontier** left Japan, docking at the Port of Hastings, Victoria, Australia, on January 20, 2022. The arrival of the **Suiso Frontier** was marked by an arrival ceremony. The arrival of the **Suiso Frontier** marks the final piece in the jigsaw puzzle called the **HESC**. The concept of the **HESC** was developed in 2015 (long before hydrogen plans, road maps and strategies became common), and involved forward thinking folk committing to the development of the **HESC**, including forward-thinking by the Federal Government of Australia, in particular the funding support that it provided.

- **No time for complacency in the Lucky Country:**

On January 20, 2022, the author of Low Carbon Pulse came across a map showing CO₂ emissions arising from electric energy consumption.



Blue and Green Carbon Initiatives and Biodiversity:

This section considers news items that have arisen within the news cycle of this **Edition 33** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.

For the purpose of this **Edition 33** of Low Carbon Pulse, the author decided to focus on the issue forestry and land management and land-use, in particular whether to allow re-growth to be natural or planned (including for commercial purposes). While there are many variables, it is clear that there is common ground that allowing natural re-growth will favour the maintenance or the re-generation of biodiversity.

For these purposes, areas of at least 50,000 hectares are to be favoured for reforestation. This may be regarded as the gold standard for forests, both existing and natural re-growth.

The capacity of forests to absorb **CO₂** and to manage the release of **CH₄** as biomass decomposes can be assisted greatly by effective husbandry. For the author whether natural re-growth or planned, or both, the only benchmarks that really matter are **CO₂** absorption and accompanying biodiversity.

- **More CO₂, more photosynthesis:** On December 21, 2021, cleantechnica.com reported on a [new study](#) on the impact of increased levels of **CO₂** in the climate system on the rate of photosynthesis. There has been debate for a while around whether or not increased levels of **CO₂** affect the rate of photosynthesis of **CO₂** by flora. Research undertaken by the Lawrence Berkeley National Laboratory and UC Berkeley found that flora is photosynthesising in 2020 (with 420 ppm of **CO₂**) at a rate that is 12% greater than was the case in 1982 (with 360 ppm of **CO₂**).

The lead author of the study, Mr Trevor Kennan noted that the study shows that there has been "a very large increase in photosynthesis, but it is nowhere close to removing the amount of carbon dioxide we're putting into the atmosphere. It's not stopping climate change by any means, but it is helping us slow it down".

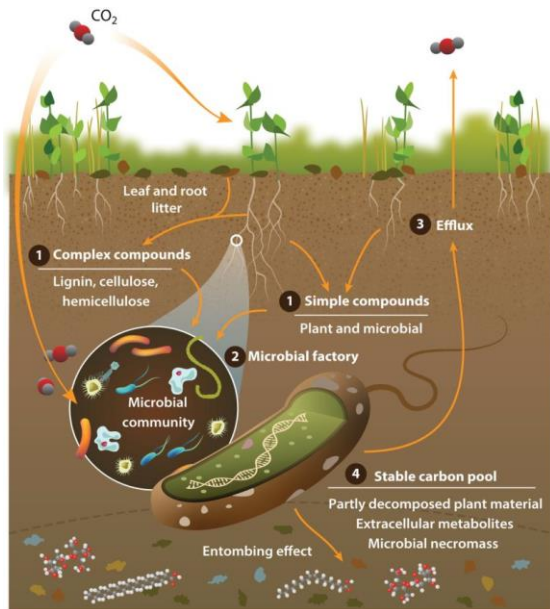
The study does not allow us to conclude that there is or is not a point at which flora will cease to increase the rate of photosynthesis, but the study does underline the importance of ceasing deforestation, and accelerating reforestation and the increased use of afforestation.

- **Tropical Rainforests in view (not gone with the wind):** On December 29, 2021, in mongabay.com Mr Rhett A Butler published a great article, *The year in rainforests 2021*. The article provides a helpful overview of 2021, focussing on the persistence of tropical rain forest deforestation. Also the article provides a look forward to the [year ahead](#), and provides previous years-in-reviews [2020 to 2009](#). All up, the article and the links are helpful and informative resources.

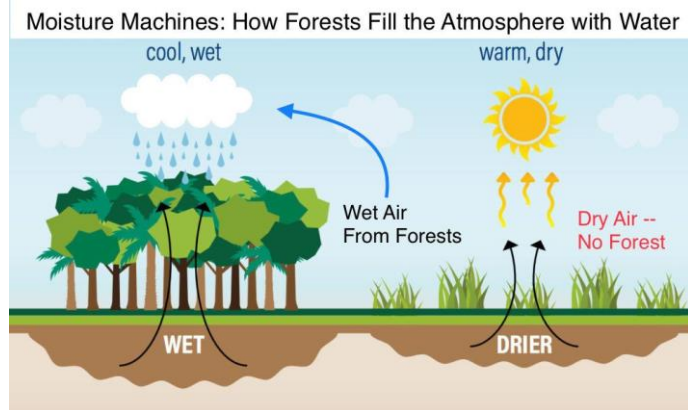
- **Soil microorganisms and carbon capture:** **Edition 32** of Low Carbon Pulse included two diagrams providing a diagrammatic representation of the [function of soil](#) and [the role of healthy soils](#) in the context of Sustainable Development Goals.

These diagrams put the author in mind of the diagram to the left (below) outlining in simple terms the role of microorganisms on carbon capture in the soil ecosystem. The diagram is taken from the [following study](#). In the context of the next piece, this diagram underlines the importance of understanding the role of ecosystems in the context of reforestation and afforestation, in the context of natural and planned re-growth.

The diagram to the right (below) provides a diagrammatic representation of the role of forests as "moisture machines" (**Moisture Machines: How Forests Fill the Atmosphere with Water**). The message conveyed by this diagram ties even closer to the next piece: forests recycle 200 km³ of water a day (through the evaporation of water vapour transpired). In contrast, human activities globally use 10 km³ of water a day.



Naylor D, et al. 2020. *Annu. Rev. Environ. Resour.* 45:29–59



Source: [Michael Stanley Gallisdorfer LinkedIn](#)

Green Carbon – the "wood-wide web":

A Trillion Trees to three trillion trees: During down time over the holiday season, the author read ***A Trillion Trees*** by Mr Fred Pearce. The book provides a helpful reminder of the importance of trees, and because of this the author has shared some of the most cogent facts and stats:

- Among the many memorable passages in ***A Trillion Trees*** Mr Pearce writes: "*Before the existence of forests, the atmosphere of the Earth was baking hot, bone dry, short of oxygen and thick with carbon dioxide. Today, three million trees keep us cool and watered, by soaking up the carbon dioxide and by sweating moisture to sustain "flying rivers" that deliver rain across the world. Their breath alters atmospheric chemistry too, making clouds and even generating the winds. Trees, in short, created and sustain the life-supporting climate of our planet.*"
- "**Trees don't just dominate our living world, they made it**": "*Half the biomass in trees is made up of carbon ... there are still around three trillion trees. They contain as much carbon as mankind has deposited into the atmosphere since the start of the Industrial Revolution ... A tree's relationship to carbon changes through its life-cycle. Growing trees absorb carbon. Dying trees release it, as their biomass rots.*"
- "... stomata – the microscopic pores on leaves that take in carbon dioxide from the air and release oxygen and water ... a chemical process that uses energy from the sun to combine carbon dioxide from the air with water drawn up from the [roots of trees]. This creates glucose from which plant cells form ... the stomata take in the carbon dioxide and then release the main waste products from photosynthesis: oxygen and excess water [in the form of water vapour]".

The release of excess water to the atmosphere (transpiration) moistens the atmosphere ...

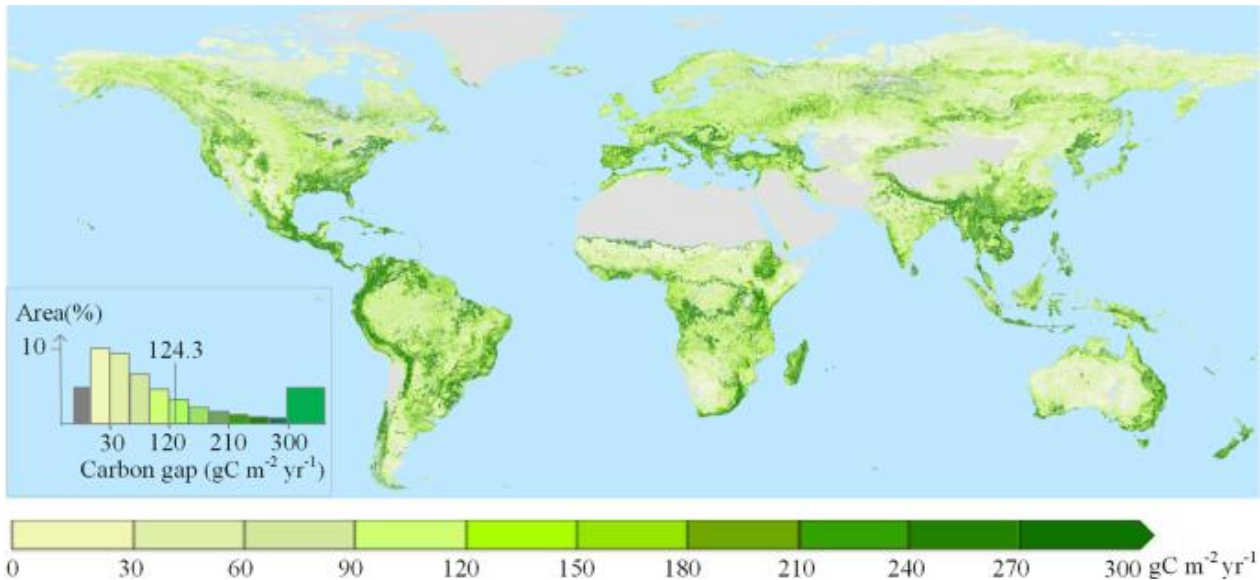
The planet's three trillion trees release an estimated 60,000 cubic kilometres of water a year [Note: This is at the lower end of estimates with others as high as 73,000 km³]. Forming clouds as moisture blows downwind, this moisture is responsible for at least half of all the rain and snow that falls on land. In continental interiors that figure raises to more than 90%. This recycling of moisture makes a world fit for more trees.

- In addition to keeping the air moist, water recycling keeps the air cool.
- Transpiration requires energy. A single tree in a tropical forest can transpire a hundred litres of water a day – equivalent to two-household air-conditioning units. "On the giant forested island of Sumatra in Indonesia, the air around the forests can be up to ten degrees cooler than in the neighbouring palm oil plantations".
- Global greening is not clearly not enough to stop global warming. It may turn out to be temporary if, as many researchers believe, the end result of all the extra carbon dioxide is that trees "grow fast by dying young".

Optimising land-use can increase absorption capacity: On January 18, 2022, [nature.com](#) published a [paper](#) entitled ***The global carbon sink potential of terrestrial vegetation can be increased substantially by optimal land management.***

The paper is powerful:

"Vegetation carbon sequestration varies under different land management practices ... [the proposed] integrated method ... of optimal land management .. finds that global land vegetation can sequester an extra 13.74 PgC per year [13.74 giga-tonnes of CO₂-e] if location-specific optimal land management practices are taken ...".



- **More about mangroves:** On January 4, 2022, the WWF at www.worldwildlife.org published a feature entitled **Mangroves as a Solution to the Climate Crisis**. For the regular reader of Low Carbon Pulse, there will be nothing new in the feature, but it is well-worth a read because it picks-up on all of the policy setting benefits of restoration of mangroves as a "nature based solution".
- **CO₂ and mosses:** On January 5, 2022, an article was published by physorg entitled **Rising atmospheric CO₂ concentrations globally affect photosynthesis of peat-forming mosses**, reporting on research by scientists at Umea University and the Swedish University of Agricultural Sciences.
The most telling paragraph in the article is: " .. increasing CO₂ during the last 100 years has reduced photorespiration, which has probably boosted carbon storage in peatlands to date and dampened climate change. However, increasing atmospheric CO₂ only reduced photorespiration in peatlands when water levels were intermediate, not when conditions were too wet or too dry. Unlike higher plants, mosses cannot transport water, so the water table level controls their moisture content, which affects their photosynthetic performance. So, models based on higher-plants' physiological responses cannot be applied".
- **Vale EO Wilson:** December 26, 2021 was marked with the passing of EO Wilson. As well as tireless commitment to the protection and restoration of biodiversity, EO Wilson was responsible for one of the more thought provoking quotes that stuck in the mind of the author:

"We have created a Star Wars civilisation, with Stone Age emotions, medieval institutions and god-like technology".

The Economist (January 8, 2022) provided a worthy obituary.

Bioenergy and heat-recovery:

This section of considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass.

Bioenergy includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form.

BIOENERGY IN GASEOUS FORM	
Biogas: a mixture of CH₄ and CO₂ , arising from the decomposition of organic matter, including derived or produced from anaerobic digestion.	Biomethane: CH₄ in near pure form, derived or produced from upgrading Biogas or gasification of biomass. Biogas and Biomethane are Biogases.
Bio CNG: Biogas or Biomethane that is compressed.	Bio LNG: Biomethane that is liquified.

The landmark reports of calendar year 2021, the **International Energy Agency (IEA)** [Net-zero by 2050: A Roadmap for the Global Energy Sector \(IEA Roadmap\)](#), and the International Renewable Energy Agency (**IRENA**) World Energy Outlook ([WETO](#)) both identified Bioenergy and **BECCS** (and **BECCUS**) as key to achieving **NZE** by 2050.

IEA ROADMAP AND WETO – SIX AND SEVEN PILLARS	
IEA Roadmap	The seven pillars of the IEA Roadmap are: 1. Energy efficiency; 2. Behavioural change; 3. Electrification; 4. Renewables; 5. Hydrogen and hydrogen-based fuels; 6. Bioenergy and land use change; and 7. Carbon capture, utilisation and storage.
WETO	The six pillars of the WETO are: 1. Energy conservation and efficiency; 2. Renewables (power and direct uses); 3. Electrification of end use (direct); 4. Hydrogen and its derivatives; 5. CCS and CCUS in industry; and 6. BECCS and other carbon removal measures.

In addition, recovered heat and waste heat (derive from any source, including waste water) has been added to this section. From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted.

The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.

- **Anaerobic digestion ecosystem:** By way of background, one of the technologies used to derive and produce biogas is anaerobic digestion, and with further processing biogas is the feedstock for biomethane.

Among other things (as explained in **Edition 32** of Low Carbon Pulse, under **Bio-LNG in Tassie**), biomethane can be used as the feedstock to produce bio-LNG.

Anaerobic digestion is explained in detail Ashurst article [Waste to Wealth compendium](#).

TotalEnergies (leading international energy corporation) has developed a helpful [graphic](#) explaining the Anaerobic digestion ecosystem, including how to derive biomethane.



- **Heat recovery from cement production:** On January 7, 2022, thyssenkrupp (on its [website](#)) featured the recovery of heat energy, in the form of hot air, from the production of cement as follows: "In the production of cement, raw materials such as limestone ... are burned at more than 1,400°C to produce clinker [which is] then ground with gypsum to produce ... finished cement. The air generated in the preheater during cooling of the cement clinker, which can reach 400°C is ... often released unused to the atmosphere".

Thyssenkrupp has waste heat energy recovery systems that allow the recovery of the heat energy and its use to generate electrical energy, with waste heat energy used to heat water to produce steam using long-proven technology. While the recovery and use of waste heat is not new, in the author's day job, the author is seeing ever increasing recovery and use of heat in a number of industries.

- **Heat recovery from waste water:** On January 20, 2022, based on a report from [bioenergy-news.com](#), the World Biogas Association reported that Lahti Aqua Oy and Lahti Energia Oy in Finland have signed an agreement to derive heat arising from the processing and treatment of waste water and to use that heat in district heating.

The project involves the augmentation of the Ali-Juhakkala waste water treatment plant with a heat pump. It is reported that the heat pump project has received funding support from the Finnish Ministry of the Environment.

- **Biomethane on the move:** On January 19, 2022 (or thereabouts) the European Biogas Association (**EBA**) published an [article](#) on the progress made in the production and use of biomethane during 2021: the **EBA** reports that Europe has 1,023 production facilities.

As noted above in the definition of **bioenergy**, biomethane is sourced from a feedstock of biogas, with the biogas being processed and treated to ensure that the biomethane complies with the specification requirements of the pipeline system that is to haul the biomethane. While not all biomethane is hauled through a pipeline system, the **EBA** estimates that 87% of the biomethane plants across Europe are connected to pipeline systems, and the broader gas (or should we renamed "methane") grid.

The report **EBA** article has a helpful map. This format of Low Carbon Pulse does not allow us to do justice to the map, but a [link](#) to it is attached.

BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage.

On January 18, 2022, the author of Low Carbon Pulse came across an excellent infographic developed by the Grantham Institute entitled **Which Energy Storage Technology Can Meet My Needs?** The publishing format of Low Carbon Pulse cannot do justice to the infographic, but a link to it is [attached](#).

- **HESS off-shore:** On December 17, 2021 it was reported widely that Tractebel Overdick GmbH had undertaken a design study for the development of an off-shore hydrogen production and storage facility, capable of the compression and storage of up to 1.2 million m³ of hydrogen, with the compressed hydrogen to be stored underground in salt caverns. The combination of production and storage at this scale will assist in the development of industrial-scale production and supply.
See: [World's first offshore hydrogen storage concept developed by Tractebel and partners](#)
- **Meridian plans first Big BESS in NZ:** On December 22, 2021, it was reported widely that Meridian Energy (leading energy corporation) had announced plans to develop and to deploy the first Big **BESS** in New Zealand (the **Marsden Point BESS**), to be located adjacent to the Marsden Point oil refinery north of Auckland, within the Ruakaka Energy Park (which will be co-located with a utility-scale photovoltaic solar farm). The size of the **Marsden Point BESS** continues to be considered, but Meridian Energy has indicated that the **BESS** will be at least 100 MW.
- **San Miguel to top BESS:** On January 5, 2022 [pv-magazine.com](#) reported that San Miguel Corporation is to commence the operation of 690 MW of **BESS** early in 2022, and that by the end of 2022 is projected to have 1 GW of **BESS** operational.
- **Tesla big in Texas:** On January 6, 2022 (or thereabouts), Tesla released a video on [Youtube](#) unveiling its 81 Megapack battery, 100 MW / 200 MWh project in Angleton, Texas. The **Angleton BESS** will provide support for the grid. Coming up to the first anniversary of the rolling power blackouts in the Lone Star State during February 2021, the **Angleton BESS** is one of a number measures that have been undertaken to bolster the integrity and stability of the grid.
- **Sun Metals and Energy Vault:** On January 10, 2022, [reneweconomy.com.au](#) reported that Sun Metals (subsidiary of Korea Zinc) had contracted with Energy Vault to deploy Energy Vault's long-duration energy storage technology at the Sun Metals zinc refinery in Townsville, Queensland, Australia. (See **Editions 4, 18, 22, and 27** for news items on Korea Zinc and Sun Metals). As reported it is expected that the deployment will commence by mid-2022.
- **Hydrostor and Goldman Sachs: Edition 21** of Low Carbon Pulse reported in **CAES** (compressed air energy storage). On January 10, 2022, [rechargenews.com](#) reported that Goldman Sachs is providing up to USD 250 million to allow Canadian based **CAES** technology corporation to expand to develop up to 1 GW / 8.7 GWh of advanced CAES (**A-CAES**).
- **Rye Development in Blue Grass State:** On January 10, 2022, [cleantechnica.com](#) reported (under **Kentucky Coal Mine Will Become Giant "Water Battery" Energy Storage Project**) that leading hydroelectric power corporation, Rye Development, proposes to make Kentucky the centre of long-duration energy storage with the development of its closed loop pumped storage system in Bell County, south east Kentucky (badged as the **Lewis Ridge Close Loop Pumped Hydropower Storage** project, descriptive, if not overly punchy). It is reported that applications have been filed with the Federal Energy Regulatory Commission seeking a 50 year operating licence / permit.
As explained in **Edition 6** of Low Carbon Pulse, pumped storage is the original means of energy storage, with water stored, and then released to generate hydro-electric energy, captured following released, and then pumped back into storage.
- **Portland General Electric (PGE) picks BESS:** On January 14, 2022 [energy-storage.news](#) reported that **PGE** had selected ESS Inc's long duration iron electrolyte flow battery energy storage solution for a pilot / test project.
- **Maoneng gets green light:** On January 20, 2021, [Maoneng](#) (leading renewable energy corporation) announced that it had received development approval for the development of the 240 MW Mornington **BESS** (in the State of Victoria, Australia). In the words of Maoneng: "Victoria's BIGGEST battery energy storage system!". Maoneng has indicated that this is the first of up to five large-scale **BESS** projects. (See **Editions 21, 23, 31 and 32** for other news items on **BESS** in Victoria, Australia.)

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

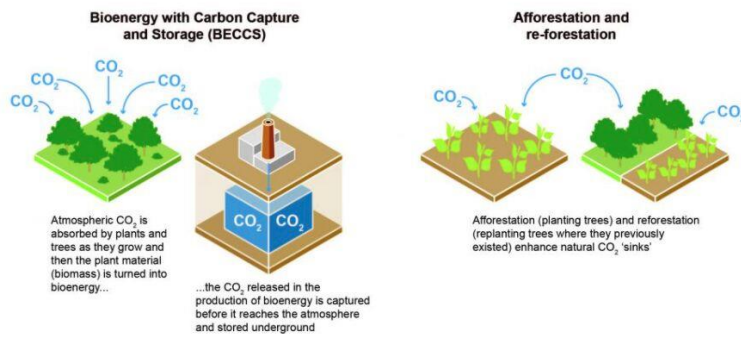
This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including to bioenergy carbon capture (**BECCs**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture and storage (**CCS**), carbon capture use and storage (**CCUS**) and direct air capture (**DACS**). Effective accounting for carbon arising and **CDR** go hand-in-hand.

Carbon accounting is critical to assessing carbon emissions and reductions in those emissions. Also it is critical to some of the concepts on which carbon-neutrality rests. For example, conceptually bioenergy is carbon-neutral at the point of use if the biomass from which the bioenergy is derived or produced is renewable. There are two primary challenges with the concept, first, whether or not the biomass will be renewed with new growth, and secondly, if it is renewed, the time-lag between carbon emissions arising from the use of the biomass to derive or to produce bioenergy and growth of new biomass to absorb the carbon emissions arising on use. At the moment, it is fair to say that neither of the two primary challenges are addressed. Over time it is necessary for the concept of carbon-neutrality to address the two primary challenges – matching carbon emissions with the absorption that actually occurs, with a clear line of sight and a clear timeline. If this is not addressed, and accounted, the necessary reductions in **GHG** emissions will not be achieved.

By way of background **CDR** is recognised in the **2021 Report** as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (**BECCS**), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (**DACS**) are all means of **CO₂** removal.

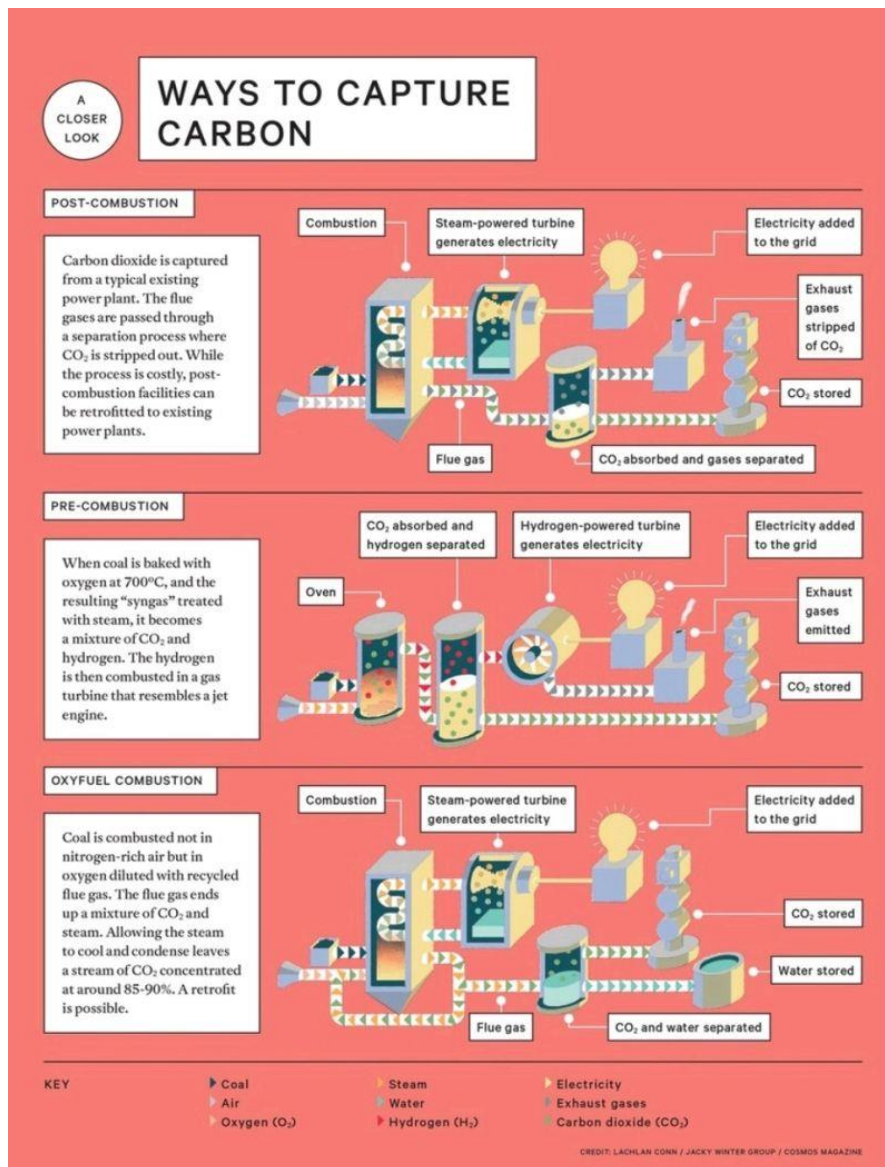
On December 28, 2021, the **IPCC** provided a simple graphic to provide its perspective on **CDR** and negative emissions.

FAQ4.2: Carbon dioxide removal and negative emissions
 Examples of some CDR / negative emissions techniques and practices



Source: [IPCC LinkedIn](#)

The **IEA** pathway to **NZE** estimates that in order to achieve **NZE** it will be necessary to capture and to remove up to 7.6 giga-tonnes of **CO₂** each year through **CCS**, **CCUS** and **CDR**. **CCS** and **CCUS** (and **BECCS** and **BECCUS**) involve the capture at source of **CO₂**, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.



- **First, Polaris to progress, now Barents Blue:** [Edition 32](#) of Low Carbon Pulse reported that on December 10, 2021, it was announced that Equinor ASA, Horisont Energy AS, and Vår Energi had entered into an agreement to collaborate on the development for the carbon transportation and storage project, Polaris off the coast of Northern Norway (see [Editions 25](#) and [27](#) of Low Carbon Pulse).

The Polaris storage project is expected to have **CO₂** storage capacity of 100 million tonnes, or stated another way, twice the mass of **GHG** emissions arising from activities in Norway each year. As noted in previous editions of Low Carbon Pulse, the Polaris storage project is key to the development of the **Barents Blue** project in Finnmark – Europe's first world-scale carbon neutral ammonia production plant.

By way of reminder, [Edition 27](#) of Low Carbon Pulse reported that on September 13, 2021, Horisont Energi announced that it had made an application for a licence to establish the Polaris **CO₂** storage facility off the coast of Finnmark. It was stated that the Horisont Energi application was intended to allow the storage of **CO₂** arising from the production of Blue Hydrogen at the **Barents Blue** project (to produce Blue Hydrogen and Blue Ammonia). [Edition 23](#) of Low Carbon Pulse reported that Horisont Energi, Equinor and Vår Energi had entered into a cooperation agreement to develop **Barents Blue**, and the development of the Polaris **CO₂** project has long been an integral part of the thinking around the development of **Barents Blue**.

On December 17, 2021, highnorthnews.com reported that **Barents Blue** was one of three major hydrogen projects chosen to receive NOK 1 billion in support from the Norwegian Government, with **Barents Blue** to receive up to NOK 482 million. The CEO of Horisont Energi, Mr Bjørgulf Haukelidsæter Eidesen is reported to have said that: "This is a big day for the Barents Blue project". It was indeed a big day: in addition to the Norwegian Government funding, the **Barents Blue Ammonia Plan** will be award Important Projects of Common European Interest (**IPCEI**) status.

The other two major hydrogen projects are Tizir Titanium & Iron (**TTI**) in Tyssedal (see [Edition 21](#) of Low Carbon Pulse) and Yara International (see [Edition 29](#) of Low Carbon Pulse) receiving NOK 261 million and NOK 283 million respectively.

See: see the website of each corporation - [Tizir, Yara begins electrifying the factory at Herøya](#)

- **CCS Norwegian continental shelf update:** [Edition 27](#) of Low Carbon Pulse reported that on September 10, 2021, the Ministry of Petroleum and Energy (**MPE**) in Norway announced that application could be made for two areas for injection and storage of **CO₂** on the Norwegian continental, under the **CO₂ Storage Regulations (CO₂ SRs)**. The **CO₂ SRs** provide a process to allow the development of **CO₂** storage facilities to allow the storage of **CO₂** in sub-ocean floor geological structures.

The deadline for the applications was stated as noon on December 9, 2021.

In mid to late December 2021 the **MPE** announced that it had received five applications in respect of the two areas for injection and storage. The **MPE** will now process the applications and allocate acreage during the first part of 2022.

- **Porthos progresses:** In mid to late December 2021, it was reported that **Porthos (Port of Rotterdam CO₂ Transport Hub Off-shore Storage)** project had concluded contracts with two of the three leading global industrial gas corporations, Air Liquide and Air Products, and two of the leading international energy corporations, ExxonMobil and Shell.

The **Porthos** project is one of the flagship CCS projects, being development by the Port of Rotterdam Authority (**PORA**) and EBN B.V. (a natural gas corporation owned by the Dutch Government), Gasunie (energy network operator in the Netherlands and Northern Germany) in joint venture, comprising the transportation of **CO₂** captured in the Port of Rotterdam (see [Edition 3](#) of Low Carbon Pulse) using a 22 km submarine pipeline into storage in a depleted gas field with storage capacity for **CO₂** of 37 million metric tonnes. The intention is that the 2.5 million metric tonnes of **CO₂** will be stored each year.

- **Carbon Capture and Storage Association (CCSA) Case Study:** On January 7, 2022, the **CCSA** released its first [case study](#) of 2022, covering the East Coast Carbon Cluster in the UK. The case study provides a helpful summary.
- **Petronas and Shell alignment:** On January 11, 2021, thestar.com.my reported that Petronas and Shell (Sarawak Shell Bhd) had signed a joint study and collaboration agreement (**JSCA**) to explore opportunities, and to collaborate in respect of those opportunities for **CCS**, so as to provide Malaysia and the region with **CO₂** storage solutions. As reported in The Star, the **JSCA** provides for Petronas and Shell to undertake an integrated **CCS** Area Development Plan study in respect of locations off-shore of Sarawak.
By way of reminder, [Edition 30](#) of Low Carbon Pulse (under **ExxonMobil and Petronas teaming**) reported that Petronas had signed a memorandum of understanding with ExxonMobil. In December 2021, Petronas signed a memorandum of understanding with POSCO (leading steel producing corporation headquartered in **ROK**) to assess opportunities for CCS.

Carbon Credits and Hydrogen Markets and Trading:

This section considers news items that have arisen within the news cycle of this [Edition 33](#) of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. To manage the length of this [Edition 33](#) of Low Carbon Pulse, [Edition 34](#) will include any relevant news items.

Also this section covers the development hydrogen markets and trading (bilateral and likely wholesale).

E-fuels and Future Fuels (increasingly "Now Fuels"):

This section considers news items that have arisen within the news cycle of this [Edition 33](#) of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and **Future Fuels** (energy carriers derive and produced that are characterised as clean carbon or low carbon fuels).

E-fuels include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.

- **Herøya Plant Fertile Plans:** On December 17, 2021, Yara (leading global fertiliser corporation) announced that Green Hydrogen would be produced to provide feedstock to allow production of Green Ammonia at Herøya, Norway. The use of Green Hydrogen will displace the use of hydrogen derived from natural gas.

See: [Yara begins electrifying the factory at Herøya](#)

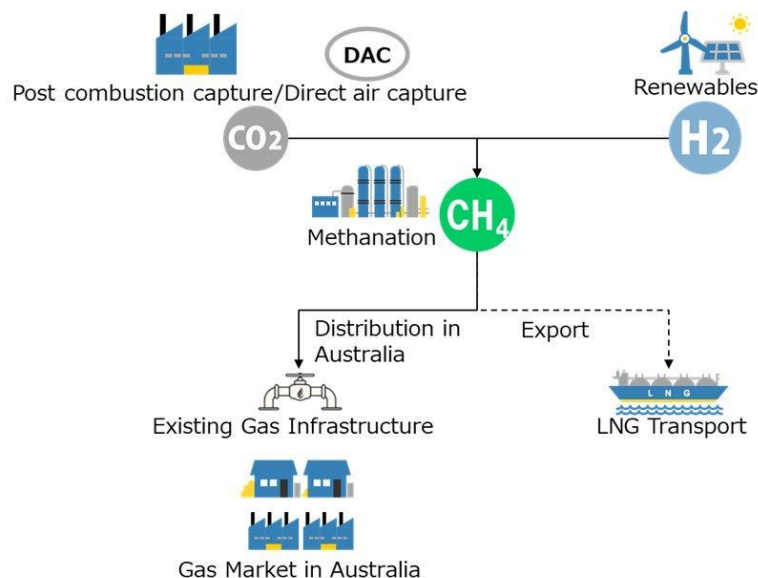
- **RWE and Linde plan PEM for Lingen:** On December 20, 2021, [RWE](#) (leading energy corporation) announced that, as part of its **Growing Green** strategy (see **Edition 31** of Low Carbon Pulse), it is to develop and to deploy two 100 MW Proton Exchange Membrane (**PEM**) electrolyzers supplied by Linde in Lingen. The renewable electrical energy to power the electrolyzers is to be sourced from off-shore wind field capacity, and, subject to confirmation of **IPCEI** status for the project, it is expected that the first electrolyser will be completed and operational by 2024, and the second by early 2025.
- **RWE and Jacobs plan PEM for Pembroke:** On December 20, 2021, [H2view.com](#), reported that RWE had teamed with Jacobs to undertake a study to develop and to deploy a 100 MW Green Hydrogen production facility at RWE's Pembroke Net Zero Centre, using **PEM** technology.
- **From Western Australia to Jurong:** On December 22, 2021, it was reported widely that Woodside Petroleum is working with Keppel Corporation (Singapore based diversified corporation) and Osaka Gas (Japan based energy corporation) to assess the long term supply of liquified hydrogen (**LH2**) from Western Australia to Singapore, and, possibly, to Japan.

For Keppel Corporation, the import and use of **LH2** would allow the decarbonisation of energy use, including by Keppel Data Centres, and City Energy (owned by Keppel Infrastructure Trust and with which Osaka Gas has a partnership).

- **GreenH2Atlantic Project takes shape:** On December 22, 2021, [H2-view.com](#) reported that a 100 MW electrolyser (supplied by leading electrolyser technology provider McPhy), will be developed and deployed. The electrolyser is being developed and deployed with a grant of €30 million from the **Horizon 2020 – Green Deal**. The **GreenH2Atlantic Project** is backed by the following corporations: Galp, ENGIE, EDP, Vestas Wind Systems A/S, Efacec, Martifer, Bondalti and McPhy.
- **Aragon moves to Green Hydrogen:** On December 22, 2021, [H2-view.com](#) reported that Enagás and the Aragonese Renewable Energy Company (**CEAR**) had entered into an agreement under which 103 MW of renewable electrical energy capacity will be developed and deployed to power a 30 MW electrolyser to produce Green Hydrogen.
- **Osaka Gas considers methanation:** On December 23, 2021, Osaka Gas Co. Ltd announced that, its wholly owned subsidiary, Osaka Gas Australia Pty Ltd (**OGA**) had undertaken a methanation study jointly with ATCO Australia Pty Ltd.

As noted in earlier editions of Low Carbon Pulse, methanation converts **CO₂** and hydrogen into synthetic methane (as opposed to methane in the form of natural gas).

The diagram below provides an overview:



Source: [Osaka Gas Singapore LinkedIn](#)

- **Province progresses: Edition 10** of Low Carbon Pulse reported that on February 19, 2021, Province Resources announced plans to develop a 1 GW solar and wind complex in the Gascoyne, Western Australia. As is the case with many locations around Australia, the site identified by Province Resources has strong on-shore wind resources, and equally prospective solar resources.

As reported in **Edition 10** of Low Carbon Pulse, Province Resources was keeping its options open: one of the good things about Green Hydrogen is that its production is necessary to produce Green Ammonia, and as such a decision on Green Hydrogen or Green Ammonia is not a pressing issue.

It is reported that the **HyEnergy** facility will have capacity to produce 60,000 metric tonnes per annum of Green Hydrogen or 300,000 metric tonnes per annum of Green Ammonia.

On December 20, 2021 it was reported that **HyEnergy** has been awarded Lead Agency Status. Hydrogen Industry Minister, Ms Alannah MacTiernan is reported to have said that: "*The Lead Agency Status recognises the very real significance of Province's HyEnergy Project as we position WA as a global renewable hydrogen force*".

- **Murchison Hydrogen and Western Green awarded Lead Agency Status:**

Edition 4 of Low Carbon Pulse reported that Hydrogen Renewables Australia had:

" ... announced a partnership with leading global infrastructure fund, Copenhagen Infrastructure Partners (**CIP**). The **Murchison Green Hydrogen Project** will use electrical energy sourced from photovoltaic solar and wind renewable energy sources to electrolyse desalinated water. The **Murchison Green Hydrogen Project** is interesting in a number of respects, including the expansion of the project to blend with natural gas for haulage in Western Australia's Dampier to Bunbury natural gas pipeline.

Edition 22 of Low Carbon Pulse reported that:

" ... during the week beginning July 12, 2021, it was widely reported that the world's largest renewable energy hub is planned for the southern coast of Western Australia. As reported in previous editions of Low Carbon Pulse, Australia has world class renewable energy resources, and south and south west coast of Western Australia has some of the best wind resources globally. As such it comes as no surprise that there are plans to develop a renewable energy hub in the region. What is a surprise is the world scale of the proposed **Western Green Energy Hub**, which when fully developed is planned to have 50 GW of installed solar photovoltaic and wind capacity used to produce Green Hydrogen for domestic use, and for export: the production is estimated to be up to 3.5 million metric tonnes per annum of Green Hydrogen and up to 20 million metric tonnes per annum of Green Ammonia. The **Western Green Energy Hub** is sponsored by CWP Global and Intercontinental Energy, leading corporations developing the 26 GW Asia Renewable Energy Hub, in the Pilbara, in the north of Western Australia."

On December 21, 2021, **Murchison Green** and the **Western Green Hydrogen Energy Hub** were awarded Lead Agency Status, along with **HyEnergy**.

- **Bolivia Green Ammonia green-lighted:** On December 23, 2021, Siemens Energy completed its feasibility study for **Productora H2 Bolivia's Pacha K'anchay Green Ammonia** project, determining that the development of the 420 MW electrolyser project was economically feasible.

See: [Study shows Bolivian Green Ammonia Competitive in Global Market](#)

- **Enterprising partnership in Vietnam:** On December 23, 2021, [renews.biz](#) reported that Enterprize Energy (the Singapore based renewable energy corporation – see **Editions 11, 25** and **31** of Low Carbon Pulse) and the Vietnamese Institute of Energy (scientific and technological research agency) have signed a memorandum of understanding to partner in a study to assess the potential of Green Hydrogen in Vietnam.

As reported in Low Carbon Pulse, Enterprize Energy is undertaking surveys to develop the 3.4 GW Thong Long off-shore wind field development in the Ke Ga Cape off the coast of Bin Thuan Province.

- **Chile Government Funding:** On December 27, 2021, [fuelcellworks.com](#) reported that the Chilean state agency, Corfo, had awarded funding to six Green Hydrogen production facilities with combined production capacity of 388 MW. The funding has been awarded on the basis that the Green Hydrogen production facilities must come into operation by no later than the end of 2025.

The Green Hydrogen production facilities are to be located in the regions of Antofagasta, Biobio, Magallanes and Valparaiso. The recipients of the funding are Air Liquide, CAP (a Chilean mining corporation), Engie, Enel Green Power Chile, and GNL. The award has been reported widely since the initial [fuelcellworks.com](#) report.

In addition to these Green Hydrogen production facilities, and by way of a reminder, **Edition 32** of Low Carbon Pulse reported on the plans of Total Eren (a leading renewable energy corporation part owned by TotalEnergies) plans to develop a 10 GW on-shore wind project to supply renewable electrical energy to power Green Hydrogen and Green Ammonia production facilities in the Magallanes region of southern Chile (**H2 Megallanes**): it is reported that **H2 Megallanes** will comprise a desalination facility, 8 GW of electrolyser capacity, and ammonia production facilities. First production is expected by 2027, with the expectation that **H2 Megallanes** will produce 800,000 metric tonnes of Green Hydrogen a year, and 4 million metric tonnes of Green Ammonia.

- **AustriaEnergy and CIP combine:** On January 13, 2022, **CIP** (leading fund management corporation focused on energy infrastructure) [announced](#) that it has agreed with AustriaEnergy (leading renewable electrical energy project developer) and Öekowind (hydroelectric and wind energy developer head-quartered in Austria) to form a joint venture for the purposes of the development of the **HNH Project** located in the Magallanes region of southern Chile.

The **HNH Project** is a Green Hydrogen and Green Ammonia projects, that will comprise 1.7 GW of on-shore wind farm capacity to power electrolysers to produce sufficient Green Hydrogen to deliver 1 million metric tonnes of Green Ammonia a year.

- **In the turquoise:** On January 5, 2022, [rechargenews.com](#) reported that Turquoise Hydrogen producer Monolith had obtained conditional approval for a USD 1.04 billion loan from the US **DOE** (under the Title XVII Innovative Energy Loan Guarantee Program) to enable expansion of Olive Creek hydrogen production facilities in Hallam, Nebraska, from 5,000 metric tonnes per annum to 50,000 metric tonnes per annum, with the hydrogen to be combined with nitrogen at the facility to produce 275,000 metric tonnes per annum of Turquoise Ammonia.

US Energy Secretary, Ms Jennifer Granholm said that: "*The Title XVII Innovative Energy Loan Guarantee Program's purpose is to recognise and support technology that reduces emissions and supports a clean energy future. Advanced, clean production technology like Monolith's are the types of impactful projects that support ... sustainability ...*"

It is reported that the hydrogen production facility sources renewable electrical energy to superheat natural gas in a pyrolysis oven to produce hydrogen and carbon black. The process to produce hydrogen and carbon black is described as **CO₂** free (with the **CO₂** arising taking solid form in the carbon black). The revenue earned from the sale of carbon black (for use in the production of inks, plastics and tyres) will allow the sale of Turquoise Ammonia at a price that is competitor in the market for ammonia.

As reported, the natural gas is to be replaced with biomethane feedstock over time.

COLOUR CODED AMMONIA (SEE [THE SHIFT TO HYDROGEN \(S2H2\): ELEMENTAL CHANGE SERIES](#))

Blue Ammonia: H_2 from CH_4 with CO_2 captured & stored (CCS) or captured & used, combined with N using Haber-Bosch process

Green Ammonia: H_2 (from electrolysis of H_2O using renewable energy) combined with N using the Haber-Bosch process

Grey (or Brown) Ammonia: H_2 derived from CH_4 (without CCS) combined with N using the Haber-Bosch process

Turquoise Ammonia: H_2 from the pyrolysis of CH_4 which produces carbon black, storing CO_2 in solid form.

- **Thyssenkrupp to supply Shell with 200 MW electrolyser:** On January 10, 2022, it was reported widely that thyssenkrupp had contracted to supply a 200 MW to Shell to be located at Shell's facilities at the Port of Rotterdam to produce Green Hydrogen, with the renewable energy to power the electrolyser to be supplied from the Hollandse Kust North off-shore wind field (see [Edition 32](#) of Low Carbon Pulse). It is understood that the supply is conditional on a final investment decision by Shell, expected during 2022, with the electrolyser to be deployed by 2024.
- **Wood Mackenzie on ammonia:** On January 10, 2021, Wood Mackenzie (at woodmac.com) published an article entitled *What role will ammonia play in global hydrogen trade?* The article is worth a read, collating in one spot key dynamics that will inform the role that ammonia will play.
- **Aalborg, CIP and Reno Nord combine:** On January 13, 2022, [CIP](#) announced that it has combined with Aalborg Utility and Reno Nord to develop an e-methanol plant at Aalborg, Denmark. The Aalborg e-methanol plant will take CO_2 arising from the combustion of waste from the Reno Nord waste to energy facility and combine that CO_2 with hydrogen produced by a 300 to 400 MW electrolyser, with the renewable electrical energy required to power the electrolyser sourced from the wind power.
- **Tiwi Islands on the map:** On January 17, 2022, [pv-magazine-australia](#) reported that Global Energy Ventures ([GEV](#)) (leading Australian renewables corporation) is continuing to develop a Green Hydrogen production, and export, facility on the Tiwi Islands, off the coast of the Northern Territory, Australia. It is reported that [GEV](#) intends to power the electrolyzers at the facility from renewable electrical energy sourced from a 500 MW (moving to 2.8 GW) photovoltaic solar farm on the Tiwi Islands.
- **Geopolitics of the Energy Transformation: The Hydrogen Factor ([IRENA H2 Report](#)):** On 18, January 2022 (or thereabouts), the International Renewable Energy Agency ([IRENA](#)) published its [IRENA H2 Report](#), which will be considered in detail in the January and February Report to comprise the Appendix to [Edition 36](#) of Low Carbon Pulse.

For the time being, there is nothing new in the findings, rather there are points of continued emphasis, critically international co-operation will be key to the development of transparent hydrogen market with coherent and consistent standards required.

The [IRENA H2 Report](#) anticipates that the cost of the production of Green Hydrogen, and therefore, Green Hydrogen derived-fuels, may reach a level at which it competes with the energy carriers sooner than other previously contemplated, and that this may result in Blue Hydrogen investments becoming stranded.

- **Rethink Energy report sizes and shakes:** On January 18, 2022, Rethink Energy published a [report](#) (entitled *Hydrogen will shake out industry laggards, warns Rethink*) that sits nicely alongside the [IRENA H2 Report](#). Consistent with many other reports the report contemplates that hydrogen may provide up to 25% of energy demand by 2050.

Unlike other reports, the report contemplates that up to 771 million metric tonnes of hydrogen per year may be required by 2050. This is the highest estimate that the author has encountered. If this level of production is to be achieved, development of hydrogen production capacity needs to accelerate. The need for acceleration is known, but the report adds emphasis.

- **Spain continues to SHYNE:** On January 19, 2022, rechargenews.com reported (under *Repsol-led consortium to invest \$4.4 bn in green hydrogen production and usage in Spain*) that the Spanish Hydrogen Network ([SHYNE](#)), a consortium of 33 corporations and organisations, led by Spanish oil and gas giant Repsol, is to invest €3.3 bn to develop and to install 500 MW of Green Hydrogen production capacity by 2025, and 2 GW by 2030. The installation of 2 GW of Green Hydrogen production capacity by 2030 will satisfy half to the Spanish Government's target of 4 GW (see [Editions 5](#) and [29](#) of Low Carbon Pulse).

[SHYNE](#) intends to develop a hydrogen ecosystem that connects three planned hydrogen hubs in the Basque, Catalonia and Murcia regions, and two new innovation hubs in Castile-La Mancha and Madrid (including to develop solid-oxide electrolyser technology and photo-electrocatalysts technology).

Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

This section considers news items that have arisen within the news cycle of this [Edition 33](#) of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of [NZE](#), the use of [E-fuels](#) and [Future Fuels](#) to power and to propel vehicles used to extract and to transport metals and minerals, and the use of E-fuels and Future Fuels to process and to treat those metals and minerals.

Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.

- **Anglo American and Aurizon aim to decarbonise heavy freight:** During December 2021 a number of news items were published outlining plans by Anglo American (leading mining corporation) and Aurizon (one of the leading heavy freight above rail operators in Australian) to decarbonise the haulage of from Anglo American's Dawson metallurgical coal mine and Gladstone Port and Mount Isa (the North West Minerals Province) to Townsville Port using hydrogen powered and propelled locomotives.

The decarbonisation of these routes will add impetus to the progress being made in the State of Queensland, Australia, with the demand for hydrogen for these heavy freight routes adding domestic demand to the projected export demand for Green Hydrogen produced in the State.

- **Anglo American decarbonising yellow gear:** On December 21, 2021, the [bbc.com](https://www.bbc.com) reported that Anglo American is retrofitting mining trucks with hydrogen fuel cell technology to power and to propel them, thereby displacing diesel. The use of the retrofitted mining trucks is being piloted at the Mogalakwena platinum mine, Limpopo, South Africa. The mining truck have been retrofitted with a hybrid power and propulsion system, fuel cell and battery. The retrofitting project is being undertaken by Anglo American with a veritable who's who of technology and fuel suppliers, including ABB, Ballard, Engie, First Mode, Nel, NPROXX, Plug Power, and Williams Advanced Engineering.
- **Big Three Iron Ore Miners go electric:** On January 18, 2022, [pv-magazine-australia](https://www.pv-magazine-australia.com) reported (under **Three major miners jump on electric train trend**) BHP Group, Fortescue Metals Group (**FMG**) and Rio Tinto are to purchase electric trains to haul iron ore access their rail networks in Western Australia. The electric trains are being procured from US electric locomotive manufacturers, Progress Rail and Wabtec Corporation.
 - On January 6, 2022, **FMG** announced plans to purchase two electric trains from Progress Rail.
 - On January 10, 2022, Rio Tinto announced plans to purchase four battery electric locomotives from Wabtec.
 - On January 17, 2022, BHP Group announced plans to purchase four electric locomotives, two from Progress Rail (a subsidiary of Caterpillar) and two from Wabtec.
 The announcements from the Big Three follow the line previously travelled by Roy Hill (another leading iron ore corporation in Western Australia) which purchased battery electric locomotives from Wabtec in September 2021.

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

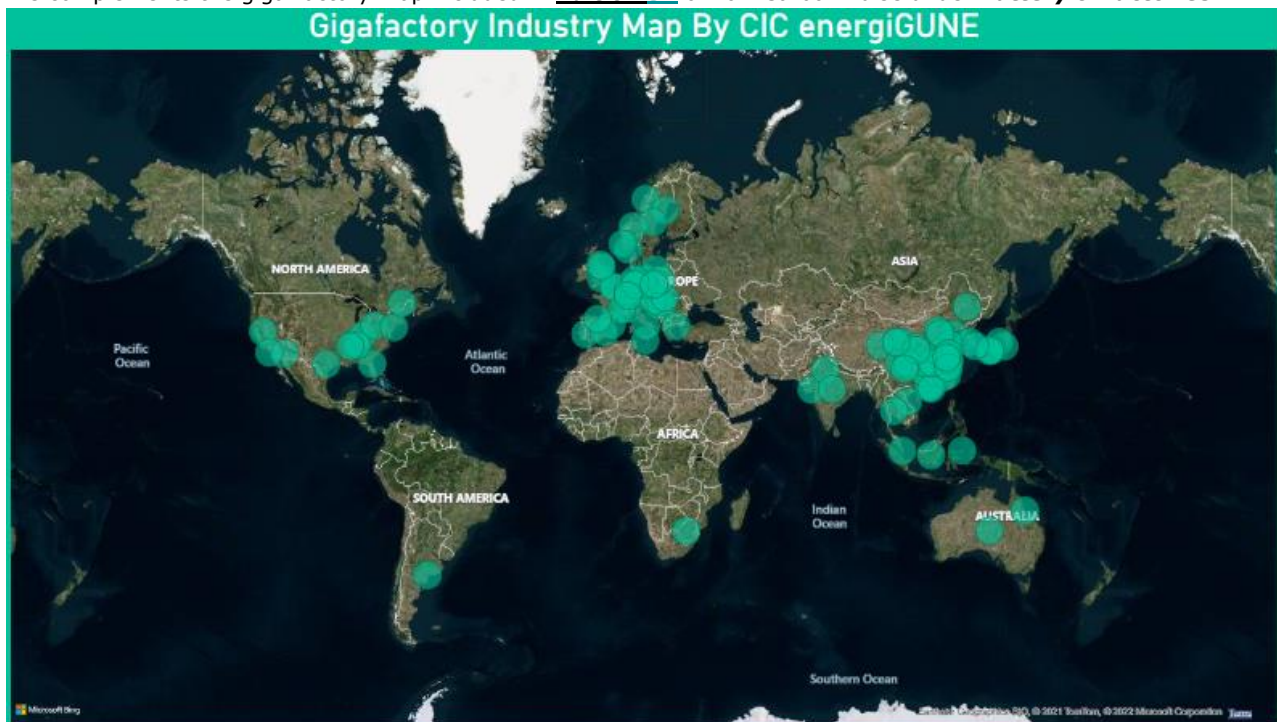
This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development of:

- areas in which: **1.** infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and **2.** technologies facilitating energy transition will concentrated and supported (**Hydrogen Corridors and Valleys**); and
- giga-factories that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).

Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.

For some time, the author of Low Carbon Pulse had promised to include a piece on giga-factories. As an early birthday present, on December 28, 2021, CIC energiGUNE provided a world map of battery giga-factories. [Link](#) to interactive map.

This complements the giga-factory map included in [Edition 32](#) of Low Carbon Pulse under **Battery of factories**.



Future editions of Low Carbon Pulse, will include maps of other categories of giga-factories.

- **First Hydrogen Town:** On December 23, 2021, [Hydrogen-Central.com](https://www.hydrogen-central.com) reported that the Humber region of the UK is being considered as the most likely location for the UK first hydrogen town (being a town in which hydrogen displaces natural gas) by 2030.

The first hydrogen town is one of the projects identified by Zero Carbon Humber (together with Zero Teesside, comprising the East Coast Cluster). Zero Carbon Humber plans to use hydrogen to decarbonise one of the largest industrial regions in the UK, including the towns of Grimsby, Hull, Selby and Scunthorpe.

- **First Bidirectional Town:** On December 28, 2021, the author picked up on reporting from [fastcompany.com](https://www.fastcompany.com) (published in December 14, 2021) that outlined the objective of the Dutch town, Utrecht, to be the first entirely bidirectional town.

The objective of creating a bidirectional town is to deploy bidirectional chargers to allow electric charging points both to off-take electrical energy from the grid, and to allow the grid to off-take electrical energy from battery electric vehicles and from household batteries. While the idea is not new, and is practised in a number of locations across Europe, the use of bidirectional chargers will allow optimisation across grids.

- **Cummins welcome continues: Edition 18** of Low Carbon Pulse reported (under **Cummins welcomed**) that on May 19, 2021, "the Cummins Wuhan Energy Engineering Center (**CWEEC**) had opened officially. The **CWEEC** is a facility at which various technologies can be trialled, including for fuel cells and pipelines. For Cummins, this continues the roll-out of its global footprint in key jurisdictions, as it continues to pivot from its traditional business."

On January 4, 2022 it was reported widely that Cummins and Sinopec (one of the Big Three PRC state-owned oil and gas corporations, and leading hydrogen corporation) had established a joint venture (**Cummins Enze**) which will develop a 1 GW **PEM** electrolyser giga-factory at Foshan, Guangdong Province, PRC. It is to be expected that Sinopec will be the primary, possibly the only, customer for the **PEM** electrolysers produced by **Cummins Enze**.

This development continues to develop Cummins' global footprint. **Edition 18** of Low Carbon Pulse (under **Cummins welcomed again**) noted that on May 24, 2021, Cummins "announced plans to develop one of the world's largest electrolyser production plants (scalable to 1 GW a year) to allow production proton exchange membrane (**PEM**) plants.

The giga-factory is to be located in the central region of Castilla-La Mancha, Spain [one of the areas that is key to the **SHYNE** project]. It is reported that the Castilla-La Mancha **PEM** Gigafactory project will provide the electrolysers for the planned Iberdrola Palos de la Frontera Green Hydrogen project, which is to supply Green Hydrogen to Fertiberia for the production of Green Ammonia."

See: [Cummins](#) and [Sinopec](#) websites

- **HVDC off-shore to on-shore: Edition 8** of Low Carbon Pulse reported that on January 21, 2021 the transmission system operators (**TSOs**) for Denmark (**Energinet**) and Germany (**50Hertz**) had agreed a framework to work together on the Bornholm Energy Island in the Baltic Sea – a submarine HVDC project.

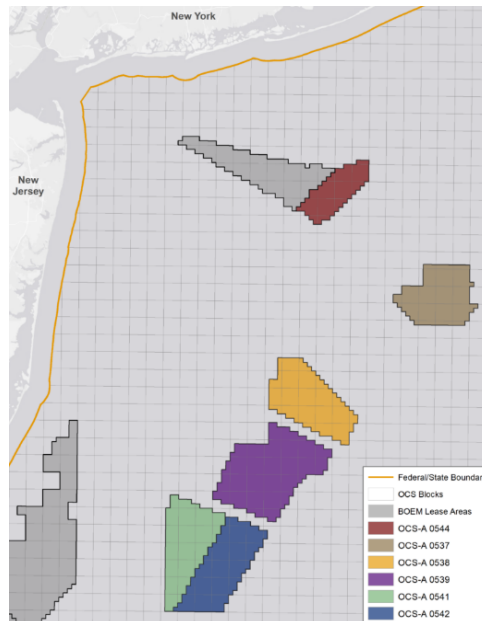
On January 18, 2022, TennetT TSO GmbH [announced](#) that it had signed a cooperation agreement with **50Hertz** to develop a hub area in Heide, Germany and a HVDC link. This development may be regarded as a forerunner of increased use of HVDC on-shore within Germany, and within Europe more generally.

In the German context the implementation of the on-shore hub and the use HVDC on-shore will allow the connection of 4 GW of off-shore wind field capacity from the North Sea to the area of Heide by the early to mid-2030s.

Wind round-up, on-shore and off-shore:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).

- **Bureau of Ocean Energy Management (BOEM) okay's New York Bight:** On December 17, 2021, it was reported widely that the **BOEM** had completed its assessment of the development of the 800,000 acre New York Bight, allowing the lease of off-shore wind fields with capacity of up to 7 GW of new renewable electrical energy.



New York Bight Lease Areas, Source: boem.gov

The January 12, 2022 edition of [offshorewind.biz](https://www.offshorewind.biz) reports that the auction for the development of off-shore wind field development will be held on February 23, 2022 with six areas up for bids by developers.

The US Department of Interior Secretary, Ms Deb Haaland, is reported to have stated that: "We are at an inflection point for domestic offshore wind energy development. We must seize this moment – and we must to it together".

- **Maryland and Massachusetts award concessions for 3.2 GW of off-shore wind:**

- **Momentum and Ørsted awards:** On December 18, 2021, the Maryland Public Commission (**PSC**) approved the development of 1.65 GW of off-shore wind fields - the 808 MW Momentum Wind project and the 846 MW Ørsted Skipjack Wind 2 project.

- **Commonwealth Wind progresses with 1.232 GW off-shore wind:** On December 18, 2021, it was reported widely that Commonwealth Wind is to develop its 1.232 GW off-shore wind project, and Mayflower Wind is to develop its 400 GW off-shore wind project, both off New England. Commonwealth Wind comprises **CIP** and Avangrid Renewables (Iberdrola's US renewable energy corporation), Mayflower Wind comprises Ocean Winds (comprising Engie and EDP Renewables) and Shell.

- **RWE Renewables Bolter:** On December 20, 2021, offshorewind.biz reported that RWE Renewables was progressing towards the development of the 1.6 GW Södra Midsjobanken off-shore wind-field project in the Swedish sector of the Baltic Sea.

- **BlueFloat looks to Big Sky Country:** On December 22, 2021, reneweconomy.com.au reported that BlueFloat (leading renewable energy corporation) has plans to develop at least 4.3 GW off-shore wind field capacity in Australian waters.

BlueFloat is reported to be teaming with Energy Estate (leading renewables energy sponsor), and that three projects are being contemplated, two off-shore of the State of New South Wales (NSW), and one off-shore of the State of Victoria.

The two NSW projects are a 1.4 GW project off-shore of the Hunter region of NSW, and a 1.6 GW project off the coast of the Illawarra region of NSW.

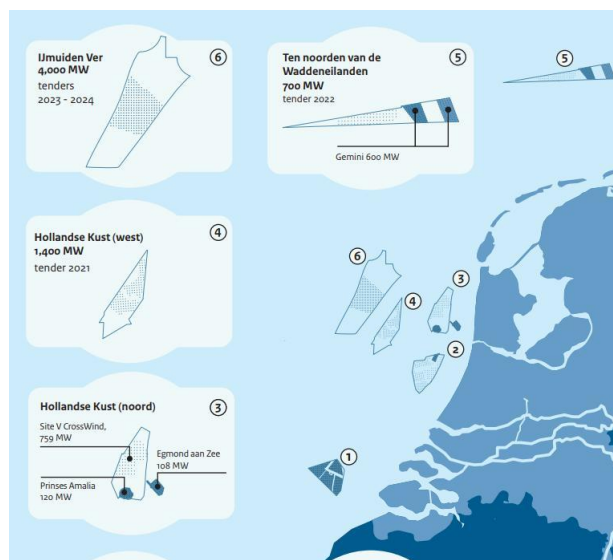
The Victorian project is a 1.3 GW fixed bottom project to be developed off the coast of Gippsland.

Country Manager of BlueFloat Energy, Mr Nick Sankey, is reported as having said that: "*The timing of our announcement comes hot on the heels of Australia's Federal Government passing legislation that provides a framework for developing offshore wind projects here*". See **Edition 32** of Low Carbon Pulse.

- **Japan announces fixed bottom results for 1.76 GW:** On December 24, 2021, renews.biz reported that successful tenderers had been announced in respect of the first auction of fixed bottom off-shore wind field projects by Japan. The successful tenderers are the 891 MW Yurihonjo wind field and the 478.8 MW Noshiro Mitane Oga wind field, off Akita prefecture, and the 390.6 MW Choshi wind field development, off Chiba prefecture. The renews.biz article details the corporations comprising each successful tendering consortium. (See also Mitsubishi website.)

- **Firm Dates:** On December 24, 2021, the Government of the Netherlands announced that from April 14, 2022 it would open the tender for bids for the off-shore wind fields, Hollandse Kust Sites VI and VII, comprising the **Hollandse Kust Wind Farm Zone** or **HKWWFZ** (see **Edition 32** of Low Carbon Pulse), with the tender to close on May 12, 2022.

The **HKWWFZ** is located approximately 53 kilometres off the west coast of the Netherlands, and the total surface area of Hollandse Kust Sites VI and VII being 176 km², each Site allowing for the development of 60 turbine of at least 14 MW.



Source: offshoreWIND.biz [LinkedIn](https://www.linkedin.com)

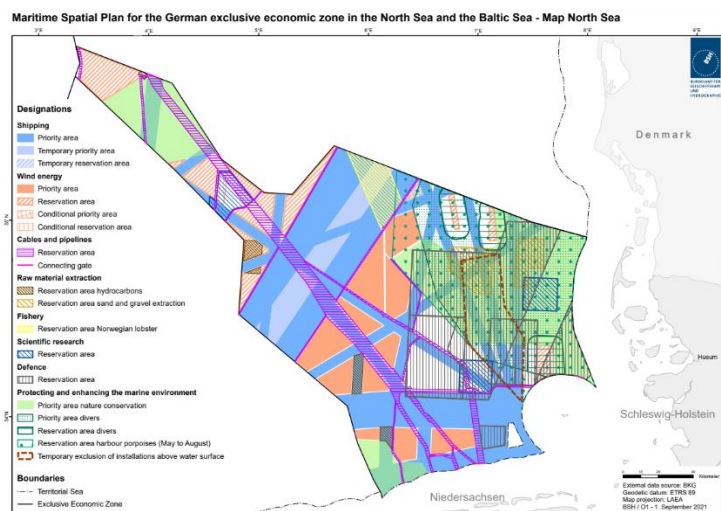
By way of a background and reminder: **Edition 32** of Low Carbon Pulse reported that during "the second week of December 2021 it was reported that the Dutch Government intended to expand its off-shore wind capacity, possibly through the development of a further 10.7 GW by 2030, from 11.5 GW to 22.2 GW, with newly designated zones in 1, 2 and 5-East (to accommodate an additional 8 GW), the IJmuiden Ver North (2 GW) and Hollandse Kust (700 MW). The development of this further capacity would align with the **EU's** commitment to reduce **GHG** emissions by 55% by 2030".

- **Gorges Day:** It was reported widely that on December 25, 2021, the China Three Gorges (CTG) connected to the transmission grid three off-shore wind field projects, together with combined installed capacity of 3.1 GW, the 1.1 GW Jianguo Rudong, the 300 MW Jianguo Dafeng H8-2 and the 1.7 GW Yangjiang Shapa.

- **Boxed in Day:** On December 26, 2021, [ocean-energyresources.com](https://www.ocean-energyresources.com) reported that Statkraft (leading renewable energy corporation, Europe's largest renewable energy generator) had been granted a foreshore licence by the Government of the Republic of Ireland.

The foreshore licence permits Statkraft to undertake marine surveys to determine the optimum location for its proposed €1 billion off-shore wind field project called the North Irish Sea Array, currently planned to be located 7 km and 17 km off shore of the coast of Dublin, Louth and Meath.

- **More of OWF for Germany:** On December 29, 2021 it was reported widely that the German Federal Maritime and Hydrographic Agency (**BSH**) has commenced updating maritime plans to accommodate an additional 3 GW of off-shore wind field capacity in the German sector of the North Sea.



Source: www.bsh.de

- **OX2 given legs offshore shore:**

- On December 30, 2021, [offshorewind.biz](https://www.offshorewind.biz) reported that OX2 had applied for a Natura 2000 permit to develop the 1.8 GW Triton off-shore wind field, located within the economic zone off the coast of Skåne, Sweden.

- On January 17, 2021, [offshorewind.biz](https://www.offshorewind.biz) reported that OX2 had been granted exploration permits for two off-shore wind fields in the Gulf of Bothnia Exclusive Economic Zone (EEZ): the permits were granted at a plenary session of the Finnish Government, and are in respect the Halla project (approximately 35 km off-shore the city of Raahel) and Laine project (approximately 30 km off-shore of the adjacent cities of Kokkola and Pietarsaari).

- **New York funds on-shore to go off-shore:** On January 6, 2022, [gcaptain.com](https://www.gcaptain.com) reported that New York State Governor, Ms Kathy Hochul, had announced a "nation leading" USD 500 million funding support investment for off-shore wind. The investment will support the development of ports, manufacturing, and supply chain infrastructure necessary for the development of off-shore wind fields.

The wind infrastructure plan of Governor Hochul supports the development of 4.3 GW of off-shore wind field capacity. New York State intends to develop 9 GW of off-shore wind field development by 2035. The New York State Energy Research and Development Authority is to launch the next off-shore wind field procurement for 2 GW of capacity in 2022.

- **Flotation Energy plans 500 MW off-shore Perth:** On January 10, 2022, [watoday.com.au](https://www.watoday.com.au) reported (under **UK firm pursues massive wind farm off Perth's coast**) that Flotation Energy intends to develop and 500 MW fixed bottom off-shore wind farm field around 20 kilometres off the coast of Perth, Western Australia, south of Rottnest Island.

- **Iberdrola to develop up to 3.5 GW of off-shore wind capacity in The Philippines:** On January 12, 2022, [rechargenews.com](https://www.rechargenews.com), reported that Iberdrola is considering options to develop five off-shore wind field development off-shore of The Philippines, with the five projects reported as having potential to install up to 3.5 GW of capacity.

- **BP and Equinor sign PSAs with New York:** On January 14, 2022, BP and Equinor announced the finalisation of Purchase and Sale Agreements (**PSAs**) with the New York State Energy Research and Development Authority (**NYSERDA**) for Beacon Wind 1 (see **Edition 8** of Low Carbon Pulse) and Empire Wind 2 (see **Edition 20** of Low Carbon Pulse).

Under the **PSAs** renewable electrical energy will be purchased and sold. The significance of the **PSAs** was signified by the attendance of US Energy Secretary, Ms Jennifer Granholm, the New York Governor, Ms Kathy Hochul, and US Congressman, Mr Paul Tonko (representing New York's 20th Congressional District).

- **The Philippine Government on the move:**

- The Philippine Government Clean Energy Scenario (**CES**), outlined in the Energy Plan 2020-2040, identifies the need to develop 92 GW of renewable energy by 2040. From assessments undertaken, The Philippines has over 170 GW of off-shore wind field capacity that could be developed to achieve the **CES**.

- On January 18, 2022, [pv-magazine-australia](https://www.pv-magazine-australia.com) reported (under **Philippines clears 62 PV projects totalling 1.3 GW for renewable portfolio standards**) that the Philippine Department of Energy had published a [list](#) of operational renewable energy projects eligible for renewable portfolio standards. The effect of being on the list is that electrical energy suppliers must source an agreed percentage of their electrical energy supply from one of the listed projects.

- **Blue Circle and CleanTech Global Renewables progress 1.2 GW OWF:** On January 20, 2022, [offshorewind.biz](https://www.offshorewind.biz) reported on progress of the development of the 1.2 GW off-shore wind field development project off-shore Bulalacao, Oriental Mindoro, The Philippines. Off-shore Oriental Mindoro is reported as being the best off-shore wind site in The Philippines.
- **Ørsted and Korea Southern Power and Korea Midland Power aligned:** On January 21, 2022 it was reported widely that Ørsted (leading renewable energy corporation) had signed memoranda of understanding with two **ROK** utilities, Korea Southern Power (**KOSPO**) and Korea Midland Power (**KOMIPO**) in respect of the proposed development of a 1.6 GW off-shore wind field development off shore Incheon. From earlier reports it seems likely that **KOSPO** and **KOMIPO** are seeking to share the renewable electrical energy generated.

Solar and Sustainability:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating.

- **Solar-plus-storage-facility:** On December 17, 2021, it was reported widely that EDF Renewables is to develop, build and operate a 100 MW / 100 MWh solar-plus-storage facility to provide electrical energy to the city of Iquitos, Peru (the largest city in the Peruvian Amazon) under a 20 year PPA with the Peruvian utility corporation Electro Oriente.
- **Solar allocations at Christmas:** On December 21, 2021, [pv-magazine](https://www.pv-magazine.com) reported that Israel had allocated more than 1.14 GW of photovoltaic solar and 210 MWh of **BESS** under two tenders.
The Ministry of Finance (**MOF**) announced that it had allocated 330 MW of photovoltaic solar capacity in the Negev desert to Shikun & Binui Energy Ltd at a bid price of USD 0.0272. The project includes 210 MWh of **BESS**.
The **MOF** announced that it had allocated a further 814 MW of photovoltaic capacity under its innovative photovoltaic projects tender. The [pv-magazine](https://www.pv-magazine.com) contains details of the corporations allocated capacity under this tender, including Prime Energy allocated 475 MW.
- **A look ahead to 2022: Edition 32** of Low Carbon Pulse (under **Addressing adverse pricing consequences and bottlenecks**) reported on the findings of **IEA Renewable Market Report** in particular that the increased costs of photovoltaic solar panels experienced during 2021 was likely to continue to during 2022.
The **IEA** report outlined the cost pressure points that have prevailed since the beginning of 2020: the price of photovoltaic grade polysilicon has increased over four-fold, the price of steel by more than 50%, aluminium by more than 80%, copper by more than 60%, and wait for it, freight costs have increased six-fold.
On December 27, 2021, [pv-magazine.com](https://www.pv-magazine.com) reported that notwithstanding these dynamics (and others) there was "a bright future for PV deployments in 2022" on the basis of forecasts from Corrine Lin of InfoLink. The brightest light in global demand remains the **PRC**, with photovoltaic solar installation expected to reach 70 GW during 2022, with total global demand to be in a 196 to 212 GW range, being a 20% increase on the 164 GW of photovoltaic solar capacity installed during 2021. The demand for solar is expected to be rise as solar and storage are stapled. Roof-top solar installations are expected to pass the 11 million mark globally, with continued strong growth in the leading German, Japanese, Australian and US markets, with energy storage expected to pass 1.5 million in homes.
- **Algeria opens 1 GW tender:** On December 28, 2021, [energy-utilities.com](https://www.energy-utilities.com) reported that the Ministry of Energy Transition and Renewable Energy had opened a tender for a 1 GW program. It is reported that the tender is seeking proposals for projects ranging from 50 MW to 300 MW to be located on 11 sites. The tender closes on April 30, 2022. The successful tenderers will develop the solar facilities under an independent power producer (IPP) model.
The tender is expected to be followed by a further three tenders in respect of like capacity during each of the three years 2022, 2023 and 2024. Algeria is understood to have around 423 MW of installed photovoltaic solar capacity, but the Algerian Government is targeting the installation of 16 GW of renewable energy capacity by 2035.
- **Lightsource BP "agri-solar" + BESS project proposed:** On January 11, 2022, [pv-magazine-australia](https://www.pv-magazine-australia.com), reported that lightsource bp, the solar arm of BP (leading international energy corporation), intends to develop a 520 MW (DC) agri-solar project, and 296 / 588 MWh **BESS** in the Upper Hunter Valley region of the State of New South Wales, Australia.
Agri-solar or agri-voltaics are now regarded as a viable option, and are gaining an increasing share of on-shore photovoltaic solar developments: agri-solar or agri-voltaics projects allow the continued use of farmland while at the same time yielding renewable electrical energy.
- **Woodside Energy Limited (WEL) photovoltaic solar project proposed:** On January 12, 2022, [pv-magazine-australia](https://www.pv-magazine-australia.com), reported that **WEL** intends to develop a 500 MW photovoltaic solar project in the Pilbara region of Western Australia. The renewable electrical energy generated will be used by WEL at its expanded Pluto LNG export facility and supplied to other industrial users within the Pilbara region. While the development was announced in May 2021, the final investment decision in respect of the expansion of the Pluto LNG export facility has provided the impetus to progress.

NZE Waste:

This section of considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.

To manage the length of this **Edition 33** of Low Carbon Pulse, **Edition 34** will include news items.

Land Mobility / Transport:

This section of considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.

In addition to the news on land vehicles under **GCC Countries**, the following news has struck the author as material and significant, and, in the case of eCargo bikes, novel yet practical.

- **Buses and coaches:**

9 metres & 32 seats = it for purpose: On December 23, 2021, [h2view.com](https://www.h2view.com), reported that a new hydrogen powered and propelled bus had been developed in India by Sentient Labs, the Council of Scientific and Industrial Research (**CSIR**) and the National Chemical Laboratory (**NCL**). The bus may be regarded as made for the Indian urban market, being a nine metre, 32 seat, vehicle, designed to travel 450 kilometres on 30 kg of hydrogen.

710 hydrogen fuel cell vehicles at the Olympics: The Beijing 2022 Winter Olympics start on Friday February 4, 2022. It is reported that 710 hydrogen fuel cell vehicles will be deployed at the Winter Olympics.

100% electric school buses in NY by 2035: On January 5, 2022, Governor of New York State, Ms Kathy Hochul, announced, in her first State of the State Address, that legislation will be introduced to mandate progress to move to 100% electric powered and propelled school buses by 2035.

624 hydrogen buses to be procured in ROK: On January 21, 2022, it was reported widely that the Government of **ROK** is to provide USD 157 million of funding support to enable the purchase of 624 hydrogen fuel cell powered and propelled buses. This funding support reflects the commitment of the Government of **ROK** to the decarbonisation of road travel.

- **eCargo bikes:** On January 6, 2022 it was reported widely that hydrogen powered and propelled eCargo bikes were being trialled in Aberdeen, Scotland. The eCargo bikes are badged as Electric Assisted Vehicles: they are four wheeled vehicles powered and propelled by a combination of pedalling and electrical energy, which means that they can use designated cycle lanes. An article in hydrogen-central.com provides detail.

- **Cars (including taxis):**

Hyundai to develop two new hydrogen fuel cell plants: On December 27, 2021, [carbuzz.com](https://www.carbuzz.com) reported that Hyundai Motor Group intends to invest USD 1.1 billion to develop two hydrogen fuel-cell production plants in the **ROK**. In addition, it is understood that Hyundai intends to progress with investments to derive hydrogen from plastic waste, with the by-line being that it is less expensive to produce hydrogen from plastic and other waste than using renewable electrical energy. This will be the subject of an article on bio-fuels and carbon neutral fuels in a sibling publication of Low Carbon Pulse during Q1 of 2022.

Toyota Motor Corporation (TMC) commits to enhance taxi fleet in Copenhagen: On January 7, 2022 (or thereabouts) it was reported that **TMC**, Everfuel and DRIVR had entered into a five year collaboration agreement intended to scale-up the number of hydrogen fuel-cell taxis in Copenhagen, Denmark.

- **Industrial Vehicles and Trucks:**

Pan-United Concrete plans to power and to propel: On January 5, 2022, Pan-United Concrete, subsidiary of the largest cement and concrete producer in Singapore, announced that it is working with Surbana Jurong in assessing retrofitting concrete mixers and tipper trucks with hydrogen fuel cell technology to displace the use of diesel.

As noted in previous editions of Low Carbon Pulse (and sibling publications), the cement and concrete industry gives rise to a greater mass of **GHG** emissions than the iron and steel industry: between 3,500 to 4,000 billion tonnes of **GHG** emissions arise each year from the production of cement. In addition to **GHG** emissions arising from the production of cement and concrete, the transportation of limestone (as feedstock to produce cement) and the transportation of concrete to the point of pour give rise to additional **GHG** emissions.

- **Trains:**

Deutsche Bahn to replace diesel trains with hydrogen trains: It has been understood for some time that Deutsche Bahn is to phase out its fleet of 1,300 diesel trains with hydrogen fuel-cell trains by 2050. This is part of the **H2goesRail** project. On December 6, 2022 it was reported widely that Green Hydrogen Systems (**GHS**) is to supply technology: the **GHS** HyProvide™ A90 electrolyser will produce hydrogen to power and to propel the Siemens trains. An announcement from [Green Hydrogen Systems](https://www.greenhydrogensystems.com) provides further detail.

Ports Progress and Shipping Forecast:

This section of considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use of carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland.

Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.

- **Port of Duisburg in the news:** On December 17, 2021, it was reported widely that the Port of Duisburg, Germany (and the largest inland port in Europe) had contracted with Rolls Royce Power Systems to supply mtu fuel cell hydrogen technology to ensure climate-neutral energy supply at a container terminal at the Port.

On December 28 2021, it was reported widely that Rolls-Royce Power Systems is developing mtu engines to be fuelled by methanol are planned to be made available for commercial vessels as soon as possible. Vice President Global Marine at Rolls Royce Power Systems, Ms Denise Kurtulus is reported to have said: "With new development of mtu methanol engines, we want to lead the way as pioneers in the marine industry. We are clearly committed to methanol as a power source for green shipping and want to set standards and create planning security for our customers".

The most complete articles that the author has read on these news items are from [splash247.com](https://www.splash247.com), and the [maritime-executive.com](https://www.maritime-executive.com).

- **PORA Highlights:** On December 24, 2021, the Port of Rotterdam Authority (**PORA**) released a [feature](#) outlining **10 highlights in the energy transition** at the Port of Rotterdam and the extended hinterland of the Port: the projects include the LyondellBasel circular steam project, the heat pipeline from Rotterdam to The Hague, the Porthos project (see [Edition 3](#) of Low Carbon Pulse), the Net Op Zee Hollandse Kust project, the Maasvlakte – Pernis pipeline (see [Edition 30](#) of Low Carbon Pulse), Green Hydrogen production facilities (see [Edition 27](#) of Low Carbon Pulse), the Shell biofuel production facility at Pernis (see [Edition 19](#) of Low Carbon Pulse), and the proposed Neste sustainable fuels production facility.



Source: [Port of Rotterdam LinkedIn](#)

- Port of Hanstholm fishing to land Power-to-X:** On January 5, 2022, [stateofgreen.com](https://www.stateofgreen.com) announced that the Danish fishing port, Port of Hanstholm, in Northern Denmark aims to be the first **CO₂** neutral fishing port in Europe. For this purpose the Port has entered into a letter of intent with European Energy (a Danish developer of renewable energy) to develop photovoltaic solar and on-shore wind renewable energy capacity. In addition, the development of a Power-to-X plant is being considered, to produce both e-methanol (being methanol produced using renewable electrical energy) and hydrogen. For more detail, see an article in [hydrogen-central.com](https://www.hydrogen-central.com) (dated January 4, 2022).

Airports and Aviation:

This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.

- De Havilland and ZeroAvia team:** On December 19, 2021 it was reported widely that De Havilland (leading Canadian aircraft manufacturer) is to work with ZeroAvia (a hydroge-electric aircraft developer) to develop a zero-emissions hydrogen fuel-cell powertrain for its Dash-8 , 400, airliner. ZeroAvia has been working with Alaska Airlines to retrofit the Dash-8-400, and Universal Hydrogen has been working with Air Nostrum, IcelandAir Group and Ravn Alaska to retrofit the smaller Dash-8-300.

Low Carbon Pulse - Edition 34

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading later in the week, welcome to Friday February 11, 2022 version of **Edition 34** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Monday January 24, 2022 to Sunday February 6, 2022 (inclusive of each day). [The November and December Report on Reports](#) will be included in the link to the [Second Low Carbon Pulse Compendium](#) during the course of next week.

Please click [here](#) for the **Second Low Carbon Pulse Compendium** containing **Editions 29 to 33** (covering October 6, 2021 to January 23, 2022) and [here](#) for the **First Low Carbon Pulse Compendium** (containing **Editions 1 to 28**, covering October 6, 2020 to October 5, 2021). Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

A Belated Lunar New Year:

A happy lunar new year to all readers of Low Carbon Pulse! Wishing you all a healthy and prosperous year of the Tiger! Gong xi fa cai!

Content of this Edition 34:

As the length of Low Carbon Pulse has increased, it has become apparent that a list of contents might assist the reader. Clicking on the contents list will take the reader to the section clicked:

LIST OF CONTENTS: EDITION 34 OF LOW CARBON PULSE			
Pages 2 & 3:	Timeline for 2022	Pages 17 to 18:	Carbon Accounting, Carbon Capture, Carbon Capture and Use and CDR;
Pages 3 & 4:	Legal and Regulatory Highlights	Page 18:	Carbon Credits, Hydrogen Markets & Trading
Pages 5 & 6:	Climate change reported and explained	Pages 18 to 20:	E-fuels and Future Fuels;
Pages 6 & 7:	GCC Countries	Page 20:	Green Metals / Minerals, Mining and Difficult to Decarbonise Industries
Pages 8 & 9:	Africa, India and Indonesia; Japan & ROK	Page 20:	Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories
Page 9:	PRC and Russia	Page 21:	Wind round-up, on-shore and off-shore;
Page 10:	Europe and UK; and Americas	Pages 21 and 22:	Solar, Sustainability and NZE Waste;
Pages 11 to 13:	France and Germany; and Australia	Pages 22 to 24:	Land Mobility / Transport
Pages 13 & 14:	Blue Green Carbon Initiatives & Biodiversity	Pages 24 to 26:	Ports Progress and Shipping Forecast
Pages 15 and 16:	Bioenergy and Heat Recovery	Page 26:	Airports and Aviation
Pages 16 & 17:	BESS & HESS (and other energy storage)	Page 26:	NZE Publications

Timeline for 2022:

- **Key conferences and publications: Edition 33** of Low Carbon Pulse identified events that may influence or impact progress to **NZE**. While the events identified will not be the only events that will influence or impact progress, they are events on the radar of the author as likely to do so. Each event, and progress in respect of each event, will be covered in Low Carbon Pulse as outlined below.

As noted in **Edition 33** of Low Carbon Pulse:

- The date of the [Fifth United Nations Conference on Least Developed Countries \(LDC5\)](#), scheduled to be held from January 23 to 27 2022, remains to be rescheduled;
- During February 2022 the International Panel on Climate Change (**IPCC**) was expected to have updated, and pretty much finalised, the **Summary for Policymakers** contained in the **Sixth Assessment Report – Climate Change 2021, The Physical Science Basis** published in August 2021 (and reported on in **Edition 24** of Low Carbon Pulse) (**2021 Report**). It is understood that this continues to be the plan.
- From February to September 2022 the **IPCC** will progress finalisation of its first comprehensive assessment report (**IPCC's Sixth Assessment Report**) since the **IPCC's** Fifth Assessment Report. The **IPCC's Sixth Assessment Report** will be based on reports from three Working Groups, I, II and III detailed as follows:
 - the findings of **Working Group I** (Physical Science Basis) as to the physical impact of climate change in the **2021 Report** (reported on in **Edition 24** of Low Carbon Pulse);
 - the assessment of **Working Group II** (Impacts, Adaption and Vulnerability) on the impact of climate change; and
 - the assessment of **Working Group III** (Mitigation of Climate Change) on the mitigation of the effects of, and progress to limit emissions causing, climate change.

The **IPCC** has alerted the media that from noon CET on February 28, 2022, the authors of Impacts, Adaption and Vulnerability (Working Group II's contribution to the **IPCC's Sixth Assessment Report**) will be available for interviews, tending to indicate that the report of Working Group II will be completed by the end of February.

If the report of **Working Group II** is published by the **end of February 2022** as scheduled, **Edition 37** will cover that report. If the report of **Working Group III** is published **during April 2022** as scheduled, **Edition 39** or **40** of Low Carbon Pulse will report on it.

Further, the **IPCC** has invited feedback on the first draft of the Synthesis Report of the **IPCC's Sixth Assessment Report**, the period to give feedback open through to March 13, 2022 (**Synthesis Report**).

In **September**, the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each Working Group, and in three Special Reports ([Global Warming of 1.5°C](#), [Climate Change and Land](#) and [The Ocean and Cryosphere in a Changing Climate](#)). The **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**. Neither part of the **Synthesis Report** will be anywhere near the length of each Working Group Report and each Special Report.

- **Edition 36** of Low Carbon Pulse will report on the inaugural **Middle East and North Africa Week**, organised under the auspices of the United Nations Framework Convention on Climate Change (**UNFCCC**), scheduled to be held from **February 28 to March 3 2022**, hosted by the United Arab Emirates (**UAE**). [Note: This event was postponed]
 - **Edition 37** of Low Carbon Pulse will report on the **IUCN Africa Protected Areas Congress (APAC)** scheduled to take place in Kigali, Rwanda from **March 7 to 12 2022**. **APAC** is the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on action required to establish and to preserve protected areas. [Note: This event was postponed]
 - **Edition 41** of Low Carbon Pulse will report on:
 - the **UN Biodiversity Conference (or COP 15)** rescheduled to take place in Kunming, Peoples Republic of China (**PRC**) from **April 25 to May 8 2022**;
 - the **XV World Forestry Congress** scheduled to take place held in Seoul, Republic of Korea (**ROK**) from **May 2 to May 6, 2022**, under the theme of **Building a Green Healthy and Resilient Future with Forests**; and
 - the **15th United Nations Conference on Diversification** scheduled to take place in the Côte d'Ivoire from **May 9 to May 21, 2022**.
 - **Edition 43** of Low Carbon Pulse will report on the **Stockholm+50** conference to take place in Sweden from **June 2 and 3, 2022**.
 - **Edition 44** of Low Carbon Pulse will report on:
 - the **G7 Summit** scheduled to take place at Schloss Elmau, Bavaria, Germany from **June 26 to 28, 2022**;
 - the **World Urban Forum 11** scheduled to take place in Katowice, Poland from **June 26 to 30, 2022**; and
 - the **UN Ocean Conference** rescheduled to take place in Lisbon, Portugal from **June 27 to July 1, 2022**.
- In addition, **Edition 44** will detail which editions of Low Carbon Pulse (during the balance of 2022) will report on:
- the **World Conference on Climate Change & Sustainability** which will take place in Frankfurt, Germany, from **August 22 to 24, 2022**;
 - the **77th session of the UN General Assembly** which will take place in New York City, New York State, the United States, from **September 13 to 27, 2022**;
 - the **Synthesis Report** which is scheduled to be published by **IPCC** during September 2022;
 - the **17th G20 Summit** which will take place in Bali, Indonesia, on **October 30 and 31, 2022**; and
 - the 27th session of the Conference of the Parties (**COP-27**), which will take place in Sharm El-Sheikh, South Sinai, Egypt from **November 7 to 18, 2022**. As with **COP-26**, Low Carbon Pulse will identify the key issues and themes ahead of **COP-27**.

- **By the end of Q1:**

- **Carbon Credits, Article 6 and the Paris Rulebook:**

The demand for carbon credits appears to be increasing at pace, in particular in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**.

In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions and, in the longer term, **NZE**, on the basis of carbon neutrality.

Previous editions of Low Carbon Pulse have covered the uses of words and phrases in this context, critically, the concept of carbon neutrality. Ultimately, decarbonisation is required, and decarbonisation takes time, and needs to be achieved across Scope 1, 2 and 3 emissions. To buy time, while still reducing **GHG** emissions on a net-basis, corporations buy carbon credits.

In the stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and as there appear to be increasingly calls for the regulation of the **Voluntary Carbon Market / Voluntary Carbon Credit Market**.

By way of reminder, **Edition 32** of Low Carbon Pulse noted that a publication entitled, [Why was it so significant that COP-26 completed the Paris Rulebook?](#) contained a high-level summary of the significance of the **Paris Rulebook** as follows:



- **Taxonomy and regulatory perspective included:**

The standalone article will include a taxonomy of terms used in the arena of carbon credits, and relevant more broadly.

In addition the standalone article will include perspectives on the need for the regulation of carbon credits and carbon credit markets, including to address the fact that not all carbon credits are created equal. These perspectives will tie back to Article 6 of the Paris Agreement and the Paris Rulebook.

Legal and Regulatory highlights:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.*

- **EU policy settings to achieve 55 by 30:** **Edition 32** of Low Carbon Pulse reported that on December 15, 2021, a package of legislation and policy settings was released by the European Commission (**EC**) providing a framework to decarbonise gas markets, to promote hydrogen production and use, and to reduce **CH₄** emissions.

This framework provided comprises a regulation and a directive - see links to each: [Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal markets for renewable and natural gases and for hydrogen](#) and [Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules the internal markets in renewable and natural gases and in hydrogen](#).

- **EU Green Taxonomy:** In addition, **Edition 32** of Low Carbon Pulse reported on the adoption of the **EU Green Taxonomy** and that its adoption and application may mean.

- **EU Green Taxonomy adopted:**

On December 9, 2021, the first climate delegated act (the [EU Taxonomy Climate Delegated Act](#)) was approved by the **EC**, and became law on January 1, 2022, confirming the adoption of the **Technical Screening Criteria**. Among other things, the **EU Green Taxonomy** provides:

1. a basis by reference to which corporations may report; and
2. **CO₂-e** intensity benchmarks for the energy sector (that are neutral as to technology) of 100 g **CO₂-e/kWh** as making a substantial contribution to climate mitigation, and 250 g **CO₂-e/ kWh** giving rise to significant harm.

- **What this does not mean and what is its practical application?**

As noted in **Edition 32**, the effect of the **EU Taxonomy Climate Delegated Act** is that the **EC** must use the **EU Green Taxonomy** to assess climate change adaptation and climate change mitigation activities, including to do no significant harm across environmental objectives.

Effectively, the **EU Green Taxonomy** does not define what technology must be used (hence it is neutral as to technology), but the technology used for the purposes of prescribed activities will be assessed against the **Taxonomy**, including the benchmarks, critically that of carbon intensity.

While the **EC** did not acknowledge formally that the **EU Green Taxonomy** might include natural gas or nuclear energy sources, informally the **EC** flagged that it might: Mr Frans Timmermans: " ... *nuclear and transition gas play a role in energy transition ... [but] that does not make them green*".

(A link is attached to the [ec.europa.eu website](http://ec.europa.eu/website) that contains relevant materials under **EU taxonomy for sustainable activities**.)

- **Badging natural gas and nuclear energy:**

Edition 32 of Low Carbon Pulse noted that: "**The EC will determine how to badge natural gas and nuclear energy by the end of 2021**".

- On January 1, 2022:

The **EC** began consulting with the Member States Expert Group on Sustainable Finance and the Platform on Sustainable Finance in respect of the draft text of a **Taxonomy Complementary Delegated Act** covering natural gas and nuclear activities (see **EC** press release entitled [EU Taxonomy: Commission begins expert consultations on Complementary Delegated Act covering certain nuclear and gas activities](#)). Consultation is required in respect of all Delegated Acts under the Taxonomy Regulation;

The **EC** stated that:

"The EU Taxonomy guides and mobilises private investment in activities that are needed to achieve climate neutrality in the next 30 years ...

The Taxonomy provides for energy activities that enable Member States to move towards climate neutrality ... the Commission considers that there is a role for natural gas and nuclear [power] as a means to facilitate the transition towards a predominantly renewable-based future [the EC Position]. Within the Taxonomy framework, this would mean classifying these energy sources under clear and tight conditions (for example, gas must come from renewable sources or have low emissions by 2035), in particular as they contribute to climate neutrality".

- On January 21, 2022, the consultation process ended. Following the end of the consultation process, the **EC** analysed the contributions made during the consultation process, ahead of the adoption formally of the **Taxonomy Complementary Delegated Act**. The **EC** has noted that in addition to the expert consultation process "it listened to feedback from the European Parliament".

- On February 2, 2022, the **EC** presented the [Taxonomy Complementary Climate Delegated Act](#).

As foreshadowed the **Taxonomy Complementary Climate Delegated Act** covers specified natural gas and nuclear activities.

In the context of the presentation of the **Taxonomy Complementary Climate Delegated Act**, the **EC** noted:

"The text sets out clear and strict conditions, under Article 10(2) of the Taxonomy Regulation [see the link above], subject to which certain [natural gas and nuclear] activities can be added as transitional activities to those already covered by the first Delegated Act on climate mitigation and adaptation applicable since 1 January 2022..."

"To ensure transparency, the Commission as today amended the [Taxonomy Disclosures Delegated Act](#) to that investors can identify which investment opportunities include [natural gas or nuclear] activities and make informed choices..."

- **Next steps:** The European Parliament and the European Council have four months to scrutinise, and to object to, the **Taxonomy Complementary Climate Delegated Act**.

Given the majorities required to object, it should be assumed that the **Taxonomy Complementary Climate Delegated Act** will become law.

- **Standalone article about EU Taxonomy:**

The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**.

In anticipation of the expiry of the four month scrutiny and objection period expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article.

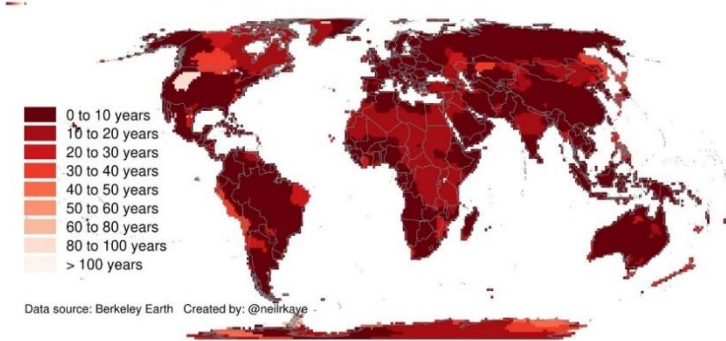
Climate change reported and explained:

This section considers news items within the news cycle of this **Edition 34** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.

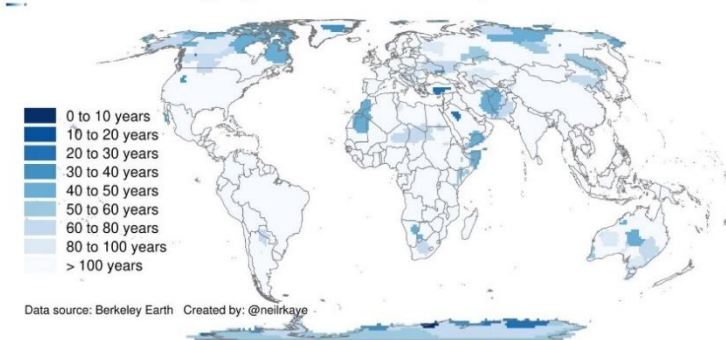
- **How long ago were the coldest and hottest years:**

The following maps demonstrate how long ago it was since each area of the world experienced its coldest and warmest years. These maps were developed by scientist Mr Neil Kaye.

How long ago was the hottest year on record

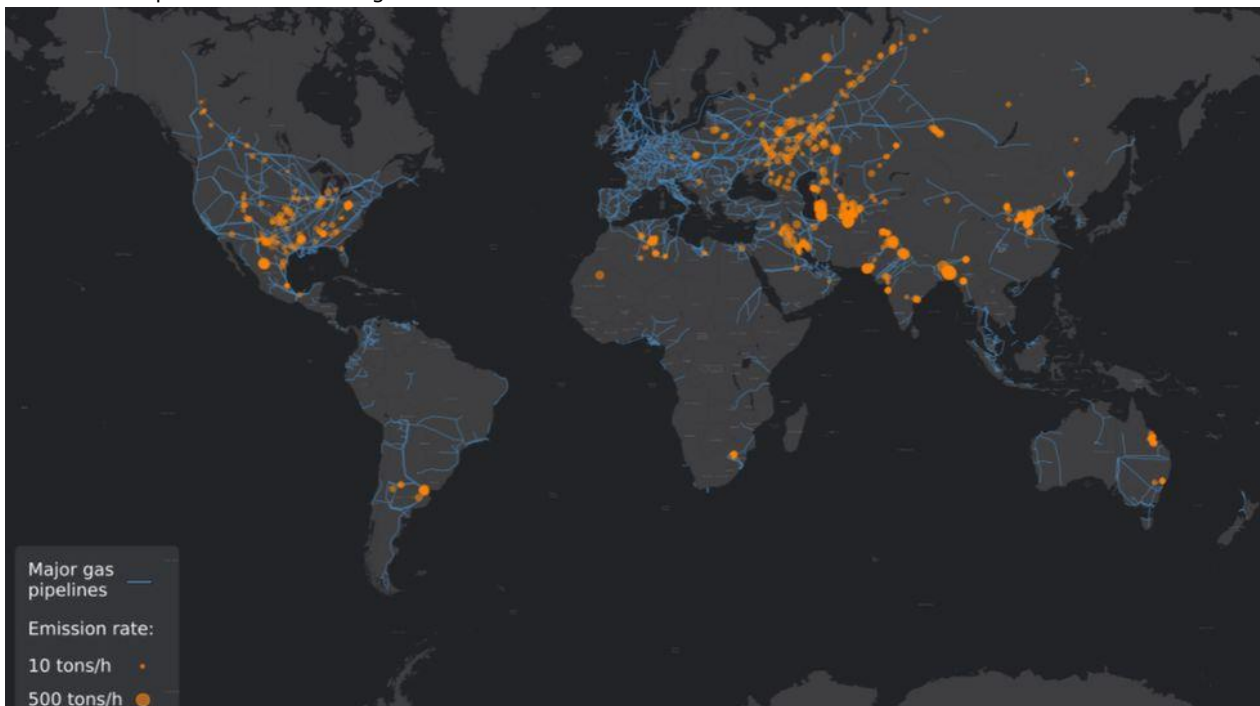


How long ago was the coldest year on record



- **Fugitive emission:**

- **Background:** Towards the end of the week beginning 31 January 2022, a number of news reports arose accompanied by the following representation of fugitive methane (**CH₄**) emissions. It is estimated that up to 6% of total **GHG** emissions globally arise from fugitive emissions from energy production, including on the production and transportation of natural gas.



- **Edition 24** of Low Carbon Pulse (based on the information from the **2021 Report**) noted that the reduction in **CH₄** emissions is important because the global warming potential of **CH₄**, as a **GHG**, in terms of potency per tonne, is greater than carbon dioxide (**CO₂**): a molecule of **CH₄** has a half-life of 9 years, compared to **CO₂** with a half-life of 100 years. Over 20 years, **CH₄** traps up to 84 times as much heat energy as **CO₂**.
- **Edition 27** of Low Carbon Pulse reported that on September 17, 2021, the **EC** and **US** announced a pledge (the **Global Methane Pledge**), given jointly, to reduce **CH₄** emissions by nearly a third within the next decade. **Editions 28** and **29** have reported on countries that have signed up to the Global Methane Pledge. The number of countries that have signed the Pledge is 103 as at February 4, 2022. While many countries have signed the Pledge, work needs to be done to implement the Pledge, considerable work.
- **Edition 29** of Low Carbon Pulse reported on International Energy Agency (**IEA**) **Curtailing Methane Emissions from Fossil Fuel Operations (CCH4R)**. The headline from the **CCH4R** is that the reduction in methane (**CH₄**) emissions is "among the most impactful ways to combat near-term climate change".

The **CCH4R** notes that:

"Methane has contributed around 30% of the global rise in temperature to date ... Emissions from fossil fuel operations present a major opportunity [to limit global warming in the near term] since the pathways to reduction are both clear and cost-effective".

- **News Coverage:**

The reason for the level of news coverage is tied to the publication in [Science](#) of a study undertaken by atmospheric scientist, Mr Thomas Lauvaux (at the Laboratory of Climate and Environmental Sciences, University of Scalay, France). The study identified and mapped "ultra-emitting" events, i.e., where a mass of greater than 25 tonnes of **CH₄** was released to the climate system. Mr Lauvaux used imagery from the Tropospheric Monitoring Instrument (TROPMI) for the purposes of the study.

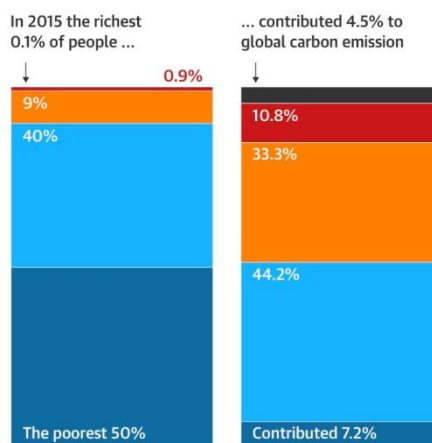
The coverage in The Economist noted that, "Two thirds of the ultra-emitting events were co-located with oil and gas production sites and pipelines, the rest came from coal production, agricultural or waste-management facilities".

The causes and sources of **CH₄** emission are known. The work of Mr Lauvaux is important because it locates areas for immediate action, and it raises the spectre that a greater mass of **CH₄** is being released to the climate system than previously estimated. There is more to do, and there is more to measure.

An [npr.org](#) article provides a fuller analysis of the underlying data and process under [A satellite finds massive methane leaks from gas pipelines](#).

- **The Guardian Graphic:** While it is known that developed countries have contributed to the mass of **CO₂** in the climate system overtime to a much greater extent than countries that are developing, The Guardian has produced a graphic that conveys a message that to many folk may not be a surprise.

The wealthiest 10% of people are responsible for nearly half the world's CO2 emissions



Guardian graphic. Source: Emissions-inequality.org

Note: The author has included the graphic to promote thinking, but has not verified that which it conveys.

GCC Countries:

This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the Gulf Cooperation Council (GCC) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.

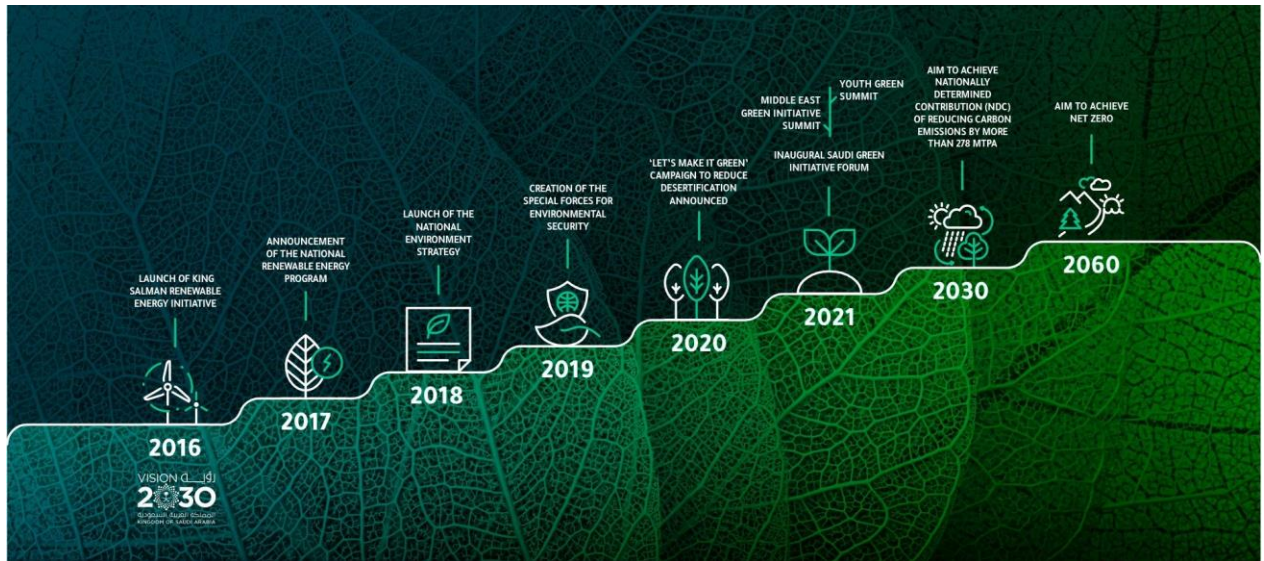
- **Background on Blue Carbon and Green Carbon initiatives:**

After a bumper pack of news during the period from December 17, 2021, to January 23, 2022 (see **Edition 33** of Low Carbon Pulse), there have been fewer news items in the news cycle for **Edition 34** of Low Carbon Pulse. Given these dynamics, this **Edition 34** covers the policy settings in the Kingdom of Saudi Arabia (**KSA**) and United Arab Emirates (**UAE**) to afforest and to restore the Blue Carbon and Green Carbon capacity within the Middle East, and to address environmental degradation generally.

- **KSA:**

The Saudi Green Initiatives (**SGI**) is intended to improve the quality of life and to protect future generations in the Kingdom of Saudi Arabia, and to support **KSA** in becoming an international leader in sustainability. All activities by Saudi Arabia to combat climate change comes under the auspices of the **SGI**.

The following timeline provides a helpful overview of the key elements of **SGI**:



The **SGI** comprises the following commitments and the initiatives are aligned with the three overarching targets to realise a green future: **1.** Reducing GHG Emission; **2.** Greening Saudi Arabia; and **3.** Protecting Land and Sea. In October 2021, at the **SGI Forum**, [60 initiatives](#) were unveiled, representing SAR 700 billion (or USD 190 billion) of investment.

In addition to initiatives aimed at achieving overarching targets within Saudi Arabia, the **SGI** commits Saudi Arabia to:

- [Global Ocean Alliance](#) – intended to protect at least 30% of global ocean in Marine Protected Areas and to achieve other effective area-based conservation measures;
- [Global Methane Pledge](#) – intended to reduce **CH₄** emissions by a third by 2030; and
- [Middle East Green Initiative](#) – intended to address climate change through regional collaboration (announced in March 2021) – including the 50 billion tree initiative across Middle East.

The initiatives outlined at the **SGI Forum** build on the commitments from April 2021 to conserve and to restore, and then to manage, sustainably, one billion hectares of land by 2040 and to plant 10 billion trees (effectively rehabilitating and restoring 200 million hectares of *degraded* land).

In the context of the target of planting 1 trillion trees (see **Edition 33** of Low Carbon Pulse) globally to restore degraded land, the **KSA** is committed to achieving 4% of this global target.

As part of the broader 2021 plan to conserve and to restore, and then to manage, sustainably one billion hectares of land by 2040, 30% of the land mass of the **KSA** (600,000 million km²) is to be conserved within protected areas, with particular focus on coastal environments.

- **UAE:**

On February 4, 2022, the **UAE** celebrated its 25th National Environment Day, two days after World Wetlands Day (see below under **WorldWetlandsDay**). The theme for the current year is Climate Action Now.

Responding to climate change and environmental degradation is not new in the UAE:

1. In 1989 **UAE** ratified the Vienna Convention for the Protection of the Ozone Layer, and its Montreal Protocol;
2. In 1995 **UAE** joined the United Nations Framework Convention on Climate Change (**UNFCCC**);
3. In 2005 **UAE** ratified the Kyoto Protocol;
4. In 2015 **UAE** became a party to the Paris Agreement; and
5. in 2023 **UAE** will host 28th session of the Conference of the Parties (**COP-28**).

While the key policy setting in the **UAE** may be said to arise under **The National Climate Change Plan** of the **UAE**, there are many initiatives that are progressing the decarbonisation of:

1. Electrical energy generation;
2. Increased energy efficiency;
3. Transportation, to ensure sustainable transportation (see the **Abu Dhabi Transportation Mobility Management Strategy**, **Surface Transport Mast Plan (Abu Dhabi)**, **Dubai Autonomous Transportation Strategy**, and **Dubai Green Mobility initiative**);
4. Sustainable Environment and Infrastructure ([UAE Vision 2021](#) focuses on improving air quality, treatment of waste, and preserving water resources, consistent with the [National Agenda](#)).

Africa:

*This section considers news items within the news cycle of this **Edition 34** of Low Carbon Pulse relating to Africa. Africa remains the continent with most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.*

- **Botswana-Namibia 5 GW Green Hydrogen project:**

Edition 26 of Low Carbon Pulse (**under Green Hydrogen from Namibia**) stated that Germany was to partner with Namibia to allow the production and export of Green Hydrogen from Namibia and transportation and import into Germany at a price of USD 1.8 per kg.

Namibia has world class renewable energy resources, with over 3,500 hours of sun each year, and strong wind resources. These world class resources are considered close to ideal for the production of Green Hydrogen at a price of between €1.50-2 per kg. It was estimated that up to 1.7 million metric tonnes per annum of Green Hydrogen could be produced by 2030. This mass of Green Hydrogen production delivered into Germany would be close to sufficient to decarbonise the German iron and steel industry given its current rate of production.

On January 31, 2022, pv-magazine.com reported that plans for a Green Hydrogen Project in Botswana and Namibia had expanded from 1 GW to 5 GW to be powered by photovoltaic solar electrical energy. Further detail will be reported in due course.

- **Egypt 1 GW Waste to Hydrogen project:**

Sibling publication, [Hydrogen for Industry \(H24I\)](#) provides an overview of the potential and science behind the use of waste and waste water to derive and to produce hydrogen.

On February 2, 2022, it was reported widely that H2-Industries is to develop a USD 3 billion, 1 GW, waste to hydrogen production facility at East Port-Said, Egypt (in the Suez Canal Economic Zone). It is understood that H2-Industries is to use organic and inorganic waste streams, and waste water, as feedstock for the production of clean hydrogen.

It is understood that the waste to hydrogen production facility will process up to 4 million metric tonnes a year of feedstock, from which up to 300,000 metric tonnes of clean hydrogen will be derived each year.

- **Rwanda and TotalEnergies energised:** At the end of January and start of February 2022 it was reported widely that the Rwanda Development Board and TotalEnergies had signed a memorandum of understanding to collaborate in the development of range of energy projects. It is understood that the energy projects contemplated include hydro-electric generation, electric and energy storage systems, and a Nature Based Solutions for carbon storage.

India and Indonesia:

*This section considers news items within the news cycle of **Edition 34** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.*

- **Air Liquide and Pertamina looking at clean hydrogen projects:** On January 24, 2022, h2-view.com reported that Air Liquide and Pertamina had signed a memorandum of understanding (**MOU**) to assess the basis upon which Indonesian industry may be decarbonised, and how Air Liquide and Pertamina may work together in a manner aligned with the achievement of **NZE** by 2060 across Indonesia. As might be expected, it is reported that the **MOU** will focus on the decarbonisation of the activities of Pertamina across Indonesia, including the use of clean hydrogen.

- **Giga-scale electrolyser capacity:** On January 27, 2022, h2-view.com, reported that HydrogenPro and Larsen & Toubro intend to work jointly to establish a joint venture to expand electrolyser manufacturing capacity in India and to promote the use of hydrogen in India.

While at the memorandum of understanding stage, the plans appear reasonably developed in terms of the electrolyser technology (the alkaline water electrolyzers of HydrogenPro) and site identification.

- **Reliance hub plans:** At the end of January and start of February 2022 it was reported widely that Reliance Industries (leading conglomerate, headquartered in India) intends to invest up to USD 75 billion in renewable energy infrastructure, including for the purposes of powering electrolyzers to produce Green Hydrogen.

It has been suggested that all of the renewable energy infrastructure may be dedicated to the production of Green Hydrogen. Mr Gagan Sihu, director at the Centre of Energy Finance, at New Delhi based think-tank CEEW, said that: "Reliance is preparing itself to capture the entire value chain of the green hydrogen economy".

- **India Hydrogen Alliance – January 2022:** Attached is the link to the January edition of [India H2 Monitor – January 2021](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the context of the **India H2 Monitor**.

Japan and Republic of Korea (ROK):

*This section considers news items within the news cycle of this **Edition 34** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

- **Hyosung on song:** On February 4, 2022, hydrogenfuelnews reported that Hyosung Group (an industrial conglomerate) is to invest USD 835 million in the development and deployment of Green Hydrogen production facilities in South Jeolla Province.

- **HESC:** The big news (covered in **Editions 32** and **33**) has been the successful passage of the **MV Suiso Frontier** to Australia, loading of liquid hydrogen, and its return to Kobe, Japan (see under **Australia, If you say so**): the final piece in the jig-saw puzzle that is the Hydrogen Energy Supply Chain (**HESC**) from Australia to Japan.

As will have been apparent from previous editions of Low Carbon Pulse, Japanese corporations are essential to all links in the **HESC**, and the progress, and the success, of its development.

As noted in **Edition 10** of Low Carbon Pulse:

"Among other things, the Hydrogen Energy Supply Chain uses the Kawasaki Heavy Industries (**KHI**) designed and built **LHG** carrier (the Suiso Frontier) to deliver **LHG** to the **KHI** designed and built **LHG** terminal at Kobe, Japan.

The Hydrogen Energy Supply Chain project showcases cooperation and dedication of Japanese and Australian corporations. The corporations involved in the **HESC Project** are **KHI**, Electric Power Development Co., Ltd (J-Power), Iwatani Corporation, Marubeni Corporation, Sumitomo Corporation, and AGL Energy, investing in Australian end of the supply chain, and Shell, ENEOS Corporation and Kawasaki Kisen Kaisha, Ltd (K-Line), investing in the Japanese end of the supply chain."

PRC and Russia:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the **PRC** and Russia, being countries that give rise to the most and the fourth most **GHG** emissions.*

- **Russia able to become leading Hydrogen exporter:** On January 27, 2022, [h2-view.com](https://www.h2-view.com) stated that the Tass News Agency had reported on comments from Russian President, Mr Vladimir Putin, while meeting with Italian business leaders. It is understood the President Putin said that: "Russia can become one of the world's largest hydrogen producers and exporters by 2035."

Consistent with statements made previously, President Putin noted that the development of hydrogen production capacity reflects the intention "to reach net zero by 2060, simultaneously keeping sustainable economic growth".

- **Hydrogen Production commences:**

- **In time for the Beijing Winter Olympics:** On January 28, 2022, it was reported widely that Shell has commenced production of Green Hydrogen at its 20 MW Zhangjiakou facility, in northern China. The development of the Zhangjiakou facility has been undertaken and completed by Shell in joint venture with Zhangjiakou City Transport Construction Investment Holding Group.

The commencement of the production of Green Hydrogen is timely, with the Beijing Winter Olympics starting on February 4, 2022. After the Olympics, the Green Hydrogen from the Zhangjiakou facility will be used to power and to propel commercial and public transport vehicles in the Beijing-Tianjin-Hebei region, with the hydrogen production capacity of the facility to increase from 20 MW to 60 MW over the next two years or so.

It has been reported that all 26 Olympic venues for the Beijing Winter Olympics are powered by renewable energy. As noted in **Edition 33** of Low Carbon Pulse, this includes the use of over 700 hydrogen fuel cell vehicles.

- **In time for Christmas, 2021:** In early February, in the context of news reports about the commencement of production of Green Hydrogen at the 20 MW Zhangjiakou facility, BloombergNEF noted that on December 22, 2021, commencement of production of hydrogen commenced at the 150 MW Baofeng Energy Group electrolyser (a chemical manufacturer), in Ningxia, north central China. The commencement of production at the Baofeng Energy Group facility had rather gone under the radar.
- **Hydrogen Production expected:** For the time being, the 150 MW Baofeng Energy Group electrolyser is the largest deployed, but Sinopec (one of the big three Chinese oil and gas state-owned corporations) is developing a 260 MW alkaline electrolyser production facility in Xinjiang, north west China.
- **Off-shore wind at gale force:** **Edition 33** of Low Carbon Pulse (under **Gorges Day**) reported that on December 25, 2021, the China Three Gorges (**CTG**) connected to the transmission grid three off-shore wind field projects, together with combined installed capacity of 3.1 GW, the 1.1 GW Jiangsu Rudong, the 300 MW Jiangsu Dafeng H8-2 and the 1.7 GW Yangjiang Shapa.

The **CTG** connection of 3.1 GW was illustrative of the level of off-shore wind generation capacity installed in the **PRC**. On January 26, 2022, [Forbes.com](https://www.forbes.com) reported that in 2021 the **PRC** connected more off-shore wind than "every other country in the world had managed to install in the last five years".

Data from the PRC's **National Energy Administration** indicate that a little under 17 GW of off-shore wind capacity was installed in 2021. Of the total global installed off-shore wind capacity of 54 GW, the **PRC** has 26 GW.

- **CCS Project completed:** On January 31, 2022, it was reported widely that Sinopec had completed the first 1 million metric tonnes per year CCUS. The article in [hydrocarbonprocessing](#) (under **Carbon+Intel: Sinopec completes China's first megaton scale CCUS project**) provides the background and facts and stats.

The speed of the development of the project is marked. **Edition 21** of Low Carbon Pulse reported as follows:

"On July 5, 2021, China Petrochemical Corporation (**Sinopec**) announced the development of a CCUS project (reportedly the largest in the **PRC**, megaton-scale). The project is to use the Sinopec Qilu-Shengli Oilfield for CCUS, taking **CO₂** arising and captured from Sinopec's Oil refinery, in Shandong province, and to inject that **CO₂** into 73 wells to the Qilu-Shengli Oilfield as part of an enhanced oil recovery (**EOR**). It is understood the **Sinopec** is considering the development of further CCUS projects."

- **Natural gas deal:** On February 4, 2022, it was reported widely that the **PRC** and Russia had agreed to the sale and purchase of natural gas (Gazprom selling natural gas to CNPC purchasing), to be delivered via a new natural gas pipeline. It is understood that the contract is a 30 year contract for 10 billion m³ of natural gas a year.

This is not a first: Russia is already delivering natural gas via the Power of Siberia pipeline (in addition to liquefied natural gas (LNG)).

Leaving to one side the geo-political dimensions of the natural gas deal, in the context of **NZE**, what is telling is the term of the deal (30 years) and apparent increase in the quantity of natural gas to be delivered from Russia to the **PRC**: it is understood that by 2025 38 billion m³ of natural gas was to be delivered each year via the Power of Siberia Pipeline. The new natural gas deal appears to take the natural gas sales to 48 billion m³ a year by 2025.

Europe and UK:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to countries within the European Union (EU) and the EU itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards NZE. In combination, countries comprising the EU give rise to the most GHG emissions after the Peoples Republic of China (PRC) and the US. The UK is a top-twenty GHG emitter, but has been a front-runner in progress towards NZE.*

- **EU across-borders:** On January 26, 2022, ec.europa.eu (under [EU invests over €1 billion in energy infrastructure in support of the Green Deal](#)) reported that EU member states have agreed on a EC proposal to invest €1.037 billion in five cross border infrastructure projects under the Connecting Europe Facility (CEF).
The largest amount of funding from the CEF is the €657 million to support the development of the EuroAsia Interconnector project to connect Cyprus with the European Grid – see **Editions 23** and **32** of Low Carbon Pulse.
Other projects receiving funding support from the CEF are the Baltic Synchronisation Project Phase II to support the improvement of integrity and stability of the grid in Poland and upgrading transmission infrastructure in Estonia, Latvia and Lithuania (€170 million), the Aurora Line to support the development of a third transmission line between Finland and Sweden (€127 million), the Chiren Expansion to increase natural gas storage capacity in Bulgaria (€78 million) and Norther Lights Project Phase II which is to receive €4 million for a study to assess the expansion of the CO₂ transportation and storage capacity of the North Lights Project (see **Editions 11, 20, and 31** of Low Carbon Pulse).
- **EU gross electrical energy:** pv-magazine.com reported (under [Solar the fastest growing European clean power source](#)) on the [data](#) released by Eurostat on electrical energy consumption across the EU. The data was released on January 26, 2022. The headline is that renewable electrical energy contributed 37% to gross electrical energy consumption in 2020. Photovoltaic solar continues as the fastest growing renewable energy source in the EU.
- **Final UK GHG national statistics:** On February 1, 2022, the UK Government, Department for Business, Energy & Industrial Strategy, published, from National Statistics, (**Final UK greenhouse gas emissions national statistics: 1990 to 2020**). The publication will be considered in the **January and February Report on Reports** to be contained in the Appendix to the Second Compendium of Low Carbon Pulse published with **Edition 37** of Low Carbon Pulse.
- **UK establishes a Hydrogen Policy Commission:** At the end of January it was reported widely that a Hydrogen Policy Commission (HPC) has been established for the purposes of identifying and avoiding policy setting and implementation pitfalls.
The first scheduled task of the HPC is to undertake an assessment of the UK Hydrogen Strategy (UK H2S) released on August 17, 2021 (and reported on in **Editions 25** and **26** of Low Carbon Pulse, and the [Report on Reports – Edition 1](#)). In this context, consistent with many commentators, the HPC will assess whether or not the UK H2S is ambitious enough.
- **UK launches CfD change consultation process:** On February 4, 2022, the UK Government launched an open consultation process [Contracts for Difference \(CfD\): proposals for changes to supply chain plans and CfD delivery](#). The consultation process ends at 11.45 pm on March 15, 2022.
- **UK CCS and CCUS business model update:** On December 21, 2022, the UK Government, Department for Business, Energy & Industrial Strategy published updates on the proposed commercial frameworks for transport and storage, power and industrial carbon capture business models – [Transport and storage business model: January 2022 update](#) and [Transport and Storage – heads of terms: January 2022 update](#).
- **Edition 33** of Low Carbon Pulse contemplated that this **Edition 34** of Low Carbon Pulse would cover in detail the applications made for funding to develop **Track 1 Clusters**. To manage the length of this **Edition 34**, all being well this update will be provided in **Edition 35**.

Americas:

*This section of considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most GHG emissions.*

- **More thinking about a NZE electrical energy network:** **Edition 29** of Low Carbon Pulse reported (under [Oversize is the right size](#)) on [research](#) done Caldeira on the size and shape of renewable electrical energy capacity, and energy storage capacity, development in the US.

In summary:

"The headline from the research is that in some countries it should be possible to match renewable electrical energy to load by the installation of a combination of photovoltaic solar and wind renewable electrical energy capacity having in combination equalling 150% of standard generation capacity and with nearly four hours of BESS capacity. This combination will result in load matched by dispatch in respect of all but 200 hours in a 8,760 hour standard electrical energy year."

In January 2022, the National Renewable Energy Laboratory (NREL) of the US Department of Energy published [Grid Operational Impacts of Widespread Storage Deployment](#) (one of a number of publications in a series about the [Storage Future](#)).

The study contains a number of scenarios as progress is made to NZE by 2050. One of the scenarios is a Reference Scenario. Under the scenarios there is a range of energy storage capacity development – a 213 GW to 932 GW range, with an average energy storage duration ranging from 4.7 to 6.5 hours.

The **January and February Report on Reports** will consider the conclusions of the NREL study. The **January and February Report on Reports** will be included in the Appendix to the **Second Compendium of Low Carbon Pulse** to be published (in updated form) at the same time as **Edition 37** of Low Carbon Pulse.

France and Germany:

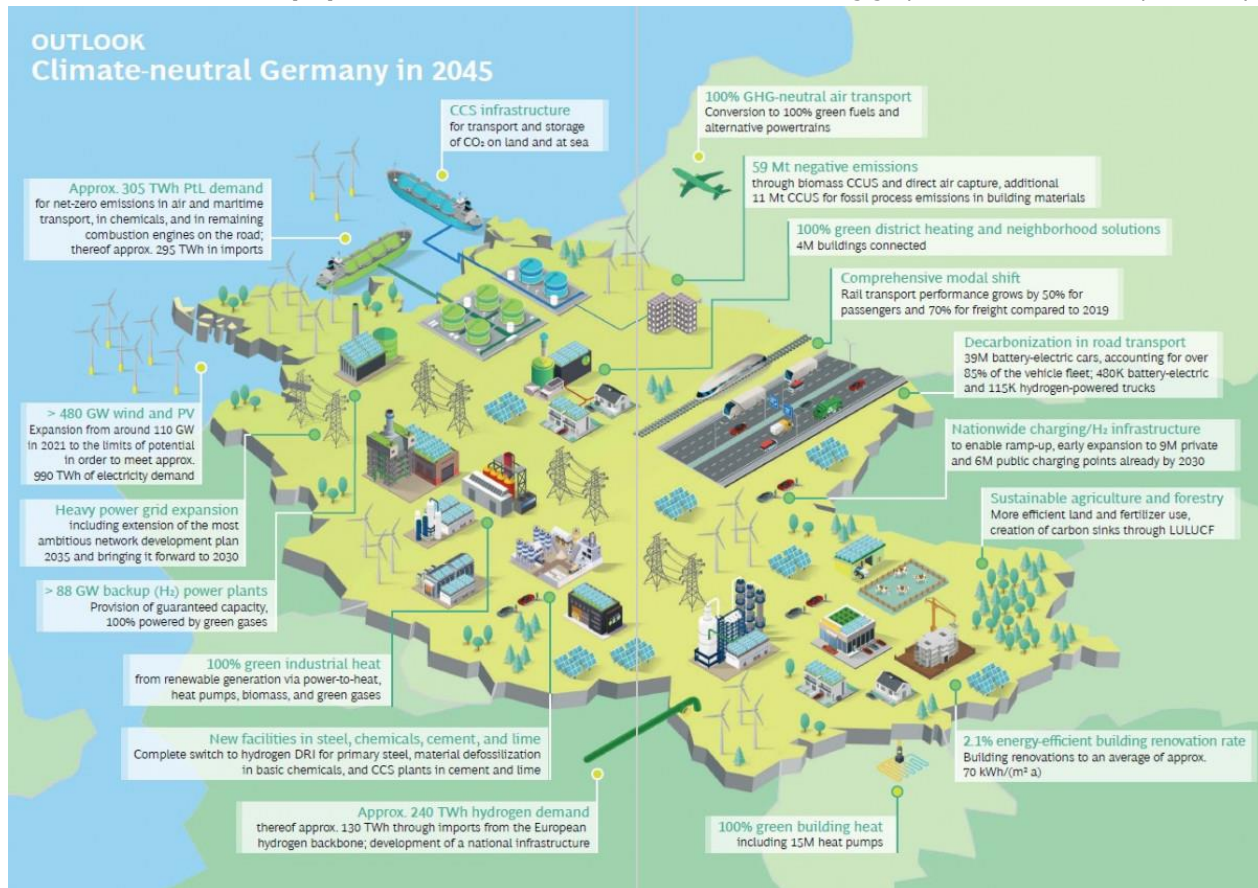
This section considers news items within the news cycle of this **Edition 34** of Low Carbon Pulse relating to France and Germany.

- **Hamburg continues progress:**

A number of previous editions of Low Carbon Pulse have covered initiatives in respect of Hamburg and the Port of Hamburg – see **Editions 9, 12, 13, and 32** of Low Carbon Pulse.

On February 4, 2022, it was reported widely that the Hamburg Port Authority (**HPA**) and Air Projects (one of the big three global industrial gas corporations with Air Liquide and Linde) are working to develop a comprehensive hydrogen supply / value chain across the Port of Hamburg. Given the location of the Hamburg and the Port of Hamburg, and other activities within Hamburg and more broadly across northern Europe the supply / value chain initiative might be expected to support supply and demand development.

- **Carbon Neutral Germany by 2045:** The author has come across the following graphic which tells a complete story:



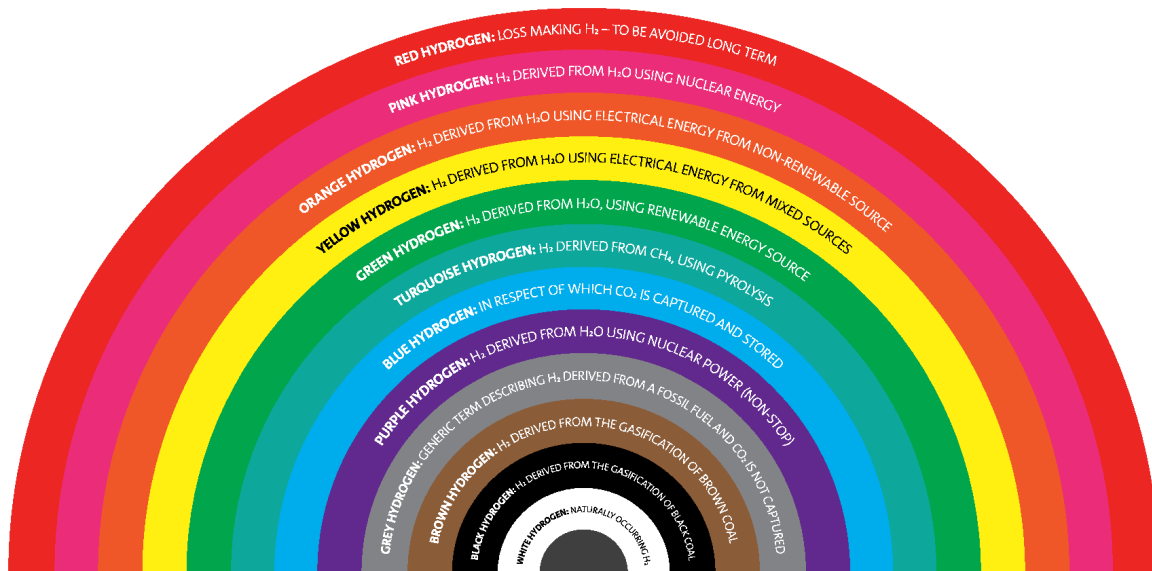
Australia:

This section of considers news items that have arisen within the news cycle of this **Edition 34** Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita.

Australia is however progressing to **NZE** at a faster rate than many other developed countries, and, along with the GCC Countries, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.

- **Northern Territory (NT) in the mix:** On January 25, 2022, [pv-magazine-australia](#) (under **NT hydrogen ambitions grow as FRV signs agreement with Aussie exploration company**) provides an overview of the development of hydrogen production [projects](#) in the **NT**, with a focus on the Hexagon Energy's hydrogen project. Hexagon Energy (Hexagon Energy Materials Limited) is reported to have signed a non-binding memorandum of understanding with FRV (a renewable energy project development corporation). Future editions of Low Carbon Pulse will follow progress.
- **A new gold rush:** On February 2, 2022, [pv-magazine-australia](#) (under **Natural hydrogen exploration "boom" snaps up one third of South Australia**) reports on the phenomenon of prospecting for natural hydrogen arising in the context of a range of geological and geothermal settings.

Natural hydrogen, described as White Hydrogen in the Ashurst Hydrogen Rainbow, appears to have been given a new moniker, Gold Hydrogen.



Ashurst Hydrogen Rainbow ©Ashurst 2021

Note: Some authors / commentators use Purple Hydrogen to refer to the production of hydrogen using coal or petcoke gasification using CCS to capture the CO₂ arising.

In South Australia, White Hydrogen is being referred to as Gold Hydrogen, reflecting the rush to acquire exploration licenses

While it remains to be seen whether the "mining" of Gold Hydrogen can be undertaken to scale commercially, Australia has a range of geological and geothermal settings in which natural hydrogen arises.

For further background on natural hydrogen in the Australian context, see the **CSIRO** (Commonwealth [of Australia] Scientific and Industrial Research Organisation, being the national science agency of Australia), report [Hydrogen in Australian natural gas: occurrences, sources and resources](#).

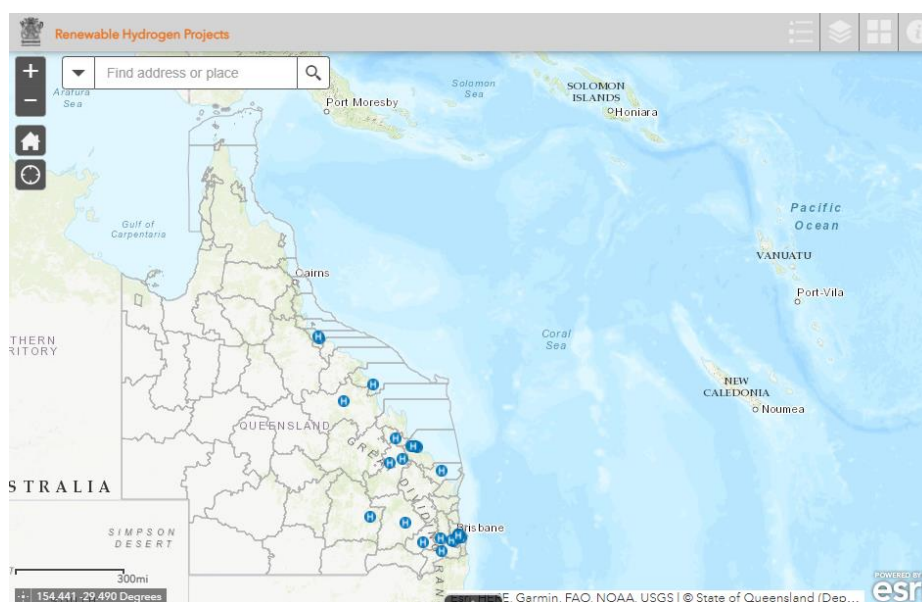
- **If you say so: Edition 32** of Low Carbon Pulse reported that it was likely that the **MV "Suiso Frontier"** (see Editions 2, 8, 10 and 17 of Low Carbon Pulse) built by Kawasaki Heavy Industries Limited (**KHI**), and owned by HySTRA, would travel to Australia during December 2021 to load, to transport and to deliver to Kobe, Japan, the first cargo of liquid hydrogen (**LH₂**) as the Hydrogen Energy Supply Chain (**HESC**) project progresses (see Editions 10 and 12 of Low Carbon Pulse).

On December 24, 2021, the **Suiso Frontier** left Japan, docking at the Port of Hastings, Victoria, Australia, on January 20, 2022. The arrival of the **Suiso Frontier** was marked by an arrival ceremony. The arrival of the **Suiso Frontier** marks the final piece in the jigsaw puzzle called the **HESC**.

The concept of the **HESC** was developed in 2015 (long before hydrogen plans, road maps and strategies became common), and involved forward thinking folk committing to the development of the **HESC**, including forward-thinking by the Federal Government of Australia, in particular the funding support that it provided.

On January 31, 2021, the **Suiso Frontier** departed the Port of Hastings, Victoria, Australia headed back to Kobe.

- **Queensland Hydrogen Map:** As covered in previous editions of Low Carbon Pulse, the State of Queensland, Australia, is hosting many hydrogen and ammonia project developments. On February 4, 2022, the Department of State Development provided [background](#) and launched a map of the project development across the hydrogen supply / value chain.



- **South West REZ interest: Edition 30** of Low Carbon Pulse reported that: "On November 1, 2021, it was reported widely that the NSW Government had invited registrations of interest for its third renewable energy zone (**REZ**) – the **South West REZ**. There are three more **REZs** to come to market, the **Illawarra REZ** and the **Hunter-Central Coast REZ**. Please click [here](#) to view the NSW Government's electricity roadmap.

NSW REZS – THE STORY SO FAR...	
Central West Orana REZ – interest expressed by the private sector to develop 27 GW of renewable electrical energy capacity	New England REZ – interest expressed by the private sector to develop 34 GW of renewable electrical energy capacity

On November 11, 2021, [pv magazine](#), reported that Australia's first coordinated renewable energy zone is to be built in the central west of NSW, the **Central-West Orana REZ**.

The **Central-West Orana REZ** will deliver up to 3 GW of renewable electrical energy into the grid. The development of the **Central-West Orana REZ** is aligned with the NSW Government policy setting of the development and deployment of 12 GW of renewable electrical energy and 2 GW of BESS by 2030.

It is understood that the **Central-West Oran REZ** was preferred as the first **REZ** to be developed because of the level of investment in renewable electrical energy development already underway in the Central-West region.

It will be interesting to follow the developing of the NSW **REZ** development as Australia's most populous State progresses to the development and deployment of 12 GW of renewable electrical energy capacity across the State (see **Edition 4** of Low Carbon Pulse)."

On February 4, 2022, the NSW Government reported that it had received registrations of interest (**ROI**) for the **South West REZ** in respect of 34 GW of renewable electrical energy capacity.

The CEO of Energy Corporation NSW, Mr James Hay said that the level of ROIs received from industry was "outstanding". Mr Hay said that: "There were 49 registrations totalling over 34 GW from potential generation and storage projects – 13 times the intended capacity for the South-West REZ, which will be no less than 2.5 GW".

Low Carbon Pulse has noted on a number of occasions, that the States and Territories of Australia continue to blaze a trail to **NZE**. This is another instance of this trail blazing, noting always, that the private sector is key to the continued progress to **NZE**.

Blue and Green Carbon Initiatives and Biodiversity:

*This section considers news items that have arisen within the news cycle of this **Edition 34** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.*

WETLANDS A CALL FOR ACTION

NATURAL WETLANDS ARE DISAPPEARING THREE TIMES FASTER THAN FORESTS

- 35% of global wetlands lost in 55 years (1970-2015)
- 85% lost since 1700s

WHAT LOSS OF WETLANDS MEANS

FOR PEOPLE

- Water scarcity
- Exposure to flooding and extreme weather events
- Lost livelihoods and well-being
- Flood insecurity

FOR THE PLANET

- Biodiversity decline
- Increased carbon and methane emissions
- Loss of natural freshwater filtration

TAKE THREE ACTIONS

- VALUE WETLANDS**: BIODIVERSITY HOTSPOTS, FRESH WATER STORES, CARBON SINKS, SOURCE OF LIVELIHOODS
- STOP DRAINING**: THE LIFE FROM WETLANDS USE WISELY
- REWET REFOREST RESTORE WETLANDS**

SOME WETLANDS TO LOVE

PEATLANDS Pantane Marshes - France Foreland Basin - Peru	CORAL REEFS Great Barrier Reef - Australia	MANGROVES Sundarbans - Bangladesh
MARSHES Okavango Delta - Botswana	FLOOD PLAINS Pantane - Brazil, Bolivia, Paraguay	ESTUARIES Severn Estuary - UK
COASTLINES Amalfi Coast - Italy	SWAMPS Everglades - USA	BOGS Cuvette Centrale - Republic of Congo

VALUE - MANAGE - RESTORE - LOVE

#WorldWetlandsDay #ActForWetlands www.worldwetlandsday.org

World Wetlands Day 2 February 2022
Wetlands Action For People and Nature

- **WorldWetlandsDay:** Wednesday February 2, 2022, was World Wetlands Day. As noted in previous editions of Low Carbon Pulse, "wetlands" is a generic term that includes mangrove swamps, bogs, estuaries, lakes and lagoons, marshes and mud-flats that experience perennial or seasonal flooding.

[Copernicus.eu](#) (under [Working for our wetlands](#)) provides a helpful summary of the initiatives and issues that are relevant to wetlands.

To mark World Wetlands Day the summary to the left of the key actions required to preserve wetlands was released. While it does not do justice to the range and complexity of the action required, it provides a helpful summary.

For the author, the voyages of discovery of "world days continues": **Edition 32** of Low Carbon Pulse noted that December 5 is world soil day.

- **Visual Capitalist Graphic:** Previous editions of Low Carbon Pulse have include diagrams and graphics from the Visual Capitalist, which are consistently excellent, and not infrequently brilliant. In the context of wetlands, and their importance, the following graphic is an brilliant addition to the Visual Capitalist catalogue:

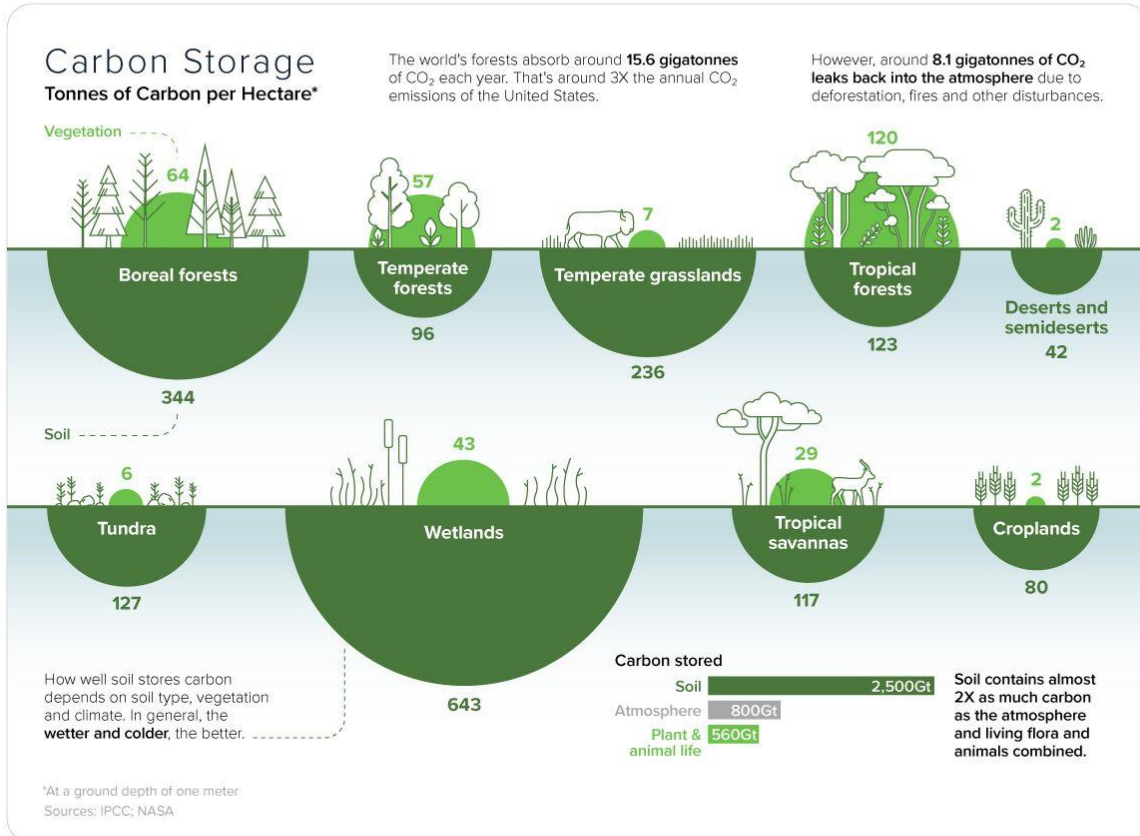
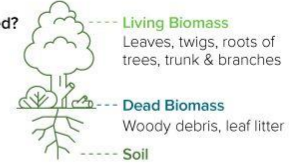
Carbon Storage in Earth's Ecosystems

Achieving net-zero by 2050 depends on the Earth's natural carbon sinks.

Forests play a critical role in regulating the global climate. They absorb carbon from the atmosphere and then store it, acting as natural carbon sinks.

Where is Carbon Stored?

There are various carbon pools in a forest ecosystem.



Carbon Streaming is protecting the Earth's natural carbon sinks with carbon credit streams across the following REDD+ projects:



Rimba Raya
Borneo, Indonesia
~64,000 hectares



Cerrado Biome
Brazil
~11,000 hectares



MarVivo Blue Carbon
Baja California Sur, Mexico
~22,000 hectares



Learn more at
CARBONSTREAMING.COM

NEO: **NETZ**
OTCQB: **OFSTF**
FSE: **M2Q**



[/visualcapitalist](https://www.facebook.com/visualcapitalist) [@visualcap](https://www.instagram.com/visualcap) visualcapitalist.com

Bioenergy and heat-recovery:

This section of considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass.

Bioenergy includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form.

In addition, recovered heat and waste heat (derive from any source, including waste water) has been added to this section.

From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted. The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.

- **TotalEnergies and Veolia team to go green:**

On February 2, 2022, TotalEnergies announced (under **TotalEnergies and Veolia Join Forces to Accelerate the Development of Biomethane**) that it is had agreed with Veolia to produce biomethane from waste and waste water treatment facilities in more than 15 countries.

TotalEnergies and Veolia will co-invest in projects with the target of producing 1.5 terawatt-hours of biomethane hours by 2025.

While Europe and the US are leading the way in the production and use of biomethane (including in the US as renewable natural gas (**RNG**)), the derivation and production of biomethane from organic waste streams represents a key part of global progress towards **GHG** reductions and **NZE**, in particular if the **CO₂** arising from the deviation and production of biomethane can be captured.



BIOENERGY IN GASEOUS FORM

Biogas: a mixture of **CH₄** and **CO₂**, arising from the decomposition of organic matter, including derived or produced from anaerobic digestion.

Biomethane: **CH₄** in near pure form, derived or produced from upgrading **Biogas** or gasification of biomass. Biogas and Biomethane are Biogases.

Bio CNG: Biogas or Biomethane that is compressed.

Bio LNG: Biomethane that is liquified.

- **Europe – ever increasing progress to use of biomethane:** On February 3, 2022, [NGVA Europe](#), released information that outlined the growth in the use of biomethane, in compressed form as bio-CNG, in the transport sector across Europe. The information from NGVA Europe is accompanied by a helpful map.



At the start of 2022 there are 4,110 CNG and 499 LNG refuelling stations across Europe.

Both BIO-CNG and Bio-LNG are produced from biomethane. The Secretary General of **NGVA** Europe (**NGVA** standing for **Natural and Bio Gas Vehicle Association**) in promoting the information provided by **NGVA** Europe said: "These impressive numbers prove that biomethane is a rapidly growing reality, able to support the transition to climate neutrality and the objectives of the European Green Deal in a very effective, efficient and especially realistic way ...".

BESS and HESS (and energy storage):

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "**BESS** storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events".*

- **PG&E amasses BESS capacity:** On January 25, 2022, [energy-storage.news](#) reported that California Utility, Pacific Gas and Electric (**PG&E**), proposes to procure 1.6 GW / 6.4 GWh of new **BESS** capacity through the development and deployment of nine large-scale projects. This procurement is intended to respond to the mandate of the California Public Utilities Commission (**CPUC**) in June 2021 to procure 11.5 GW of electrical energy capacity from **GHG** free sources.

PG&E is one of three investor owned utilities (together with and community choice aggregators) required to contract for **GHG** free sources that must come on line between 2023 and 2026. Under the **CPUC** mandate, **PG&E** is required to procure 2.302 GW of electrical energy capacity from **GHG** free sources. The procurement of 1.6 GW / 6.4 GWh of new **BESS**, discharges all but 702 MW (or 0.702 GW) of electrical energy capacity from **GHG** free sources.

- **Vistra expands BESS capacity:** On January 25, 2022, [energy-storage.news](#) reported that Vistra Energy (Texas headquartered integrated power generation and utility corporation) intends to add a further 350 MW / 1,400 MWh of **BESS** capacity to the Moss Landing Energy Storage Facility located in Monterey Bay, California which has 400 MW / 1,600 MWh of existing **BESS** capacity (300 MW / 1,200 MWh coming on line at the end of 2020, and 100 MW / 400 MWh having coming on line in August 2021).

With the expansion to 750 MWh / 3000 MWh of **BESS** capacity, the Moss Landing Storage Facility will continue to be the biggest **BESS** globally. It is reported that **PG&E** has signed a 15 year resource adequacy agreement for the expanded **BESS** capacity.

- **Amping up energy storage:** Completing a trifecta of new items from [energy-storage.news](#), on January 27, 2022, [energy-storage.news](#) reported that Amp Energy is to develop and to deploy in Scotland two grid-connected **BESS's**, each of 400 MW / 800 MWh (the **Scottish Green Battery Complex**). The **BESS's** are to be located in Hunterson and Kincardine in central Scotland. It is understood the operation of the two **BESS's** will be optimised using Amp Energy technology Amp X (an AI-driven digital platform).
- **TransAlta to develop BESS in Alberta:** On January 30, 2022, it was reported widely that TransAlta (leading energy corporation) is to develop a 180 MW **BESS** in Alberta, Canada. The 180 MW **BESS** is to be developed and deployed in two stages, and will be charged using renewable electrical energy sourced from an existing TransAlta hydroelectric storage plant.

- **LDES Council membership grows:**

Edition 30 of Low Carbon Pulse reported on the establishment of the Long Duration Energy Storage (**LDES**) Council (**LDESC**) at **COP-26** as follows:

"On November 4, 2021, the **LDESC** was established to provide guidance to Governments to the transmission grid operators on the objective of working towards global deployment of 85 – 140 TWh of long duration energy storage by 2040. The founding members of the **LDESCs** are (in alphabetical order): Alfa Laval, Ambri, Azelio, Baker Hughes, Breakthrough Energy, BP, CellCube, Ceres, Echogen Power Systems, EnergyDome, Enlighten, EOS, ESS, Inc., Ezinc, Form Energy, Greenko, Highview Power, Malta, Neom, Quidnet Energy, Redflow, Rio Tinto, Siemens Energy, and Stiesdal."

On February 1, 2022, the LDESC announced that a further 12 corporations had joined as new members: Corre Energy, Enervenue, Google, Kraft Block, Kyoto Group, Magaldi, Microsoft, Orsted, Pumped Hydro Storage, Sumitomo, TORC, and Volt Storage.

The establishment of the **LDESC** and the continued growth of its membership appears aligned entirely with the progress towards development and deployment of **LDES** across grids, behind the meter, and remotely.

- **LDESC emphasises the importance of LDES:**

On February 4, 2022, the **LDESC** noted that the role of long duration energy storage will be critical to progress to net-zero electrical energy generation. The **LDESC** points to a [study](#) by researchers at **Stanford University, Stanford Woods Institute for the Environment** (covered in **Edition 31** of Low Carbon Pulse).

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including to bioenergy carbon capture (**BECCs**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture and storage (**CCS**), carbon capture use and storage (**CCUS**) and direct air capture (**DACS**). Effective accounting for carbon arising and **CDR** go hand-in-hand. By way of background **CDR** is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (**BECCS**), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (**DACS**) are all means of **CO₂** removal. The IEA pathway to **NZE** estimates that in order to achieve **NZE** it will be necessary to capture and to remove up to 7.6 giga-tonnes of **CO₂** each year through **CCS**, **CCUS** and **CDR**. **CCS** and **CCUS** (and **BECCS** and **BECCUS**) involve the capture at source of **CO₂**, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.*

- **Lehigh Cement and Enbridge close to set:** On January 26, 2022, [Enbridge, Inc](#) (under [Lehigh Cement and Enbridge Agree to Advance a CO₂ storage solution in Alberta](#)) announced that it had signed a memorandum of understanding with Lehigh Cement (a division of Lehigh Hanson Materials Limited) to work together on a carbon solution for Lehigh's cement manufacturing facility in Edmonton, Alberta.

Lehigh is developing the first full-scale carbon capture, utilization and storage (**CCUS**) solution in North America for its Edmonton facility to capture up to 780,000 metric tonnes of **CO₂** annually. The stated intention is that Lehigh Cement will haul the **CO₂** by pipeline, delivering **CO₂** hauled to Enbridge for storage.

Enbridge considers that the **CO₂** from Lehigh Cement and Capital Power Corporation, and other industrials, represents an opportunity to store up to 4 million tonnes of **CO₂** a year. Enbridge is reported to be applying to develop an open access carbon storage hub in the Wabamun area, west of Edmonton (the **Open Access Wabamun Carbon Hub**).

- **Eni and Holcim combine:** On January 28, 2021, [Eni](#) announced that it was collaborating with Holcim to explore with Holcim the use of Eni technology to produce a material in which **CO₂** is fixed permanently and stably, and as such to store **CO₂** captured in difficult to decarbonise industries, including cement production. As announced, the Eni technology uses a carbonator in which **CO₂** is sequestered in ground Olivine before being incorporated into cement: in other words magnesium silicate is carbonated.

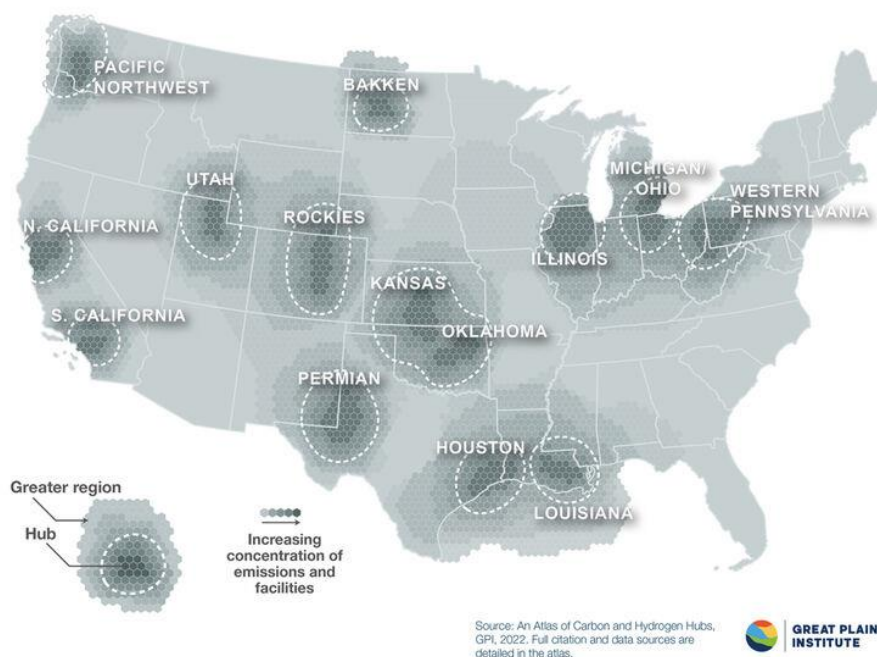
It is understood that a demonstration plant is to be developed to test the reduction in **CO₂** and the integration of carbonators into cement production plants.

- **Battelle and Equinor to explore CCS in Appalachian Basin:** On February 1, 2022, [Battelle](#) (leading science and technology business) announced the signing of a memorandum of understanding (**MOU**) with Equinor (leading international energy corporation) to advance the development within a tri-state region of Ohio, Pennsylvania and West Virginia of "decarbonisation energy cluster / hub".

The Country Manager of Equinor US, Mr Chris Golden stated: "The Appalachian Basin is an important energy-producing region that also shows great promise in being a leader for decarbonisation of American industry. Our regional hub vision will meet tomorrow's energy demands while maintaining America's industrial competitiveness with a net-zero scenario".

A view part of this vision is the use of **CCS**. The **MOU** provides that Battelle and Equinor are to undertake feasibility studies to assess the potential of the Appalachian Basin to store permanently **CO₂** captured.

- **Great Plains, Great Resource and Great Report:** On February 1, 2022, the Great Plains Institute launched **An Atlas of Carbon and Hydrogen Hubs for United States Decarbonisation** [report](#). The report is excellent. The following map provides a helpful overview of the subject matter of the report.



- **Petronas' progress continues:** On January 28, 2022, [Petronas](#) announced that it had signed a memorandum of understanding with Japan Petroleum Exploration Co. Limited (**JAPEX**) to collaborate on **CCS** opportunities, including suitable **CO₂** storage solutions in Malaysia. The first step in this collaboration is to undertake a study jointly on means of capture and transportation of **CO₂** from the Petronas LNG Complex in Bintulu.

By way of reminder:

Edition 33 of Low Carbon Pulse (under **Petronas and Shell alignment**) reported that Petronas and Shell had signed a joint study and collaboration agreement (**JSCA**) to explore opportunities, and to collaborate in respect of those opportunities, for **CCS**, so as to provide Malaysia and the region with **CO₂** storage solutions. As reported, the **JSCA** provides for Petronas and Shell to undertake an integrated **CCS** Area Development Plan study in respect of locations off-shore of Sarawak.

Edition 30 of Low Carbon Pulse (under **ExxonMobil and Petronas teaming**) reported that Petronas had signed a memorandum of understanding with ExxonMobil. Also, in December 2021, Petronas signed a memorandum of understanding with POSCO to assess opportunities for **CCS**.

Carbon Credits and Hydrogen Markets and Trading:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development hydrogen markets and trading (bilateral and likely wholesale).*

- **Giving (carbon) credits where additionality:** On February 5, 2022, climatetechv.sustack.com published an excellent article, the by-line for which is **Wrangling the wild west of the voluntary carbon offset market**. The article is well-worth a read, indeed for this interested in the **Voluntary Carbon Market / Voluntary Carbon Credit Market** it may be considered mandatory market reading!

"The world of climate tech overflows with mind-bending technologies. But perhaps the most mind bending of all? The voluntary carbon markets".

This is an early contender for quote of the year.

The issues explored in the article will be covered in the stand-alone article on **Carbon Credits, Article 6 and the Paris Rulebook**.

E-fuels / Future Fuels / Now Fuels:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and **Future Fuels** (energy carriers derive and produced that are characterised as clean carbon or low carbon fuels). **E-fuels** include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.*

- **BloombergNEF hydrogen predications:** While it may be getting a little too far into 2022 to include predictions, the perspective of the good folk at BloombergNEF is always worth sharing. Their predications are as follows: **1.** Electrolyser sales will quadruple, with the **PRC** being the largest market; **2.** The US will see many announcements of many hydrogen production projects, but development of those projects will lag; **3.** New policy settings providing subsidies will spur a boom in the hydrogen market in Europe; **4.** A number of hydrogen corporations will go public

during 2022; **5.** Hydrogen strategies will be adopted by 22 countries in 2022; **6.** *NZE* will derive demand for hydrogen more than carbon pricing / a cost of carbon; **7.** Industry, in particular heavy industry, will dominate demand for hydrogen; **8.** Globally many announcements about Green Ammonia will be made; **9.** Policy settings will keep Blue Hydrogen supply and demand development on life-support; and **10.** Alkaline electrolyzers will increase their market share over other technologies.

- **Wilhelmshaven Grey Plans:** On January 24, 2022, AtlasInvest (a corporation that invests in both conventional oil and gas and renewable projects) announced plans to develop a €2.5 billion hydrogen facility that will derive hydrogen from methane (i.e., Liquid Natural Gas or LNG) imported from **GCC countries**.

The hydrogen facility will be located within the hinterland of the Port of Wilhelmshaven. It is reported that the hydrogen facility will have capacity to produce up to 500,000 metric tonnes of hydrogen per year. It is understood that CCS / CCUS is not contemplated, and as such the hydrogen produced will be Grey Hydrogen.

By way of reminder, **Edition 14** of Low Carbon Pulse reported that on April 15, 2021, Uniper (German utility giant) planned to develop a hydrogen hub located in Wilhelmshaven (**Green Wilhelmshaven**) comprising a receiving terminal for Green Ammonia, then using a cracker to derive Green Hydrogen. The plans included a 410 MW electrolyser. On full development, it was estimated that the facilities at **Green Wilhelmshaven** would produce up to 295,000 metric tonnes per year of Green Hydrogen.

In **Edition 14** it was noted that the decision of Uniper to develop **Green Wilhelmshaven** may end its plans to import LNG using a floating storage and regasification unit at Jade Bay, in Wilhelmshaven. Given the plans of AtlasInvest, it would seem likely that Wilhelmshaven may become a key Green Hydrogen and Grey Hydrogen Hub.

- **Liquid Wind and Ørsted breeze to deal:** On January 25, 2022, it was reported widely that Liquid Wind AB and Ørsted had contracted for Ørsted to invest in a large-scale e-methanol project in FlagshipOne, in Sweden, with Ørsted taking a 45 equity interest.

FlagshipOne is likely to be the world's first large-scale e-methanol production project, using a 70 MW electrolyser. It is anticipated the FlagshipOne will produce up to 50,000 metric tonnes of e-methanol a year using renewable electrical energy to produce Green Hydrogen and to combine that Green Hydrogen with **CO₂** captured from the combined heat and power plant at Hörneborgsverket, Örnsköldsvik, Sweden. Assuming that a final investment decision is taken during 2022, the expectation is that FlagshipOne will be commissioned by the end of 2024.

For some time Liquid Wind AB has been concentrating on the means to decarbonise the maritime sector, with FlagshipOne being thought to be the first of a number of projects in the pipeline.

For Ørsted, its investment in FlagshipOne emphasises its perspective on Power-to-X.

- **Yara and Linde contract:** Previous editions of Low Carbon Pulse have covered various aspects of the ammonia production facility of Yara (leading fertiliser producer) at Herøya, Porsgrunn, Norway. Most recently, **Edition 33** of Low Carbon Pulse covered the award of NOK 283 million in funding support from the Norwegian Government, though Government agency Enova.

On January 28, 2022, [Yara](#) announced that Yara and Linde Engineering had contracted for Linde (one of the big three industrial gas producers globally, with Air Liquide and Air Products) to develop and to deploy a 24 MW Green Hydrogen production facility at Herøya, using proton exchange membrane (**PEM**) electrolyser technology, with technology provided by ITM Power (UK headquartered leading technology corporations).

It is understood that Green Hydrogen produced will displace, in part, Grey Hydrogen currently used at Yara's ammonia plant: as currently contemplated up to 20,500 metric tonnes of ammonia will be produced annually, sufficient to produce up to 80,000 metric tonnes of fertilizer.

- **ROK corporations in Sarawak:** On January 26, 2022, [Aju Business Daily](#) reported that a consortium of Malaysian and **ROK** corporations are to commence the production of Green Hydrogen, Green Ammonia and Green Methanol in Sarawak, East Malaysia (**H2biscus Green Hydrogen Project**). SEDC Energy, a wholly-owned subsidiary of the Sarawak Economic Development Company (**SEDC**), has signed a memorandum of understanding with leading **ROK** corporations, Lotte Chemical, POSCO and Samsung Engineering.

It is understood that the feasibility study for the **H2biscus Green Hydrogen Project** contemplates annual production of 600,000 metric tonnes of Blue Ammonia, 630,000 metric tonnes of Green Ammonia, and 460,000 metric tonnes of Green Methanol.

Big BESS and Green Hydrogen Hub in NZ: **Edition 33** of Low Carbon Pulse reported that Meridian Energy (leading energy corporation) had announced plans to develop and to deploy the first Big **BESS** in New Zealand (the **Marsden Point BESS**), to be located adjacent to the Marsden Point oil refinery north of Auckland, within the Ruakaka Energy Park (which will be co-located with a utility-scale photovoltaic solar farm).

For some time it has been reported that the Marsden Point oil refinery is scheduled to close in April of this year. Also it has been reported widely that Fortescue Future Industries (**FFI**), a subsidiary of Fortescue Metals Group (founded by Dr Andrew Forrest, AO), is exploring options for the use of the Marsden Point oil refinery as the location for a Green Hydrogen Hub. This is consistent with the use of the Liddell coal-fired power station in the Hunter Valley, NSW, Australia as a Green Hydrogen Hub (see **Edition 32** of Low Carbon Pulse).

- **Project Catalina fully sized:** On February 1, 2022, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) (and **CIP** announced that it was, working with Enagás, Fertiberia, Naturgy, and Vestas) is to develop and to deploy a 2 GW Green Hydrogen production facility in Aragon, north west Spain (**Project Catalina**). **Project Catalina** will source renewable electrical energy from 5 GW on-shore photovoltaic solar and wind sources.

Project Catalina is to be developed in two phases, with Phase I currently progressing. The Green Hydrogen will be hauled from Aragón to Valencia for use as feedstock by Fertiberia (leading ammonia and fertiliser producer) to produce Green Ammonia and fertiliser.

Project Catalina is the second GW scale Green Hydrogen production facility to be announced since the turn of the calendar new year. By way of a reminder, **Edition 33** of Low Carbon Pulse reported on the **SHYNE** project as follows: " ... the Spanish Hydrogen Network (**SHYNE**), a consortium of 33 corporations and organisations, led by Spanish oil

and gas giant Repsol, is to invest €3.3 bn to develop and to install 500 MW of Green Hydrogen production capacity by 2025, and 2 GW by 2030. The installation of 2 GW of Green Hydrogen production capacity by 2030 will satisfy half to the Spanish Government's target of 4 GW (see **Editions 5** and **29** of Low Carbon Pulse)".

The installation of the 2 GW of Green Hydrogen production contemplated by **Project Catalina** combined with the 2 GW contemplated by **SHYNE**, will mean that these projects will match the Spanish Government's target of 4 GW. With other projects announced and planned, Spain appears likely to lead Europe in Green Hydrogen production.

• **BP Australia progressing at Kwinana:**

• **Edition 27** of Low Carbon Pulse (under **BP weighing up Kwinana Energy Hub**) reported that, "BP Australia was undertaking a feasibility study to produce Green Hydrogen at the site of its Kwinana refinery, working with leading renewables energy and hydrogen adviser and participant Macquarie Group.

While this may be regarded as early days, the repurposing of the Kwinana site, and the supportive policies of the Western Australian Government, may be regarded positively, including the possibility of the development of Kwinana as a hydrogen hub and carbon cluster."

• **Waste to fuel:** It is understood that considerable progress has been made that the BP Australia is likely to enter Front End Engineering and Design (**FEED**) to scope and to cost the decarbonisation of the carbon cluster of which Kwinana is a part. Waste based feedstock will be used to produce sustainable / synthetic aviation fuel (**SAF**) and renewable diesel. To produce these biofuels hydrogen will be required, which it is understood will be derived from the production of biogas.

• **And on the other side of the world ... bp wins Aberdeen approval:** On February 3, 2022, it was reported widely that bp is become a joint venture partner of Aberdeen City Council (**ACC**) to develop the first scalable Green Hydrogen production facility in Scotland.

• **And on the other side of the North Sea:** On February 3, 2022, it was reported widely that Copenhagen Infrastructure Partners (**CIP**), Hy2gen, and Trafigura intend to develop a 240 MW electrolyser in Sauda, Norway, to produce Green Hydrogen to be combined with nitrogen to produce Green Ammonia (Iverson e-Fuels AS). It is anticipated that the electrolyser capacity will increase over time.

• **And in Finland ...:** On February 4, 2022, [H2-view.com](https://www.h2-view.com) reported on the development of a Green Hydrogen production facility in Harjavalta, Finland by P2X Solutions. Construction of the facility is to commence in Q3 of 2022.

Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of E-fuels and Future Fuels to process and to treat those metals and minerals. Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.*

• **ArcelorMittal accelerates:** On February 4, 2022, ArcelorMittal announced that it is to accelerate its decarbonisation of iron and steel production in France. The acceleration involves the investment of €1.7 billion at its Dunkirk and Fos-sur-Mer iron and steel mills.

At **Fos-sur-Mer** ArcelorMittal will build an electric arc furnace (**EAF**). The development of the **EAF** is complementary to the development of the ladle furnace announced in March 2021, which the French Government supported under the France Relance recovery plan.

At **Dunkirk** ArcelorMittal will build a direct reduction of iron (**DRI**) plant to produce direct reduced iron / sponge iron using high-temperature heat from hydrogen rather than from coal, and the development of an **EAF** to produce steel. The French Prime Minister, Mr Jean Castex announced the support of the French Government for the acceleration program.

IRON AND STEEL

Blast Furnace: a high-pressure, high-temperature heat environment, using metallurgical coal, in which iron ore is smelted to produce pig-iron	Electric Arc Furnace: high-voltage electrical energy is applied to graphite electrodes creating a high-temperature environment in which iron ore or scrap metal is melted
Pig Iron: The crude iron used to produce steel	DRI / Sponge Iron: Iron reduced directly from iron ore, using carbon monoxide and hydrogen derived from natural gas or coal, or using Green Hydrogen

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development of:*

- *areas in which: 1. infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and 2. technologies facilitating energy transition will concentrated and supported (**Hydrogen Corridors and Valleys**); and*
- *giga-factories that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).*

*Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.*

To manage the length of Low Carbon Pulse, news items that have arisen during the last two weeks will be picked up in **Edition 35**.

Wind round-up, on-shore and off-shore:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).*

- **Thor's day on a Tuesday:** On January 24, 2022, **RWE**, announced that it had signed the concession agreement with the Danish Government for the Thor off-shore wind field (**TOSW**) project awarded to **RWE** on the drawing of lots on December 1, 2022 - see **Edition 32** of Low Carbon Pulse under "**Luck of the Thor**".

Edition 31 of Low Carbon Pulse reported that:

"On November 25, 2021, the Danish Energy Agency (**DEA**) announced that the award of the 1 GW Thor offshore wind field (**Thor OWF**) project will be decided by a lottery.

It is understood the multiple bidders, including heavy weight consortiums, Copenhagen Infrastructure Partners and SSE, Iberdrola and Total Energies, Ørsted and RWE, Swan Wind (Eneco and European Energy) and Vattenfall, are to draw lots for the award.

The **Thor OWF** project is to be developed by the winner of the lottery without any Government support in the form of a subsidy. The **DEA** announced that: "*More than one bidder has offered to build Thor offshore wind farm with a capacity of 1,000 MW at the minimum price of Dkr0.10 / MWh, and the tender will therefore, in accordance with the tender conditions, be decided by drawing lots*".

The **TOSW** project is scheduled to reach operational completion by 2027, with a total cost of USD 2.3 billion. While the full terms of the concession agreement have not been sighted by the author, it is understood that the Danish Government will earn in the region of USD 400 million.

- **ROCKING off-shore ROK:** On January 25, 2022, [Aker Offshore Wind](#), announced that Aker Offshore Wind, with OW Oceans Winds, in their Korea Floating Wind off-shore wind field project had been granted its first Electricity Business Licence (**EBL**) for 870 MW. The CEO of Aker Offshore Wind, Mr Phillippe Kavagyan stated: "*We are very pleased by this timely grant of the first Electric Business Licence, confirming that strong support that we receive in South Korea to make offshore wind a national ambition.*"

By way of reminder:

- **Edition 25** of Low Carbon Pulse reported that the Green Investment Group Limited (**GIG**) and TotalEnergies had been granted an electricity business licence (**EBL**) from the Ministry of Trade, Industry and Energy. The grant of an **EPL** allows the development, on an exclusive basis, of the first phase (504 MW) of the three phase 1.5 GW off-shore floating wind field project off Ulsan, South Korea; and
- **Edition 26** of Low Carbon Pulse reported that Shell Overseas Investment B.V. had announced its joint venture with CoensHexicon Co. Ltd, with Shell a 80%, CoensHexicon, a 20%, equity participant, to develop and then to operate the 1.4 GW Ulsan **OWF** project (the **MunmuBaram Project**). As reported in **Edition 32** of Low Carbon Pulse (under **MunmuBaram licensed**), the **MunmuBaram Project** has been granted an Electricity Business Licence (**EBL**), for its floating off-shore wind field project development.
- **More of OWF for Germany:** **Edition 33** of Low Carbon Pulse reported noted that it was reported widely that the German Federal Maritime and Hydrographic Agency (**BSH**) had commenced updating maritime plans to accommodate an additional 3 GW of off-shore wind field capacity in the German sector of the North Sea.
On January 28, 2022, [offshorewind.biz](#) reported (under **Germany to Auction Off 1,880 MW of Offshore Wind Capacity in 2022.23**) that the **BSH** had approved the suitability of areas N-3.5, N-3.6 and N-7.2 in the German sector of the North Sea for development of off-shore wind fields. The three areas are stated to have wind resources giving a combined capacity of 1,888 MW.
- **OWF for Brazil:** On January 27, 2022, [offshoreWIND.biz](#) reported (under **Brazil Takes Major Step Towards Developing Offshore Wind Potential**) that the Government of Brazil had issued Decree No. 10,946 to allow the implementation of off-shore studies for the purposes of identifying areas suitable for the development of off-shore wind projects. It is understood that the Brazil Ministry of Mines and Energy will undertake the studies, and in due course organising, will have carriage of the preparation of, and running of, auctions for the development of off-shore wind field capacity.
- **Black Sea development:** On January 31, 2022, [offshoreWIND.biz](#) reported that German headquartered renewable electrical energy developer, wpd, planned to develop two off-shore wind fields in the Romanian sector of the Black Sea – the 500 MW Black Sea 1 and the 1,400 MW Black Sea 2 projects. The development of the off-shore wind fields is a natural step for wpd which has been in Romania since 2009 and has 1,300 of on-shore wind farm projects under development in Romania.

Solar and Sustainability (including NZE Waste):

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.*

- **Giants align strategically:** Many editions of Low Carbon Pulse have covered Ørsted (see **Editions 30, 31, 32 and 33** Low Carbon Pulse) and Salzgitter AG (see **Editions 18 and 23** of Low Carbon Pulse). Both corporations lead in their fields and in progress to **NZE**.

On January 25, 2022, [Ørsted](#) (under **Heading for a circular economy – Salzgitter AG and Orsted launch strategic partnership**) announced that it was to work the Salzgitter AG in strategic partnership. For these purposes, the two have signed a memorandum of understanding under which they plan to established closed value chains: Orsted will supply renewable electrical energy from its off-shore wind fields and hydrogen for low carbon steel production, and Salzgitter will supply low carbon steel to Ørsted.

Also the two plan to develop a closed loops to recycle scrap.

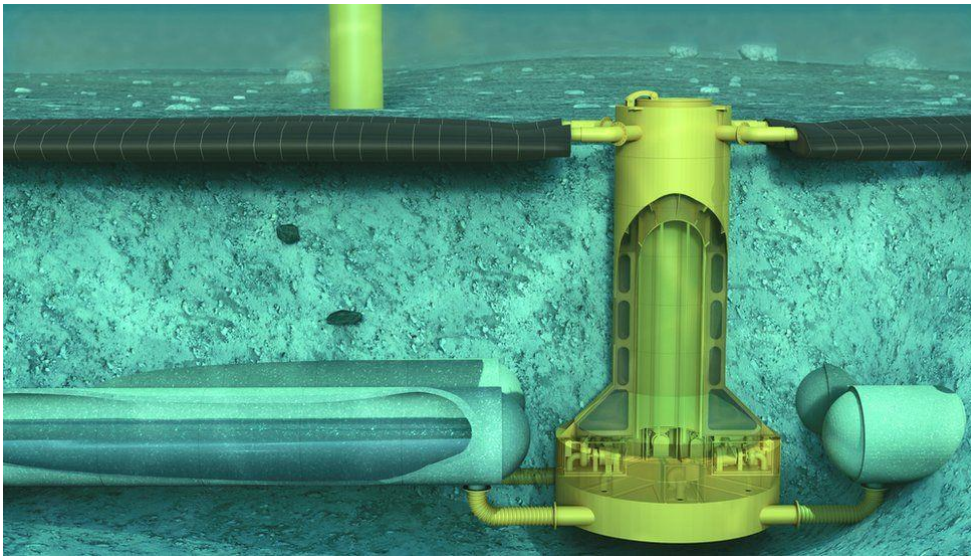
The strategic partnership illustrates once again that the private sector is continuing to progress to the reduction in **GHG** emissions and **NZE**.

- **Solar to hydrogen technology:** On January 25, 2022, [h2-view.com](https://www.h2-view.com) reported that AESA (consulting and engineering corporation) and Fusion Fuel had entered into an agreement under which the solar to hydrogen technology of Fusion Fuel is to be combined with the engineering solutions and technology of AESA. The two corporations intend to combine to offer decarbonisation projects to major industrial corporations on a turnkey basis.
- **Second life given life:** On February 3, 2022, it was reported widely that [GE Renewable Energy](https://www.ge.com/renewable-energy) had signed preliminary agreements with German and French-Swiss corporations to dismantle, shred and co-process blades from on shore wind farms, being blades that are reaching the end of their life-cycle. In addition, GE Renewable Energy has contracted with Veolia North America in respect of blades from on-shore wind farms.
- **Out of our comfort zone:** As regular readers of Low Carbon Pulse will know, Low Carbon Pulse does not tend to cover all new or novel technologies that may become the subject of news items. This said, in the current news cycle a couple of ideas have struck the author as potentially significant:

- **Energy storage in oceans:**

On February 4, 2022, the [BBC](https://www.bbc.com/news/business-58111111), Business News (under [How to store excess wind power underwater](https://www.bbc.com/news/business-58111111)) outlined the development of an Ocean Battery by a Dutch start-up, Ocean Grazer.

A graphic is included below to give a sense of how the Ocean Battery is intended to work.



- **Energy storage in data:**

On February 4, 2022, [pv-magazine.com](https://www.pv-magazine.com) reported that researcher at UC San Diego have proposed the use of excess renewable electrical energy to pre-compute certain types of data, and to store that data on servers to later use (**information batteries**). The core of the idea is to perform, on a speculative basis, computations in large, energy-intensive data centres when renewable electrical energy is available: **information batteries** provide storage through speculative load shifting, anticipating computation to be performed in the future.

- **Corporate PPAs top 30 GW:** Over the first week of February a number of news outlets reported on the ever increasing level of commitment of the private sector to renewable electrical energy through the purchase of renewable electrical energy. The most widely reported number comes from BloombergNEF (under Corporate Clean Energy Buying Tops 30 GW Mark in Record Year), which states that in 2021 corporations purchased 31.1 GW of clean power under term corporate PPAs / clean energy contracts, with over 20 GW of clean power being purchased in the US.

Land Mobility / Transport:

*This section of considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.*

- **Buses and coaches:** While news items have arisen during the last two weeks, they will be picked up in **Edition 35**.

- **Cars (including taxis):**

As the 2021 facts and stats continue to be rolled out, the **IEA** reported on **Electric Vehicles sold by automaker in 2021**.

- **Fuel Cell and Battery Technology news:**

Ballard and Chart progress: On February 1, 2022, [Ballard](https://www.ballard.com) and Chart announced that they had tested successfully the use a fuel cell using liquid hydrogen.

Ballard Power Systems and Chart Industries Inc, working together under a memorandum of understanding (signed on February 10, 2021), using a Ballard FCmove TM-HD fuel cell and a Chart liquid onboard hydrogen (**HLH2**) vehicle fuel system, demonstrated that heavy-duty vehicles can be powered and propelled using liquid hydrogen (**LH2**).

This is significant because **LH2** has a mass and volume range advantage over compressed hydrogen (**CH2**). It is understood that the range of a heavy-duty vehicle powered and propelled by **LH2** is more than twice that of a heavy-duty vehicle powered and propelled by **CH2**.

Industrial Vehicles and Trucks:

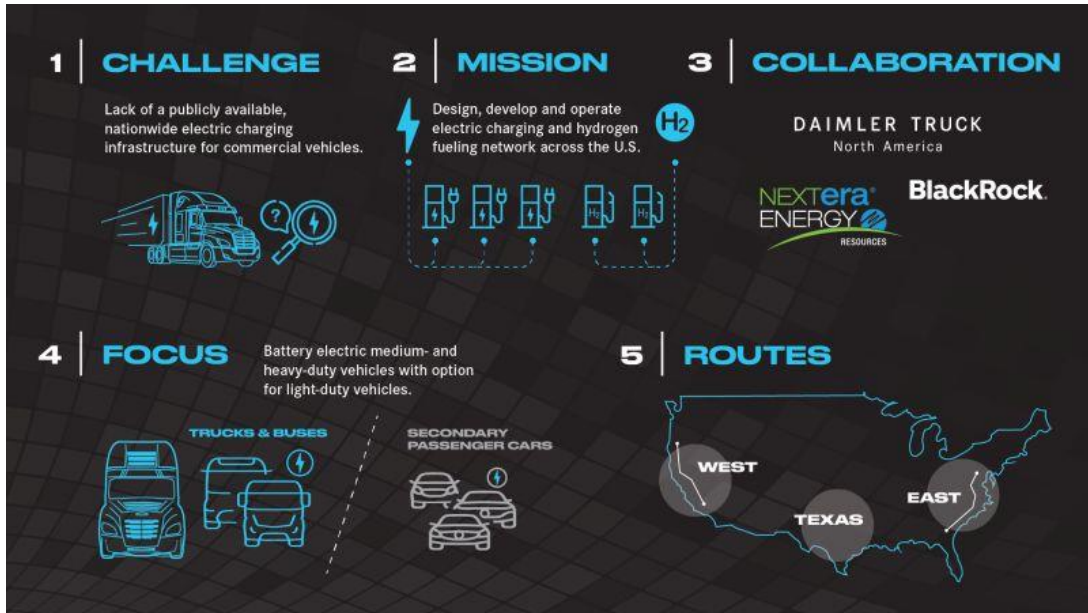
DHL procures Volvo Bio-LNG trucks: On January 27, 2022, biogaschannel.com that DHL in the UK had procured 13 Volvo Bio-LNG trucks as part of the DHL GoGreen plan. The Volvo FH6x2 tractor units have 155 kg bio-LNG tanks giving a maximum range of 1,000 km.

Recharging and refuelling infrastructure:

BlackRock, Daimler and NextEra Energy roadside: On January 31, 2022, it was reported widely that BlackRock Renewable Power, Daimler Truck North America, and NextEra Energy Resources LCC had agreed on principles for the formation of a joint venture to develop and to deploy electric recharging stations and hydrogen refuelling infrastructure.

In passing, it is worthwhile reminding oneself that Daimler Truck AG is developing both a hydrogen fuel cell (GenH2 Truck) and an electric battery truck (eActros).

It is understood that up to USD 650 million in funding is to be provided initially, split equally between electric recharging stations and hydrogen refuelling infrastructure.



Hydrogen refuelling infrastructure development in 2021: On February 2, 2022, Mr Uwe Albercht, published a summary of the number of hydrogen refuelling infrastructure developments that opened during 2021. The raw facts and stats being, Asia – 89, Europe 37, and North America 13, and 33 countries in which hydrogen refuelling is possible.



- **All in on hydrogen:** On February 4, 2022, [hydrogen-central.com](https://www.hydrogen-central.com) reported that ORLEN Group is to invest USD 1.9 billion by 2030 across Poland, the Czech Republic and Slovakia. It is reported that the investment will be made in low to zero carbon hydrogen development projects based renewable energy sources and use of municipal solid waste to derive hydrogen from waste, and a distribution network involving the development of 100 hydrogen refuelling stations across the three countries.
- **Trains:** News items that have arisen during the last two weeks will be picked up in **Edition 35**.

Ports Progress and Shipping Forecast:

*This section of considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use of carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland. Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.*

• Ferries and floating boats:

- **Having a whale of a time:** In late January 2022, Green City Ferries provided an overview of fast passenger ferries power and propelled by hydrogen, outlining the **Beluga24** – the world's first hydrogen powered and propelled high-speed catamaran ferry. The **Beluga24** has an electric energy option for shorter journeys. Both the hydrogen fuel cell and the electric energy options are designed to carry 150 passengers and 28 bicycles. As announced the first **Beluga24** is to be used in the Stockholm archipelago, with support from the **EU** funding.
- **Glassy waters:** On January 26, 2022, [High North News](https://www.highnorthnews.com) (under **Signed Contract Worth Billions for Operating Hydrogen Ferries between Bodo and Lofoten: "World Class Climate Project"**) reported that the Norwegian Public Roads Administration and Torghatten Nord had signed an agreement to operate the first full-scale hydrogen ferry on the Hjelmeland-Skipavik-Nesvik route in Rogaland (on the west coast of Norway), with operation commencing during 2022.
- **Hydra meets Ballard:** **Edition 23** reported that in late July 2021, the **MF Hydra** (styled as the first liquid hydrogen powered ferry) had been delivered. As reported, the **MF Hydra** is 82.4 metres in length, with capacity for 300 passengers and 80 motor cars. On February 2, 2022, it was reported widely that Ballard Power Systems is to supply two of its 200KW FCwave fuel cell modules to Norled A/S, the owner of the **MF Hydra**. As will be apparent from the previous news items, during 2022 the **MF Hydra** will start to serve the Hjelmeland-Skipavik-Nesvik route in Rogaland.
- **Hydrogen Hydrofoil:** On January 30, 2022, the [nationalnews.com](https://www.nationalnews.com) reported (under **World's first hydrogen-powered hydrofoil to be made in Dubai**), that "the Jet", a hydrofoil, is to be manufactured in Dubai, in the **UAE**. As has been the case with the **MF Hydra**, Low Carbon Pulse will follow the development of the Jet.

• Green Shipping Corridors:

Edition 30 of Low Carbon pulse reported on Green Shipping Corridors as follows:

"Clydebank Declaration: On November 10, 2021, the [Clydebank Declaration](https://www.clydebankdeclaration.com) was agreed at **COP-26**. The **Clydebank Declaration** emphasises the importance of limiting "the increase in global average temperature to **1.5°C** above pre-industrial levels", expressed great concern that if "no further action is taken, international shipping emissions are expected to represent 90% to 130% of 2008 emissions levels by 2050", and recognised that "a rapid transition in the coming decade to clean maritime fuels, zero-emission vessels, alternative propulsion systems, and the global availability of landside infrastructure to support these, is imperative for the transition to clean shipping".

In addition the signatories to the **Clydebank Declaration** commit to facilitate the development of **Green Shipping Corridors**, with at least six **Green Shipping Corridors** by "the middle of this decade ... [and] many more corridors ... by 2030". A **Green Shipping Corridor** is a route between two or more ports that are "zero-emission maritime routes".

The signatories to the **Clydebank Declaration** are: Australia, Belgium, Canada, Chile, Denmark, Fiji, Finland, France, Germany, Republic of Ireland, Italy, Japan, Republic of the Marshall Islands, Morocco, the Netherlands, Norway, Spain, Sweden the UK, and the US."

On January 28, 2022, or thereabouts, it was reported widely that the Port of Los Angeles, the Port of Shanghai and **C40 Cities** (a global network of mayors taking action to confront climate change), are to create the first transpacific Green Shipping Corridor between the US and the **PRC**.

It is difficult to overstate the significance of the establishment of the first transpacific Green Shipping Corridor between the US and the **PRC**. The US and the **PRC** have the largest bilateral trading relationship globally, and the ports of Los Angeles and the Shanghai are key gateways to the seaborne trade, which accounts for the vast majority of trade.

• PORA Highlights and Insights:

- **PORA Highlights:** **Edition 33** of Low Carbon Pulse reported on a Port of Rotterdam Authority (**PORA**) [feature](#) outlining **10 highlights in the energy transition** at the Port of Rotterdam and the extended hinterland of the Port: the projects include the LyondellBasel circular steam project, the heat pipeline from Rotterdam to The Hague, the Porthos project (see **Edition 3** of Low Carbon Pulse and below), the Net Op Zee Hollandse Kust project, the Maasvlakte – Pernis pipeline (see **Edition 30** of Low Carbon Pulse), Green Hydrogen production facilities (see **Edition 27** of Low Carbon Pulse), the Shell biofuel production facility at Pernis (see **Edition 19** of Low Carbon Pulse), and the proposed Neste sustainable fuels production facility (see below).
- **PORA Insights:** On February 1, 2022, the CEO of **PORA**, Mr Allard Castlein (under **"Hydrogen: the challenges of a whole new system"**) identifies four key insights as follows: **1.** Green versus Blue Hydrogen: Both Blue and Green Hydrogen are required, with Blue Hydrogen required to fulfil 2030 ambitions, and Green Hydrogen to

achieve 2040 and 2050 goals; **2.** A certification system for hydrogen is essential (carbon intensity certification and guarantee of origin), for both Green Hydrogen and Blue Hydrogen, and progress needs to be made promptly; **3.** The Port of Rotterdam is essential for the development of Green Hydrogen and Blue Hydrogen facilities and infrastructure (including because the Port will be land-fall for off-shore wind electrical energy production, the development, currently, of five electrolyzers (together having 500 MW of electrolyser capacity) within the precinct of the Port, and role of the Port in pipeline development); and **4.** The role of **PORA**, together with the Sustainable Energy Council, the City of Rotterdam and the province of Zuid-Holland, in the World Hydrogen Summit.

As noted in previous editions of Low Carbon Pulse (see **Editions 19, 27, 30 and 33**), for some time, the **PORA** has been, and continues to be, aware of the central role that ports, and their hinterlands, have to play in the development of the hydrogen economy.

- **Port of Rotterdam to site bp and HyCC 250 MW electrolyser:** While this news item could be placed here or under **E-Fuels / Future Fuels / Now Fuels**, given the previous piece, it appears best placed here.

On February 1, 2022, it was reported widely that bp and HyCC BV had agreed to develop further their Green Hydrogen production facility Masavlake in the Port of Rotterdam, the Netherlands (the **H2-Fifty project**).

The Green Hydrogen produced by the **H2-Fifty project** will displace fossil fuel sourced feedstocks used currently by bp at its refinery in Rotterdam.

- **And Rotterdam is not Finished yet:** On January 27, 2022, UPM (a Finnish corporation) announced that it wants to increase its biofuel production capacity, and its preferred location of a new biorefinery is the Port of Rotterdam.
- **Work commences on Neste sustainable fuels production facility:** On February 4, 2022, Neste reported that work had commenced at its Rotterdam refinery to produce Green Hydrogen, at part of the MultiPLHY project.

The MultiPLHY project is an initiative that is enabling Neste to transition to the use of new technologies, including Power-to-X and renewable hydrogen production. The installation of solid-oxide electrolyser cell (**SOEC**) is regarded as an important step in this transition. The MultiPLHY project involves a number of corporations, including CEA (French public research organisation), Engie (leading international energy corporation), Paul Wurth (leading engineering and technology corporation) and Sunfire (leading technology provider, and the provider of the **SOEC**).

By way of reminder: In addition to the projects detailed above, in December 2022 the **Porthos (Port of Rotterdam CO₂ Transport Hub Off-shore Storage)** project contracted with Air Liquide and Air Products, and two of the leading international energy corporations, ExxonMobil and Shell in respect of carbon capture and storage.

The **Porthos** project is one of the flagship CCS projects, being development by the **PORA** and EBN B.V. (a natural gas corporation owned by the Dutch Government), Gasunie (energy network operator in the Netherlands and Northern Germany) in joint venture, comprising the transportation of **CO₂** captured in the Port of Rotterdam (see **Edition 3** of Low Carbon Pulse) using a 22 km submarine pipeline into storage in a depleted gas field with storage capacity for **CO₂** of 37 million metric tonnes. The intention is that the 2.5 million metric tonnes of **CO₂** will be stored each year.

- **LCO₂ Carrier development:** As has been noted consistently in Low Carbon Pulse, while the development of hydrogen, ammonia, methanol and carbon dioxide production and capture technologies is key to progress to **NZE**, as important is the development and deployment of sea-going carriers that can transport these energy carriers from the point of production to the market in which they are to be used.

As noted above in respect of the **MV Suiso Frontier**, progress is being made, but the technology used for the **MV Suiso Frontier** is being scaled up by **KHI**, with containment tanks of 40,000 m³ having already being certified, and plans for four tanks per vessel. Once the technologies are established and tested, sea-going carriers need to be built at a rate consistent with the in tandem growth of the supply and demand for the energy carriers of the future.

On February 2, 2022, it was reported widely that Mitsubishi Heavy Industries (**MHI**) Group unit Mitsubishi Shipbuilding Unit entered into a contract with Sanyu Kisen, based in Kobe, Japan, to build a demonstration test vessel to carry liquified carbon dioxide (**LCO₂**). The **LCO₂** is to be built at the **MHI** Enoura Plant, at **MHI's** Shimonoseki Shipyard Machinery Works.

As has been the case with the development of the **HESC** (see above under **Japan and Republic of Korea**) from Australia to Japan (which developed with a demonstration hydrogen production plant, and the development of hydrogen compression, transportation and liquefaction technologies), the **LCO₂** carrier project is to develop along with CCUS technology and demonstration projects, and **CO₂** transportation projects.

- **Energy carrier production for vessels needs to be accelerated:**

Edition 26 of Low Carbon Pulse reported that on August 24, 2021:

"A.P. Moller – Maersk announced that Maersk had accelerated the rate of its fleet decarbonisation with an order for eight container vessels capable of being powered and propelled using carbon neutral methanol. With each container vessel costing USD 175 million, this is a USD 1.4 billion commitment.

The eight container vessels are to be built by Hyundai Heavy Industries (**HHI**) and delivered in 2024. The multi-vessel shipbuilding contract with **HHI** gives Maersk an option for four additional container vessels. As would be expected, the engines will be dual fuel, to allow the use of both low carbon methanol and low sulphur heavy fuel oil. As noted in previous editions of Low Carbon Pulse, **HHI** has been working on the dual fuel technology for some time with MAN ES and Alfa Laval (see **Edition 21** of Low Carbon Pulse)."

Edition 26 of Low Carbon Pulse noted that:

"Possibly the most stated and restated theme in Low Carbon Pulse (and sibling publications relating to hydrogen and hydrogen-based fuels) is the need for supply and demand for hydrogen and hydrogen based energy carriers to develop in tandem.

In the announcement of the order for the eight container vessels, Mr Soren Skou noted that: " .. **this is a firm signal to fuel producers that sizeable market demand for the green fuels of the future is emerging at speed**".

It is understood that Maersk will use **carbon neutral e-methanol or sustainable bio-methanol** as soon as possible. **Also it is understood that in the near to medium term, the supply of low carbon methanol is**

likely to be challenging. To address this challenge, **it should be expected that A.P. Moller – Maersk will increase demand from corporations with which it has existing supply arrangements, and contract with other corporations for supply.**"

More methanol required: On February 4, 2022, it was reported widely that a consortium, comprising A.P. Moller – Maersk, Copenhagen Airports, DFDS, DSV, Ørsted and SAS, working with Everfuel, Haldor Topsøe and NEL, intends to accelerate the rate of Green Hydrogen production at their Power-to-X project to ensure that 100 MW of electrolyser capacity is installed to ensure that 50,000 metric tonnes of clean / sustainable fuels are produced by 2050, mainly to respond to the coming demand for e-methanol for shipping.

Airports and Aviation:

*This section considers news items that have arisen within the news cycle of this **Edition 34** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

To manage the length of this **Edition 34** of Low Carbon Pulse, **Edition 35** will include a catch up on Airport and Aviation news items.

Low Carbon Pulse - Edition 35

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading later in the week, welcome to the Friday February 25, 2022, version of **Edition 35** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Monday February 7, 2022 to Sunday February 20, 2022 (inclusive of each day). The **November and December Report on Reports** has been included in the [Second Compendium of Low Carbon Pulse](#), which contains **Editions 29 to 34** of Low Carbon Pulse (covering October 6, 2021 to February 6, 2022).

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1 to 28**, covering October 6, 2020 to October 5, 2021). Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

IPCC - busy again:

As noted in recent editions of Low Carbon Pulse, the International Panel on Climate Change (**IPCC**) **Working Group II** (on Impacts, Adaption and Vulnerability) (**WGII**) is in the process of finalising its findings as part of the Sixth Assessment Report (**AR6**). For some time, the **IPCC** has signalled the release of the **WGII** report during February 2022. It is understood that the **IPCC WGII** report will be released on February 28, 2022. As the author finalises this **Edition 35** of Low Carbon Pulse, the **WGII** is at the half-way point of two weeks' of meeting to finalise the **Summary for Policymakers**.

Content of this Edition 35:

As the length of Low Carbon Pulse increased, it became apparent that a list of contents might assist the reader. Clicking on the contents list will take the reader to the section clicked:

LIST OF CONTENTS: EDITION 35 OF LOW CARBON PULSE			
Pages 2	Timeline for 2022	Pages 15 to 16:	Carbon Accounting, Carbon Capture, Carbon Capture and Use and CDR
Pages 3	Legal and Regulatory highlights	Page 16:	Carbon Credits, Hydrogen Markets and Trading
Pages 3 to 5:	Climate change reported and explained	Pages 16 to 19:	E-fuels / Future Fuels / Now Fuels
Pages 6:	GCC Countries	Page 19 to 20:	Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories
Pages 6 to 7:	Africa, India and Indonesia; Japan & ROK	Page 21 to 22:	Wind round-up, on-shore and off-shore
Page 8 to 9:	PRC and Russia	Pages 22 to 23:	Solar, Sustainability and NZE Waste:
Page 9 to 11:	Europe and UK; and Americas	Pages 23:	Land Mobility / Transport
Pages 11 to 13	France and Germany; and Australia	Pages 24 to 25:	Ports Progress and Shipping Forecast
Pages 14:	Blue Green Carbon Initiatives & Biodiversity	Page 25 to 28:	Airports and Aviation
Pages 14:	Bioenergy and heat-recovery	Page 29 to 30:	Green Metals / Minerals, Mining and Difficult to Decarbonise Industries
Pages 14 to 15:	BESS and HESS (and other energy storage)	Page 31:	NZE Publications

Timeline for 2022:

- **Key conferences and publications: Editions 33 and 34** of Low Carbon Pulse identified events that may influence or impact progress to **NZE** (and the editions of Low Carbon Pulse that will cover each event).

- **Edition 36** of Low Carbon Pulse will cover:

- **IPCC WGII:** The **IPCC WGII** report on Impacts, Adaption and Vulnerability (**WGII's** contribution to the **IPCC's Sixth Assessment Report**), the report being titled **Climate Change 2022: Impacts, Adaptation and Vulnerability**.

Starting on Monday February 14, 2022 the **IPCC WGII** has been meeting to finalise its findings ahead of the release of the **IPCC WGII** report. The commencement of the meeting was marked by an opening ceremony, live-streamed on February 14. The virtual meeting will conclude on February 25, 2022.

The meeting is the 12th session of **IPCC WGII** (and the 55th of the **IPCC**). The **IPCC WGII** is considering the **Summary for Policymakers**, to approve it. Once approved by the **IPCC WGII**, the **IPCC** will accept formally the entirety of the **IPCC WGII report - Climate Change 2022: Impacts, Adaptation and Vulnerability**.

As reported by the **IPCC**, 195 countries are meeting with **IPCC WGII** to approve, line-by-line, the **Summary for Policy Makers**. While not on the scale of **COP-26**, the 12th session of **IPCC WGII** (and the 55th of the **IPCC**) represents another critical step in understanding the impacts of climate change on the climate system, and the basis for adaptation to those impacts, and how adaptation will address vulnerability to climate change.

Throughout the first week of the virtual meeting to approve the **Summary for Policy Makers**, the **IPCC** released snippets of information illustrating the extent of the work undertaken by the **IPCC WGII**: the work has involved 270 scientists, with over 34,000 publications assessed, and 62,418 comments reviewed.

The **IPCC** alerted the media to register for embargoed material by the end of Friday **February 18, 2022**, and that from noon CET on Monday **February 28, 2022**, among others, the authors of the **IPCC WGII** report will be available for interviews, confirming that the **IPCC WGII** report will be published by the end of February.

- **IPCC WGIII:** The assessment of **IPCC Working Group III** (Mitigation of Climate Change) on the mitigation of the effects of, and progress to limit emissions causing, climate change is scheduled to be published during April 2022, with an update to be provided in Edition 36 of Low Carbon Pulse.

IPCC: In **September**, the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each Working Group, and in three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**). The **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**. Neither part of the **Synthesis Report** will be anywhere near the length of each Working Group Report and each Special Report.

- **Hot on the heels of IPCC WGII:**

Straddling the news cycles of Editions 36 and 37 of Low Carbon Pulse are two key events:

- **Middle East and North Africa Week:** As the authors of the **IPCC WGII** report on Impacts, Adaption and Vulnerability are being interviewed, the inaugural **Middle East and North Africa Week**, organised under the auspices of the United Nations Framework Convention on Climate Change (**UNFCCC**), will commence on **February 28, 2022**, and will continue through **March 3, 2022**.

The **Middle East and North Africa Week** is eagerly anticipated by the author of Low Carbon Pulse, providing an opportunity to place the Middle East and North Africa clearly at the centre of production of renewable electrical energy and clean hydrogen.

- **IUCN Africa Protected Areas Congress (APAC):** Four days after the end of **Middle East and North Africa Week**, **APAC** will commence on **March 7, 2022** in Kigali, Rwanda, and will continue to **March 12, 2022**.

APAC is the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on action required to establish and to preserve protected areas.

Edition 37 of Low Carbon Pulse will report on the **Middle East and North Africa Week** and **APAC** events, including anticipating the emerging agenda that is likely to carry through to **COP-27**.

- **By the end of April 2022:**

- **Carbon Credits, Article 6 and the Paris Rulebook:**

The demand for carbon credits is increasing at pace in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**. In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions and, in the longer term, **NZE**, on the basis of carbon neutrality.

In a stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and possible regulation of the **Voluntary Carbon Markets / Voluntary Carbon Credit Markets**.

- **E-Fuels / Future Fuels, including derived from biomass and bioenergy:**

The focus on fuels there are not derived or produced from fossil fuels is increasing. Low Carbon Pulse covers E-Fuels / Future Fuels and bio-energy. In addition to the focus on hydrogen and hydrogen based fuels (including ammonia and methanol), including hydrogen derived from biomass, there is focus on the derivation and production of Renewable Natural Gas, derived from biomass, including biomethane, both for use as pipeline gas and for use as bio-compressed natural gas (**Bio-CNG**) and bio-liquified natural gas (**Bio-LNG**).

In a stand-alone article, Michael Harrison and Richard Guit will outline the sources of fossil fuels and non-biomass fuels (including crop fuels), and the feedstocks and technologies used to produce each E-Fuel / Future Fuel, and each form of bio-energy, and of course the **GHG** arising from their deviation and production, and use.

Legal and Regulatory highlights:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.

- **Carbon properly priced in Singapore:** On February 18, 2022, as part of the Budget 2022, Singapore [announced](#) that the price on carbon would increase incrementally over time to between S\$50 and S\$ 80 per tonne of **CO₂-e** by 2030. The increase in the price on carbon is part of an integrated plan to ensure that Singapore reaches **NZE** "by or around mid-century". This aligns with the achievement of the outcomes in the [Glasgow Climate Pact](#).

SINGAPORE BUDGET 2022

Carbon tax increase

Currently	S\$5 per tonne
2024 & 2025	S\$25 per tonne
2026 & 2027	S\$45 per tonne
By 2030	S\$50 to S\$80 per tonne

- Current carbon tax will remain unchanged until 2023
- No additional carbon tax on the use of petrol, diesel and CNG as they already have excise duties
- Households will mainly feel an impact via their utility bills. Support, such as additional GSTV - U-Save rebates, will be announced in 2023



Infographic: Dawn Teo
Source: Ministry of Finance, Feb 18, 2022



Mr Toh (Director at Energy Market Authority, Singapore), has provided a very helpful summary on Linked-In. A link to Mr Toh's summary is [attached](#).

- **Standalone article about EU Green Taxonomy:**
The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**.
In anticipation of the expiry of the four month scrutiny and objection period expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article by the end of June 2022.

Climate change reported and explained:

This section considers news items within the news cycle of this **Edition 35** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.

- **CH₄ concentration on the rise:** On February 8, 2022, [nature.com](#) reported on increasing levels of methane (**CH₄**) in the climate system (under **Scientists raise alarm over "dangerously fast" growth in atmospheric methane**). **CH₄** concentration exceeded 1,900 parts per billion during 2021 – see the piece below on the [NOAA 2022 Sea Level Rise Technical Report](#).

The article in nature is well-worth a read – it hones in on the fact that: "The causes of the methane trends have indeed proved rather enigmatic". Mr Alex Turner (an atmospheric chemist at the University of Washington, Seattle) goes on to observe that he is yet to see any conclusive answer emerge.

The nature article notes that the increase in **CH₄** is caused by both human activities and naturally: 62% of global **CH₄** emissions from 2007 to 2016 are estimated to have arisen from human activities – see the bar chart at the end of this section.

As is noted (again) in the nature article, tackling methane is probably the best opportunity to buy some time to allow decarbonisation to progress so as to avoid the worst effects of climate change by limiting the increase in average global temperatures to **1.5°C** above pre-industrial times.

By way of reminder:

- **Edition 24** of Low Carbon Pulse noted that the reduction in **CH₄** emissions is important because the global warming potential of **CH₄**, as a **GHG**, in terms of potency per tonne, is greater than carbon dioxide (**CO₂**): a molecule of **CH₄** has a half-life of 9 years, compared to **CO₂** with a half-life of 100 years. Over 20 years, **CH₄** traps up to 84 times as much heat energy as **CO₂**.
- **Edition 27** of Low Carbon Pulse reported that "Increasing concern about increasing the concentration of **CH₄** resulted in the announcement on September 17, 2021, by the **EC** and US of the [Global Methane Pledge](#), given jointly, to reduce **CH₄** emissions by nearly a third within the next decade. At that time Low Carbon Pulse expressed: "The hope, and the objective of the **EC** and US now has to be to ensure that as many countries as possible join with them in this critical initiative".

Edition 34 of Low Carbon Pulse noted that as at February 4, 2022, 103 countries had signed the Global Methane Pledge. **Edition 34** also noted that: "While many countries have signed the Pledge, work needs to be done to implement the Pledge, considerable work".

- **Edition 29** of Low Carbon Pulse reported on International Energy Agency (**IEA**) [Curtailling Methane Emissions from Fossil Fuel Operations \(CCH4R\)](#). This headline from the **CCH4R** is that the reduction in methane (**CH₄**) emissions is "among the most impactful ways to combat near-term climate change".

The **CCH4R** notes that:

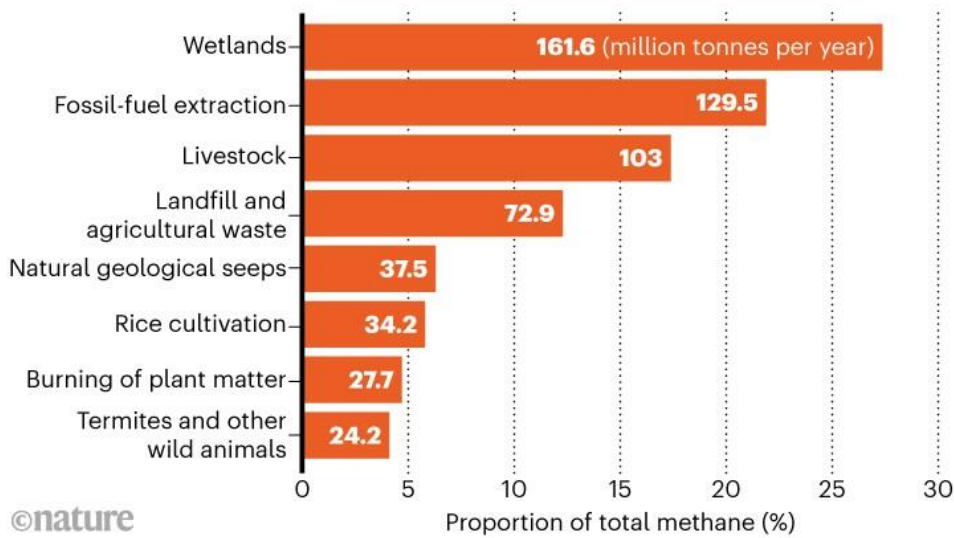
"Methane has contributed around 30% of the global rise in temperature to date ... Emissions from fossil fuel operations present a major opportunity [to limit global warming in the near term] since the pathways to reduction are both clear and cost-effective".

Greater concentration is required to address greater concentration!

On February 23, 2022, the International Energy Agency (**IEA**) will present is [Global Methane Tracker 2022](#). The **January and February Report on Reports** will provide detail from the Tracker.

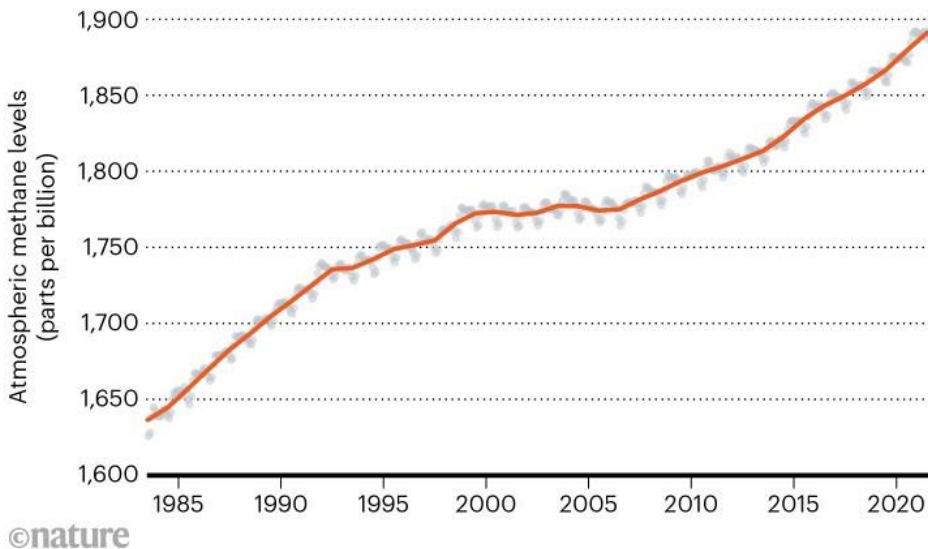
WHERE IS METHANE COMING FROM?

Studies of the isotopic signature of methane building up in the atmosphere suggest that it has a variety of sources. Most of the increase in emissions seems to be biological in origin, rather than having been released from below Earth's surface during the extraction of fossil fuels.



A WORRYING TREND

Atmospheric methane levels have been rising since the Industrial Revolution. Growth slowed between 1999 and 2006, but methane levels have increased sharply since 2007. Neither trend is well understood.



- **National Oceanic and Atmospheric Administration (NOAA) releases Sea Level Rise Technical Report:** On February 16, 2022, the **NOAA** published its [2022 Sea Level Rise Technical Report \(2022 SLRR\)](#). The **2022 SLRR** provides absorbing analysis (a little too absorbing for the already challenged sleep patterns of the author). **Attached** is the [link](#) to the conclusion section of the **2022 SLRR**.

Physical Factors Directly Contributing to Coastal Flood Exposure

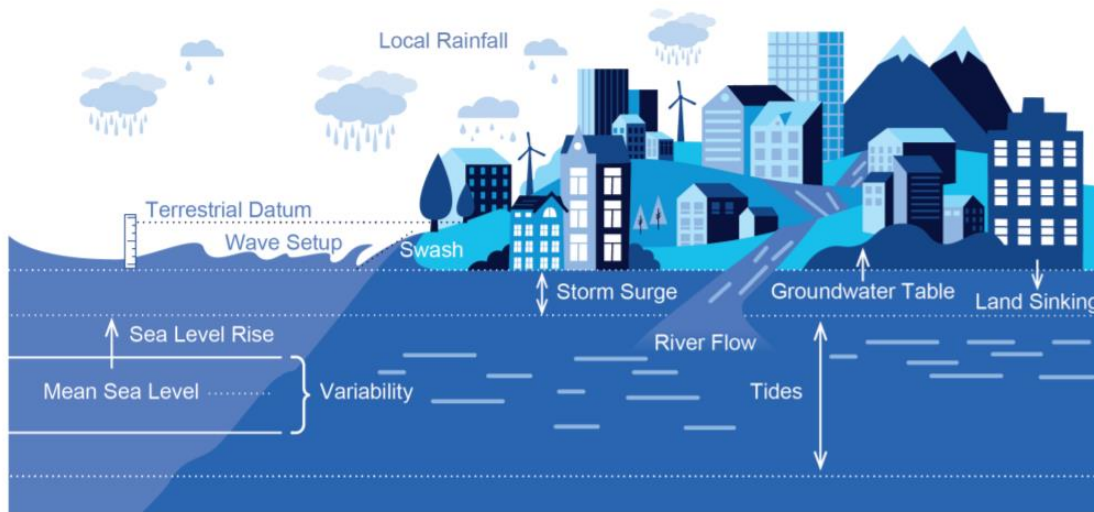


Figure 1.1: Schematic (not to scale) showing physical factors affecting coastal flood exposure. Due to the clear and strong relative sea level rise signal (i.e., combination of sea level rise and sinking lands), the probability of flooding and impacts are increasing along most U.S. coastlines.

Source: [2022 Sea Level Rise Technical Report](#)

- **World Bank Blog on the Money:**

- **What is needed is known:** On February 9, 2022, [worldbank.org](#) published [How can developing countries get to net zero in a financeable and affordable way?](#) The blog is excellent. By the use of one example from The Washington Post, the blog illustrates the existential and fundamental dynamics of the need for the more developed countries to work with developing countries to address the competing imperatives of economic development of developing countries and environmental preservation.
- **One example:** The Democratic Republic of Congo (**DRC**) has peatland covering an area the size of the US State of Iowa, and is estimated to retain as much as three years of **GHG** emissions as is emitted each year globally. If the peatland in the **DRC** were to be drained, as developed countries have drained their peatland in the past, **GHG** emissions would be emitted to the climate system. As reported in recent editions of Low Carbon Pulse, the **DRC** is one of the Least Developed Countries and one of the most vulnerable countries to climate change (see **Editions 33** and **34** of Low Carbon Pulse). The **DRC** is essential to the electric battery market, with around 70% of cobalt sourced the country, and year more than 73% of the Congolese people live below the poverty line. These dynamics are repeated across Africa at **COP27**.
- **Africa has to be a focus:** This is why the **IUCN Africa Protected Areas Congress (APAC)** scheduled to take place in Kigali, Rwanda from **March 7 to 12 2022**. **APAC** (being the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on action required to establish and to preserve protected areas) is so important. Also, this explains why Egypt, as the host nation for **COP-27**, wants to focus on Africa.
- **All less developed countries need to be a focus:** The World Bank estimates (see **Beyond the Cap – How Countries Can Afford the Infrastructure They Need while Protecting the Planet**) that developing countries need to invest around 4.5% of GDP to develop infrastructure-related Sustainable Development Goals to avoid more than a **2°C** increase in average global temperatures. This analysis was published in 2019. This analysis is from pre-COVID 19 and a pre-**COP 26** era. A greater proportion of GDP is now required, with targets now tied to avoiding more than a **1.5°C** increase in average global temperatures.
- **The means to provide what is needed is known:** In this context, the World Bank blog states that it is essential to develop climate-smart and bankable project pipelines, and to mobilize private capital. This is not new. As regular readers of Low Carbon Pulse will know, these objectives were front and centre at **COP-26** as one of the four pillars.

As reported in **Edition 30** of Low Carbon Pulse:

"Pillar 3 contemplated:

"To deliver on our first two goals, developed countries must make good on their promise to mobilise at least USD 100 billion in climate change funding a year by 2020.

International financial institutions must play their parts and we need to work towards unleashing the trillions in private and public sector finance to secure global net zero".

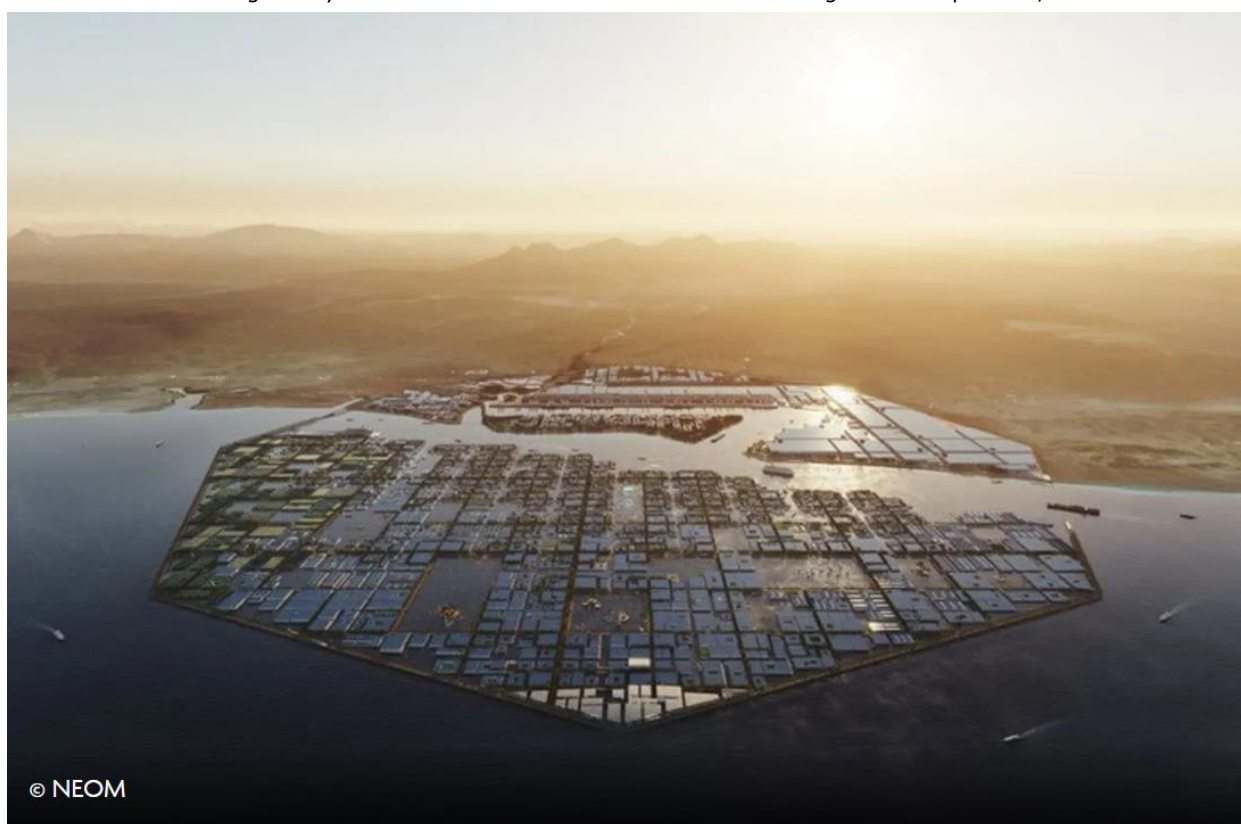
Progress was made in the sense of a clear acknowledgment (through an expression of "deep regret" - see paragraph 44 of the [Glasgow Climate Pact] that the goal of mobilising USD 100 billion a year by 2020 "had not yet been met". Developed countries are urged to mobilise "fully on the USD 100 billion a year commitment urgently through to 2025" (paragraph 46), and at least to double "their collective provision of climate finance for adaptation to developing countries from 2019 levels by 2025" (paragraph 18)."

What needs to be done is known, the means of achieving what needs to be done is also known.

GCC Countries:

*This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.*

- **Dubai Carbon Abatement Strategy approved:** On February 6, 2022, [khaleejtimes.com](https://www.khaleejtimes.com) reported that Dubai is to reduce **GHG** emissions by 30% by 2030, providing a progress check on the road to achieving **NZE** by 2050. The **Dubai Carbon Abatement Strategy 2030 (DCAS)** was approved by The Supreme Council of Energy. The **DCAS** is aligned with the **UAE Net Zero Goal by 2050**, as announced on October 21, 2021 (see **Edition 29** of Low Carbon Pulse). The **DCAS** provides the basis for great granularity to develop initiatives and measures to reduce **GHG** emissions.
- **NEOM cellular development:** On February 15, 2022, [h2-view.com](https://www.h2-view.com) reported that NEOM (see **Editions 29, 31** and **32** of Low Carbon Pulse), is to undertake heavy-duty hydrogen fuel cell stack manufacturing, having contracted with Al Misehal Group for this purpose. Subject to finalisation of contractual arrangements, the heavy-duty hydrogen fuel cell stack manufacturing facility is to be located on NEOM's innovative floating industrial precinct, OXAGON.



- **High-level hydrogen cooperation:** On February 16, 2022, [Masdar](https://www.masdar.ae/en) (Abu Dhabi Future Energy Company) announced that Masdar and the Korean Agency for Infrastructure Technology Advancement (**KAIA**) had signed a memorandum of understanding (**MOU**) providing for them to explore the development of clean technology solutions, with a particular focus on hydrogen and smart cities. The **MOU** continues, and strengthens further, the long and strong partnership between the **UAE** and the **ROK**.

Africa:

*This section considers news items within the news cycle of this **Edition 35** of Low Carbon Pulse relating to Africa. Africa remains the continent with most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.*

- **South Africa sizing-up Green Hydrogen:** On February 11, 2022, [hydrogen.central.com](https://www.hydrogen.central.com) reported (under **South Africa Talks with Investors on Green Hydrogen Projects**) that the Government of South Africa is in talks with potential investors to develop Green Hydrogen production projects. The current thinking of the Government of South Africa is to support the development of a pipeline of Green Hydrogen production projects requiring investment of USD 18 billion over the coming decade.

- **President von der Leyen on song:** In the opening speech at the **EU – African Union Summit** (that commenced on February 17, 2022 and closed on February 18, 2022) President von der Leyen set the scene for the continued development of a Global Gateway:

"[The] Global Gateway is a strategy of investment in infrastructure and people ... We want investments in quality infrastructure – connecting people and good and services ... [the] Global Gateway will muster Europe's power to unlock unprecedented levels of investment ... We can expect a package of at least EUR 150 billion for Africa in the next seven years. This is the first package under our Global Gateway Strategy ... With this [first] package, we want to catalyse investments in three categories. The first, of course is infrastructure. And there, the top priority is energy. The pathway to renewable energy and, of course, the transition towards renewable energy. Because we all know first-hand that sustained economic development hinges on reliable access to energy. Africa has solar, wind and hydropower in abundance. So let us build on that. Let us invest in Global Gateway projects, for example to build together green hydrogen capacity"

The speech is worth reading in full, but putting energy front and centre is what was hoped for.

- **Germany to transfer Hydrogen Technology:** On February 17, 2022, hydrogen-central.com reported that Germany is to transfer hydrogen production technology to African countries.

The benefits of the transfer of technology will be reciprocal: to decarbonise Germany will need to import between 40% and 60% of its hydrogen demand, and it would be reasonable to expect that technology that is transferred will be used to produce Green Hydrogen for export to Germany. The commitment from Germany was made just before the commencement of the **EU – African Union Summit**, but very much aligned with the investment message conveyed by **EU** President von der Leyen.

India and Indonesia:

*This section considers news items within the news cycle of **Edition 35** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.*

- **Green Hydrogen exempt from transmission costs:** On February 16 and 17, 2022 it was reported widely that India is to exempt Green Hydrogen (and Green Ammonia) producers from the cost of transmission. In addition, producers of Green Hydrogen (Green Ammonia) are to have flexibility to purchase renewable electrical energy (without incurring transmission charges) or develop their own renewable electrical sources, or exchange renewable energy.
The initiative also allows dispatch to a distributor of renewable electrical energy that is not needed to produce Green Hydrogen (or Green Ammonia), and to bank that dispatched renewable electrical energy, and then draw from that bank. The exemption and initiative are available to Green Hydrogen producers that establish Green Hydrogen production facilities before 2025.
The detail of the exemption and the initiative can be found in the attached [link](#).
- **Pertamina and Marubeni have a plan:** On February 19, 2022, solarquarter.com reported that PT Pertamina and Marubeni Corporation had signed a memorandum of understanding to work together to on CCS / CCUS and BECCS / BECCUS, including at the Marubeni paper mill in Indonesia, with the possible use of biomass, and the creation of carbon credits understood to be being contemplated.
- **India Hydrogen Alliance – January 2022:** Attached is the link to the January edition of [India H2 Monitor – January 2022](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the context of the **India H2 Monitor**.

Japan and Republic of Korea (ROK):

*This section considers news items within the news cycle of this **Edition 35** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

- **Teaming with ideas:** On February 7, 2022, it was reported widely that Doosan Fuel Cell had signed a letter of intent to cooperate with Shell (international energy corporation) and Korea Shipbuilding & Offshore Engineering (**KSOE**) (a leading corporation in shipbuilding and the offshore market, with Hyundai Heavy Industries as part of its group).
The three leading corporations are to develop, and to test the use of, marine fuel cell technology. It is understood that as the development and testing progresses, additional leading corporations (including ship builders and owners) will be involved, as will leading classification societies.
Doosan Fuel Cell is to develop and to test its low temperature solid oxide fuel cells (**SOFCs**) for the purposes of its work with Shell and **KSOE**, with the **SOFCs** to be certified by 2024. Shell will manage shipping and **KSOE** will install the marine fuel cells.
- **Lotte Ecosystem:** On February 7, 2022, it was reported widely that Lotte Chemical (see **Editions 22, 23, and 34** of Low Carbon Pulse) is to invest up to USD 3.7 billion to develop hydrogen business across the **ROK**. This investment will support the development plans for Lotte Chemical for a hydrogen supply / value chain across the **ROK**. Future editions of Low Carbon Pulse will follow the developments.
- **ROK battery majors sit tight at 30% market share:** On February 8, 2022, pulseneews.co.kr reported that **ROK's** battery majors, LG Energy Solution, SK On, and Samsung SDI has maintained a combined 30% share of the battery market globally. In GWh, this means that batteries from the Big Three were mounted on pure battery electric vehicles with a capacity of 90.1 GWh, and 296.8 GWh if plug-in-hybrid and hybrid vehicles are added to the 90.1 GWh for pure battery electric vehicles.
The following table provides details of the top 10 battery majors.

Global electric vehicle battery application

(Unit: GWh, market share)

Company	Capacity Jan.-Dec. 2020	Capacity Jan.- Dec. 2021
(1) CATL	36.2	96.7 (32.6%)
(2) LG Energy Solution	34.3	60.2 (20.3%)
(3) Panasonic	27.0	36.1 (12.2%)
(4) BYD	9.8	26.3 (8.8%)
(5) SK On	8.1	16.7 (5.6%)
(6) Samsung SDI	8.5	13.2 (4.5%)
(7) CALB	3.4	7.9 (2.7%)
(8) Guoxuan	2.4	6.4 (2.1%)
(9) AESC	3.9	4.2 (1.4%)
(10) SVOLT	0.6	3.1 (1.0%)

(Source: SNE Research)

Graphics by Song Ji-yoon



PRC and Russia:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the **PRC** and Russia, being countries that give rise to the most and the fourth most **GHG** emissions.

- **Gobi Desert Shimmers:** On February 11, 2022, [channelnewsasia.com](https://www.channelnewsasia.com) reported that the **PRC** is to focus on the development of photovoltaic solar and wind power development. This is news is entirely aligned with plans for **PRC** to enhance its HVDC network (see **Edition 32** of Low Carbon Pulse for most recent coverage).

By way of reminder, and for those approaching the following statistic for the first time, hold on to your hat! Or take a seat! The **PRC** intends to have installed 1,200 GW of renewable electrical energy capacity by 2030.

In guidelines published by the National Energy Administration (**NEA**) on February 10, 2022, by 2030 all new energy demand is to be matched by dispatch from non-fossil fuel sources, and the development of renewable electrical energy capacity in the Gobi Desert is key to this. While the **PRC** remains on target to reach peak **GHG** emissions by 2030 (possibly a little sooner), the expectation is that coal-fired power station dispatch will increase until at least 2025, noting that a further 150 GW of coal-fired power generation capacity is expected to come on line within the 2021 to 2025 time frame.

By way of reminder: Edition 34 of Low Carbon Pulse reported that in 2021 the **PRC** connected more off-shore wind than "every other in the world had managed to install in the last five years".

Data from the **NEA** indicate that a little under 17 GW (16.9 GW) of off-shore wind capacity was installed in 2021. Of the total global installed off-shore wind capacity of 54 GW, the **PRC** has 26 GW.

- **NEA** and **WFO** reconciled:

The World Forum Offshore Wind (**WFO**) report for 2021, [Global Offshore Wind Report 2021](#) states that the **PRC** connected 12.7 GW (12.869 GW) of new off-shore wind field capacity during 2021. This is less than reported by the **NEA**. Nothing should be read into the difference, the **WFO** counts off-shore wind field capacity that is in operation with all turbines installed and first electrical energy produced.

The headlines are that, using the accounting methodology of the **WFO**, in 2021: **1.** 15.7 GW of off-shore wind field capacity was installed; **2.** The **PRC** added 12.7 GW of that capacity; **3.** New and installed capacity now comprises 48.2 GW of installed capacity; and **4.** There is 17 GW of off-shore wind field capacity currently under development and moving to deployment globally.

- **PRC renewables boom in context:** On February 17, 2022, [Wood Mckenzie](#) published an article placing the might of the **PRC's** renewable manufacturing capacity in context. As noted in previous editions of Low Carbon Pulse, the growth of the renewable manufacturing capacity of the **PRC** has assisted the **PRC**, and those trading with the **PRC**, to develop and deploy renewable capacity at a lower cost and at a faster rate than might otherwise have been the case.

Edition 33 of Low Carbon Pulse noted that the size of the **PRC** renewable manufacturing capacity in 2022 would likely exceed demand, with resulting over-supply capacity.

The Wood Mac article places these dynamics in context (including in a geopolitical context):

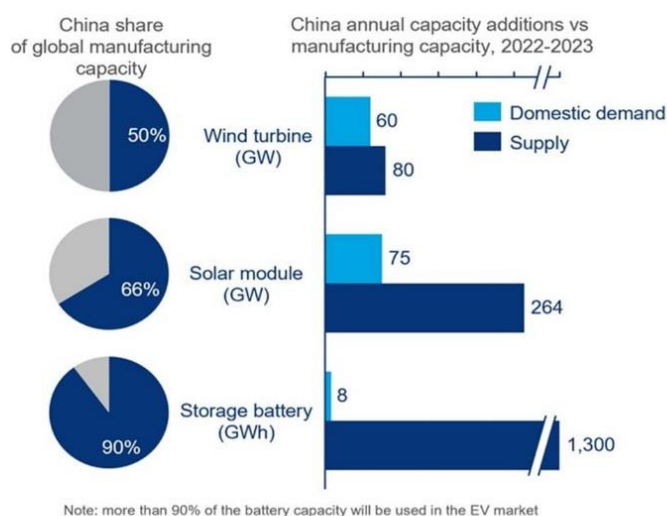
"This production [capacity] of epic proportions is enough to meet what China needs to accelerate decarbonisation while supporting the ambitions of much of the rest of the world".

"China's position as the world's dominant supplier of solar modules looks secure with nearly 70% of global manufacturing ... wind turbines ... account for 50% of global manufacturing, mainly of the [**PRC**] domestic market.

The country also accounts for nearly 90% of global manufacturing capacity of lithium-ion batteries."

As ever, the Wood Mac article is well-worth a read. And the article is complemented by Wood Mac's February [Horizons](#) thought leadership, which identifies what has driven growth in the **PRC's** renewable sector, and Wood Mac's view of the sustainability of that growth.

China's renewables and battery manufacturing dominance



Source: Wood Mackenzie APAC Power & Renewables Service

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- **Russian-German hydrogen study:** On February 16, 2022 a number of sources reported on the first-bilateral study on the potential use of hydrogen across the Russian and German energy systems, and the role of hydrogen in the development of energy markets. The bilateral study is the work of Russian and German teams working in cooperation with each other. The study is available through the AHK Russland [website](#).
- **IRENA and State Grid:** On February 17, 2022, the International Renewable Energy Agency (**IRENA**) and the State Grid Corporation of China held a virtual event, **Facilitating the Transition Toward Smart Electrification with Renewables in China**. The virtual event complemented the report prepared jointly by **IRENA** and **State Grid** [Smart Electrification with Renewables: Driving the transformation of energy services](#). The **January and February Report on Reports** will outline the findings from **Smart Electrification with Renewables: Driving the transformation of energy services**.

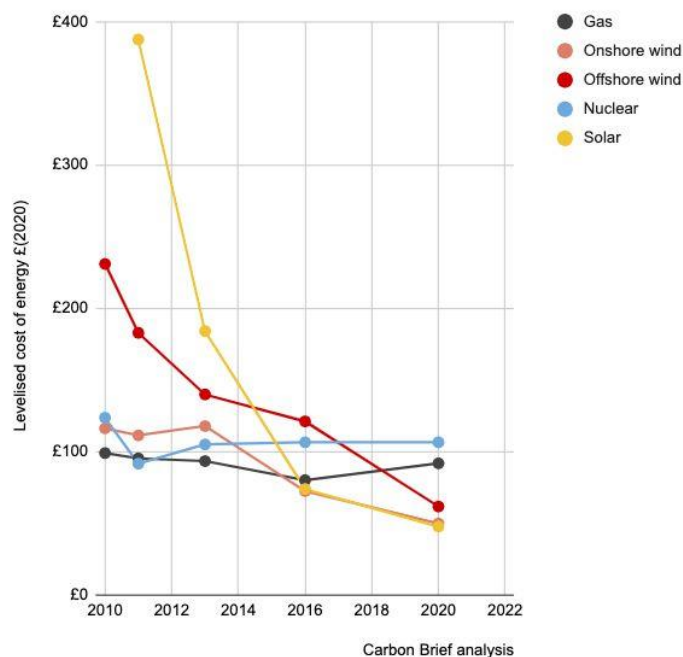
Europe and UK:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to countries within the European Union (EU) and the EU itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards NZE. In combination, countries comprising the EU give rise to the most GHG emissions after the Peoples Republic of China (PRC) and the US. The UK is a top-twenty GHG emitter, but has been a front-runner in progress towards NZE.*

- **UK Decarbonising Heat in Homes:** On February 3, 2022 the UK Government Department of Busines, Energy and Industrial Strategy (**DBEIS**) released its report [Decarbonising heat in homes](#) (**DHIIH** report). The **DHIIH** report will be covered in detail in the **January and February Report on Reports**, which will be included in the [Second Compendium of Low Carbon Pulse](#) updated at the end of March / start of April, 2022.
- **CfD Auctions Annual: Edition 34** of Low Carbon Pulse reported that: "the UK Government launched an open consultation process [Contracts for Difference \(CfD\): proposals for changes to supply chain plans and CfD delivery](#). The consultation process ends at 11.45 pm on March 15, 2022." By way of reminder, **Edition 17** of Low Carbon Pulse outlined changes to the form of CfD in 2021. On February 9, 2022, **DBEIS** announced (under [Government hits accelerator on low-cost renewable power](#)) that contract for differences auctions will be held annually, rather any every other year as currently, to accelerate adoption of renewable electrical energy and enhance energy security. The next CfD round will open in March 2023.
- **Cluster sequencing for carbon capture, usage and storge (CCUS) deployment: Phase 2: Edition 33** of Low Carbon Pulse noted the passing of the deadlines for applications for funding to develop **Phase 2** projects, **Phase 2** projects being **Power**, **Industrial Carbon Capture** and **Hydrogen** production projects. In addition, Greenhouse Gas Removal (**GGR**) projects (**GGR** including **BECCS** and **DACs**) with an interest in requesting access to **Track 1 Clusters** (the Track 1 Clusters being East Coast and HyNet North West, with the Scottish Cluster in reserve) were invited to complete expressions of interest. It has been the intention to include an update on the applications in **Edition 34** or this **Edition 35** of Low Carbon Pulse, but to manage the length of each Edition the author has deferred this idea, rather a future edition of Low Carbon Pulse to cover the successful applicants.
- **Photovoltaic Solar cheaper than a decade ago:** It was reported from a number of sources that the levelized cost of energy (**LCOE**) from photovoltaic solar sources is lower in the UK than was the case a decade ago.

Solar is now 88% cheaper than thought a decade ago, UK gov't says – and half its estimate for gas power

Levelised cost estimates are down 57% for onshore and 73% for offshore wind



Source: [Jan Rosenow LinkedIn](#)

Americas:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.

- Canada Hydrogen Alliance (CHA) plans acceleration:** On February 7, 2022, [h2-view.com](#) (under **Canada Hydrogen Alliance unveils project to accelerate hydrogen innovation**) reported that the Hydrogen Transition Hub is to begin a new project to support acceleration of resolution of challenges associated with the development of the global hydrogen economy – the FUSION-MAP project.
- Preparing the Californian Grid:** On February 9, 2022, [rechargenews.com](#) reported (under **California scopes \$30bn grid plan in face of "unprecedented" green power demand**) that the Californian state grid operator, Caiso, has estimated that up to USD 30 billion may be required to enhance the high-voltage transmission network across the state to ensure the integrity and stability of the grid at it moves to 100% renewable electrical energy and up to 121 GW of BESS across the grid.
 The final version of the **20 Year Transmission Outlook** will be published in March 2022, and will be covered in the **March and April Report on Reports** to be included in the Appendix to the Second Compendium to be published with **Edition 39** of Low Carbon Pulse.
- US DOE goes live:** Various editions of Low Carbon Pulse reported have reported on the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**, its progress and its passing. The initiatives in the **IIAJA** are now being rolled out.
 - Clean Hydrogen RDD goes live:** On February 9, 2022, the US Department of Energy (**DOE**), through the Office of Fossil Energy and Carbon Management (**FCEM**), announced formally the roll-out of the USD 24 million in federal funding for research and development and front-end engineering and design that will advance the adoption of clean hydrogen as a carbon free fuel for electrical energy generation, industrial use and transportation. This is the first step in provision of funding for **RDD**.
 - EV charger funding goes live:** On February 10, 2022, the Biden Administration rolled out its plan to allocate USD 5 billion to fund the development and deployment of electric vehicle chargers over the coming five years. This initiative is part of, which earmarked USD 7.5 billion to roll-out a nationwide electric vehicle charging network of 500,000 electric vehicle chargers. The initiative includes the designation of alternative fuel corridors.
 - Clean Hydrogen Project Process goes live:** On February 15, 2022, the US **DOE** announced that it requires information on the development of hydrogen hubs across the US, with at least four hydrogen hubs contemplated.
By way of reminder: The largest hydrogen program in the **IIAJA** provides the US (**DOE**) with USD 8 billion to provide support for at least four hydrogen hubs that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.

Also there is funding to support lowering the cost of production of Green Hydrogen with the goal of achieving a cost of USD 2 per kg by 2026 and for research, development and demonstration (**RDD**) to develop and deliver clean hydrogen production, delivery, storage and use technologies. Finally, the **IIAJA** contemplates the development of a national hydrogen strategy and roadmap to facilitate large-scale, and wide-spread, production, delivery, storage and use of clean hydrogen.

France and Germany:

*This section considers news items within the news cycle of this **Edition 35** of Low Carbon Pulse relating to France and Germany.*

- **One Ocean Summit:** On February 9, 2022, the three day **One Ocean Summit** opened in the sea port of Brest, France, on the Brittany Coast. The **One Ocean Summit** was convened by the President of France, Mr Emmanuel Macron, and may be regarded as the centre piece of the six month **EU** presidency of France.

In the lead-up to the **One Ocean Summit** there was considerable coverage of the agenda and the basis for engagement, with identified role of blue diplomacy "in a host of area, from privacy to pollution to overfishing and carbon storage [Blue Carbon]".

In addition to countries attending the **One Ocean Summit** (in person and virtually), the **One Ocean Summit** was attended by leading shipping companies, AP Moller Maersk, CGM and Hapag-Lloyd (each in the vanguard of the decarbonisation of shipping). The **One Ocean Summit** is to be followed by the **UN Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction** to be held in New York in March 7 to 18, 2022.

[Note: At the time of publication of this Edition 35 of Low Carbon Pulse, the UN Intergovernmental Conference of Marine Biodiversity of Areas Beyond National Jurisdiction is under maintenance.]

The key points to take away from the **One Ocean Summit** are:

- **High Seas Agreement on the horizon:** **EU** Member States and 16 other countries agreed to pursue a global agreement by the end of 2022 to regulate the use of sea-waters lying outside the jurisdiction of each country (the **High Seas**). The hope is that agreement can be reached in New York in March 2022.
- **30X30 Coalition:** More than 30 countries committed to the **30x30 Coalition**, the purpose of which is to protect 30% of the world's land and sea by 2030.
- **Banking on clean oceans:** French, German, Italian and Spanish development banks, and the European Bank for Reconstruction and Development and European Investment Bank are aligned around the clean oceans initiative to reduce the mass of plastic at large in oceans by 9 million metric tonnes each year, with financing of €4 billion pledged by 2025.
- **Blue Carbon Coalition:** Columbia and France announced the establishment of a **Blue Carbon Coalition** to provide financial support for the restoration of coastal ecosystems, including mangrove swamps, salt marshes and sea-grass beds.

For all agreements and initiatives click on the following [link](#).

- **France joins the Ocean Panel:** On February 11, 2022, President Macron announced that France would join the High Level Panel for a Sustainable Ocean Economy (**Ocean Panel**). France joins 15 other countries on the **Ocean Panel** (Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau, Portugal, and the US). With France joining, the 16 countries (represented on the **Ocean Panel**) represent globally nearly 46% of exclusive economic zones (comprising areas of sea within the jurisdiction of countries, as opposed to the **High Seas** – see below), 25% of fisheries and 20% of the shipping fleet.

In a busy few days for Norwegian Prime Minister, Mr Jonas Gahr Støre (see below under **Wind round-up, on-shore and off-shore: Norwegian off-shore winding up**), as the co-chair of the **Ocean Panel**, Prime Minister Støre welcomed the announcement:

"I am delighted to see President Macron and France commit to the ambitious agenda of the Ocean Panel. With a sustainably managed ocean, we will all stand better equipped to meet many of our challenges, such as climate change, plastic pollution and biodiversity loss."

THE AIMS OF THE OCEAN PANEL

By enhancing humanity's relationship with the ocean, bridging ocean health and wealth, working with diverse stakeholders and harnessing the latest knowledge, the Ocean Panel aims to facilitate a better, more resilient future for people and the planet.

- **France to increase nuclear capacity and renewable capacity:**
 - **Clear on nuclear:** In a busy week for President Macron, on February 10, 2022, President Macron announced that the nuclear industry in France was to undergo a rebirth. The announcement by President Macron has been signalled for a while (see **Editions 29** and **31** of Low Carbon Pulse), and aligns with the **EU Green Taxonomy**. President Macron announced that six new nuclear reactors would be developed (with options to develop a further eight to make 14) so as to remove the reliance of France on fossil fuels, and to allow France to achieve carbon neutrality by 2050. As noted in previous Ashurst publications, around 70% of the electrical energy generated in France is derived from use of nuclear reactors. In context, it is important to understand that the rebirth is a matter of renewal – a firm proportion of France's existing nuclear reactor power stations will come to the end of their life-cycle by 2035. It is understood that the six new nuclear reactors will be 1,650 MW EPR2 – being third generation pressurized water reactors.

- **Clear line of sight on renewables:** At the same time as the development of new nuclear reactors was announced, President Macron announced that the development and deployment of photovoltaic solar and off-shore wind field capacity would be accelerated. In this context, President Macron announced that France will have developed 40 GW of off-shore wind field capacity by 2050, on a rough and ready basis, equating to 50 off-shore wind field projects. Currently France has 2 GW of off-shore wind field capacity, and it has plans to procure a further 8.75 GW of off-shore wind field capacity by 2028 (see **Editions 16** and **32** of Low Carbon Pulse).

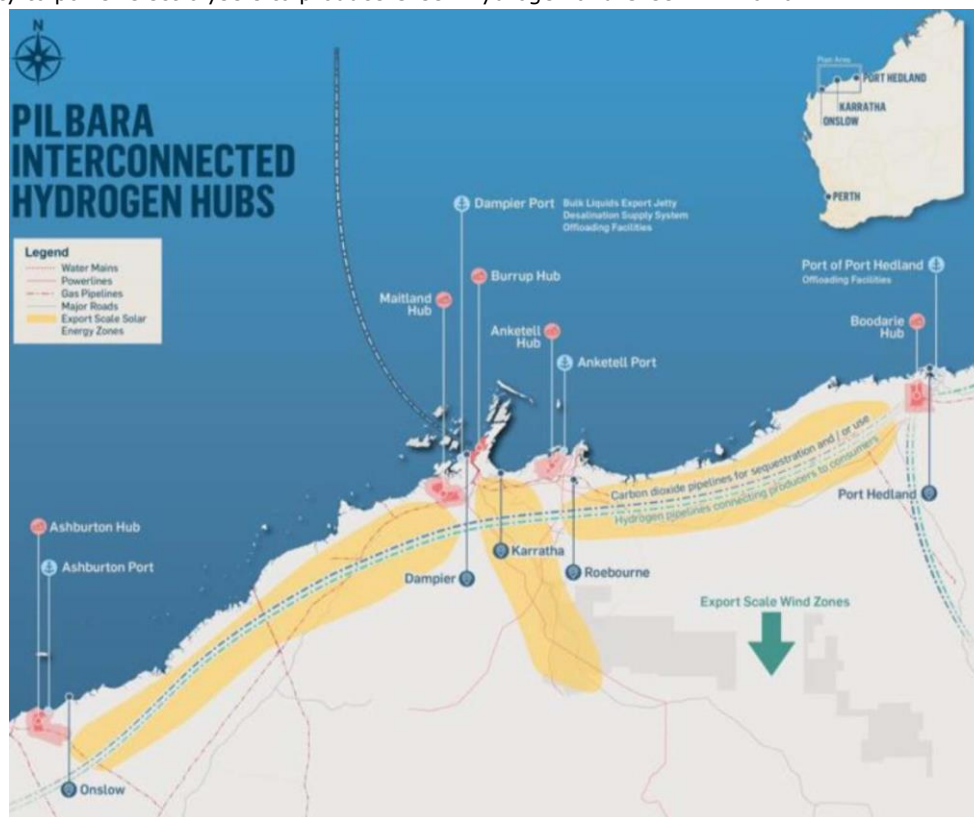
In addition, President Macron said that €1 billion in funding support would be provided to allow the development and deployment of emerging and new technologies, including the development and deployment of floating off-shore wind field capacity.

Australia:

*This section considers news items that have arisen within the news cycle of this **Edition 35** Low Carbon Pulse relating to Australia, a top-twenty GHG emitting country, and a developed country with the highest GHG emissions per capita.*

*Australia is however progressing to **NZE** at a faster rate than many other developed countries, and, along with the GCC Countries, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.*

- **Western Australia 500 km strip:** On February 8, 2022, [WAtoday](#) (under **Billions to transform the Pilbara: WA's hydrogen hubs plan revealed**) report that the Government of Western Australia intends to develop hydrogen hubs along the coast of Western Australia, making use of 500 km of Pilbara coastline to develop the necessary photovoltaic solar capacity to power electrolyzers to produce Green Hydrogen and Green Ammonia.



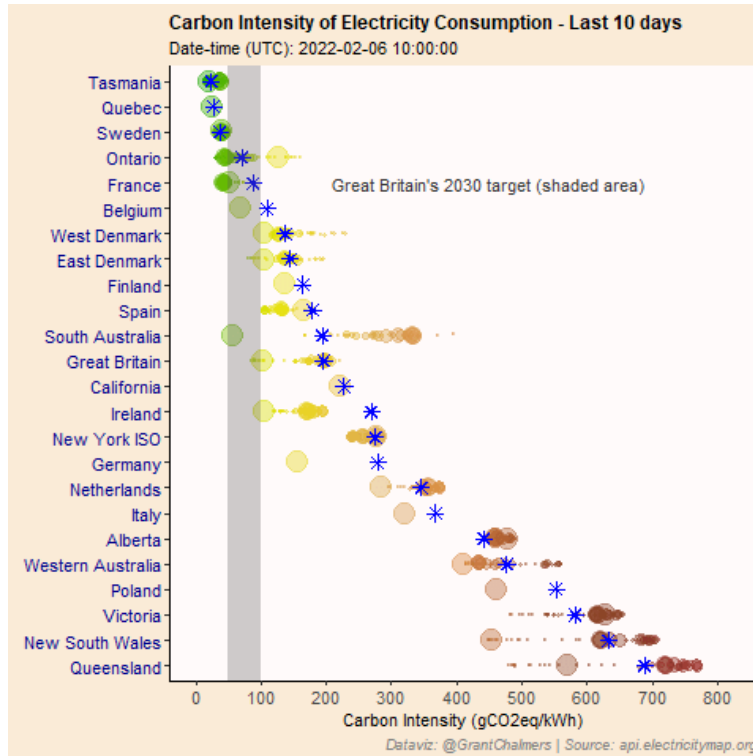
The development of the hydrogen hubs and solar strip would further monetise the renewable resources of the Pilbara region – principally its solar resource. The Pilbara region would become a "global centre for hydrogen production, use and export at scale". The development of the Green Hydrogen and Green Ammonia production capacity in the Pilbara, would allow the greening of the iron ore industry.

As outlined, there will be five hydrogen hubs producing Green Hydrogen, from Onslow to Port Hedland. Critically, a Green Hydrogen pipeline is planned. The plans have the support of leading international energy corporations and leading iron ore producers, Fortescue Metals Group (and its subsidiary, Fortescue Future Industries), and Rio Tinto.

- **A rush on records:** On February 8, 2022, Rystad Energy reported on the quantity of renewable electrical energy dispatched to match load across Australia during January 2022 – 3,628 GWh, an historical high. This was a result of many factors, but some standouts were that each of the six wind farms in Western Australia, Badgingarra, Emu Downs, Mumbida, Walkaway, Warradarge and Yandin, delivered capacity factors of greater than 50% during January. The two best performing photovoltaic solar farms during January were also in Western Australia – Merredin and Greenough River (the first utility scale solar project in Australia).
- **FMG continues development plan roll-out:** On February 9, 2022, Dr Andrew Forrest, AO (founder of Fortescue Metals Group) announced plans to develop a 5.4 GW, AU\$ 10 billion, photovoltaic solar and wind project to power its iron ore operations in the Pilbara, Western Australia (the **Uaroo Hub**). The **Uaroo Hub** project involves the deployment of around 25 km² of photovoltaic solar panels and 340 wind turbines. Coming up for 12 months on since

the commitment of FMG to achieve carbon neutrality in its mining operations (in mid-March 2021), the basis of the realisation of that commitment is now becoming apparent.

- **Carbon Intensity:** While renewable electrical energy is being developed at good rate in Australia, the carbon intensity of electrical energy generation is still high – please click to the attached graphic to get a sense of this ([Carbon Intensity Link](#)).



- **Coal fired generation has a glide path** Within the news cycle of this **Edition 35** of Low Carbon Pulse, AGL Energy and Origin Energy (two of the big three integrated energy corporations in Australia, the third being EnergyAustralia) announced plans to shutter the two largest coal-fired power stations in New South Wales, and the largest remaining coal-fired power station in Victoria:

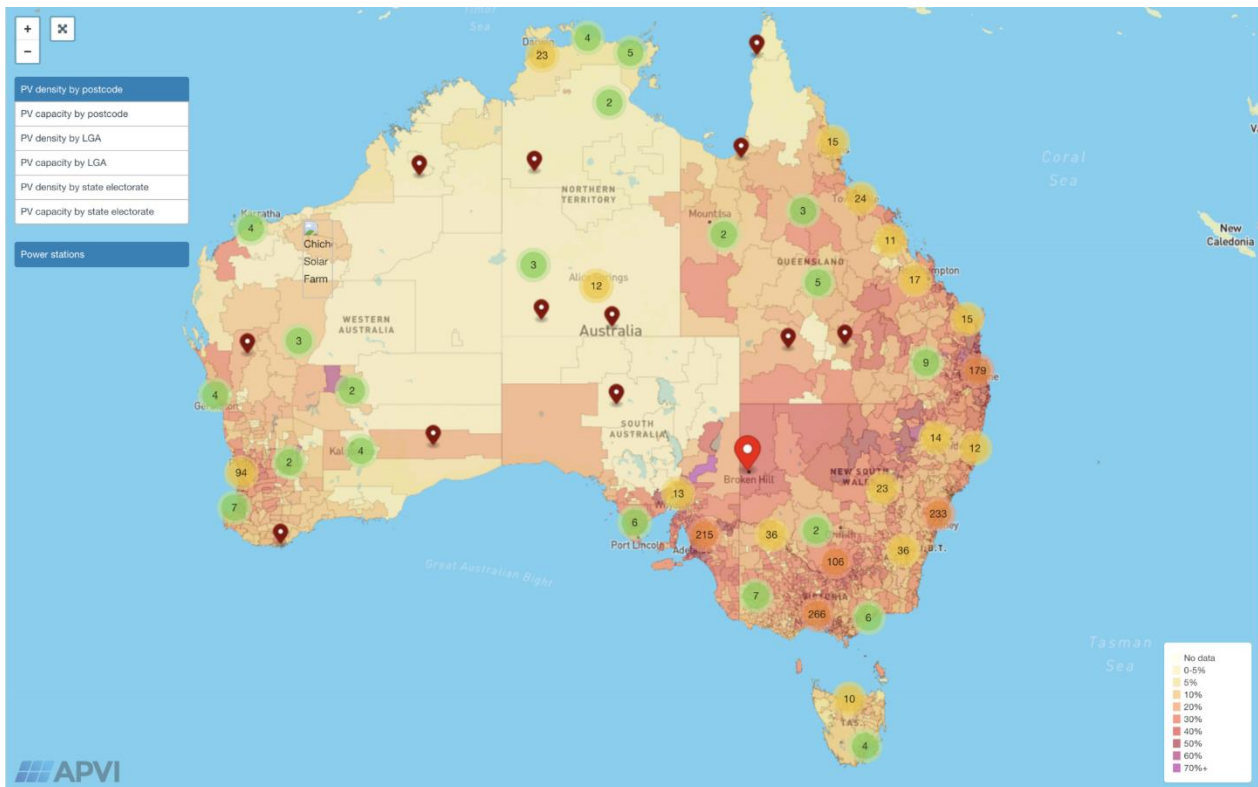
- On February 10, 2022 AGL Energy announced that its 2,640 MW Bayswater power station, in NSW, would close no later than 2033 and that its 2,210 MW Loy Yang A power station, in Victoria, would close in 2045. On February 16, 2022 Origin Energy announced that its 2,880 MW Eraring power station, in NSW, would close by August 2025 (seven years ahead of previous its planned closure). Eraring is the largest remaining coal-fired power station in Australia. As reported previously in Low Carbon Pulse, Origin Energy intends to install a 700 MW / 1,400 MWh **BESS**, on the site of the decommissioned power station.

- **ANZ for A - Z:** On February 10, 2022, the Australia and New Zealand Bank (**ANZ**) released its [Hydrogen Handbook](#). The **Hydrogen Handbook** is a very useful addition to the commonwealth of knowledge available for those active in the Australian market.

The **January and February Report on Reports** will be outline the key elements covered by the **Hydrogen Handbook**.

- **25 GW of solar, and counting:** On February 15, 2022, [pv-australia.com](#) reported that Australia has installed 25 GW of photovoltaic solar capacity – almost 1 kW for each person resident of the Lucky Country. As has been noted in previous editions of Low Carbon Pulse, this progress has been achieved primarily by the forward thinking States and Territories of Australia.

While this places Australia at the forefront of installed photovoltaic solar capacity per capita, as is apparent from the **Carbon Intensity Link**, Australia still has a ways to go to lead the world in the lowest **GHG** emissions per capita.



Blue and Green Carbon Initiatives and Biodiversity:

This section considers news items that have arisen within the news cycle of this **Edition 35** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.

To manage the length of this **Edition 35** of Low Carbon Pulse, and noting the detailed coverage in **Editions 32, 33** and **34, Edition 36** of Low Carbon Pulse will include features on Blue and Green Carbon, and Bio-diversity.

Bioenergy and heat-recovery:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass.

Bioenergy includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form.

In addition, recovered heat and waste heat (derive from any source, including waste water) has been added to this section.

From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted. The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.

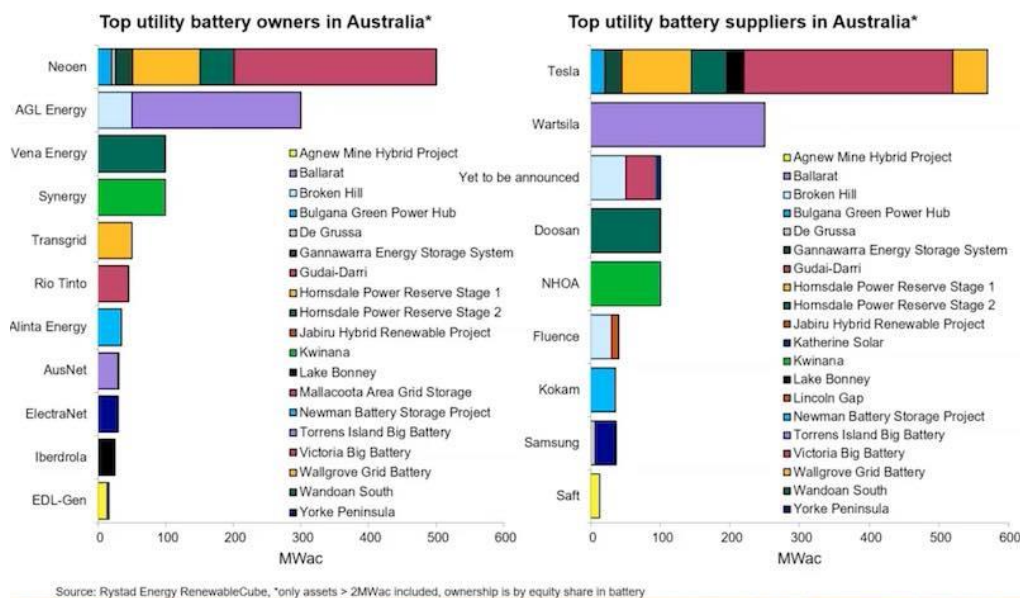
To manage the length of this **Edition 35** of Low Carbon Pulse, and noting the detailed coverage in **Editions 32, 33** and **34, Edition 36** of Low Carbon Pulse will include features on bioenergy and heat-recovery.

BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "**BESS** storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events". The **November and December Report on Report** provides a summary of the LDES Council and McKinsey report from November 2021.

- **Big Battery Flood:** On February 8, 2022, [pv-magazine-australia](#) reported that [Rystad Energy](#) (see **Edition 27** of Low Carbon Pulse) expected that the BESS capacity of Australia would double during 2022.

Overview of utility batteries in Australia



• More news on BESS in CA:

- **Edition 34 of Low Carbon Pulsed** reported that California Utility, Pacific Gas and Electric (**PG&E**), proposed to procure 1.6 GW / 6.4 GWh of new **BESS** capacity through the development and deployment of nine large-scale projects. This procurement is intended to respond to the mandate of the California Public Utilities Commission (**CPUC**) in June 2021 to procure 11.5 GW of electrical energy capacity from **GHG** free sources. **PG&E** is one of three investor owned utilities (together with and community choice aggregators) required to contract for **GHG** free sources that must come on line between 2023 and 2026. Under the **CPUC** mandate, **PG&E** is required to procure 2.302 GW of electrical energy capacity from **GHG** free sources. The procurement of 1.6 GW / 6.4 GWh of new **BESS**, discharges all but 702 MW (or 0.702 GW) of electrical energy capacity from **GHG** free sources.
- **Progress check on IOUs:** On February 11, 2022, [energy-storage.news](https://www.energy-storage.news) reported that the **CPUC** had authorised San Diego Gas and Electric (**SDG&E**) to develop and to deploy three **BESSs**, together providing 161 MW / 664 MWh. Also the **CPUC** made public further details of the Arevon and Tenaska developers 300 MW / 1,200 MWh Nighthawk BESS project, within **PG&E** territory.

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including to bioenergy carbon capture (**BECCS**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture and storage (**CCS**), carbon capture use and storage (**CCUS**) and direct air capture (**DACS**). Effective accounting for carbon arising and **CDR** go hand-in-hand. By way of background **CDR** is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (**BECCS**), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (**DACS**) are all means of **CO₂** removal. The IEA pathway to **NZE** estimates that in order to achieve **NZE** it will be necessary to capture and to remove up to 7.6 giga-tonnes of **CO₂** each year through **CCS**, **CCUS** and **CDR**. **CCS** and **CCUS** (and **BECCS** and **BECCUS**) involve the capture at source of **CO₂**, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.

- **Eni more for eni more?:** On February 9, 2022, [eni.com](https://www.eni.com) announced that Eni UK had signed 19 memorandums of understanding with corporations interested in the provision of carbon transportation and storage services by Eni UK, so as to store permanently **CO₂** in Eni UK's depleted hydrocarbon reservoirs in Liverpool Bay, as part of the HyNet North West Project.
- **INPEX plans CCS:** On February 12, 2022 (and after), it was reported widely that INPEX is to invest around USD 850 million to develop the world's largest CCS facilities in Australia. The CCS project will capture **CO₂** arising from the Ichthys Project.
- **Nippon Steel looks to CCS down-under:** On February 14, 2022, [upstreamonline.com](https://www.upstreamonline.com) reported (under **Decarbonising industry: Nippon Steel looks to DeepC Store's Australian floating CCS hub**) that Nippon Steel Corporation (the largest steel producer in Japan) is exploring the export of **CO₂** to what has been described at the first off-shore floating CCS hub in the Asia Pacific – off-shore of Australia.

For these purposes, it is reported that DeepC Store had signed a study agreement with Nippon Steel, under which jointly, DeepC Store and Nippon Steel will assess the storage of between 1 to 5 million metric tonnes per annum of liquified **CO₂** captured by Nippon Steel and transported for storage to the Cstorel project (DeepC Store's flagship multi-user off-shore floating CCS hub).

- **Storegga and Talos Energy triple up:** On February 16, 2022, energy voice.com reported that Storegga and Talos are to work together on a new CCS project in Louisiana, US (**River Bend CCS**). Talos has announced that it is to lease around 26,000 acres. The area under lease is in Iberville, St James, Assumption and Lafourche parishes, with capacity to store up to 500 million metric tonnes of **CO₂**. As reported, the location of the **River Bend CCS** is ideal with up to 80 million metric tonnes of **CO₂** arising annually within the region.
- **Aker Carbon Capture and Northern Lights Joint Venture:** On February 17, 2022, Aker Carbon Capture announced progress on carbon capture on the Northern Lights Project, with Aker Carbon Capture and the Northern Light Joint Venture signing a memorandum of understanding to realise carbon capture and storage projects together in Norway, and across Europe. The Northern Lights Project involves the collection of **CO₂** captured by emitters which is to be transported by **CO₂** carriers to a receiving terminal in Norway, and then transported by pipeline into storage in a geological sub-surface structure 2,600 metres under the sea-bed of the North Sea.

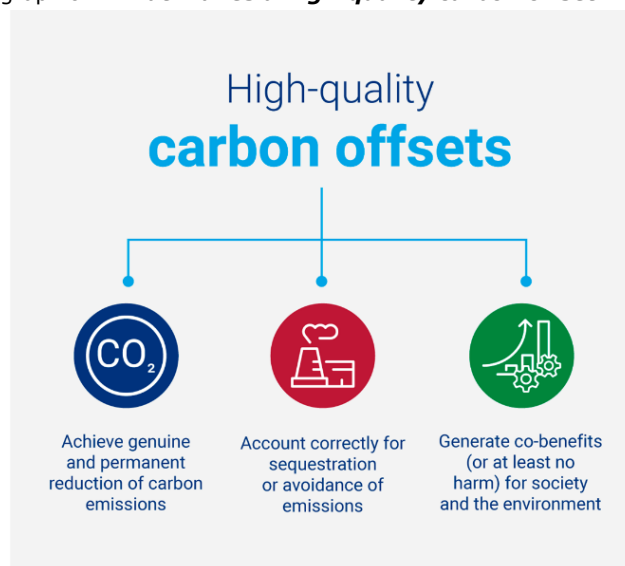
Carbon Credits and Hydrogen Markets and Trading:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development of hydrogen markets and trading (bilateral and likely wholesale).*

- **Wood Mac on Voluntary Markets:** On February 8, 2022, Wood Mackenzie published an article entitled [Voluntary carbon markets: here to stay?](#) The article is stated to be the first in a series of articles. Among other things, the article frames the use of voluntary carbon markets by corporations, outlines the genesis of the market, and notes the varying quality of carbon credits / offsets that may be acquired from the voluntary carbon market. In this context, the authors provide a helpful graphic – **What makes a high-quality carbon offset?**

What makes a high-quality carbon offset?

Source: Wood Mackenzie



As ever, the Wood Mac article is well-worth a read, especially for those wishing to orientate their thinking clearly.

- **Worth another read:** In the context of work on a standalone article on **Carbon Credits, Article 6 and the Paris Rulebook**, the author re-read the excellent article published in climatetechv.sustack.com - **Wrangling the wild west of the voluntary carbon offset market**.

As noted in **Edition 35** of Low Carbon Pulse, the article may be considered mandatory market reading for this interested in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**:

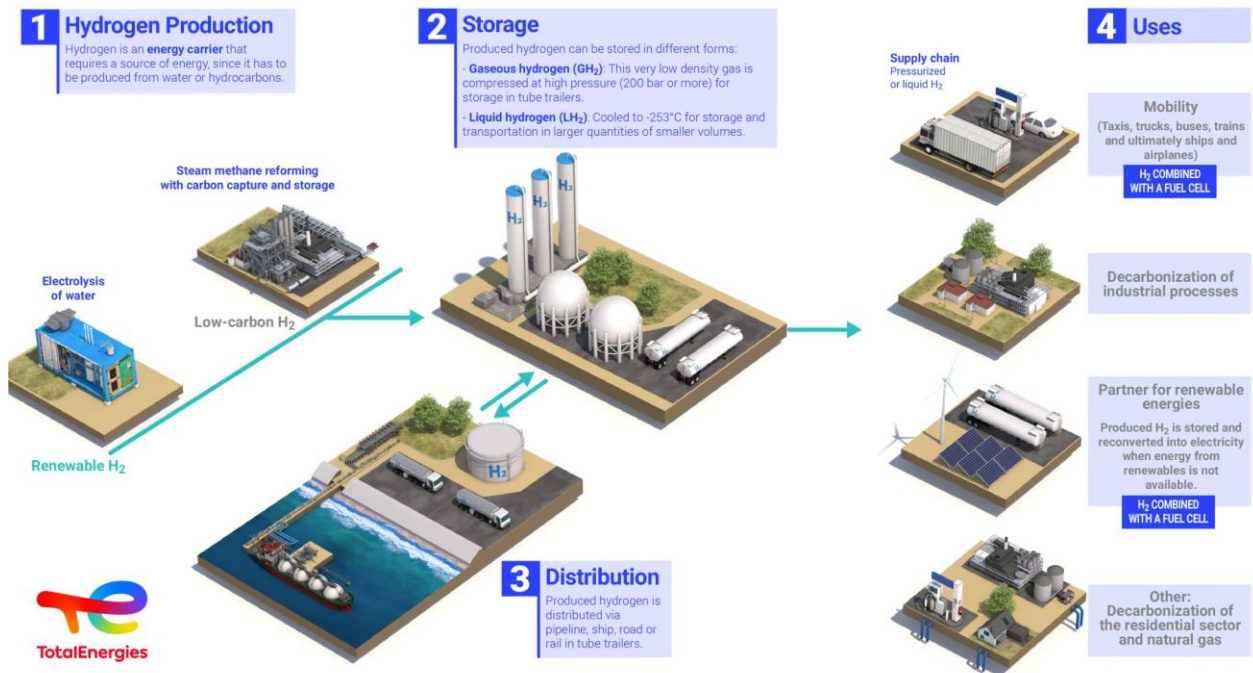
"The world of climate tech overflows with mind-bending technologies. But perhaps the most mind bending of all? The voluntary carbon markets".

E-fuels / Future Fuels / Now Fuels:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and **Future Fuels** (energy carriers derive and produced that are characterised as clean carbon or low carbon fuels). **E-fuels** include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.*

- **Hydrogen Ecosystem: Editions 33 and 34** of Low Carbon Pulse included the TotalEnergies' Aerobic Digestion Ecosystem infographic. TotalEnergies has produced a Hydrogen Production Ecosystem infographic, which is set out below:

HYDROGEN PRODUCTION ECOSYSTEM



- **Cactus Energie Verde plans GH₂ in Brazil:** On February 9, 2022, it was reported widely that Cactus Energia Verde (**CEV**) plans to invest €5 billion in the development of a Green Hydrogen Project in Ceara, Brazil, to produce 126,000 metric tonnes of hydrogen and 63,000 metric tonnes of oxygen annually.

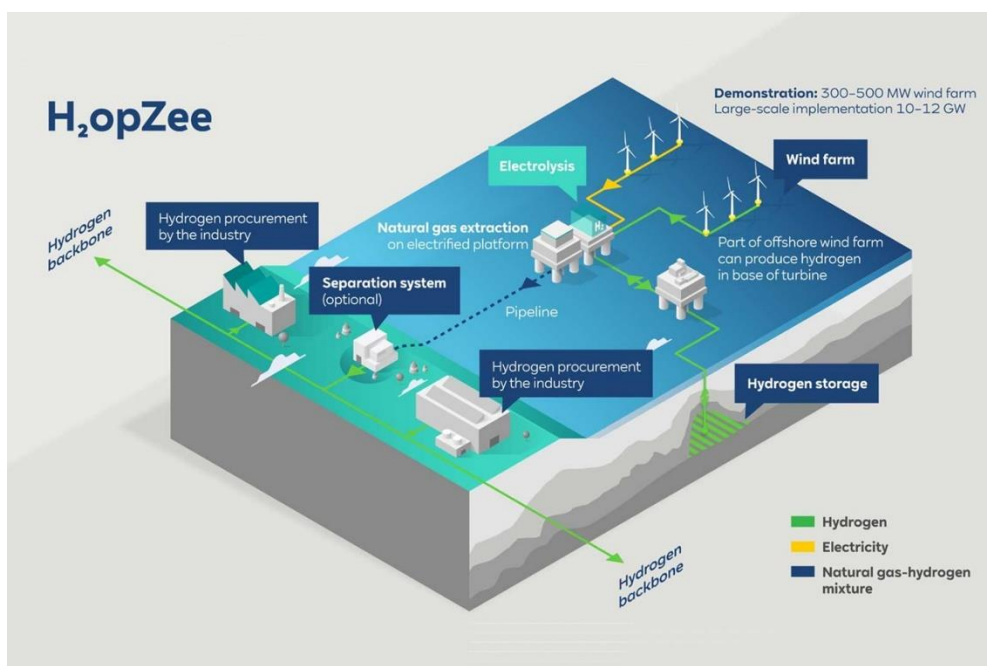
For these purposes, it is reported that **CEV** had signed a memorandum of understanding (**MOU**) with the Government of Ceara (**GOC**) to develop a Green Hydrogen production facility at the Pecém Port Complex. The renewable electrical energy to power the electrolyzers will be sourced from a photovoltaic solar project (the 2.4 GW Uruque Photovoltaic Park) and wind project (a 1.2 GW offshore wind field currently under construction).

The **MOU** with **CEV** is the 15th MOU signed by the Government of Ceara with prospective proponents (see **Editions 10** and **21** of Low Carbon Pulse): AES, Differential, EDP, EneGix, Eneva, Engie, FFI, Green Energy Cactus, H2Helium, Hytron, Neoenergy, Qair, Total Eren, Transhydrogen Alliance, and White Martins / Linde have all signed **MOUs** with **GOC**.

- **Essar First:** On February 9, 2022, Essar Oil UK announced plans to develop the first refinery-based hydrogen (powered) furnace at its Stanlow refinery. On the installation of the hydrogen furnace, existing furnaces will be decommissioned.
- **Government Green Lights for Oracle Power and PowerChina International:**
 - **Edition 29** of Low Carbon Pulse (under **PowerChina International and Oracle Power Green Flag**) reported that: "On October 25, 2021, [H2-view.com](https://www.h2-view.com), reported that PowerChina International and Oracle Power had signed a co-operation agreement to develop a 400 MW Green Hydrogen production facility in Pakistan".
 - **Government support:** On February 10, 2022, [H2-view.com](https://www.h2-view.com) reported that the proposed Green Hydrogen production facility, to be located in Jhimpir Gharo or Keti Bandar is targeting a sub-USD 2 per kilogram production cost, and in so doing allowing use of Green Hydrogen and Green Ammonia across a broad range of sectors, including aviation, fertiliser production, and ocean going shipping, and some transport mobility.
The Green Hydrogen production facility is reported to have the support of the Government of Pakistan, and is progressing to bi-lateral government support, with support expected from the **PRC**.
- **Total Eren in Morocco:** On February 11, 2022, [Total Eren](https://www.total.com) announced plans to develop a 10 GW Green Hydrogen production facility in the Western Sahara. The investment is estimated to be US\$10.6 billion and will be located in Morocco's southern region of Guelmim-Oued Nour.
- **Neptune and RWE team for off-shore green:** On February 15, 2022, it was reported widely that Neptune Energy (leading independent UK oil and gas company) and RWE (German energy giant) are to develop the **H2opZee** project to demonstrate production of Green Hydrogen off-shore. The **H2opZee** is to develop and to deploy 300 to 500 MW of electrolyser capacity in the Dutch Sector of the North Sea to produce Green Hydrogen, using off-shore wind field capacity to power the electrolyzers.

The Green Hydrogen produced by **H2opZee** will be transported to the Netherlands using an existing pipeline, repurposed for this use. It is understood that Neptune Energy and RWE intend H2opZee to be operational before 2030. Ahead of a final investment decision, Neptune Energy will undertake a feasibility study, commencing 2022.

The **H2opZee** project is supported by the Dutch Government under the auspices of TKI Wind op Zee, an initiative to bring tougher financing, knowledge and people to support the development of off-shore energy transition projects.



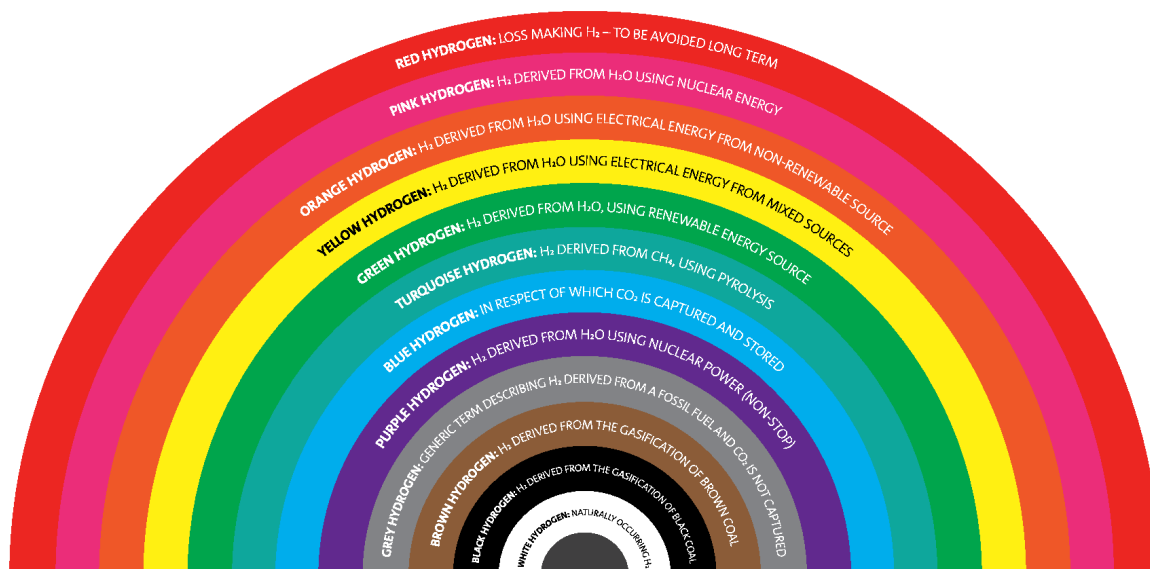
Source: [RWE website](#)

- **Takasago Hydrogen Park:** On February 16, 2022, it was reported widely that Mitsubishi Heavy Industries (**MHI**) is to establish the **Takasago Hydrogen Park** to produce hydrogen that **MHI** will use to allow it to develop and to commercialise its hydrogen gas turbine technology. **Takasago Hydrogen Park** will use electrolyser technology to produce Green Hydrogen, and it will produce hydrogen from the thermal treatment of methane (Grey without CCS / CCUS, Blue Hydrogen, without CCS / CCUS).
- **Southern Green Hydrogen:** On February 16, 2022, it was reported widely that Fortescue Future Industries and Woodside Energy had been shortlisted as partners to Contact Energy and Meridian Energy for the **Southern Green Hydrogen** project. Other shortlisted potential partners are said to include a consortium comprising ENEOS, Mitsui and BOC Gases.

As understood, the current intention is to develop 600 MW of Green Hydrogen production capacity. The Green Hydrogen produced by the **Southern Green Hydrogen** project would be used domestically within New Zealand and exported.

By way of reminder:

- **Edition 22** of Low Carbon Pulse reported that in July 2021 the [Otago Daily Times](#), had outlined plans for the development of renewable electrical energy, and use of that energy at Tiwai Point, Southland. Contact Energy and Meridian Energy (two of New Zealand's electricity generation corporations) are testing the appetite for the development of a world-scale Green Hydrogen production facility (**Southern Green Hydrogen**).
The CEOs of Contact Energy (Mr Mike Fuge) and Meridian Energy (Mr Neal Barclay) regard the development of the **Southern Green Project** as "whole of economy" development, facilitating the development of domestic demand for hydrogen and allowing New Zealand to achieve 100% renewable electrical energy generation country wide.
- **Edition 23** of Low Carbon Pulse Contact Energy and Meridian Energy (two of New Zealand's electricity generation corporations) are testing the appetite for the development of a world-scale Green Hydrogen production facility (**Southern Green Hydrogen**).
On August 1, 2021, the [Otago Times](#) provided an update on **Southern Green Hydrogen**, noting that production of Green Hydrogen may commence as early as 2023. The update noted the likely involvement of Fortescue Future Industries or **FFI** (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO).
On August 3, 2021, [The West Australian](#) (Western Australia being the home state of Dr Forrest, AO, and **FFI**), picked up on the **FFI** interest in **Southern Green Hydrogen**.
On August 4, 2021, **FFI** announced that it had signed a collaboration agreement with Murihiku Hapu of Ngai Tahu in respect of the potential development of a large scale, Green Hydrogen production project in Southland, New Zealand.
- **Gold Hydrogen for USA:** On February 17, 2022, [h2-view.com](#) reported (under **US-based Gold Hydrogen Programme to extract natural hydrogen from underground**) and **Edition 34** of Low Carbon Pulse reported on the extraction of Gold Hydrogen in Australia, with a particular focus on South Australia.
The Gold Hydrogen Programme comprises key players, including Cemvita Factory, Chart Industries, EXP and Center for Houston's Future.



Note: Some authors / commentators use Purple Hydrogen to refer to the production of hydrogen using coal or petcoke gasification using CCS to capture the CO₂ arising.

In South Australia, White Hydrogen is being referred to as Gold Hydrogen, reflecting the rush to acquire exploration licenses.

Green Hydrogen for LA: On February 18, 2022, [reuters.com](https://www.reuters.com) reported that Southern California Gas Co (the largest gas utility in the US, and division of Sempra Energy) intended to deliver Green Hydrogen to Los Angeles (the **Angeles Link**) to assist in the decarbonisation of the electrical energy, industrial and manufacturing and transportation sectors. SoCalGas announced that the **Angeles Link** could displace up to 3 million gallons of diesel fuel a day and may be used to convert up to four natural gas fired power stations to hydrogen.

The reported scale of the SoCalGas' plans is epic: up to 20 GW of electrolyser capacity sourcing renewable electrical energy from up to 35 GW of installed photovoltaic solar and wind capacity, 2 GW of BESS, and a 200 to 700 mile pipeline to haul Green Hydrogen to the point of use.

- **Green Hydrogen for Belgium:** On February 17, 2022, it was reported widely that a 100 MW Green Hydrogen production facility is to be developed at the Port of Zeebrugge, Belgium. The facility is to be developed by BESIX and John Cockerill, working with Fluxys and Virya Energy.

The Flemish Minister for Economy and Innovation, Ms Hilde Crevits stated: "Hyoffwind is one of the projects that Flanders has submitted in connection with the European call for IPCEIs".

- **Hydrogen from waste:** The derivation and production of hydrogen from waste appears to be gathering momentum. In the first of the Hydrogen for Industry publications (entitled [Feature 1: Hydrogen from Waste](#)), the derivation / production of hydrogen from waste was considered. In a number of recent news items, it is clear that hydrogen from waste, organics and plastics is coming close to breaking through as a viable source of hydrogen. In the standalone article referred to above (under **E-Fuels / Future Fuels**), Michael Harrison and Richard Guit will provide an update.

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development of:*

- *areas in which: 1. infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and 2. technologies facilitating energy transition will be concentrated and supported (**Hydrogen Corridors and Valleys**); and*
- *giga-factories that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).*

*Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.*

- **Basque Hydrogen Corridor development:** On February 8, 2022 it was reported widely that the [Basque Hydrogen Corridor Association \(BH₂CA\)](#) has identified investment decisions of over USD 200 million to be made in 2022. (By way of reminder, [Edition 11](#) of Low Carbon Pulse outlined the establishment of the **BH₂CA**.) The **BH₂CA** held a conference on February 7, 2022. Low Carbon Pulse will follow the development of the Basque Hydrogen Corridor as it widens and lengthens.
- **A world first in Levenmouth, Fife:** On February 9, 2022, SGN H100 Fife (h100fife.co.uk) provided an outline of **A world-first green hydrogen gas network in the heat of Fife**. The H100 Fife is described as "a first-of-a-kind demonstration project that's leading the way in decarbonising home heating ... [bringing] 100% green hydrogen gas

to customers for the first time". As is the case in a number of northern European countries heating accounts of a material proportion of **GHG** emission, according to SGN in the UK 37% of "all UK carbon emissions".

- **Enapter plans giga-factory at Saerbeck:** On February 11, 2022, cleantech corporation [Enapter](#) announced plans to develop a giga-factory to manufacture up to 2.1 GW of electrolyzers in Saerbeck, a town in North-Rhine-Westphalia, Germany.
- **H2PiyR Corridor:** In February 2022 a hydrogen corridor for the Pyrenees Region was announced. Future editions of Low Carbon Pulse will cover its development.
- **Spanish Hydrogen Hub:** On February 12, 2022 it was reported widely that ArcelorMittal, Enagas, Grupo Fertiberia and DH2 Energy intend to develop "the world's largest renewable and competitive hydrogen hub" (**HyDeal España**) that will result in an additional installed electrolyser capacity of 7.4 GW by 2030, with power to be sourced from 9.5 GW of renewable electrical energy, with the production and supply of Green Hydrogen to increase incrementally, starting in 2025.

The Green Hydrogen produced by **HyDeal España** will be supplied to industrial users located in Asturias, Spain. It has been reported that those industrial users will commit to offtake for 20 years, thereby matching supply with sufficient demand to allow the **HyDeal España** to proceed.

The headline grabbing fact that has emerged from the news items around **HyDeal España** is that:

"HyDeal Spain is the first concrete implementation of the green hydrogen model with a cost of €1.5 / kg [of hydrogen] announced .."

The installation of the 7.4 GW of Green Hydrogen production capacity contemplated **HyDeal España**, the 2 GW of Green Hydrogen production capacity contemplated by **Project Catalina**, and 2 GW of Green Hydrogen production capacity contemplated by **SHYNE**, means that these projects will match the Spanish Government's target and will then exceed (by nearly 8 GW) 4 GW of installed capacity by 2030. With other projects announced and planned, Spain appears well set to lead Europe in Green Hydrogen production.

By way of reminder, since the start of 2022, **Editions 33** and **34** have reported as follows:

- **SHYNE project: Edition 33** of Low Carbon Pulse reported on the **SHYNE** project as follows: " ... the Spanish Hydrogen Network (**SHYNE**), a consortium of 33 corporations and organisations, led by Spanish oil and gas giant Repsol, is to invest €3.3 bn to develop and to install 500 MW of Green Hydrogen production capacity by 2025, and 2 GW by 2030. The installation of 2 GW of Green Hydrogen production capacity by 2030 will satisfy half to the Spanish Government's target of 4 GW (see **Editions 5** and **29** of Low Carbon Pulse)".
- **Project Catalina fully sized: Edition 34** of Low Carbon Pulse reported as follows: "Copenhagen Infrastructure Partners (**CIP**) (and **CIP** announced that it was, working with Enagás, Fertiberia, Naturgy, and Vestas) is to develop and to deploy a 2 GW Green Hydrogen production facility in Aragon, north west Spain (**Project Catalina**). **Project Catalina** will source renewable electrical energy from 5 GW on-shore photovoltaic solar and wind sources. **Project Catalina** is to be developed in two phases, with Phase I currently progressing. The Green Hydrogen will be hauled from Aragón to Valencia for use as feedstock by Fertiberia (leading ammonia and fertiliser producer) to produce Ammonia and fertiliser".

By way of summary: To reflect the momentum around hydrogen production development in Spain, the following infographic is helpful. In summary, all targets in the road to 2030 are going to be in the rear-view mirror:



Wind round-up, on-shore and off-shore:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).

- **Norwegian off-shore winding up:** On February 7, 2022, www.the-eic.com (under **Adger Energi, GIG to bid for floating wind project in Norway**) reported that Norwegian power utility, Adger Energi had partnered with Macquarie-owned Green Investment Group (**GIG**) to bid for floating off-shore wind field site within the **Utsira Nord** zone (covering 1,010 km² and having an average depth of 267 metres).

The 1.5 GW **Utsira Nord** (North Utsira) zone is one of the two zones for which the Norwegian Government is seeking licensing applications, the other zone being **Sørilige Nordsjø II** (South Utsira). **GIG** regards Utsira Nord as suitable for the development of floating off-shore wind field capacity because of its deep waters strong wind conditions/resources, and relatively close proximity to industrial off-takers of renewable electrical energy.

- **Auction Process:** The Norwegian Government intends to auction the 3 GW **Sørilige Nordsjø II** in two phases. The auction model is under-development, with legislation required to support the off-shore wind development. It was reported widely that the [Norwegian Offshore Wind Cluster](#), met to debate the off-shore auction model with the Norwegian Prime Minister, Mr Jonas Gahr Støre.

On February 10, 2022, Prime Minister Støre outlined first phase (comprising 1.5 GW) of the **Sørilige Nordsjø II** off-shore wind field development: the first phase was to be completed in the second half of the current decade, providing up to 7 TWh per annum of renewable electrical energy.

Prime Minister Støre did not rule out the provision of government funding support (through subsidies of the electrical energy price). In respect of the second phase of the development of **Sørilige Nordsjø II** project the Prime Minister contemplated that 1.5 GW of renewable electrical energy from this off-shore wind field development may find a market in northern Europe, rather than Norway.

Regular readers of Low Carbon Pulse will recall earlier coverage of both **Utsira Nord** and **Sørilige Nordsjø II**. For ease of reference, that earlier coverage is included below.

- **Edition 18** of Low Carbon Pulse reported as follows:

- **"Equinor, Norsk and RWE cooperate to bid for Southern North Sea 2:** Oil major (**Equinor**), aluminium giant (**Norsk**) and giant utility (**RWE**) are reported to have signed a cooperation agreement to inform the basis of a joint bid for the fixed bottom off-shore wind field auction in respect of **Sørilige Nordsjø II**, in the Norwegian sector of the North Sea.

Sørilige Nordsjø II is one of two areas that the Norwegian Government has opened up for development, the other being **Utsira Nord**, which is to be developed as a floating offshore wind field development. In respect of **Utsira Nord**, **Equinor** is cooperating with Eni SPA and HitecVision.

- **A fair wind:** On May 25, 2021, Norseman Wind Consortium (**NWC**) announced that it has applied for a licence to develop a €3 billion, 1.4 GW off-shore wind field project off Norway, in respect of the **Sørilige Nordsjø II** area. The **NWC** comprises ASKO Fornybar, EnBw, NorgesGruppen, and Norseman Wind. The **NWC** business model is reported as meaning that its proposed off-shore wind field project will be developed without the need for government support of any kind: "Our business model means that we do not need government subsidies. Thus the state's green money can rather be spent on floating offshore wind at Utsira Nord as well as on hydrogen and carbon capture".

- **Edition 20** of Low Carbon Pulse reported as follows:

"North and South Utsira bottom or floating forecast news:

- **"Status check: Edition 18** of Low Carbon Pulse reported on the **Utsira Nord** and **Sørilige Nordsjø II** areas (known on UK shipping forecasts, as North Utsira and South Utsira) in the Norwegian sector of the North Sea. Together, **Utsira Nord** and **Sørilige Nordsjø II** have wind resource potential of up to 4.5 GW of installed capacity. The Norwegian Government (Ministry of Petroleum and Energy) has indicated that **Utsira Nord** is suitable for floating off-shore wind and that **Sørilige Nordsjø II** must be developed without any state-aid.

- **BP and Aker Offshore Wind and Statkraft:** On June 14, 2021, it was announced that BP is partnering with Aker Offshore Wind and Statkraft in a consortium to apply to develop a fixed bottom off-shore wind field in the **Sørilige Nordsjø II** area.

- **Shell and BKK and Lyse bottom out and float:** On June 17, 2021, it was announced that Shell intends to partner with Norwegian hydro-electric companies, BKK and Lyse, to apply to develop off-shore wind field projects in both the **Utsira Nord** and **Sørilige Nordsjø II** areas. It is understood that the partners are contemplating the development of floating off-shore wind field capacity in the **Utsira Nord** area, and each partner has a clear view about the quality of the wind resources in the North Sea.

Also BBK, CEO, Ms Jannicke Hilland provided an interesting perspective on the interface between hydro-electric and wind: "[When these off-shore wind fields produce electrical energy], we can hold back the water in our reservoirs, we can cover the demand for power by phasing in hydro-production".

- **Poland off-shore wind capacity progressing:** On February 8, 2022, offshoreWIND.biz (under **Race for New Mega Offshore Wind Acreage Starts in Poland**) reported that **PKN Orlen** (a Polish based oil refiner and petroleum retailer, see [Editions 20 and 34](#) of Low Carbon Pulse) and Polska Grupa Energetyczna (**PGE**) has submitted multiple applications for permits to develop off-shore wind field capacity in areas recently designated for development in the Polish sector of the Baltic Sea.

It is reported that there are 11 areas for which applications may be submitted to build and to operate off-shore wind fields and energy islands. **PKN Orlen** has submitted applications for seven areas, covering around 3 GW of installed capacity. **PGE** has submitted applications for six areas, with two applications submitted jointly with Enea and one jointly with Tauron.

WHY IS THE BALTIC SEA IS HIGHLY PROSPECTIVE?

WindEurope estimates that the Baltic Sea will allow the development of up to 80 GW of off-shore wind capacity

Strong and stable winds, particularly the case across the Polish sector

The Polish sector of the Baltic Sea has relatively shallow waters suitable for fixed bottom off-shore wind fields

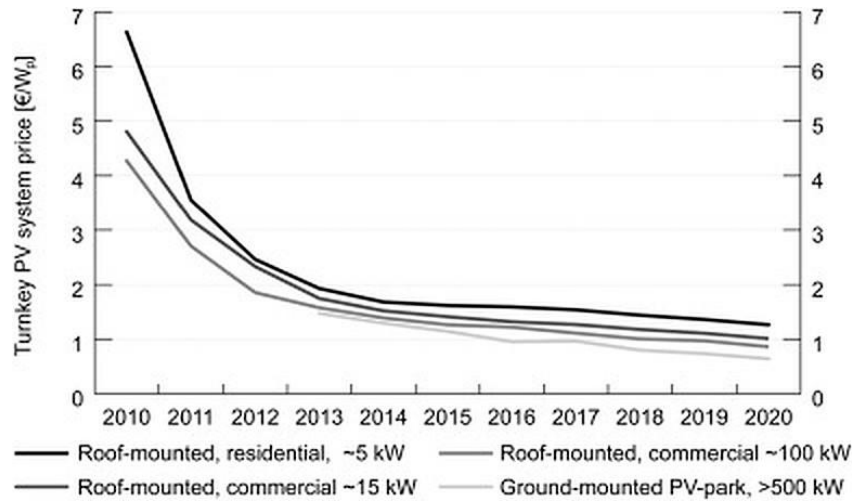
The Polish sector of the Baltic Sea will allow the development of up to 28 GW of off-shore wind capacity

- Norfolk Vanguard approved:** On February 11, 2022, it was reported widely that the Vattenfall (Swedish state owned energy corporation) 1.8 GW Norfolk Vanguard off-shore wind field project had been approved by the UK Secretary of State for Business, Energy and Industrial Strategy, Mr Kwais Kwarteng.
 The Norfolk Vanguard off-shore wind field development is within the Norfolk Offshore Wind Zone, covering an area of 1,3067 km², located 47 km of the coast of Norfolk, England. The Norfolk Vanguard is in addition to the 1.8 GW Norfolk Boreas, in respect of which approval has already been given.
- Swedish Government in search of wind:** On February 15, 2022, [offshoreWIND.biz](https://www.offshorewind.biz) reported that the Swedish Government is to identify suitable areas to develop off-shore wind fields for the purposes of generating 120 TWh annually from sources of renewable electrical energy (noting that the electrical energy consumption of Sweden is 140 TWh annually).
 It is understood that the Swedish Energy Agency (**SEA**) has identified, and reported on, three areas – located in the Baltic Sea, the Gulf of Bothnia and the North Sea having wind resources of between 20 to 30 TWh annually. The **SEA** will work with the Swedish Maritime Administration (**SMA**) to identify areas from which 90 TWh annually can be generated. The **SEA** is to report on progress by no later than March 2023, the SMA no later than December 2024.

Solar and Sustainability (including NZE Waste):

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.*

- Egypt leading into COP-27:** On February 8, 2022, [energy-utilities.com](https://www.energy-utilities.com) (under **Egypt reviews offers of green hydrogen projects in Suez ahead of COP 27**) reported that the Government of Egypt and the Suez Canal Economic Zoen (**SCZone**) had met to discuss offers received for the development of Green Hydrogen projects in the **SCZone**. Future editions of Low Carbon Pulse will report on developments.
- Singapore – lofty mandate:** On February 7, 2022, [jtc.gov.sg](https://www.jtc.gov.sg) announced that JTC Corporation (a Singapore government agency championing sustainable industrial development in Singapore) intends to mandate the installation of roof-top photovoltaic solar panels on new land and land-based allocation, lease renewals, and land launches. This initiative extends the mandate that already existed in respect of some, but not all, property. JTC Corporation anticipates that this initiative will result in the installation of 82 MW at peak (82 MWp). In context, by 2030, Singapore anticipates that it will have installed 2 GWp, sufficient for around 350,000 households a year, and comprising around 3% of electrical energy load of Singapore in 2030.
- Iberdrola pumps-up scale:** On February 8, 2022, it was reported widely that Spanish renewable energy giant, Iberdrola is developing a MW hydro-electric power complex in northern Portugal, using water from three reservoirs: Alto Tâmega, Daivões and Gouvães.
 The hydro-electric power complex will deploy a 880 MW reversible storage facility (pumped-storage), which is able to store water from the Daivões reservoir delivered into the Gouvães reservoir. There is a 650 metre differential between the two reservoirs, use of the differential will generate renewable electrical energy, with the water in the Gouvães reservoir pumped into the Alto Tâmega reservoir. The pumped storage is being described as the "Alto Tâmega giga battery": on operation the energy storage of Portugal will increase by 30%.
- Canal plus:** On February 11, 2022, it was reported widely that the State of California, US, is to cover canals with photovoltaic solar "canopies", with the expectation being that the use of photovoltaic solar "canopies" will realise multiple GW of renewable electrical energy.
- Hydroelectric plus:** On February 15, 2022, [h2-view.com](https://www.h2-view.com) reported that "the worlds' second largest hydroelectric facility" in Paraguay (having peak capacity of 14 GW) is considering the development of a pilot project to produce Green Hydrogen using 50% of the capacity of the hydroelectric facility. It is reported that NeoGreen Hydrogen (comprising an experienced team of developers and financiers) will undertake a feasibility and scoping study for these purposes.
- LCOE reaches €0.02737 kWh in Sweden:** On February 15, 2022, [pv-magazine.com](https://www.pv-magazine.com) reported that [new research](https://www.new-research.com) indicated that choice of location and financing conditions are key in reducing the levelized cost of energy (**LCOE**), allowing the development of utility-scale photovoltaic solar facilities in Sweden without the need for financial support from Government. The researchers found that the lowest **LCOE** was **€0.02737 kWh**.



Source: [Economic analysis of the early market of centralized photovoltaic parks in Sweden](#)

- **Electricity Market Report from IEA:** On February 16, 2022, **IEA** published its [Electricity Market Report – January 2022](#). The **January and February Report on Reports** will outline the findings from the **Electricity Market Report – January 2022**.
- **Octopus Outback:** On February 18, 2022 it was reported widely that the UK Octopus Group intends to partner with First Nation communities to develop renewable electrical energy projects in Australia's Northern Territory. It was reported that Octopus Group has teamed up with the Northern Territory Indigenous Business Network (**NTIBN**) to establish Desert Springs Octopus (**DCO**). Low Carbon Pulse will follow the development of this initiative.

Land Mobility / Transport:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.*

• Buses and coaches:

Daimler all electric: On February 9, 2022, [daimlertruck.com](#) announced that it had completed the first trial of its 10 metre electric eCitaro articulated bus on the in schedule service route at Seiser Alm in South Tyrol.

• Cars (including taxis); Fuel Cell and Battery Technology; Industrial Vehicles and Trucks; Recharging and refuelling infrastructure

To manage the length of this **Edition 35** of Low Carbon Pulse, news items have been included on trains only. **Edition 36** of Low Carbon Pulse will "catch-up" on other Land mobility news items.

• Trains:

• **Berlin and Brandenburg aligned:** On February 2, 2022, [railjournal.com](#) reported that the German States of Berlin and Brandenburg, and train operator and infrastructure manager Niederbarnimer Railway (**NEB**) had reached agreement to procure and to deploy hydrogen fuel cell technology on trains in the German Capital region, and the development of infrastructure.

The deployment will commence on the Berlin-Wilhelmsruh-Basdorf line. The initial procurement is reported to be for seven hydrogen fuel cell technology powered and propelled units. The procurement and deployment is proceeding with the benefit of €25 million of grant support from the German Federal Ministry of Finance.

• **CAF AND Iberdrola lining up:** On February 9, 2022, railway-news.com (under [CAF and Iberdrola Partner on Hydrogen-Powered Train Project](#)) reported that CAF (Spanish rail vehicle and equipment manufacturer) and Iberdrola (Spanish integrated energy giant) had signed a framework agreement to promote the use of Green Hydrogen in the rail and passenger.

The signing of the framework agreement comes ahead of the testing of the hybrid electric battery and hydrogen-powered and propelled train developed by CAF at its Zaragoza plant as part of the **FCH2RAIL project** (see **Edition 26** of Low Carbon Pulse). The tests are to commence in April 2022, and hydrogen supplied by Iberdrola will be used.

• **Porterbrook and Rolls Royce on track:** Both [Porterbrook](#) (the UK's largest rolling stock owner) and [Rolls Royce](#) have announced that they were working together to pioneer the advancement of rail decarbonisation.

To date, Porterbrook and Rolls Royce have worked together on the **HybridFLEX** (combining power and propulsion using diesel and battery) for Chiltern Railways (dear to the heart of the author). The **HybridFLEX** has been developed further so that it can use hydrogen too - making it the world's "first tri-mode" train.

Moving forward, Porterbrook and Rolls Royce intend to work together to develop the use of sustainable / synthetic fuel and net-zero fuels, including hydrogen using both fuel cell technology and internal combustion engine technology.

• **JR East Hybrid running:** On February 19, 2022, [asia.nikkei.com](#) reported that East Japan Railway (**JR East**) had unveiled Japan's first hydrogen-powered hybrid train (**Hybari**) on February 18, 2022, using technologies developed by Hitachi Corporation and Toyota Motor Corporation - hydrogen fuel cells and electric battery technologies. **JR East** is to commence testing of the **Hybari** in March 2022.

Ports Progress and Shipping Forecast:

This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use of carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland.

Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.

- **Ferries:**

Within the news cycle covered by this **Edition 35** of Low Carbon Pulse, no news items have come to light on Ferries that may be regarded as significant for the purposes of Low Carbon Pulse.

- **Green Shipping:**

- **Energy Observer well and truly observed:** For some time, the Energy Observer 2 has received considerable news coverage across many industry and main stream and network news outlines.

The reason for this are that the Energy Observer is powered and propelled by liquid hydrogen using fuel cell technology and by Oceanwings®, and is a multipurpose cargo ship that would result in zero emission sea borne transportation of cargo. The **Energy Observer 2** was presented at the **One Ocean Summit** in Brest, France (see France and Germany: [One Ocean Summit](#) above).

The **Energy Observer 2** has been developed by Energy Observer (and its industrial subsidiary, EODev), and its technology and operational partners, Air Liquide, Ayro (the developer of Oceanwings®) CMA CGM Group (global leader in maritime transport and logistics), LMG Marin (naval architecture corporation, and developer of the world's first liquid hydrogen powered and propelled ferry, the **MV Hydra** – see **Editions 23** and **34** of Low Carbon Pulse). Bureau Veritas has been providing ongoing input as the design of the Energy Observer has developed.



Source: [Energy Observer](#)

- **Shell accelerating with GTT:** As noted above (under [Teaming with ideas](#)), Shell is working with Doosan and **KSOE** to develop fuel cell technology to power and to propel vessels using liquid hydrogen (**LH₂O**). On February 8, 2022 it was reported widely that Shell International Trading and Shipping is working with GTT to accelerate technology development to allow the carriage of **LH₂O** as an energy carrier: GTT is a proven technology developer and provider of cryogenic technologies. GTT and Shell are going to work together to design containment systems to allow the storage and transportation of **LH₂O**. As readers of Low Carbon Pulse and sibling publications will know, the development of containment systems and scaling up the capacity of **LH₂O** is key to the development of the world trade in hydrogen.
- **Aker Clean Hydrogen and Kuehne+Nagel clean above and below decks:** On February 11, 2022, [h2-view.com](#) reported that Aker Clean Hydrogen (a corporation within the Aker ASA Group) and Kuehne+Nagel (leading logistics solutions corporation) are combining to continue progress in decarbonising the shipping industry in Norway. Aker Clean Hydrogen is to supply green fuels to Kuehne+Nagel (including Green Hydrogen, Green Ammonia and Green Methanol) for the purposes of its maritime logistics business so as to power and to propel vessels with engines converted to use or the green fuels, including dual fuel engines.
- **Zero carbon shipping:**
 - **World Shipping Council (WSC) plan for zero carbon shipping:** On February 10, 2022, [gcaptain.com](#) reported that the **WSC** has identified six pathways (economic and regulatory) that it regards as key for nations within the UN International Maritime Organisation (**IMO**) to address to achieve a successful transition to zero carbon shipping. The **WSC** made a [formal submission](#) to the **IMO** dated February 9, 2022. For those that have been following the **WSC**, the pathways will not be a surprise: **1.** Applied R&D for ship-board to shoreside systems, to allow use of zero-carbon fuels; **2.** Global application of a carbon price (**GHG Price**) (see **Edition 27** of Low Carbon Pulse); **3.** Life-cycle fuel accounting with appropriate regulatory mechanisms for first movers, critically, transparent well-to-wake life-cycle analysis of fuels, distinguishing well-to-tank and tank-to-wake emissions, coupled with incentives to encourage use of zero carbon fuels; **4.** Integrated development of global production and supply of zero carbon fuels; **5.** The Green Corridors as an enabler of the fuel / technology transition (see below for **Green Shipping Corridors in practice**); **6.** New build standards that support energy transition by requiring energy transition to zero carbon.

As has been the case before, the author looks for the Maersk McKinney Moller Center for Carbon Shipping perspective, which is fully supportive of the approach of the **WSC**. The perspective of the [Maersk McKinney Moller Center](#) for each pathway is worth a read.

- **Green Shipping Corridors in practice:**

Edition 30 of Low Carbon Pulse reported on Green Shipping Corridors as follows:

"**Clydebank Declaration:** On November 10, 2021, the [Clydebank Declaration](#) was agreed at **COP-26**. The **Clydebank Declaration** emphasises the importance of limiting "the increase in global average temperature to **1.5°C** above pre-industrial levels", expressed great concern that if "no further action is taken, international shipping emissions are expected to represent 90% to 130% of 2008 emissions levels by 2050", and recognised that "a rapid transition in the coming decade to clean maritime fuels, zero-emission vessels, alternative propulsion systems, and the global availability of landside infrastructure to support these, is imperative for the transition to clean shipping".

In addition the signatories to the **Clydebank Declaration** commit to facilitate the development of **Green Shipping Corridors**, with at least six **Green Shipping Corridors** by "the middle of this decade ... [and] many more corridors ... by 2030". A **Green Shipping Corridor** is a route between two or more ports that are "zero-emission maritime routes".

The signatories to the **Clydebank Declaration** are: Australia, Belgium, Canada, Chile, Denmark, Fiji, Finland, France, Germany, Republic of Ireland, Italy, Japan, Republic of the Marshall Islands, Morocco, the Netherlands, Norway, Spain, Sweden the UK, and the US.

- **Green Free Ports:** On February 13, 2022, it was reported widely that two Green Freeports are to be established in Scotland. Each Green Freeport will offer incentives to investors (including tax incentives). Low Carbon Pulse will cover the process and outcome of the tendering and bidding process as it develops.

- **LCO₂ and LHOC carrier development continues apace:** As has been noted consistently in Low Carbon Pulse, while the development of hydrogen, ammonia, methanol and carbon dioxide production and capture technologies is key to progress to **NZE**, as important is the development and deployment of sea-going carriers that can transport these energy carriers and **CO₂** from the point of production to the market in which they are to be used or stored.

As noted in **Edition 34** of Low Carbon Pulse, progress is being made in respect of the **MV Suiso Frontier**, but the technology used for the **MV Suiso Frontier** is being scaled up by **KHI**, with containment tanks of 40,000 m³ having already been certified, and plans for four tanks per vessel. Once the technologies are established and tested, sea-going carriers need to be built at a rate consistent with the in tandem growth of the supply and demand for the energy carriers of the future.

Edition 34 of Low Carbon Pulse reported that Mitsubishi Heavy Industries (**MHI**) Group unit, Mitsubishi Shipbuilding, entered into a contract with Sanyu Kisen, based in Kobe, Japan, to build a demonstration test vessel to carry liquified carbon dioxide (**LCO₂**). The **LCO₂** carrier is to be built at the **MHI** Enoura Plant, at **MHI's** Shimonoseki Shipyard Machinery Works.

- **On February 7, 2022**, [akercarboncapture.com](#) reported that Aker Carbon Capture (of Norway, the world's first carbon capture and storage-specific shipping entity, having been established by Evergas and Navigator Gas) and Dan-Unity CO₂ (of Denmark) had signed a collaboration agreement to develop flexible **CO₂** transport solutions, with the aim of establishing a full carbon capture, utilisation and storage value chain.

The focus of Dan-Unity **CO₂** is: "*Transporting CO₂ by sea allows for maximum flexibility and multiple sourcing points, thus unlocking economies of scale for many CCS projects, often delivering a lower cost per tonnes with other transport solutions*".

- **On February 8, 2022**, Mitsui O.S.K Lines (**MOL**) and Petronas signed a memorandum of understanding to study the transportation of liquified **CO₂** (**LCO₂**) for the purposes of facilitating carbon capture, utilisation and storage within the Asia Pacific and Oceania region. Larvik Shipping will work with MOL and Petronas given its experience in managing **LCO₂** carriers, contributing know-how, in particular

- **LHOC now available:** On February 10, 2022, it was reported widely, and announced by [Chiyoda Corporation](#), that a world first had been achieved with the transportation of hydrogen in the form methylcyclohexane (**MCH**) by chemical tanker from Brunei Darussalam to an ENEOS refinery in Japan.

This world first has been achieved under the auspices, and support, of the Advanced Hydrogen Energy Chain Association (**AHEAD**). Liquid Hydrogen having been recently transported from Australia to Japan as the final piece in the jigsaw puzzle to complete the Hydrogen Energy Supply Chain (most recently, see **Editions 32, 33 and 34** of Low Carbon Pulse).

ENEOS uses **MCH** as feedstock for its demonstration project, under the auspices, and support, of the Consortium for Resilient Oil Supply System (**CROS**). The **MCH** is subject to dehydrogenation at the ENEOS refinery in Japan.

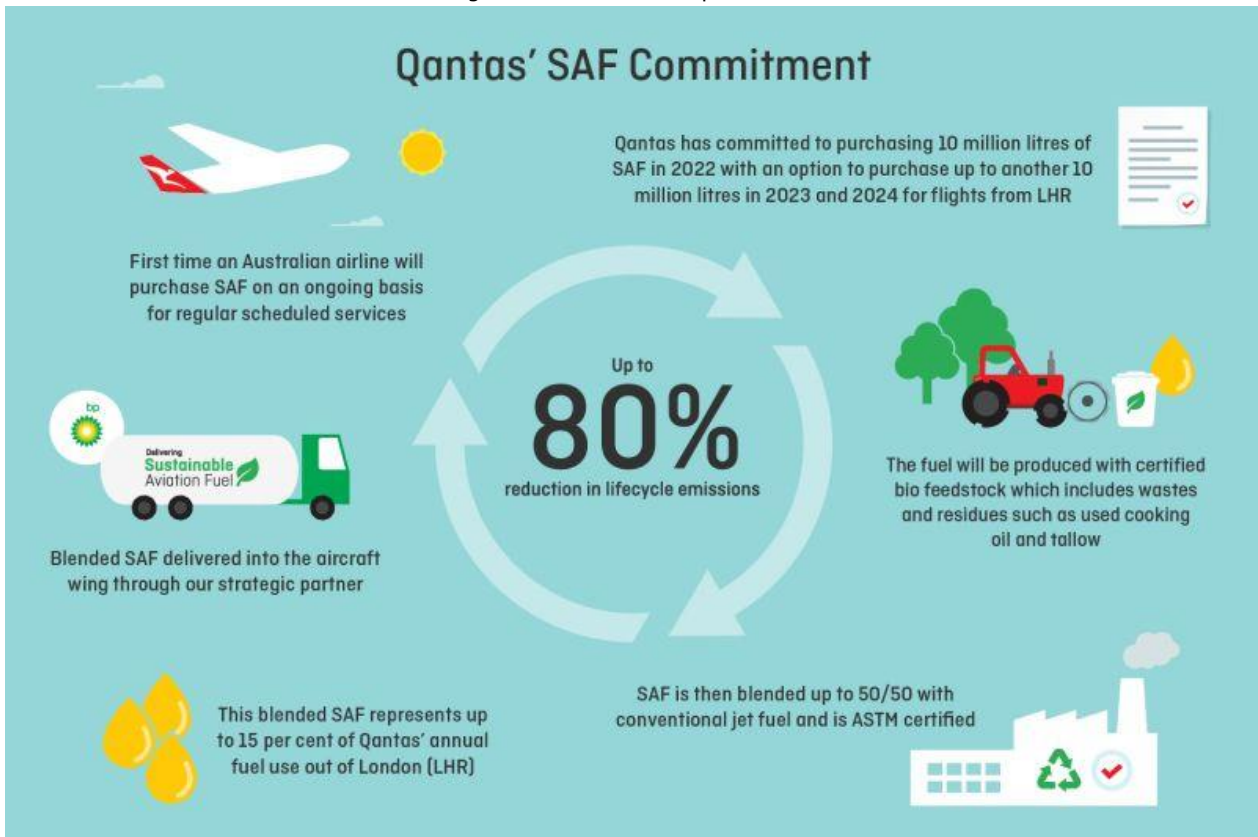
As reported recently (in **Editions 32, 33 and 34** of Low Carbon Pulse), Japanese corporations have been key to the development of the Hydrogen Energy Supply Chain, including the use of the MV Suiso Frontier LH₂ carrier to transport liquid hydrogen from Victoria Australia, to Kobe, Japan.

Airports and Aviation:

*This section considers news items that have arisen within the news cycle of this **Edition 35** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

- **Airbus moves to H₂ engines:** On February 7, 2022, it was reported widely that Airbus Industries may manufacture engines powered by hydrogen. **Edition 32** of Low Carbon Pulse reported that Airbus Industries intends to develop a zero-emission hydrogen powered and propelled commercial aircraft by 2035.

- **ATR, BRA and Neste firm SAF: Editions 30 and 33** of Low Carbon Pulse reported on the testing of engines using sustainable / synthetic aviation fuel (**SAF**). ATR (joint partnership between major European players Airbus and Leonardo), Braethens Regional Airlines and Neste (World's largest producer of renewable diesel and sustainable aviation fuel refined from waste and residues) are to test the use of 100% **SAF** for one engine to achieve 100% **SAF** certification.
- **QF using SAF:** On January 27, 2022, Qantas Airlines (the Australian Flag Carrier) announced that it had been using blended biofuel on its flights from London to Australia, in partnership with bp. QF has been using **SAF** provided by bp as certified bio-feedstock from used cooking oil and other waste products.



- **German Aerospace Centre (GAC) to develop FC:** On February 9, 2022 the BALIS Project was reported widely. The BALIS Project is an initiative of the **GAC** to develop fuel cell technology to provide up to 1.5 MW for the propulsion of aircraft. In this context, the MW scale of the BALIS Project makes it a world first. The BALIS Project includes the development of a 2,000 m² test field.



- **Air borne:** On February 9, 2022, [Air Liquide](#) announced that Air Liquide, Airbus, Korean Air and Incheon International Airport Corporation has signed a memorandum of understanding (**MOU**) to explore the use of hydrogen at Incheon International Airport (**IIA**), **ROK**. In addition, it is understood that the **MOU** contemplates the study of **ROK** airport infrastructure to support the development of hydrogen-powered and propelled commercial aircraft.

For the purpose of the **MOU**, first, a hydrogen use roadmap will be developed, identifying the uses for hydrogen air and land side, and within the vicinity of, **IIA**, and secondly, studies will be undertaken to define the infrastructure that will be required at **IIA** to allow hydrogen-powered and propelled aircraft to use **IIA**.

- **Topsoe SAF View:** On February 10, 2022, [topsoe.com](#) published an article entitled **What does it take to decarbonize aviation?** the author of which is Mr Ulrik Frehike. The article is well-worth a read (and can be accessed through the attached link above).

Mr Frehike provides a perspective on why there is not greater uptake, and faster progress in the use of **SAF**:

1. commercial aircraft are not permitted to use **SAF** on its own to propel aircraft (a maximum blend ration of 50% fossil fuel to 50% **SAF** is permitted);

2. the process to produce **SAF** – there is only one commercially scalable production progress – the use of fatty acids and hydrogenated acids as feedstock to produce synthetic paraffinic kerosene (to be covered in greater detail in an upcoming stand alone E-Fuels and Future Fuel article from Michael Harrison and Richard Guit). As such, while there are seven approved means of production of **SAF**, only one means is currently commercially scalable; and

3. there is limited available feedstock (i.e., fatty and hydrogenated acids) from which to produce **SAF**. The primary sources of feedstock are animal fats and used cooking oils. As a result, current supply (200,000 metric tonnes of **SAF** annually) is a drop in the ocean of demand for aviation fuel (300 million metric tonnes annually). There is a market for **SAF**, not least because the aviation industry gives rise to around 1 billion metric tonnes of **CO₂-e** each year.

- **SIA and Scott SAF:** On February 11, 2022, [channelnewsasia.com](#) reported that Singapore Airlines (**SIA**) and budget carrier, Scoot, are to begin using **SAF** in Q3 of 2022. The Civil Aviation Authority of Singapore (**CCAS**) having approved the use of **SAF** as part of a 12 month pilot program involving **SIA**, Scoot and Temasek that will comprise the use of 1.25 million litres of **SAF**.

The **SAF** (as noted above produced from feedstocks animal fats and used cooking oil) is to be supplied by Neste and will be blended with fossil fuel sourced aviation fuel from ExxonMobil refining facilities in Singapore, with the blended fuel then purchased from ExxonMobil, and delivered to Changi Airport using the existing fuel hydrant system.

[Neste](#) (see previous editions of Low Carbon Pulse, most recently **Edition 34** under **Work commences on Neste sustainable fuels production facility**) announced that it was working with ExxonMobil on the pilot program, noting the use of its Neste MY Sustainable Aviation Fuel. With the expansion of its Singapore refinery, by early 2023 the refinery will be able to produce and supply up to 1 million metric tonnes of **SAF** a year. In global terms, this is a significant increase in **SAF** supply capacity.

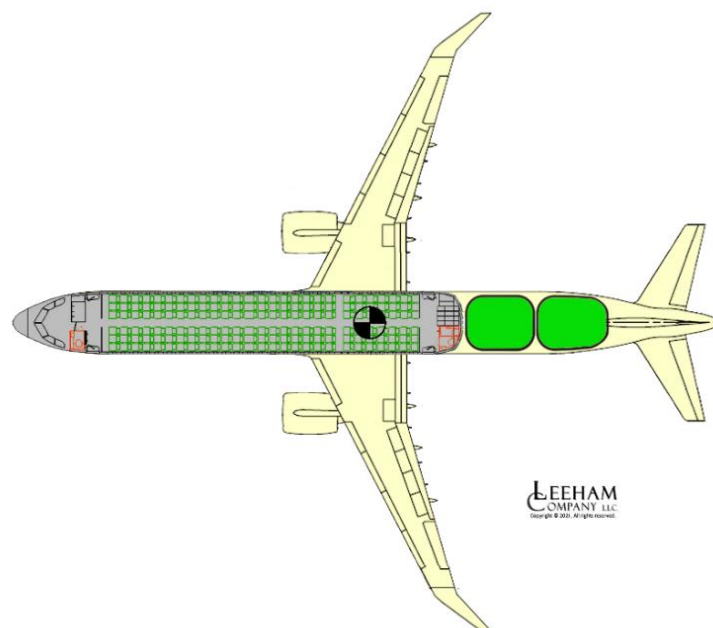
- **Neste flying high:**

- On February 11, 2022, [edie-net](#) reported that Virgin Atlantic had signed a supply arrangement with Neste and ExxonMobil for the supply of 2.5 million litres of **SAF**. The **SAF** is to be supplied during the first half of 2022.

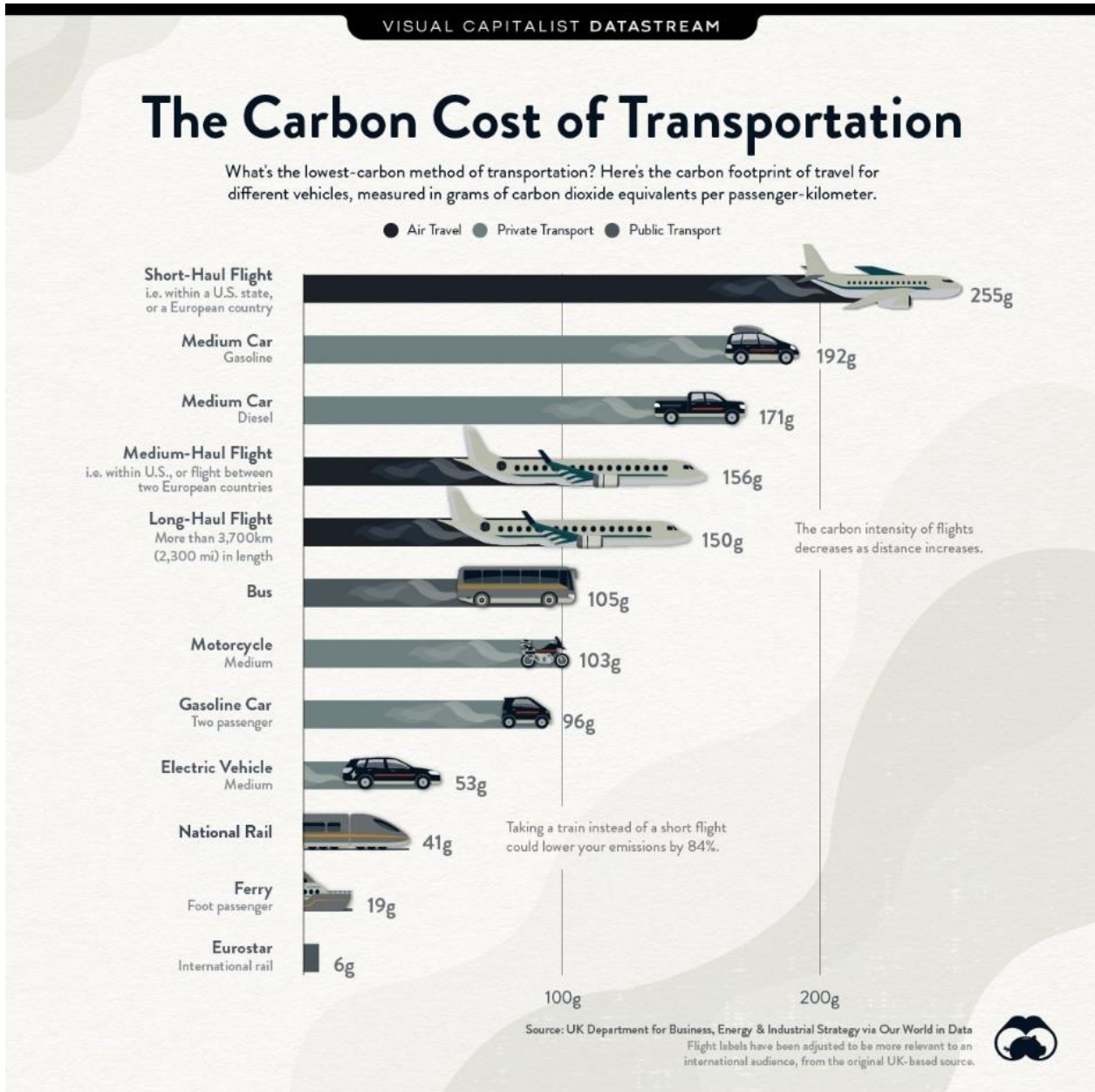
- On February 16, 2022, [Neste](#) announced that Neste and Itochu Corporation had expanded their partnership to increase the availability of **SAF** in Japan. The expansion referred to in the announcement reflects that Neste, Itochu and All Nippon Airways established a **SAF** supply chain in 2020.

The announcement from Neste notes that by the end of 2023 it will have 1.5 million metric tonnes of production capacity by the end of 2023, including 1 million metric tonnes of capacity at its Singapore refinery.

- **Airbus moves Zero-e demonstrator:** On February 8, 2022, it was reported widely that Airbus plans to fly a hydrogen fuelled **Zero-e demonstrator** aircraft soon, possibly within February 2022.



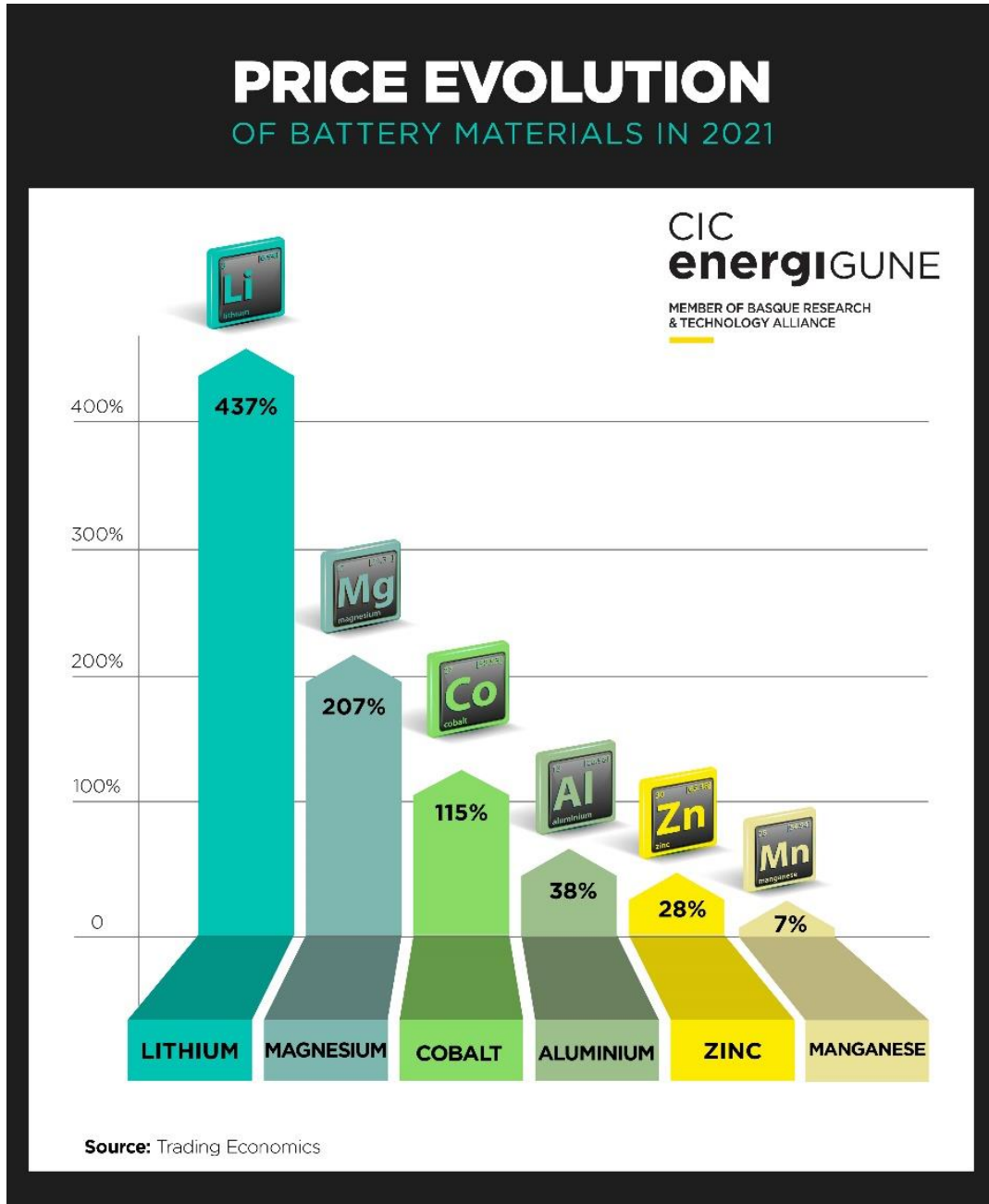
- **Airbus moves again:** On February 15, 2022, it was reported widely that Airbus, Snam (Italian gas and infrastructure company) and SAVE (the group that manages Venice Airport) had signed memorandum of understanding for the purposes of promoting the use of hydrogen in the airport and aviation sector. Each of Airbus, Snam and SAVE have aligned aims in the reduction of **GHG** emissions arising from activities undertaken at airports. The promotion of the use of hydrogen is to commence at the Marco Polo Airport, Venice (managed by SAVE). It is expected that there will be particular focus on the design and engineering of infrastructure to store fuel and to fuel aircraft.
- **Shell SAF fast:** On February 17, 2022, [channelnewsasia.com](https://www.channelnewsasia.com) reported that Shell had supplied the first **SAF** to Singapore customers. Shell announced that it had: "... delivered [**SAF**] to ... customers as SIA Engineering Company and the Republic of Singapore Airforce".
- **The Carbon Cost of Transportation:** As regular readers of Low Carbon Pulse will know the author is a devotee of the work of the folks at the VisualCapitalist. The folk at the VisualCapitalist have produced another excellent infographic, this time on the Carbon Cost of Transportation.



Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

This section considers news items that have arisen within the news cycle of this **Edition 35** of *Low Carbon Pulse* relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of **E-fuels** and **Future Fuels** to process and to treat those metals and minerals. Also this section considers the *Difficult to Decarbonise industries*, including the iron and steel sector.

- **Metals and Minerals:** On February 8, 2022, or thereabouts, CICenergigune published an infographic headed *Price Evolution*, representing the shift in the price of metals and minerals key to the battery industry during 2021.



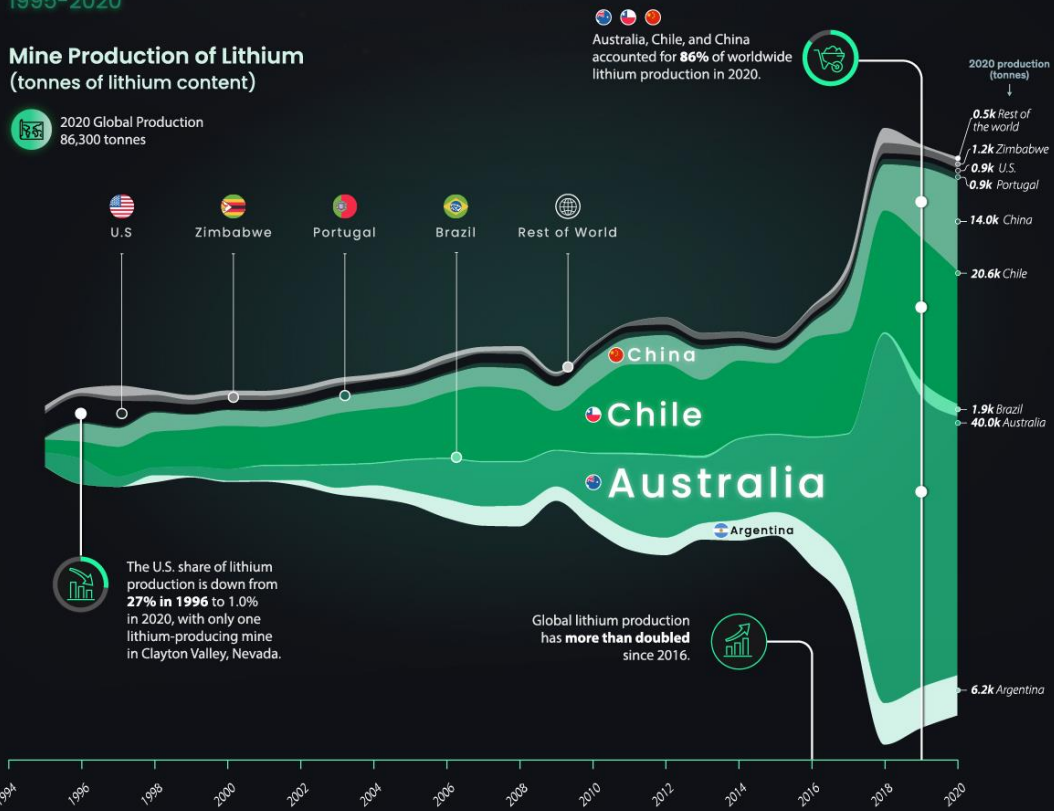
- **Lithium from the perspective of the VisualCapitalist:** On February 13, 2022, the author came across the following infographic conveying the proportion of world lithium production, by country.

LITHIUM PRODUCTION BY COUNTRY

1995-2020

Increasing adoption of electric vehicles (EVs) and energy storage technologies has fueled a global boom in lithium production.

Here's a historical look at lithium production by country.



Source: BP Statistical Review of World Energy 2021

Distribution of Lithium Reserves



*Based on reserves-to-production ratio.
Source: BP Statistical Review of World Energy 2021

For every tonne of lithium the U.S. produced in 2020, it has 833 tonnes* in reserves.

Countries like the U.S. need to ramp up domestic lithium production to support EV adoption, especially as demand increases.

Scotch Creek Ventures is developing two lithium mining projects in Clayton Valley, Nevada, to supply lithium for the green future.

SCOTCH CREEK
VENTURES INC.
LITHIUM EXPLORATION IN THE CLAYTON VALLEY

Click here to learn more about Scotch Creek Ventures

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Low Carbon Pulse - Edition 36

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading later in the week, welcome to the Friday March 11, 2022 version of **Edition 36** of Low Carbon Pulse – sharing significant news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from February 21, 2022 to March 6, 2022.

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1 to 28**, covering October 6, 2020 to October 5, 2021) and [here](#) for the **Second Compendium of Low Carbon Pulse** containing Editions 29 to 35, covering October 7, 2021 to February 20, 2022). Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

Having received feedback, **Low Carbon Pulse** will move to a monthly news cycle (to be published during the first week of each calendar month) with Edition 37 to be published April 5, 2022. As news items arise throughout each month, **Low Carbon Pulse Bulletins**, will be published. The move to a longer news cycle allows the author to complete articles in the **S2H2: Elemental Change** series and further **H24I** features, and other articles.

Headlines:

US Federal waters off-shore bonanza:

As foreshadowed in **Edition 33** of Low Carbon Pulse, the US Federal government held its first auction process for the award of off-shore wind fields in US Federal waters field in the final week of February 2022. On Friday 24, 2022 the hammer fell on the auction process, with heightened expectations matched – see **page 22** below.

Burning platform risk:

The International Panel on Climate Change (**IPCC**) **Working Group II** (on Impacts, Adaption and Vulnerability) (**WGII**) finalised its findings as part of the Sixth Assessment Report (**AR6**), which were published on February 28, 2022 (see **page 2** below), with the headline being that: "**The extent and magnitude of climate change impacts are larger than estimated in previous assessments**".

Burning issue of plastics gets a platform:

At the meeting of the UN Environment Assembly (**UNEA**) in Nairobi, Kenya, 175 UN Member States agreed to address plastic at large in the environment (see **page 4** below). An article on plastics is close to being finalised.

Vale SK Warne:

Each Saturday (and Sunday) morning, at around 4 am, the author sits down to write Low Carbon Pulse. On the morning of Saturday March 5, 2022, the author's routine was upset by news of the passing of Mr SK Warne, or **Warnie** to millions around the world. One of the author's favourite sporting memories arises from a One Day International day night match at the Sydney Cricket Ground (Steve Waugh was injured), Warnie was captain. At slip, in ringing bowling changes and field settings Warnie was as masterful as he was at leg-spin bowling. Vale, Warnie.

Content of this Edition 36:

Clicking on the contents list will take the reader to the section clicked:

LIST OF CONTENTS: EDITION 36 OF LOW CARBON PULSE			
Pages 2 to 6	Timeline for 2022	Pages 15 to 16:	Carbon Accounting, Carbon Capture, Carbon Capture and Use and CDR
Page 6	Legal and Regulatory highlights	Page 16:	Carbon Credits, Hydrogen Markets and Trading
Pages 6 to 7:	Climate change reported and explained	Pages 16 to 18:	E-fuels / Future Fuels / Now Fuels
Page 7	GCC Countries	Page 19 to 20:	Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories
Pages 7 to 9:	Africa, India and Indonesia; Japan & ROK	Page 20:	Green Metals / Minerals, Mining and Difficult to Decarbonise Industries
Pages 9 to 10:	PRC and Russia	Page 20 to 23:	Wind round-up, on-shore and off-shore
Pages 10 to 12:	Europe and UK; and Americas	Page 24:	Solar, Sustainability and NZE Waste;
Pages 12 to 13	France and Germany; and Australia	Pages 24 to 26:	Land Mobility / Transport
Page 13:	Blue Green Carbon Initiatives & Biodiversity	Page 26:	Ports Progress and Shipping Forecast
Page 14:	Bioenergy and heat-recovery	Pages 26 to 28:	Airports and Aviation
Page 15:	BESS and HESS (and other energy storage)	Page 29:	NZE Publications

Timeline for February and March 2022:

- **Key conferences and publications:**

- **Climate Change 2022: Impacts, Adaptation and Vulnerability** report:

- **IPCC WGII:** From February 14, 2022 to publication on February 28, 2022, the **IPCC WGII** met to finalise its findings ahead of the release of the **IPCC WGII** report - The **Climate Change 2022: Impacts, Adaptation and Vulnerability** report which was published on February 28, 2022

The meeting was the 12th session of **IPCC WGII** (and the 55th of the **IPCC**). The **IPCC WGII** considered the **Summary for Policymakers**, and approved it. On approval, the **IPCC** formally accepted the entirety of the **IPCC WGII** report.

- **Coverage ahead of publication:** On February 22, 2022, the [BBC News, Science](#) (under **IPCC: Climate change report to sound warning on impacts**) flagged that the the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report would outline key "tipping points" that are likely to be passed as the impacts of climate change eventuate, including some tipping points that will not be capable of being reversed. The [BBC News](#) item stated that "**the impact of climate change will likely be the most worrying assessment yet of how rising temperature affects every living thing**". While this statement has the sharp edge of the by-line writer, the statement is entirely valid – the impact of climate change needs to be understood to impart the sense of urgency required to avoid the worst impacts of climate change and, if not possible to avoid, to manage the mitigation of the impacts effectively.

It is clear that the world is not well equipped to avoid or to mitigate the impact of climate change. It is hoped that the findings of the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report will focus the minds of governments globally.

The signals going into and during the 12th session of **IPCC WGII**, and in the report, stress urgency, tempered by "real politics". It is important to understand the continuing political reality: as noted by the chair of **IPCC WGII**, Professor Hans-Otto Pörtner "**One key message has come out of previous reports – political will, in terms of climate action, is the bottleneck for a sustainable future**".

- **Headlines from the Summary of Policy Makers:**

The author is continuing to read the [Climate Change 2022: Impacts, Adaptation and Vulnerability](#) report in full:

The [Summary of Policy Makers](#) presents the key findings of the **IPCC WGII**, and its key contribution to the Sixth Assessment Report (**AR6**) of the **IPCC**.

The key findings are as follows:

1. Human induced climate change has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt;
2. Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change;
3. Global warming, reaching 1.5°C in the near term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. Near-term actions would reduce substantially projected losses and damages related to climate change in human systems and ecosystems compared to higher-warming levels, but cannot eliminate them all;
4. Beyond 2040 and depending on the level of global warming, climate change will lead to numerous risks to natural and human systems;
5. Climate change impacts and risks are becoming increasingly complex and more difficult to manage;
6. If global warming transiently exceeds 1.5°C in the coming decades or later (overshoot), then many human and natural systems will face additional severe risks;
7. Progress in adaptation has been observed across all sectors and regions, generating multiple benefits;

8. There are feasible and effective adaptation options that can reduce risks to people and nature;
 9. Soft limits to some human adaptation have been reached, but can be overcome by addressing a range of constraints. With increasing global warming, losses and damages will increase and additional human and natural systems will reach adaptation limits;
 10. Maladaptation needs to be avoided – this requires flexible policy settings and implementation;
 11. Political commitment and follow through is required to enable adaptation;
 12. Worldwide climate resilient development action is more urgent than assessed in AR5;
 13. Climate resilient development is enabled by governments, civil society and the private sector, and requires inclusive development choices;
 14. The global trend in urbanisation offers a critical opportunity in the near-term;
 15. Safeguarding biodiversity is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation, pointing to the conservation of approximately 30% to 50% of the Earth's land, freshwater and ocean seas; and
 16. It is unequivocal that climate change has already disrupted human and natural systems.
- **Adaptation from COP-26:** In seeking to frame thinking around the *Climate Change 2022: Impacts, Adaptation and Vulnerability* report, it is helpful to reflect on what was agreed at **COP-26** in respect of Adaptation, and to follow the narrative thread that has emerged.



- **Loss and damage versus Losses and damages – a focus of debate and wording:** It was reported ahead of the *IPCC WGII* meeting that a tussle was likely to emerge to avoid the concept of loss and damage. It will be apparent from the key findings (and the balance of the report) that losses and damages are addressed. This tussle is not new. At the heart of the tussle is the concern of some more developed countries about acknowledging loss and damage as having been caused (and, therefore, how, and by whom), rather the preference of these developed countries is to look forward to recognise what is required to avoid and to mitigate, and, if not possible, to avoid, how best to mitigate. For ease of reference, set out below are six slides summarising that which was agreed on loss and damage at **COP-26**:





IPCC reports – next steps:

- In **April**, the **IPCC WGIII** will publish the **Climate Change 2022: Mitigation of Climate Change** report;
- In **May**, Low Carbon Pulse will bring together the key findings of each **IPCC** Working Group report, updating **Edition 24** of Low Carbon Pulse (which was published in mid-August 2021); and
- In **September**, the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each **IPCC** Working Group, and in three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**).

Following the tried and tested format, the **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**.

- **During the week commencing February 28, 2022:**

- The **5th UN Environment Assembly (Assembly)** met in Nairobi, Kenya, to discuss the adoption of a global plastic treaty.

On March 2, 2022, the **Assembly** concluded with [14 resolutions](#) to strengthen actions for nature to achieve Sustainable Development Goals. (The **Assembly** comprises 193 UN Member States, and convenes every two years).

The key headlines from the **Assembly** involve plastics. It was agreed to establish an Intergovernmental Negotiating Committee "**to forge an international legally binding agreement to end plastic pollution**". To many, including Executive Director of the UN Environment Program, Ms Inger Andersen, the agreement was the most significant environmental multilateral agreement since the Paris Agreement.

While not grabbing headlines in the same way as the initiative on plastic pollution, another resolution of the **Assembly** is significant, supporting the establishment of a comprehensive science policy panel to consider the sound management of chemicals and waste generally, and preventing pollution.

To many, plastics is, or has become, a second or third order issue when viewed in the context of climate change. This may be true, but it is an easier issue to address than climate change. Depending on the source from which facts and stats are drawn, between 375 and 400 million metric tonnes of plastic produced each year, with the feedstock almost entirely sourced from petroleum products. The following table illustrates this:

PLASTICS			
Petroleum Source	Monomer & Description of Production	Polymers	SPI Code (Resin Code)
Ethane (C ₂ H ₆)	Ethylene (C ₂ H ₄ , an olefin), produced by cracking ethane, used to produce polyethylene (PE)	PE is a thermoplastic (aka as polythene), the most commonly used polymer	2 (SPI Code 1) HD 4 (SPI Code 4) LD
	Ethylene (C ₂ H ₄ , an olefin), produced at very high temperatures in tubular reactor	Polyethylene terephthalate (PET/PETE) is a thermoplastic (aka as polyester)	1 (SPI Code 1)
	Ethylene (C ₂ H ₄ , an olefin) Tetra-fluoro-ethylene	Poly-tetra-fluoro-ethylene (PTFE), is a thermoplastic	7 (SPI Code 7)
	Ethyl-urea (C ₃ H ₈ N ₂ O)	Polyurethane (PUR / PU / PUT), is a thermo-stet, but can be thermoplastic	7 (SPI Code 7)

Propane (C ₃ H ₈)	Propylene (C ₃ H ₆ , an olefin), produced by liquid catalytic cracking, used to produce polypropylene (PP)	PP is a thermoplastic (aka: polypropene), second most commonly used polymer	5 (SPI Code 5)
Ethane (C ₂ H ₆)	Vinyl Chloride (C ₂ H ₃ Cl): derived from ethylene and chloride (a VCM)	Polyvinylchloride (PVC), is a thermoplastic	3 (SPI Code 3)
Tri-chloro-ethane	Vinylidene Chloride (C ₂ H ₂ Cl ₂)	Poly-vinylidene chloride (PVDC), is a thermoplastic	7 (SPI Code 7)
Ethane (C ₂ H ₆)	Vinyl Acetate (C ₄ H ₆ O ₂) (a VAM)	Poly-vinyl acetate (PVAc), is a thermoplastic	7 (SPI Code 7)
Ethane (C ₂ H ₆) Benzene (C ₆ H ₆)	Styrene (C ₈ H ₈): derived from Benzene and Ethylene, ethylbenzene	Polystyrene (PS), is a thermoplastic	6 (SPI Code 6)
Propane (C ₃ H ₈)	Acrylonitrile (C ₃ H ₃ N): derived from Propylene (C ₃ H ₆), catalysed with ammonia	Poly-acrylonitrile (PAN), is a thermoplastic	7 (SPI Code 7)
	Acrylonitrile can produce co-polymers acrylonitrile butadiene styrene (ABS) and styrene-acrylonitrile (SAN), both are thermoplastics		7 (SPI Code 7)
Ethane (C ₂ H ₆)	Methyl methacrylate (C ₅ H ₈ O ₂): ethylene (C ₂ H ₆) source	Poly-methyl methacrylate (PMMA)	7 (SPI Code 7)
Natural polymer	Isoprene	cis-Polyisoprene (Natural Rubber)	Not applicable because natural
Butane (C ₄ H ₁₀)	Chloroprene (CD): derived from Butadiene (C ₄ H ₆ , an olefin), then chlorinated	Poly-chloroprene (Synthetic Rubber, including Neoprene)	7 (SPI Code 7)
Methane (CH ₄)	Formaldehyde is catalysed (anionic), to produce homo-polymer Formaldehyde is catalysed (acid), to produce co-polymer	Poly-oxy-methylene (POM) is a bio-inert thermoplastic (Also known poly-formaldehyde)	7 (SPI Code 7)
Not applicable	Caprolactam (Nylon 6) and adipoyl chloride and hexa-methylene diamine (Nylon 66)	Nylon	7 (SPI Code 7)
Natural polymer	Lactic acid (C ₃ H ₆ O ₃) derived by the fermentation of carbohydrates or chemical synthesis, with lactic acid being polymerized using ring-opening polymerization	Polylactic (C ₃ H ₄ O ₂) or polylactide (PLA) is a thermoplastic aliphatic polyester, sometimes called a bio-plastic	Not applicable because natural

© Michael Harrison (drawn from the author's PhD material)

This does not mean that each year 375 to 400 million metric tonnes of plastics are released into the environment, but the plastics that are not collected and recycled or disposed of in an environmentally safe manner are at large in the environment, critically in waterways and oceans.

Low Carbon Pulse will follow the development of the **international legally binding agreement to end plastic pollution**. Plastics has long been a focus of the author of Low Carbon Pulse, and will become another area covered by Low Carbon Pulse. (The author is working on a PhD on plastics (part-time). The UNEP initiatives have provided renewed impetus for the author to finish it.)

- **Plastics in the air:** On February 21, 2022, Wood Mackenzie published an [opinion piece](#) (entitled [Closing the loop on plastic packaging](#)).

As always, the Wood Mackenzie opinion piece is excellent, and is well-worth a read.

The opinion piece covers a number of points, but it covers a key point (certainly from the perspective of the author), and that is the need for progress in the development of effective chemical recycling technologies to allow increased recycling noting that mechanical and thermal recycling technologies, as currently applied, do not allow recycling of the vast majority (by mass) of plastics.

- **Cooling our heels after IPCC WGII and the 5th UN Environment Assembly**

Two key events were to have straddled **Editions 36** and **37** of Low Carbon Pulse, both have been postponed as follows:

- **Middle East and North Africa Week (MENAW):** As the authors of the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report were being interviewed, the inaugural [Middle East and North Africa Week](#), organised under the auspices of the United Nations Framework Convention on Climate Change

(**UNFCCC**) was to have commenced on **February 28, 2022**, and continue through **March 3, 2022**. The **MENAW** was postponed, amidst continued concerns around Covid-19.

The **MENAW** was eagerly anticipated, providing an opportunity to place the Middle East and North Africa clearly at the centre of production of renewable electrical energy and clean hydrogen. Low Carbon Pulse will cover **MENAW** when it takes place, hopefully in Q3 of 2022.

- **IUCN Africa Protected Areas Congress (APAC)**: **APAC** was to have commenced on **March 7, 2022** in Kigali, Rwanda, and continue to **March 12, 2022**. **APAC** was postponed, amidst continued concerns around Covid-19.

APAC will be the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on action required to establish and to preserve protected areas. Low Carbon Pulse will cover **APAC** when it takes place.

The **MENAW** and **APAC** events will add to the emerging agendas for both **COP-27** and **COP-28**.

- **By the end of April 2022:**

- **Carbon Credits, Article 6 and the Paris Rulebook:**

The demand for carbon credits is increasing at pace in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**. In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions and, in the longer term, **NZE**, on the basis of carbon neutrality.

In a stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of Carbon Credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and possible regulation of the **Voluntary Carbon Markets / Voluntary Carbon Credit Markets**.

- **E-Fuels / Future Fuels, including derived from biomass and bioenergy:**

The focus on fuels there are not derived or produced from fossil fuels is increasing. Low Carbon Pulse covers E-Fuels / Future Fuels and bio-energy. In addition to the focus on hydrogen and hydrogen based fuels (including ammonia and methanol), including hydrogen derived from biomass, there is focus on the derivation and production of Renewable Natural Gas, derived from biomass, including biomethane, both for use as pipeline gas and for use as bio-compressed natural gas (**Bio-CNG**) and bio-liquified natural gas (**Bio-LNG**).

In a stand-alone article, Michael Harrison and Richard Guit will outline the sources of fossil fuels and non-biomass fuels (including crop fuels), and the feedstocks and technologies used to produce each E-Fuel / Future Fuel, and each form of bio-energy, and of course the **GHG** arising from their deviation and production, and use.

Legal and Regulatory highlights:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.*

To manage the length of this **Edition 36** of Low Carbon Pulse, legal and regulatory news items within the current news cycle will be picked up in **Edition 37** of Low Carbon Pulse.

Standalone article about **EU Green Taxonomy**:

The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**.

In anticipation of the expiry of the four month scrutiny and objection period (which started at the end of January 2022) expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article by the end of June 2022.

Climate change reported and explained:

*This section considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.*

- **CH₄ concentration on the rise: Edition 35** of Low Carbon Pulse reported that the International Energy Agency (**IEA**) would release its noted **Global Methane Tracker**, and that the **January and February Report on Reports** would outline its findings.

On February 23, 2022, the **IEA** released its **Global Methane Tracker 2022**. The key finding in the IEA's press release was as follows:

"Global methane emissions from the energy sector area are about 70% greater than the amount national governments have officially reported ... underlining the urgent need for enhanced monitoring efforts and stronger policy action to drive down emissions of the potent greenhouse gas."

By way of reminder:

- **Edition 24** of Low Carbon Pulse noted that the reduction in **CH₄** emissions is important because the global warming potential of **CH₄**, as a **GHG**, in terms of potency per tonne, is greater than carbon dioxide (**CO₂**): a molecule of **CH₄** has a half-life of 9 years, compared to **CO₂** with a half-life of 100 years. Over 20 years, **CH₄** traps up to 84 times as much heat energy as **CO₂**.
- **Edition 27** of Low Carbon Pulse reported that "Increasing concern about increasing the concentration of **CH₄** resulted in the announcement on September 17, 2021, by the **EC** and **US** of the **Global Methane Pledge**, given jointly, to reduce **CH₄** emissions by nearly a third within the next decade. At that time Low Carbon Pulse expressed:

"The hope, and the objective of the **EC** and US now has to be to ensure that as many countries as possible join with them in this critical initiative".

Edition 34 of Low Carbon Pulse noted that as at February 4, 2022, 103 countries had signed the Global Methane Pledge. **Edition 34** also noted that: "While many countries have signed the Pledge, work needs to be done to implement the Pledge, considerable work". As at March 6, 2022, 111 countries have signed.

- **Edition 29** of Low Carbon Pulse reported on International Energy Agency (**IEA**) [Curtailing Methane Emissions from Fossil Fuel Operations \(CCH4R\)](#). This headline from the **CCH4R** is that the reduction in methane (**CH₄**) emissions is "among the most impactful ways to combat near-term climate change".

The **CCH4R** notes that:

"Methane has contributed around 30% of the global rise in temperature to date ... Emissions from fossil fuel operations present a major opportunity [to limit global warming in the near term] since the pathways to reduction are both clear and cost-effective".

- **Edition 35** of Low Carbon Pulse reported on increasing levels of methane (**CH₄**) in the climate system (under **Scientists raise alarm over "dangerously fast" growth in atmospheric methane**). **CH₄** concentration exceeded 1,900 parts per billion during 2021 – see the piece below on the **NOAA 2022 Sea Level Rise Technical Report**. The nature article notes that the increase in **CH₄** is caused by both human activities and naturally: 62% of global **CH₄** emissions from 2007 to 2016 are estimated to have arisen from human activities – see the bar chart at the end of this section.

As is noted (again) in the nature article, tackling methane is probably the best opportunity to buy some time to allow decarbonisation to progress so as to avoid the worst effects of climate change by limiting the increase in average global temperatures to **1.5°C** above pre-industrial times.

- **Climate Change impacting water cycle:** On February 23, 2022, [nature](#) published a report (entitled **Observed poleward freshwater transport since 1970**), the headline from which is that the global water cycle is 7.4% (having been estimated to be between 2% and 4% previously). By way of reminder, the water cycle describes the movement of water globally: evaporation, ascension, condensation, and precipitation.

Increased global temperatures are accelerating or intensifying (depending on how one views the water cycle). In summary, the result of this acceleration / intensification is that freshwater moves to wet regions, with the result that, as a general statement, and overtime, drier regions, critically, sub-tropical regions become drier.

(For further detail on changes to the water cycle see the [IPCC WGI Climate Change 2021: The Physical Science Basis](#) Report.)

GCC Countries:

*This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.*

- **EWEC auction:** On February 21, 2022, EWEC (Emirates Water and Electricity Company) [announced](#) that it would conduct its third auction of Clean Energy Certificates (**CECs**) in Abu Dhabi on Monday March 14, 2022. The first **CEC** auction took place in September 2021, and the second in November 2021. It is reported that the auction of **CECs** as part of the **CEC** scheme has assisted greatly in the expansion of the market for EWECs' clean energy sources.
- **Jeddah the smarter city:** On February 24, 2022, [arabnews.com](#) reported (under **A \$20bn Saudi project will transform Jeddah, with history, heritage and culture at its core**) on plans for a face lift of Jeddah, Saudi Arabia's Red Sea port city, to make Jeddah one of the most liveable cities by 2030. While described as a face lift, the plans go deeper, and will result in Jeddah being a smarter historical city.
- **Global low carbon deal:** [fuelcellworks.com](#) reported that in Dubai, United Arab Emirates (**UAE**) on March 2, 2022, Engie (leading international energy corporation) and POSCO (leading iron and steel producer, headquartered in the Republic of Korea) signed a memorandum of understanding to explore the development jointly of Green Hydrogen production plants and related infrastructure in the Middle East, Australia and in South America. As reported, Engie is to leverage its existing industrial-scale hydrogen value chain experience to support POSCO's production of hydrogen.

Africa:

*This section considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to Africa. Africa remains the continent with the most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.*

- **African Development Bank steps-up:** On February 21, 2022, [energy-utilities.com](#) reported (under **African Development Bank to provide \$ 379 m financing to Sahel solar scheme**) that the African Development Bank had approved a USD 379 million financing facility as part of the funding for the **Dessert to Power G5 Sahel scheme**. The **Dessert to Power G5 Sahel scheme** involves the delivery of electrical energy within Burkina Faso, Chad, Mali, Mauritania and Niger from a 500 MW photovoltaic facility, providing renewable electrical energy to around 695,000 households across the five countries. It is reported that the African Development Bank is to provide technical assistance for seven years, in addition to the financing facility.
- **Masdar in Tanzania:** On February 28, 2022, [energy-utilities.com](#) reported that Masdar (Abu Dhabi Future Energy Company) had signed an agreement with the Tanzania Electric Supply Company (Tanesco) to develop renewable electrical energy projects in Tanzania. The agreement between Masdar and Tanesco continues the forward-thinking engagement of Masdar regionally. In 2021, Masdar entered into a similarly forward looking agreement with Ethiopia.
- **Egypt to develop smart grid:** On February 28, 2022, [itp.net/business](#) reported that CISCO (leading information technology system corporation) and Schneider Electric (leading electrical energy system corporation) are to develop a smart grid for Egypt. It was recounted that the Ministry of Electricity and Renewable Energy and Schneider Electric had contracted to develop four control centres for the national grid in 2020.

It might be expected that the smart grid developed by Schneider Electric and CISCO will provide a benchmark for smart systems, deploying the latest technology from corporations at the forefront of operational technologies and information technologies.

- **Tunisia expanding solar capacity:** On March 2, 2022, [energy-utilities.com](https://www.energy-utilities.com) reported (under [Tunisia prepares plan for 3.8 GW of solar capacity by 2030](#)) that the Tunisian Government is preparing a national strategy for photovoltaic solar installation with a view to reaching 3.8 GW of installed photovoltaic solar capacity by 2030.

India and Indonesia:

*This section considers news items within the news cycle of **Edition 36** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.*

- **Tata and RWE Giant Cause Way:** On February 21, 2022, it was reported widely that Tata Power Renewable Energy Limited (a wholly owned subsidiary of Indian power giant, Tata Power) and RWE Renewables GmbH (a world leader in off-shore wind field development, deployment and operation) had signed a memorandum of understanding (**MOU**). Viewed in the context of the good offshore-wind resources of India (with its 7,600 kilometres of coastline) and Government of India policy settings for installing 30 GW of off-shore wind field capacity by 2030, the **MOU**, is significant. The combination of Tata and RWE for these purposes is timely, with the Government of India progressing its policy settings, and the resulting regulatory framework, and technical studies.
- **Off-shore wind field development is highly prospective:** It is understood, among others, that technical studies are progressing in respect of Gujarat and Tamil Nadu. This reflects the assessment of the [World Bank](#) in respect of the prospectivity of off-shore wind field areas, with 215 GW of off-shore wind field capacity (83 GW floating and 112 fixed-bottom), with Gujarat and Tamil Nadu having the most prospective wind resources.

Edition 21 of Low Carbon Pulse identified the off-shore areas most prospective for the development of off-shore wind field capacity: the coastlines off Andhra Pradesh (south-eastern coastal region of India), Gujarat (western coast of India), Karnataka (south-western India, with Arabian Sea and Indian Ocean coastlines), Maharashtra (western coast of India) and Tamil Nadu (south coast of India) offer the most prospective off-shore wind resources.

- **Adani and Ballard coalesce:** On February 21, 2022, it was reported widely that Adani Group (leading Indian conglomerate of global scale) and Ballard Power Systems (leading fuel cell technology corporation) signed a memorandum of understanding (**MOU**). Under the **MOU**, Adani and Ballard will consider the commercialisation of the production and use of fuel cells in a range of applications, focusing on industrial applications land mobility applications in India.

As reported in **Edition 28** of Low Carbon Pulse, Adani intends to invest in the development and deployment of Green Hydrogen production capacity in India:

"On September 22, 2021, it was reported widely that Adani Group intends to invest up to USD 20 billion over the next 10 years. On October 2, 2021, Adani Green Energy reported its acquisition of 5 GW of photovoltaic solar and wind assets from SB Energy India for USD 3.5 billion.

With Adani, Reliance and TATA each now committed materially and significantly to reduce GHG emissions, and the investment necessary to achieve this, it is clear that the might of India's private sector is now very much aligned with the public sector, including state owned corporations."

The great thing for India is that it has a number of corporations actively planning and positioning to develop the Indian hydrogen industry. In addition to Tata and Adana, Reliance Industries is well-placed to develop and to deploy capacity.

- **India and Australia clear intent:** On February 23, 2022, it was reported widely that India and Australia has signed a letter of intent for the purposes of cooperating to scale up the production of ultra-low cost photovoltaic solar and clean hydrogen.
- **A reminder and an update:** **Edition 35** of Low Carbon Pulse reported that on February 17, 2022, the Ministry of Power released the [key policy settings](#) for interim (or near term) hydrogen capacity development (**Near Term Hydrogen Strategy**), with **Edition 35** honing on the policy settings supporting Green Hydrogen (and Ammonia) production.

Since the announcement of the **Near Term Hydrogen Strategy**, there has been considerable analysis of it, and its impact on the cost of production hydrogen, with the consensus being that in the near term the costs of production of hydrogen will fall below USD 2 per kilogram by the mid-2020s, and as low as USD 1.50 per kilogram by 2030. As noted in **Edition 34** of Low Carbon Pulse, Reliance Industries is targeting a cost of production of USD 1.00 per kilogram of Green Hydrogen.

- **Policy settings continuing to progress, in line with industry:** On March 3, 2022, [energetica-india](#) reported that a proposal developed by Reliance, JSW Steel and Chart Industries, and the India Hydrogen Alliance, that had been provided to NITI Aayog and the Ministry of New and Renewable Energy (**MNRE**).

From the report in energetica, it has been proposed that a Public-Private H2Bharat Taskforce be established to identify and to develop at least five GW scale Green Hydrogen Hubs across India within the next 18 months.

In a clear sign of the excellent working relationship between the Government of India and business and industry in India, the CEO of NITI Aayog Mr Amitabh Kant, welcomed the proposal, commenting as follows:

"... the aim to bring down the cost of green hydrogen to \$2.5/kg by 2025 and \$1/kg by 2030. This is possible only by increasing the size and scale of hydrogen manufacturing. The H2Bharat Taskforce is an interesting proposal to kick-start green hydrogen project development at a large GW-scale. We welcome this voluntary initiative from the industry and look forward to collaborating on it".

- **India Hydrogen Alliance – February 2022:** Attached is the link to the February edition of [India H2 Monitor – February 2022](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the content of the **India H2 Monitor**.
- **Indonesia to develop Green Hydrogen & Ammonia and CCUS:** On March 4, 2022, [hydrogen-central.com](#) reported that First Deputy Minister of State-Owned Enterprises, Mr Pahala Mugraha Mansury stated: "We have developed the ammonia and biomass co-firing as well as the utilisation of carbon capture technology to reduce the usage of coal at [coal-fired] power plants".

For these purposes, it was reported that on March 2, 2022, PT Pupuk Indonesia (state-owned fertiliser corporation), PT Pertamina (state-owned national energy corporation) and Mitsubishi Corporation had signed a cooperation agreement to progress the development of Green Hydrogen and Ammonia production capacity.

Japan and Republic of Korea (ROK):

*This section considers news items within the news cycle of this **Edition 36** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

• JERA demand for ammonia:

- **Coal case: Editions 17 and 18** reported as follows:

"On May 24, 2021, it was announced that IHI and JERA have received notice of acceptance of their joint grant application to undertake a demonstration project to co-fire ammonia in the generation of thermal power.

The co-firing project commenced in June 2021, and will continue until March 2025, with the plan at that time to progress to commence co-firing at JERA's Unit 5, Hekinan Thermal Power Station from August to December 2021. [Note: This plan was fulfilled.] With the rate of co-firing to increase over time, so that by 2024, co-firing will be taking place at a rate of 20% Green Ammonia, 80% coal, at Unit 4, Hekinan Thermal Power Station.

As is a recurring theme reflected in Low Carbon Pulse, this is another world first for Japan - the first large scale ammonia and thermal coal co-firing project. The co-firing project is consistent with the policy settings in Japan."

- **Hot tender:**

- On February 18, 2022, it was reported widely that **JERA** is running a tender to procure hydrogen based ammonia as part of its plans to reduce **GHG** emissions arising from its coal-fired power generation. It is understood that the procurement is for the supply of 500,000 metric tonnes of ammonia from 2027 through to the 2040s, with around 30 prospective suppliers approached for the purposes of the tender.

- The tender from **JERA** is significant in providing demand that will underpin, or provide demand side support for, the development of supply side. The production of 500,000 metric tonnes of ammonia will require around 88,000 metric tonnes of hydrogen, which is then combined with nitrogen. 500,000 metric tonnes of ammonia equates to 20% of the mass of fuel to fire a 1 GW coal-fired power plant – the mass of fuel required to power Unit 4 at the Hekinan coal-fired power station.

- The narrative accompanying the tender has been that it is open to suppliers of either Blue Hydrogen or Green Hydrogen, or both, but if Blue Hydrogen is to be supplied, at least 60% of **GHG** emissions arising from the production of hydrogen must be captured and stored permanently.

- Low Carbon Pulse will report on the outcome of the tender.

- **Suiso Frontier reaches Hy touch Kobe:** On February 25, 2022, Kawasaki Heavy Industries, Ltd (**KHI**) announced that Suiso Frontier (built by **KHI**) had returned to Hy touch Kobe (the liquified hydrogen receiving terminal at Kobe, Japan, built by **KHI**).

As reported in **Editions 32, 33 and 34** of Low Carbon Pulse, the arrival of the Suiso Frontier marks the completion of the world's first ocean voyage to transport liquified hydrogen over a long distance.

- **BESSs to find place on the grid, someday:** In a report that "slipped by" the author of Low Carbon Pulse, in late January 2022, [asia.nikkei.com](#) reported that Japan is to require power utilities to allow the installation of **BESSs** operated by other corporations on their grids.

The Japanese Government is to make available financial support to allow the installation of **BESSs**, and in so doing provide incentives for the installation of **BESSs** to stabilise, and to preserve the integrity of grids, as the dispatch of renewable electrical energy over those grids continues to increase.

PRC and Russia:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the **PRC** and Russia, being countries that give rise to the most and the fourth most **GHG** emissions.*

- **Energy Storage PRC Focus:** On February 25, 2022, [scmp.com](#) reported (under [Climate Change: China to slash costs of energy storage systems for industry to leapfrog the world by 2030, according to five-year plan](#)) that the **PRC** plans to cut the cost of energy storage systems by 2025, including by the use of compressed air storage (**CAS** – see **Edition 21** of Low Carbon Pulse for background on **CAS**). The plan is outlined in a five-year plan drafted by the National Development and Reform Commission (**NDRC**) and the National Energy Administration (**NEA**).
- **State Grid Corporation of China (SGCC):** **Edition 35** of Low Carbon Pulse reported on virtual event held by the International Renewable Energy Agency (**IRENA**) and the SGCC, [Facilitating the Transition Toward Smart Electrification with Renewables in China](#). The virtual event complemented the report prepared jointly by **IRENA** and **State Grid** [Smart Electrification with Renewables: Driving the transformation of energy services](#). The **January and February Report on Reports** will outline the findings from [Smart Electrification with Renewables: Driving the transformation of energy services](#).

One of the key element of **Smart Electrification with Renewables: Driving the transformation of energy services** is the development of energy storage across the electricity grids owned and operated by **SGCC**. On March 2, 2022, it was reported in the People's Daily that **SGCC** intends to develop and to deploy up to 100 GW of **BESS** by 2030, and up to 100 GW of pumped storage capacity (up from 26.3 GW currently).

• **A reminder of the plans:**

- **During the week beginning February 28, 2022:** it was reported widely that the **PRC** plans to develop and to deploy hydrogen refuelling infrastructure at 2000 sites across China, and for 1 million FCEV in China, by 2035.
- As part of continued progress, on March 4, 2022, it was announced by [Air Liquide](#) that it had contracted with Shenergy and Shanghai Chemical Industrial Park to accelerate the development of the production and use of hydrogen in Shanghai and the Yangtze River Delta.
- **On March 5, 2022:** [Reuters](#) reported that the **PRC** has firmed up plans to develop and to deploy 450 GW of new photovoltaic solar and wind capacity in the Gobi Desert, and other desert regions: Director of **NDRC**, Mr He Lifeng said:

"China is going to build the biggest scale of solar and wind power generation capacity on the Gobi desert in history, at 450 GW".

While the development and deployment of photovoltaic solar and wind power in the Gobi Desert has been flagged (for example, see **Edition 21** of Low Carbon Pulse) for some time, the confirmation from **NDRC** at the National People's Congress can be viewed as a firm policy setting.

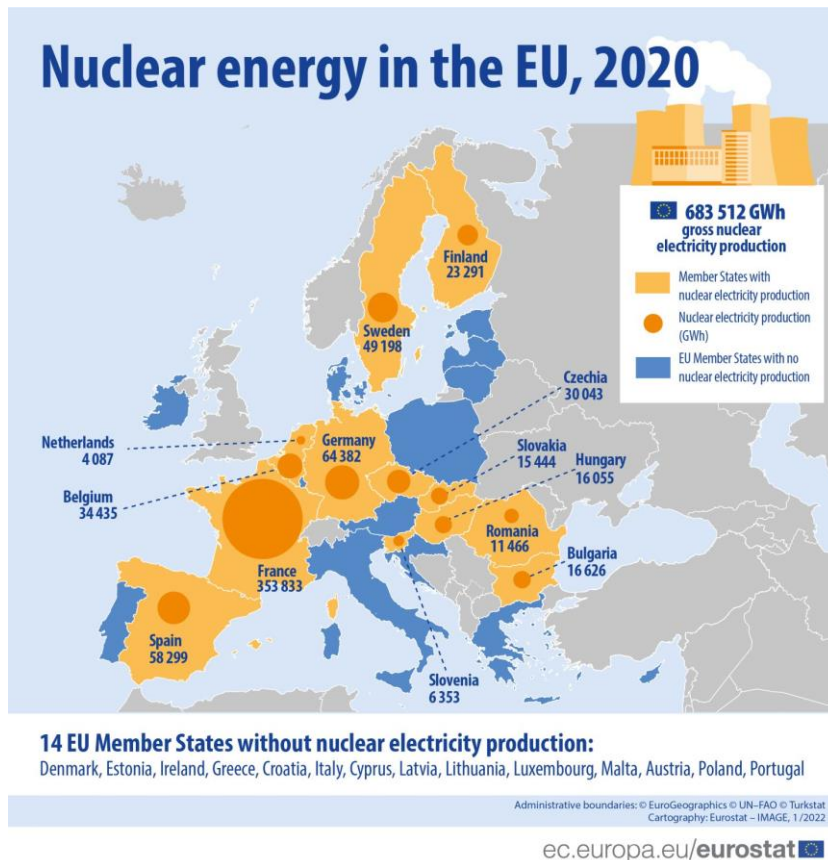
It is understood that the construction of 100 GW of photovoltaic solar capacity is already underway in the Gobi Desert. As noted in previous editions of Low Carbon Pulse, the renewable electrical energy generated in the Gobi Desert, and other desert regions, will be transmitted to the load for that electrical energy using ultra-high voltage direct current transmission systems.

Europe and UK:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to countries within the European Union (EU) and the EU itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards **NZE**. In combination, countries comprising the EU give rise to the most **GHG** emissions after the Peoples Republic of China (PRC) and the US. The UK is a top-twenty **GHG** emitter, but has been a front-runner in progress towards **NZE**.*

- **Nuclear Energy in Europe:** **Edition 35** of Low Carbon Pulse reported on the plans of France to develop and deploy six new nuclear reactors to generate electrical energy.

By way of reminder, the map below provides a summary of installed nuclear energy capacity across the **EU**.



• **Finland flagging big**

- **Edition 31** of Low Carbon Pulse reported as follows:
 - "Finland in focus: **Edition 4** of Low Carbon Pulse included a piece on Finland as follows:

"Business Finland (a public organisation directed by the Finnish Ministry of Employment and Economy) has published a **National Hydrogen Roadmap for Finland**.

The **Roadmap** is clear as to historical, current and future uses:

"Hydrogen has been used as an industrial chemical for more than 100 years. Today ... used to manufacture ammonia, and ... fertilizers, as well as methanol and hydrogen peroxide, both vital feedstocks for a wide variety of different chemical products ... Producing hydrogen via low or totally carbon-free ways, and using this "good" low-carbon hydrogen to replace hydrogen with a larger carbon footprint, we can reduce carbon emissions ... "

Hydrogen is seen as playing a key role in Finland's national goal of carbon neutrality by 2035. The **Roadmap** does not contain policy settings, rather it, and each initiative contemplated by it, is intended to provide a "knowledge base for further work" including shaping policy settings for Finland, and "determining the role of hydrogen in the national energy and climate policy".

As with the **DOE Hydrogen Program Plan**, the Finnish **National Hydrogen Roadmap** provides a good analysis of the role that hydrogen can play across sectors, and the scale of the demand side of the prospective market for hydrogen, and in the case of the **Roadmap** the role that Finnish business can play across the hydrogen value chain."

See: [Hydrogen Roadmap for Finland](#)

- **European Commission funding for CCS:** On November 17, 2021, the European Commission committed funding support, from the newly established €1.1 billion Innovation Fund, for the production of clean-hydrogen at a refinery at Porvoo, Finland, with the capture of **CO₂** and its storage in the North Sea in geological formations below the sea-bed, with the electrical energy required being produced by renewable sources.
- **Momentum accelerating:** On November 22, 2021, it was reported widely that Finland is progressing to develop a number of initiatives that will make it a leading hydrogen economy. One initiative involves the development and deployment of large-scale hydrogen production capacity around the Gulf of Bothnia and the Baltic Sea, with the Gulf of Bothnia regarded as highly prospective for hydrogen production, storage, use and transportation."
- **Raahe in the race:** On February 23, 2022, it was reported widely that the City of Raahe is to become a major location for the development of three hydrogen production, and storage, projects. For the purposes of hauling hydrogen from Raahe, while early days, there is a plan to develop a dedicated hydrogen sub-marine pipeline across the northern Baltic Sea. The hydrogen pipeline will transport hydrogen from the City of Raahe to Sweden to Germany.

As reported in previous editions of Low Carbon Pulse (see **Edition 33** of Low Carbon Pulse).

- **Belgium and UK alignment:** On February 24, 2022, it was reported widely that Belgium and the UK had signed an energy cooperation agreement providing for each country to work closely on initiatives to achieve decarbonisation, including future energy interconnection, carbon capture, use and storage, low carbon hydrogen production, and off-shore wind field development.
- **EU to accelerate decarbonisation initiatives:** During the week commencing February 28, 2022, it became apparent that the **EU** intends to seek to reduce exposure to volatile hydrocarbon prices (coal and natural gas) by accelerating progress to increased renewable electrical energy and the production and use of Green Hydrogen (**Hydrogen Accelerator**), and in the near to medium term, to access more varied sources of natural gas supply, principally in the form of LNG.

During the next two quarters of 2022, the expectation is that there will be a focus on maximising gas in storage, to at least 80% by September 30, 2022. At the same time, it is understood that the **Hydrogen Accelerator** policy setting will be implemented.

By way of rare editorial comment, the **EU** needs to be clear to the market, committing to the market to ensure that term contracts are concluded for LNG to allow the development of further LNG supply sources globally by underpinning the economics of those developments. Germany is doing this already.

Americas:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.*

- **Mountain States hub:** On February 25, 2022, it was reported widely that Colorado, New Mexico, Utah and Wyoming had signed a memorandum of understanding to develop a regional clean hydrogen hub, and in so doing position more effectively in seek funding from the **IIAJA**.

By way of reminder: The largest hydrogen program in the **IIAJA** provides the US (**DOE**) with USD 8 billion to provide support for at least four hydrogen hubs that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.

Also there is funding to support lowering the cost of production of Green Hydrogen with the goal of achieving a cost of USD 2 per kg by 2026 and for research, development and demonstration (**RDD**) to develop and deliver clean hydrogen production, delivery, storage and use technologies. Finally, the **IIAJA** contemplates the development of a national hydrogen strategy and roadmap to facilitate large-scale, and wide-spread, production, delivery, storage and use of clean hydrogen.

- **Edition 35** of Low Carbon Pulse reported that the US **DOE** had gone live on the implementation of the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**, with the initiatives in the **IIAJA** now being rolled out including:

- **Clean Hydrogen RDD goes live:** On February 9, 2022, the US Department of Energy (**DOE**), through the Office of Fossil Energy and Carbon Management (**FCEM**), announced formally the roll-out of the USD 24 million in federal funding for research and development and front-end engineering and design that will advance the adoption of clean hydrogen as a carbon free fuel for electrical energy generation, industrial use and transportation. This is the first step in the provision of funding for **RDD**.
- **EV charger funding goes live:** On February 10, 2022, the Biden Administration rolled out its plan to allocate USD 5 billion to fund the development and deployment of electric vehicle chargers over the coming five years. This initiative is part of a policy initiative that earmarked USD 7.5 billion to roll-out a nationwide electric vehicle charging network of 500,000 electric vehicle chargers. The initiative includes the designation of alternative fuel corridors.
- **Clean Hydrogen Project Process goes live:** On February 15, 2022, the US **DOE** announced that it requires information on the development of hydrogen hubs across the US, with at least four hydrogen hubs contemplated.

France and Germany:

*This section considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to France and Germany.*

- **Germany aims for 100% renewables by 2035:** On February 28, 2022, [electrive.com](https://www.electrive.com) reported that the German Federal Government wants to progress to 100% renewable electrical energy by 2035. The accelerated target contrasts with the previous target of moving away from fossil fuels "well before 2040".
To achieve this goal the German Federal Government is understood to be progressing amendments to the Renewable Energy Sources Act (**EEG**). It is understood that the **EEG** is ready, and that it will contemplate (and provide a path to) the achievement of photovoltaic solar and wind power reaching 80% of electrical energy used by 2030.
By 2030, it is expected that Germany's on-shore wind farm capacity will have doubled to 110 GW of installed capacity, with off-shore wind field capacity to reach at least 30 GW of installed capacity (equivalent to the output of 10 nuclear energy power stations). Photovoltaic solar installed capacity is planned to reach 200 GW by 2030.
Low Carbon Pulse will follow the progress of the amendment of the **EEG** and the policy settings that will result from it.
- **Other news items in the news cycle of this Edition 36 are covered elsewhere:** Other sections of this **Edition 36** of Low Carbon Pulse cover news items relating to Germany, critically the news that the German Federal Government, Kreditanstalt für Wiederaufbau (**KfW**) is to become a shareholder in the LNG terminal at Brunsbüttel.

Australia:

*This section considers news items that have arisen within the news cycle of this **Edition 36** Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita.*

*Australia is however progressing to **NZE** at a faster rate than many other developed countries, and, along with the GCC Countries, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.*

- **Dalrymple Bay Hydrogen Project:** On February 24, 2022, it was reported widely that a funding agreement had been signed by Brookfield Infrastructure Group, DBHex Management Pty Ltd, Itochu Corporation and North Queensland Bulk Ports Corporation.
The purpose of the funding agreement is reported to be the completion of detailed feasibility in respect of the proposed **Dalrymple Bay Hydrogen Project**. The funding agreement, and the completion of the detailed feasibility study that it will allow, builds on the **MoU** signed among the parties in August 2021. It is likely that **Dalrymple Bay Hydrogen Project** will benefit from being located within one of the Queensland Renewable Energy Zones (**QREZs**).
By way of reminder: **Edition 20** of Low Carbon Pulse reported that Australian Future Energy (**AFE**) announced that it had entered into a memorandum of understanding (**MoU**) with leading Japanese trading house, Itochu Corporation. **AFE** intends to develop the USD 750 million Gladstone Energy and Ammonia Project (**GEAP**), and is reportedly close to commencing front end engineering and design (**FEED**).
It is reported that under the **MoU**, Itochu Corporation will consider potential investment in **GEAP** and the role that Itochu may have in the marketing of hydrogen-based fuels produced by **GEAP**. The **GEAP** is intended to produce 230,000 metric tonnes per annum of ammonia and 91,000 metric tonnes per annum of hydrogen.
- **FFI power linked:** On February 25, 2022, it was reported widely that Fortescue Future Industries (**FFI**, a wholly-owned subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO), Powerlink (a state-owned enterprise) and Economic Development Queensland have an agreed arrangement that will provide the means to transmit renewable energy to **FFI's** Gibson Island 50,000 metric tonnes per annum Green Hydrogen production plant.
- **Orica and Origin plan Hunter Valley Hydrogen Hub:** On February 28, 2022, it was reported widely that Orica (among other things, leading manufacturer of ammonium nitrate) and Origin Energy (one of the Big Three integrated energy corporations in Australia) had signed a memorandum of understanding (**MOU**) to undertake a feasibility study in respect of the establishment of a Hunter Valley Hydrogen Hub. As noted in previous editions of Low Carbon Pulse, the Hunter Valley is one of the areas of New South Wales (and Queensland) best known for world class coal-mines. The Green Hydrogen produced would be used to displace natural gas currently used by Orica at Kooragang Island, Newcastle, New South Wales facility, with the Green Hydrogen being combined with nitrogen.
One of the key elements of the reporting around the **MOU** is that the water to be used as the feedstock to produce Green Hydrogen is to be sourced from waste water, with the recycled water to be electrolysed using a 55 MW electrolyser. In countries (and regions) scarce in fresh water, or with competing needs for water, the use of waste water is now being considered actively. The three sources of water for Green Hydrogen production are: fresh water, waste water to produce recycled water or sea-water to produce desalinated water.

By way of reminder: On February 16, 2022, Origin Energy announced that its 2,880 MW Eraring power station, in NSW, would close by August 2025 (seven years ahead of previous its planned closure). Eraring is the largest remaining coal-fired power station in Australia. As reported previously in Low Carbon Pulse, Origin Energy intends to install a 700 MW / 1,400 MWh **BESS**, on the site of the decommissioned power station.

- **Government of Tasmania rings progress:** On March 1, 2022, it was reported widely that the Government of Tasmania (Australia's Island State) is to develop a Green Hydrogen Hub in the Bell Bay region of Tasmania. Previous editions of Low Carbon Pulse have reported on the development Green Hydrogen and Green Ammonia projects in the Bell Bay region (see **Editions 4, 18, and 20** of Low Carbon Pulse).
- **Government of Victoria circles off-shore wind:** On March 4, 2022, the Government of Victoria [announced](#) its off-shore wind field (**OWF**) targets, with first electrical energy by 2028, and 9 GW of installed off-shore wind field capacity by 2040. As noted in previous editions of Low Carbon Pulse, Australia has some of the best off-shore wind resources in the world, and the State of Victoria has some of the best wind resources of the Australian states.

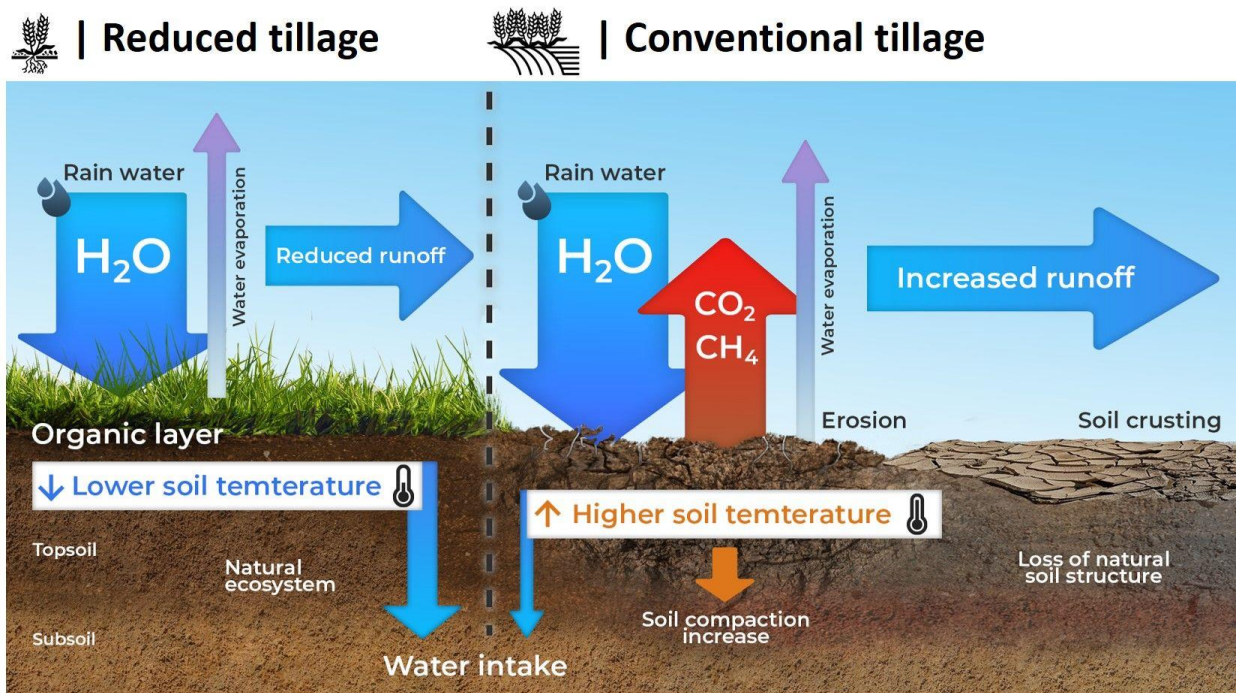
The detail of the policy settings of the Government of Victoria are in its **Offshore Wind Policy Directions Paper**.

2028	2032	2035	2040
First electrical energy	At least 2 GW of OWF capacity	At least 4 GW of OWF capacity	At least 9 GW of OWF capacity

Blue and Green Carbon Initiatives and Biodiversity:

*This section considers news items that have arisen within the news cycle of this **Edition 36** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.*

- **Blue Carbon habitats need to be mapped:** On March 3, 2022, The Irish Times reported on the initiative from environmentalists to map comprehensively and to preserve the seagrass beds. The article is well-worth a read, both for the commentary on seagrass ecosystems around the Republic of Ireland, and more broadly. While the value of seagrass beds is well-established to provide habitat for marine life and bird species, the value of seagrass as a primary means of carbon storage is receiving increasing attention in the Republic of Ireland. The Irish Times article notes that while seagrass covers around 0.1% of the ocean floor, seagrass stores 13% of carbon stored in the oceans. With the increasing awareness of the role of seagrass (as one of the means of Blue Carbon storage) is the realisation that one third of Blue Carbon sinks (including salt marshes and mangrove swamps) have been lost since 1990.
- **Until now this has not been a question:** The infographic below illustrates the impact of the answer to the question – to till or not to till?



The tillage of soil impacts the characteristics of soil and the release and the retention of **GHG** as a function of decomposition of the organic matter arising from land use. As ever, there is a balance – there are benefits in leaving residue and not tilling, including insulating soil from radiative heat, and the decomposing residue can provide structure as the organic matter combines with the soil over time.

Bioenergy and heat-recovery:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass. **Bioenergy** includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form. In addition, recovered heat and waste heat (derived from any source, including waste water) has been added to this section.

From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted. The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.

- **Another TotalEnergies' infographic:** It would not be an edition of Low Carbon Pulse without an excellent infographic from the good folk at TotalEnergies.

Edition 34 included an infographic entitled [TotalEnergies' Aerobic Digestion Ecosystem infographic](#). **Edition 35** of Low Carbon Pulse included an infographic entitled [Hydrogen Production Ecosystem](#).

As a sibling to the [TotalEnergies' Aerobic Digestion Ecosystem infographic](#), the infographic below provides an excellent overview of a biogas plant using anaerobic digestion technology to derive biogas from organic biomass (feedstock).

The biogas produced from the plant is itself feedstock for the production of biomethane (in the US referred to as **Renewable Natural Gas** or **RNG**), which can be compressed to produce compressed natural gas or **Bio-CNG** or liquified to produce **Bio-LNG**.



Attached is a [link](#) to the Ashurst Waste to Wealth Compendium including articles on waste, waste technologies, and anaerobic digestion.

- **Eni commences bio-ethanol production:** On February 16, 2022, Eni announced that it had commenced the production of bio-ethanol from lignocellulosic biomass at its Crescentino plant using Proesa® technology. As announced, the Crescentino plant (**Versalis Plant**) is self-sustaining, processing up to 200,000 metric tonnes of biomass a year to produce up to 25,000 metric tonnes of bio-ethanol a year. The processing of the biomass producing renewable electrical energy which is used to produce steam used by the **Versalis Plant**, which processes short supply chain biomass and lignin. The Proesa® technology produces bio-gas using a thermal process (rather than an aerobic process).

BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "**BESS** storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events". The **November and December Report on Report** provides a summary of the LDES Council and McKinsey report from November 2021.

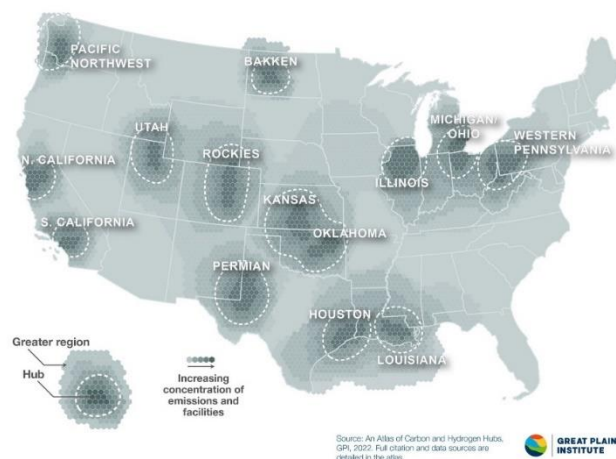
BESS and HESS (and energy storage) news items arising from the news cycle covered by this Edition 36 of Low Carbon Pulse have been covered in other sections (see "**BESSs to find place on the grid, someday**", "**State Grid Corporation of China (SGCC)**", "**Orica and Origin plan Hunter Valley Hydrogen Hub**", and "**Peabody to pivot**").

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including bioenergy carbon capture (**BECCs**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture and storage (**CCS**), carbon capture use and storage (**CCUS**) and direct air capture (**DACS**). Effective accounting for carbon arising and **CDR** go hand-in-hand. By way of background **CDR** is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (**BECCS**), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (**DACS**) are all means of **CO₂** removal. The IEA pathway to **NZE** estimates that in order to achieve **NZE** it will be necessary to capture and to remove up to 7.6 giga-tonnes of **CO₂** each year through **CCS**, **CCUS** and **CDR**. **CCS** and **CCUS** (and **BECCS** and **BECCUS**) involve the capture at the source of **CO₂**, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.

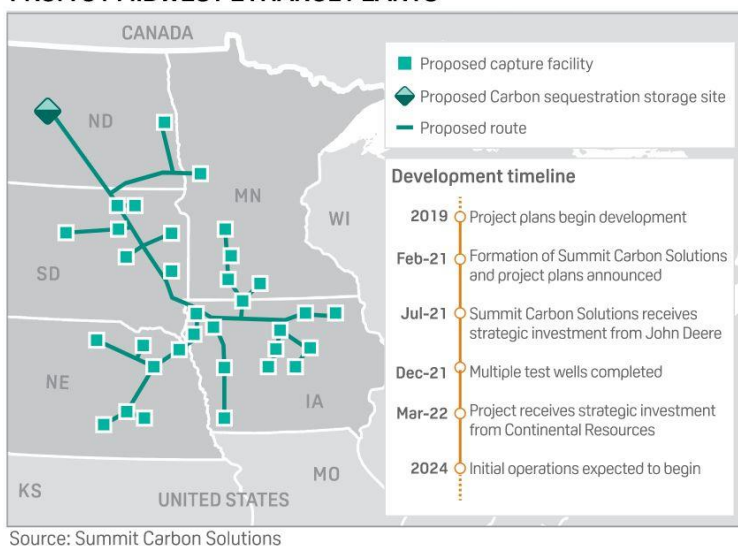
ExxonMobil expands CCS in Wyoming: On February 25, 2022, [ExxonMobil](#) announced FID to expand carbon capture capacity at its LaBarge facility in Wyoming. The expansion will increase **CO₂** capture by 1.2 million metric tonnes a year.

- **CO₂ project at Port of Antwerp:** The [Port of Antwerp](#) has announced progress on the initiative involving the Port of Antwerp, Air Liquide and Fluxys, and BASF, Borealis, INEOS, and TotalEnergies that commenced in 2019. The initiative in 2019 involved undertaking a feasibility study in respect of Antwerp@C, with the feasibility study being completed in 2021. Engineering studies are now to be undertaken, including to assess the development of infrastructure to serve as a backbone throughout the Port of Antwerp along industrial zones. The Antwerp@C **CO₂** project is to capture and to export **CO₂**, with the **CO₂** to be stored permanently. Air Liquide, Fluxys and Port of Antwerp subsidiary, Pipelink, have organised an **Open Season** to assess and to map demand for **CO₂** service provision initially and in the near term.
- **Mapping CO₂ storage in the US:** Edition **34** of Low Carbon Pulse reported on the [Atlas of Carbon and Hydrogen Hubs from the Great Plains Institute](#). The US DOE has a [Carbon Storage Atlas](#). The good folk at the Great Plains Institute sued the DOE **Carbon Storage Atlas** to produce the following map.



- **Continental Resources progressing:** On March 3 and 4, 2022, it was reported widely that Continental Resources is to invest USD 250 million to develop "the largest carbon capture and sequestration project of its kind in the world". Prospectively, the CCS project will source up to 8 million metric tonnes of **CO₂** annually from up to 31 ethanol plants in the mid-west of the US.

SUMMIT CARBON SOLUTIONS TO CAPTURE CARBON FROM 31 MIDWEST ETHANOL PLANTS



- **INPEX confirms plans for CCS:** On March 3 and 4, 2022, it was reported widely that INPEX (Japan's largest oil and gas exploration and production corporation) intends to seek to progress the development of a CCS project off-shore Darwin, Northern Territory, as part of its plans to achieve its commitment to NZE – Net Zero 2050.

Carbon Credits and Hydrogen Markets and Trading:

This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development of hydrogen markets and trading (bilateral and likely wholesale).

By way of reminder: As reported in Edition 18 of Low Carbon Pulse, on May 20, 2021, plans for a new global carbon exchange were announced. The global carbon exchange is to be located in Singapore. DBS Bank, Singapore Exchange, Standard Chartered Bank and Temasek have established a joint venture, **Climate Impact X (CIX)**, for this purpose. The stated intention of the **CIX** is to provide "high-quality carbon credits to address hard-to-abate emissions".

Managing Director of the Monetary Authority of Singapore, Mr Ravi Menon, noted that the **CIX** represented the adoption of a "twin strategy" of the reduction of **GHG** emissions and the off-set of **GHG** emissions, which provides a "practical and effective" way to achieve the Paris Agreement Goals.

On March 3, 2022, it was reported widely that DBS Bank, Standard Chartered Bank, and Temasek are continuing to put in place the arrangements to allow the development of **CIX**. It has become increasingly clear that **CIX** will provide a trading platform for high quality carbon credits / carbon offsets. The standalone article entitled **Carbon Credits, Article 6 and the Paris Rulebook** will provide a detailed perspective on the importance of effective trading platforms.

E-fuels & feedstocks / Future Fuels & Feedstocks / Now Fuels & Feedstocks:

This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the development of production capacity to derive and to produce E-fuels (energy carriers derived or produced using renewable energy) and Future Fuels (energy carriers derived and produced that are characterised as clean carbon or low carbon fuels). E-fuels include Green Hydrogen and Green Ammonia, and Future Fuels include Blue Hydrogen and Blue Ammonia.

- **Green Wilhelmshaven® Hydrogen Project:** Previous editions of Low Carbon Pulse had reported on Wilhelmshaven as follows:
 - **"Wilhelmshaven Grey Plans:** On January 24, 2022, AtlasInvest (a corporation that invests in both conventional oil and gas and renewable projects) announced plans to develop a €2.5 billion hydrogen facility that will derive hydrogen from methane (i.e., Liquid Natural Gas or LNG) imported from **GCC countries**.
The hydrogen facility will be located within the hinterland of the Port of Wilhelmshaven. It is reported that the hydrogen facility will have capacity to produce up to 500,000 metric tonnes of hydrogen per year. It is understood that CCS / CCUS is not contemplated, and as such the hydrogen produced will be Grey Hydrogen.
By way of reminder, **Edition 14** of Low Carbon Pulse reported that on April 15, 2021, Uniper (German utility giant) planned to develop a hydrogen hub located in Wilhelmshaven (**Green Wilhelmshaven**) comprising a receiving terminal for Green Ammonia, then using a cracker to derive Green Hydrogen. The plans included a 410 MW electrolyser. On full development, it was estimated that the facilities at **Green Wilhelmshaven** would produce up to 295,000 metric tonnes per year of Green Hydrogen.
 - In **Edition 14** it was noted that the decision of Uniper to develop **Green Wilhelmshaven** may end its plans to import LNG using a floating storage and regasification unit at Jade Bay, in Wilhelmshaven. Given the plans of AtlasInvest, it would seem likely that Wilhelmshaven may become a key Green Hydrogen and Grey Hydrogen Hub.
- **LNG Terminals progressing:** On February 27 and 28, 2022, it was reported widely that the German Federal Government had asked Uniper to resume its plans to develop an LNG receiving terminal in Wilhelmshaven as the

Federal German Government develops its thinking around energy security. As originally planned, Uniper intended to develop a 7.3 million metric tonnes per annum floating storage receiving terminal (**FSRU**).

In addition to a **FSRU** at Wilhelmshaven, the Federal German Government wants to develop and deploy an LNG receiving terminal at Brunsbuettel. The LNG receiving terminal at Brunsbuettel has been planned for a while by joint venturers Gasunie (a Dutch natural gas infrastructure and transportation company) and Oiltanking (a logistics service provider of tank terminals for petroleum products, chemicals, and gases), a subsidiary of Marquard & Bahis AG), with Vopak reported as passive in the joint venture. It is understood that RWE expressed interest in use of the LNG receiving terminal at Brunsbuettel to re-gasify LNG imported from Australia.

German Chancellor, Mr Olaf Scholz said: "We have decided [quicky to] build two LNG terminals at Brunsbuettel and Wilhelmshaven", the speed of that decision became apparent.

On March 5, 2022, Vopak [announced](#) (under [German LNG Terminal in implementation phase with new shareholder structure](#)) that the shareholders of German LNG Terminal GmbH and the German Federal Government had agreed on key points to allow progress of the LNG receiving terminal at Brunsbuettel. On March 4, 2022, Gasunie and Kreditanstalt für Wiederaufbau (**KfW**), acting for the German Federal Government, signed a memorandum of understanding to start construction jointly of the LNG receiving terminal at Brunsbuettel, with **KfW** to join German LNG Terminal GmbH as a shareholder, with Oiltanking and Vopak to leave as shareholders by May 2022.

The participation of the German Federal Government, through **KfW**, and the project implementation role taken by Gasunie, in the development of LNG receiving terminal at Brunsbuettel is extremely significant in all the circumstances.

- **Wilhelmshaven Green Plans:**

- On February 21, 2022, it was reported widely that Uniper and Salzgitter AG (global manufacturer of steel and technology products) had agreed arrangements for supply of Green Hydrogen from Uniper's **Green Wilhelmshaven® Hydrogen Project** to the Salzgitter SALCOS® project (see [Editions 14](#) and [34](#) of Low Carbon Pulse): **SALCOS** being **Salzgitter Low CO₂-Steelmaking**.

- On March 2, 2022, it was reported in [rechargenews.com](#) that Tree Energy Solutions (**TES**) intends to develop a "green gas" terminal within Wilhelmshaven to accept deliveries of carbon neutral liquified e-methane (**e-CH₄**). The plan is to commence operation of the green gas terminal before Q4 2025. It is reported that the **e-CH₄** would be produced using captured **CO₂** combined with low-cost renewable hydrogen (**H₂**), with the methanation of the **CO₂** and the **H₂** undertaken using the Sabatier Methanisation Process. It is understood that the **TES** green gas terminal would be able to received LNG.

- **Green Wilhelmshaven® Hydrogen Project:** By way of an update, it is apparent that the plans of Uniper for **Green Wilhelmshaven** include the development of a Green Ammonia receiving and **hydrogenation** terminal, and a Green Hydrogen production facility comprising 1 GW electrolyser capacity.

Echoing the longstanding narrative of Low Carbon Pulse, Mr Gunnar Grobler of Salzgitter AG stated: "We are aligning Salzgitter AG to low **CO₂** production processes and the circular economy ... The secure and economically viable sourcing of Green Hydrogen is a fundamental pre-requisite on our journey toward SALCOS ...".

- **S&P Global Platts – Atlas of Energy Transition:** On February 22, 2022, S&P Global Platts published its [Hydrogen Price Wall](#), mapping hydrogen prices across means of production and regions of use. The [Hydrogen Price Wall](#) is to be found in the updated [Atlas of Energy Transition](#).

While Low Carbon Pulse does not report on the cost or price of hydrogen, the S&P Global Platts [Hydrogen Price Wall](#) (as part of the [Atlas of Energy Transition](#)) provides a helpful point of reference.

- **SAF in sound: Mosjøen, Norway:** On February 28, 2022, [norsk-e-fuel.com](#) announced plans to develop a sustainable / synthetic aviation fuel (**SAF**) production plant in Mosjøen, Norway, signing an agreement with the municipality of Vefsn and Mosjøen og Omegn Naeringsselskap KF (**MON**). The **SAF** production plant is to produce **SAF** from **CO₂** and water, powered by renewable electrical energy from the Mosjøen area. The **CO₂** will be sourced from direct air capture (**DAC**), using technology developed by Climeworks (see [Editions 25](#) and [26](#) of Low Carbon Pulse) and electrolyzers provided by Sunfire (see [Editions 29](#) and [34](#) of Low Carbon Pulse).

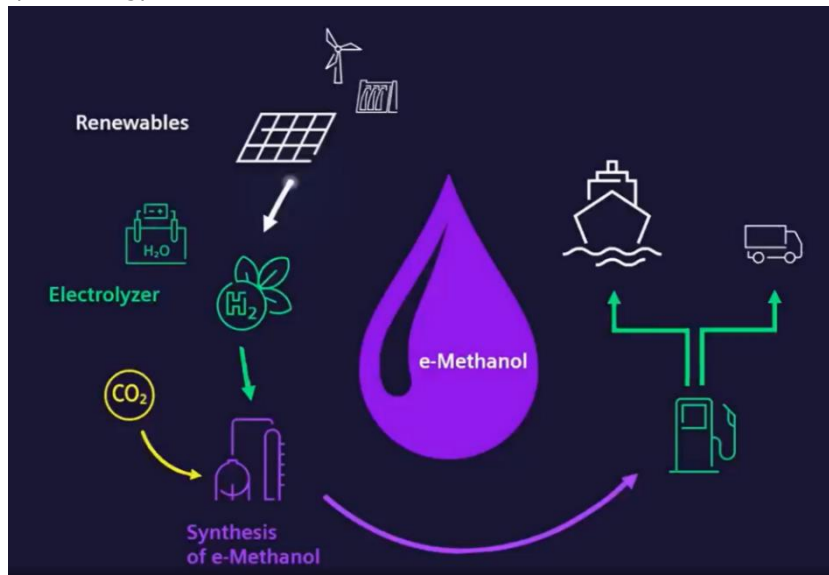
The Norsk e-Fuel consortium comprises, Climeworks, Sunfire, Valinor AS (green energy investment corporation headquartered in Norway, and parent company of Norsk Vind), and Paul Wurth / SMS Group (leading engineering, procurement and construction corporation).

- **Florida commits to Green Hydrogen:** On March 1, 2022, it was reported widely that the Florida Power & Light Company is to develop and to deploy a Green Hydrogen production plant using a 25 MW electrolyser supplied by Cummins Inc. The Green Hydrogen production plant is to be located within the Cavendish NextGen Hydrogen Hub.

- **FFI and Covestro contract:** On March 1, 2022, it was reported widely, and [covestro.com](#) announced, that **FFI** and Covestro (leading plastics manufacturer headquartered in Germany) had contracted for the sale and purchase of 100,000 metric tonnes a year of Green Hydrogen starting in 2024.

- **ExxonMobil turns blue:** On March 2, 2022, [h2.view.com](#) reported (under [ExxonMobil unveils ambitious blue hydrogen targets for integrated refining and petrochemical site](#)) on plans of ExxonMobil to produce one billion cubic feet of Blue Hydrogen daily at its petrochemical and refining site, Baytown, Texas. The Blue Hydrogen would be used as feedstock at the olefins plant at Baytown. CCS will be key to the plans, with up to 10 million metric tonnes of **CO₂** per annum to be captured.

European Energy progressing to scale e-Methanol production: On March 3, 2022, it was reported widely that European Energy had agreed to procure from Siemens Energy a 50 MW electrolyser (using proton exchange membrane technology) to produce Green Hydrogen to combine with **CO₂** to produce e-Methanol in Kassø, Denmark, located close to the source of renewable electrical energy to power the electrolyser, a 300 MW photovoltaic solar farm owned by European Energy.



The e-Methanol production project will supply e-Methanol to AP Moller Maersk and to Circle K. As noted in previous editions of Low Carbon Pulse, one of the key risks for AP Moller Maersk in procuring dual fuel container ships was the supply of sufficient clean or low carbon methanol.

Edition 26 of Low Carbon Pulse reported on the decision of AP Moller Maersk to order eight dual fuel container vessels, capable of being power and propelled by methanol. In reporting on this decision it was noted that AP Moller – Maersk was aware of the need to continue to procure supplies of methanol.

- **Takasago Hydrogen Park:** **Edition 35** of Low Carbon Pulse reported on Mitsubishi Heavy Industries (**MHI**) is to establish the **Takasago Hydrogen Park** to produce hydrogen that **MHI** will use to allow it to develop and to commercialise its hydrogen gas turbine technology. **Takasago Hydrogen Park** will use electrolyser technology to produce Green Hydrogen, and it will produce hydrogen from the thermal treatment of methane (Grey without CCS / CCUS, Blue Hydrogen, without CCS / CCUS).

On February 22, 2022, **MHI** made its own [announcement](#) which included the following infographic:



- **Gulf Coast Green Fuels Hub:** On February 22, 2022, [h2-view.com](https://www.h2-view.com) reported Apex Clean Energy (see **Edition 35** of Low Carbon Pulse) had signed a memorandum of understanding with the Port of Corpus Christi Authority and EPIC Midstream to consider the development of a GW scale green fuels hub, at the hub of which would be Green Hydrogen production capacity.

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of:

- areas in which: **1.** infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and **2.** technologies facilitating energy transition will be concentrated and supported (**Hydrogen Corridors and Valleys**); and
- *giga-factories* that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).

Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.

- **Northvolt transformation:** On February 25, 2022, [northvolt](#) (under [Northvolt to transform closed paper mill in Sweden into new Gigafactory](#)) announced that it plans to develop the Kvarnsveden Mill and the area surrounding it at Borlange, Sweden. As announced, northvolt is to use the site to manufacture battery cells - up to 100 GWh of cathode material annually.
- **Delta Corridor:** On February 25, 2022, it was reported that the Delta Corridor has the support of the Dutch Government: the Delta Corridor comprises a pipeline system between Maasvlakte (Rotterdam – see [Editions 30, 31](#) and [33](#) of Low Carbon Pulse for background on Maasvlakte) and the Ruhr region of northern Germany. The Delta Corridor is one of nine projects within the **Dutch Multi-Year Program for Infrastructure Energy and Climate** (Miek).



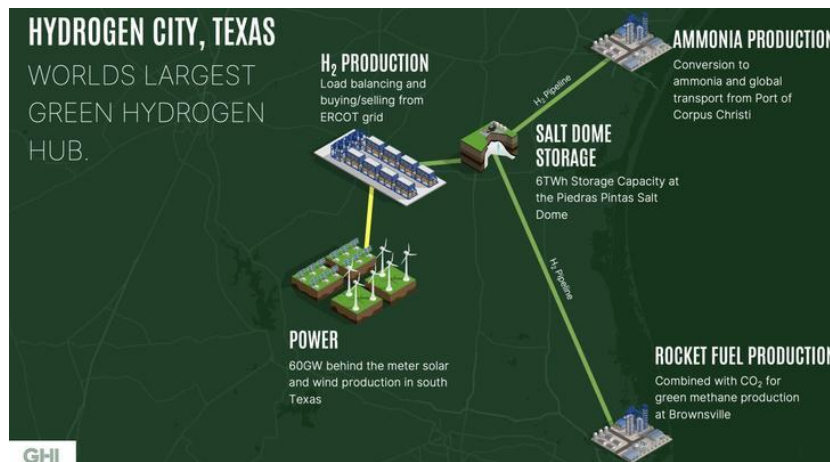
Giga-factory turns soil in Queensland, Australia: [Edition 29](#) of Low Carbon Pulse reported on the commitment of FFI and Plug Power to develop a giga-factory in Australia as follows:

"Dr Andrew Forrest, AO (founder of Fortescue Metals Group, one of the Big Three Australian iron ore producers, and before that the driving force behind the development of the enduring Murrin Nickel Project) knows the "real deal" when he sees it. Dr Forrest established Fortescue Future Industries (**FFI**), and is chair of it.

On October 10, 2021, Dr Forrest announced the development of a giga-factory at Gladstone, Queensland. On October 14, 2021 Dr Forrest announced that the giga-factory would be developed in a 50 / 50 joint venture with Plug Power, with the giga-factory to develop proton exchange membrane (**PEM**) electrolysers."

On February 28, 2022, it was reported widely that Dr Andrew Forrest AO had attended a ceremony to mark the commencement of construction of the **Green Energy Manufacturing Centre** or **GEM**. The **GEM** will manufacture electrolysers, batteries, electrical cabling, photovoltaic solar panels, and wind turbines at Gladstone, Queensland.

- **Hydrogen City, Texas:** On March 3, 2022, the plans of Green Hydrogen International were reported widely - the development of a 60 GW green hydrogen megaproject in the US State of Texas (**Hydrogen City**). The plans include the production of 2.5 million metric tonnes of Green Hydrogen a year, and the use of Piedras Pintas Salt Dome as a **HES**.



- **BP and Equinor South Brooklyn Marine Terminal:** On March 3, 2022, the Mayor of New York City, Mr Eric Adams, announced plans to redevelop the South Brooklyn Marine Terminal as the location for facilities to support off-shore wind development and operation and maintenance of the Beacon Wind (see **Edition 8** of Low Carbon Pulse) and Empire Wind (see **Edition 20** of Low Carbon Pulse) off-shore wind field projects. The redeveloped terminal will be called the Sustainable South Brooklyn Marine Terminal.
- **UN Environment Program reports on cities:** On March 4, 2022, the UNEP published [*Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions*](#). The report will be considered in the **March and April Report on Reports** to be included in the Appendix to the Second Compendium of Low Carbon Pulse with Edition 39.

Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of E-fuels and Future Fuels to process and to treat those metals and minerals. Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.*

- **Vale and Hunan Valin Group alignment:** On February 23, 2022, a number of new sources reported that Vale SA (one of the world's largest mining and resources corporations) had signed a memorandum of understanding with Hunan Valin Group. Vale SA is seeking to reduce its Scope 3 emissions by 15% by 2035, and this initiative is understood to be part of the planning.
- **Supply / Value Chains from waste:** On February 26, 2022, the [post-gazette.com](#) published an article written by Ms Jennifer Wilcox, entitled [Creating a mineral supply chain from mining wastes](#). The article is well-worth a read. The premise of the article is one that is applicable on a global scale: spoil / waste arising from mining operations (and power operations for that matter) is stored on open-sites, sites that require rehabilitation.
At many sites, metals and minerals are present, including rare earth elements (**REEs**). The challenge is the development of scalable technology, and accompanying viable economics, to recover metals and minerals from the spoil / waste. Again, this is a global challenge. This is an area in which governments have a role to play in providing funding support to allow the development of technologies that recover metals and minerals from all waste stream on a scalable and viable basis.
- **Peabody to pivot:** On March 2, 2022, it was reported widely that Peabody Coal has entered into a joint venture with Riverstone Credit Partners, **R3 Renewables**, to develop up to 3.3 GW of photovoltaic solar capacity and 1.6 GW of **BESS** capacity by the mid-2020s. The photovoltaic solar and **BESS** capacity is to be located on, or close to, land on which coal mining operations have been undertaken, starting with land in the US States of Indiana and Illinois.

Wind round-up, on-shore and off-shore:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).*

- **Poland off-shore wind progress:**
 - **Further three off-shore wind field in play:** On February 18, 2022 the Ministry of Infrastructure invited applications for three more off-shore wind field concessions (following the processes that started on January 21, 2022 and February 8, 2022). At the moment, there are three 60 day windows open for applications.
It is reported that there are 11 areas for which applications may be submitted to build and to operate off-shore wind fields and energy islands: these areas are the nine the subject of current application processes, and two in respect of which windows were opened in Q4 of 2021.

On February 25, 2022, [offshoreWIND.biz](#) reported (under [Ørsted and PGE Seek More Room Offshore Poland](#)) that on February 23, 2022, Ørsted and **PGE** had applied for off-shore wind field capacity directly adjacent to the 2.5 GW Baltica Offshore wind project (see **Editions 14** and **18** of Low Carbon Pulse for coverage of Baltica 2 and 3).

- **By way of reminder: Edition 35** of Low Carbon Pulse reported that **PKN Orlen** (a Polish based oil refiner and petroleum retailer, see **Editions 20** and **34** of Low Carbon Pulse) and Polska Grupa Energetyczna (**PGE**) has submitted multiple applications for permits to develop off-shore wind field capacity in areas recently designated for development in the Polish sector of the Baltic Sea.

PKN Orlen has submitted applications for seven areas, covering around 3 GW of installed capacity. **PGE** has submitted applications for six areas, with two applications submitted jointly with Enea and one jointly with Tauron.

- **Swedish Fair Wind :**

- **OX2 given legs offshore shore:**

- **On December 30, 2021,** [offshorewind.biz](#) reported that OX2 had applied for a Natura 2000 permit to develop the 1.8 GW Triton off-shore wind field, located within the economic zone off the coast of Skåne, Sweden.

- **On January 17, 2021,** [offshorewind.biz](#) reported that OX2 had been granted exploration permits for two off-shore wind fields in the Gulf of Bothnia Exclusive Economic Zone (**EEZ**): the permits were granted at a plenary session of the Finnish Government, and are in respect the Halla project (approximately 35 km off-shore the city of Raahе) and Laine project (approximately 30 km off-shore of the adjacent cities of Kokkola and Pietarsaari).

- **On February 22, 2022,** [offshorewind.biz](#) reported that OX2 has applied for a permit to construct the 1.8 GW Triton off-shore wind field project. On grant of the permit, the 1.8 GW Triton project will be constructed 30 kilometres south of Ystad, comprising 129 wind turbines, each with a maximum height of 370 metres. As reported, the 1.8 GW Triton project will be able to generate up to 7.5 TWh of renewable electrical energy a year. This will represent great progress in the context of the plans and policy settings of the Swedish Government outlined below (under **By way of reminder**).

- **By way of reminder: Edition 35** of Low Carbon Pulse reported that the Swedish Government is to identify suitable areas to develop off-shore wind fields for the purposes of generating 120 TWh annually from sources of renewable electrical energy (noting that the electrical energy consumption of Sweden is 140 TWh annually).

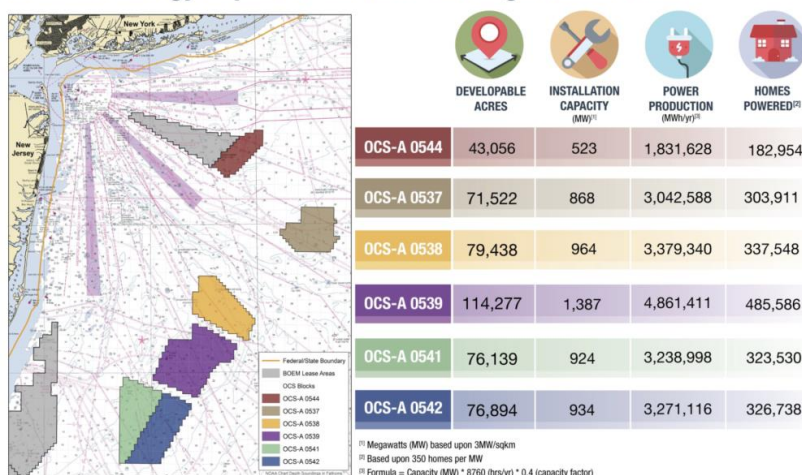
It is understood that the Swedish Energy Agency (**SEA**) has identified, and reported on, three areas – located in the Baltic Sea, the Gulf of Bothnia and the North Sea having wind resources of between 20 to 30 TWh annually. The **SEA** will work with the Swedish Maritime Administration (**SMA**) to identify areas from which 90 TWh annually can be generated. The **SEA** is to report on progress by no later than March 2023, the **SMA** no later than December 2024.

- **US off-shore wind off nearly off the scales:** As noted on page 1 above, the hammer fell on the first auction process run for the award of lease areas to develop off-shore wind fields in US Federal waters.

- **February 23 2022 will stay long in the memory:** As reported in **Edition 33** of Low Carbon Pulse, the auction process for the development of off-shore wind field development for the New York Bight would commence on February 23, 2022 with six areas up for bids by developers (**Lease Areas**). The auction process is the domain of the Bureau of Ocean Energy Management (**BOEM**).

The auction process commenced on February 23, 2022. During the first day of the auction process there were 21 rounds of bidding: see [renewableenergyworld](#) (under [New York Bight offshore wind auction advances as bids total \\$1.5 billion](#)).

Potential Energy Impact of the New York Bight Lease Areas



On February 24, 2022 (day two of the auction process), the **BOEM** suspended bidding after the rounds of bidding did not result in winners.

On February 25, 2022 (day three of the auction process), the **BOEM** continued, and completed the auction process – after three days, and 64 rounds of biddings. The headline was that the auction process had resulted in the award of the six **Lease Areas** for an aggregate of final bid prices of USD 4.37 billion.

LEASE AREA AND CAPACITY | SUCCESSFUL BIDDER AND BID

OCS-A 0539 / 1.38 GW to 3 GW	Bight Wind Holdings, LLC (National Grid & RWE Renewables) USD 1.1 billion
OCS-A 0538 / 964 MW to 1.5 GW	Attentive Energy (EnBW and TotalEnergies with Total now having 100%) USD 795 million
OCS-A 0541 / 925 MW to 1.2 GW	Atlantic Shores Offshore Wind Bight LLC (EDF and Shell) USD 780 million
OCS-A 0537 / 870 MW to 1.1 GW	OW Ocean Winds East LLC (EDP Renewables and Engie) USD 765 million
OCS-A 0541 / 925 MW to 970 GW	Invenergy Wind Offshore LLC USD 645 million
OCS-A 0544 / 525 to 700 MW	Mid-Atlantic Offshore Wind LLC (CIP) USD 285 million

- **The auction process:** There were 25 corporations that had pre-qualified to bid. Each pre-qualified bidder could bid for one or more **Lease Area**. If there were two or more live bids for any Lease Area, a further round of the auction process took place. At the start of each round, the **BOEM** increased the bid price for each **Lease Area**.
- **By way of reminder:**
 - **Edition 29** of Low Carbon Pulse reported that on October 14, 2021, the Biden Administration announced plans to allow the development of seven off-shore wind fields along the East, Gulf and West Coasts of the US: **1.** Gulf of Maine, **2. New York Bight** (between Long Island and New Jersey), **3.** Central Atlantic, **4.** the Carolinas, **5.** the Gulf of Mexico, **6.** California and **7.** Oregon.
 - **Edition 33** of Low Carbon Pulse reported that On December 17, 2021, the **BOEM** had completed its assessment of the development of the 800,000 acre **New York Bight**, allowing the lease of off-shore wind fields with capacity of up to 7 GW of new renewable electrical energy.
- **From New York Bight to Oregon:** On February 25, 2022, it was reported widely the **BOEM** has moved on from the New York Bight auction process to sizing and shaping of the offshore wind leases off the coast of the US State of Oregon: **BOEM** has identified three Call Areas, thinking around which is now being finessed to define Wind Energy Areas.



- **Germany off-shore tender commences:** On February 25, 2022, the Network Agency of the German Federal Government (Bundesnetzagentur) commenced the tender process for up to 980 MW of off-shore wind capacity. The

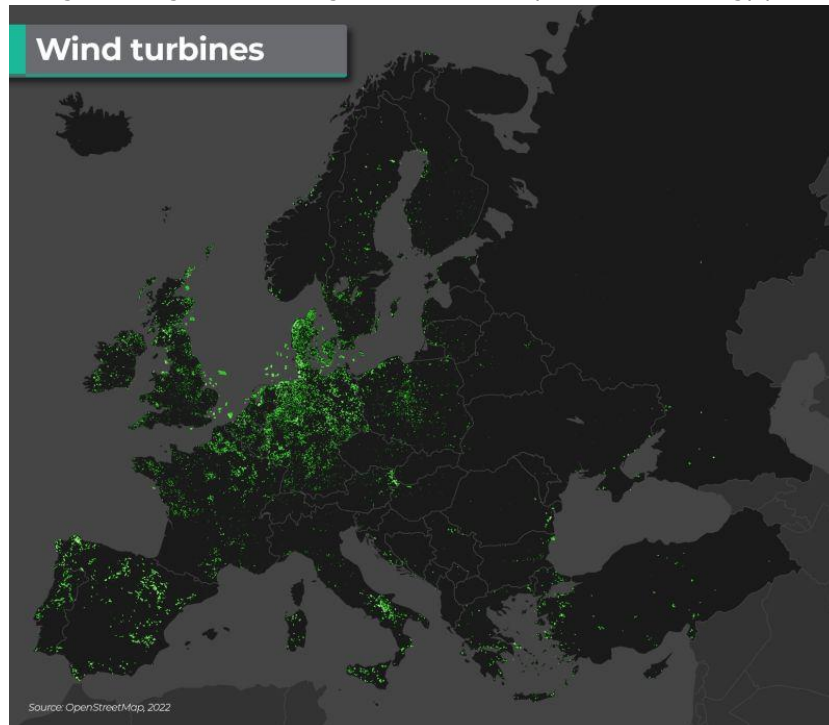
bidder with the bid that requires the least funding support will be successful. Bids must be submitted on or before September 1, 2022.

- **Netherlands off-shore expands renewable energy plans:** On February 25, 2022, Rijkdienst voor Ondernemend (RVO) Nederland (angelsized to the Enterprise Agency) published a [report](#) (entitled the [Netherlands System Integration Offshore Wind 2030-2040](#)). The RVO is proceeding on that basis that by 2040 there will be 38.5 GW of installed off-shore wind field capacity, moving to 72 GW by 2050 (under one scenario – the national scenario) and 31 GW, moving to 38, 42 GW or 43 GW of installed capacity by 2050 (under three other scenarios).

By way of reminder: Edition [29](#) of Low Carbon Pulse noted that on October 6, 2021, it was reported that the RVO is procuring the undertaking of metocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the Ijmuiden Ver Investigation Area (IVIA).

The IVIA is one of three off-shore areas identified in the Dutch Offshore Wind Energy Roadmap 2030. The IVIA is 62 kms off the west coast of the Netherlands, having an area of 400 km². The IVIA has four lots in all, with IVOA I and II to be tendered in to 2023, and IVOA III and IV to be tendered in to 2025.

Wind turbines in Europe: On March 4, 2022, the author came across the following graphic representing wind farms across Europe - the brighter the green dot, the greater the intensity of electrical energy produced by the wind farm



- **ROCKING off-shore ROK: Edition [34](#)** of Low Carbon Pulse noted that on January 25, 2022, Korea Floating Wind (comprising Aker Offshore Wind (33.3%) and Ocean Winds (66.7%)), had been granted its first Electricity Business Licence (EBL) for 870 MW in respect of its off-shore wind field. At that time, the CEO of Aker Offshore Wind, Mr Phillippe Kavagyan stated: "We are very pleased by this timely grant of the first Electric Business Licence, confirming that strong support that we receive in South Korea to make offshore wind a national ambition."

On March 4, 2022, it was reported widely that that Korea Floating Wind had been granted its second EBL for 450 MW in respect of its off-shore wind field. Ocean Winds announced the grant of the second EBL, and noted:

"obtaining the second EBL represents another key step towards realising the world's first large scale commercial floating wind project. The EBL is a mandatory requirement to generate and to supply electricity in South Korea ... [Korea Floating Wind] now holds a 1.32 GW EBL [of] capacity".

The grant of the second EBL allows continued development, on an exclusive basis, of the East Blue Power area, Korea Floating Wind working with its partner Kumyang Green Power. Looking ahead, the intention is to achieve operational completion by 2028, having achieved financial close in 2024".

By way of reminder:

- **Edition [25](#)** of Low Carbon Pulse reported that the Green Investment Group Limited (GIG) and TotalEnergies had been granted an electricity business licence (EBL) from the Ministry of Trade, Industry and Energy. The grant of an EPL allows the development, on an exclusive basis, of the first phase (504 MW) of the three phase 1.5 GW off-shore floating wind field project off Ulsan, South Korea; and
- **Edition [26](#)** of Low Carbon Pulse reported that Shell Overseas Investment B.V. had announced its joint venture with CoensHexicon Co. Ltd, with Shell an 80% equity participant, CoensHexicon, a 20%, equity participant, to develop and then to operate the 1.4 GW Ulsan OWF project (the **MunmuBaram Project**).
- **Edition [32](#)** of Low Carbon (under **MunmuBaram licensed**), the **MunmuBaram Project** has been granted an Electricity Business Licence (EBL), for its floating off-shore wind field project development.

Solar and Sustainability (including NZE Waste):

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.*

- **EDP SEA:** On February 24, 2022, it was reported widely that EDP Renewables (a leading global renewable energy corporation, headquartered in Portugal) is to invest USD 10 billion in Singapore and South East Asia (**SEA**).
EDP has concluded its acquisition of 91% of Sunseap (a Singapore renewable energy corporation – see **Editions 13, 14,** and **22** of Low Carbon Pulse).

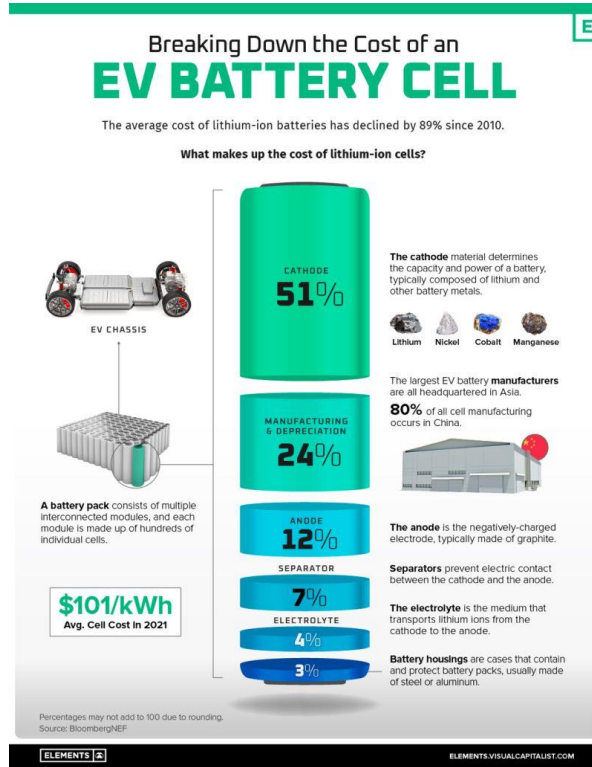
Land Mobility / Transport:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.*

• Buses and coaches:

- **Hexagon Purus to supply hydrogen buses to Poland:** On February 24, 2022, it was reported widely that Hexagon Purus (a leading hydrogen system technology provider) is to supply high-pressure hydrogen systems for use in buses powered and propelled by fuel-cell electrical technology.
 - **Santiago, Chile electrifying:** On February 25, 2022, it was reported widely that by June 2022 Santiago will have 1,775 electric buses running across the city. In addition to electromobility in Santiago, regions of Chile are progressing to electromobility.
 - **MAN moves into electrolyzers:** During the news cycle of this **Edition 36** of Low Carbon Pulse, MAN Energy Solutions (a subsidiary of Volkswagen) [announced](#) plans to move into the market for electrolyzers, investing €500 million to produce polymer electrolyte membrane electrolyzers "as quickly as possible". This may be regarded as a significant development because the application of the manufacturing and fabrication capacity of MAN Energy Solutions will increase significantly the supply of electrolyzers.
- ### • Cars (including taxis):
- **HCE coming:** Since the turn of the calendar year 2022, a number of news items have appeared indicating that progress is being made to develop hydrogen combustion engines (**HCEs**). The author was planning to include a summary of progress in this **Edition 36** of Low Carbon Pulse.
On February 24, 2022, fuelcellworks.com published an article (under [Hydrogen Combustion Engines Are Coming](#)) that provides a useful summary of the current state of play: Cummins Inc, Renault, Toyota and Yamaha have announced progress to develop **Hydrogen Combustion Engines** or **HCEs** (that combust hydrogen to power and to propel vehicles, rather than using fuel-cell technology to derive electrical energy from hydrogen). One can sense the displacement of **petrol head**, with **hydrogen head**.
 - **Wireless charging coming:** On March 4, 2022, it was [reported](#) widely that the Swedish city of Gothenburg is to test wireless charging of taxis, allowing continuous charging of taxis without the need to drivers to spend time recharging.
- ### • Fuel Cell and Battery Technology:
- **First hybrid fuel cell system:** On March 1, 2022, it was reported widely that Acciona and AFC Energy had announced the development of a hybrid hydrogen fuel cell system (**HFC**). The **HFC** will be deployed at a construction site of Acciona so as to decarbonise the site. It is understood that the **HFC** is based in Anion Exchange Membrane technology of AFC Energy, and will allow the use of green methanol.

- **Breakdown of the costs of EV battery cells:** The following infographic is helpful to understand the cost of electrical vehicle battery costs:



- **Industrial Vehicles and Trucks:**

- **Sweden first hydrogen trucks on the way:** On February 23, 2022, it was reported widely that MaserFrakt (leading transport group) had placed orders for two Hyzon HyMax-250 fuel cell trucks, having a range of 680 kilometres. This is continued and further progress for MaserFrakt which already has 750 vehicles in its transport fleet powered and propelled without the use of fossil fuels.
- **Van Kessel Group hydrogen trailers on the way:** On February 23, 2022, it was reported widely that the Van Kessel Group (headquartered in the Netherlands) had ordered five hydrogen trailers from Wystrach GmbH (a subsidiary of Hexagon Purus, a leading hydrogen system technology provider). It is understood that each trailer has capacity to transport 400 kilograms of compressed hydrogen (at 300 bar).
Van Kessel Group will use the hydrogen trailers to deliver hydrogen to sites installed with its Greenpoint Hysolar refuelling infrastructure. In addition to the Greenpoint Hysolar refuelling infrastructure in operation at Nieuwegein, Van Kessel Group is developing refuelling infrastructure at Dordrecht, Ede, and Oude-Tonge.
- **Aberdeen (and UK) first fuel cell waste truck on the way:** On February 25, 2022, it was reported widely that Aberdeen, Scotland, is to procure a waste truck powered and propelled using fuel-cell technology. This procurement is a further step in the forward looking thinking of Aberdeen City Council.

- **Recharging and refuelling infrastructure:**

- **CVX and Iwatani:** On February 24, 2022, it was reported widely that Chevron Corporation and Iwatani Corporation of America have agreed to install hydrogen refuelling infrastructure at 30 locations in California by 2026.
As might be expected, the hydrogen refuelling infrastructure is to be located at existing CVX sites, with hydrogen to be sourced from the CVX refinery at Richmond, California, and from hydrogen production plants to be developed. Iwatani is to operate and to maintain the hydrogen refuelling infrastructure and provide logistics and transportation services.
- **CP90 opens:** On February 28, 2022, Linde Engineering announced that the first CP90 hydrogen refuelling station in the US had opened in Oakland, California. The CP90 hydrogen refuelling station provides up to three times more capacity than existing hydrogen refuelling stations elsewhere in California.
- **Interstate 10 project develops:** On February 28, 2022, [h2-view.com](https://www.h2-view.com) reported that Ameresco (a cleantech integrator and renewable energy asset developer, owner and operator) is to participate in the Guidehouse Clean Hydrogen Economy consortium (which includes Bank of America, Citi Group, Cummins Inc, Linde and Walmart). By participating in the consortium, Ameresco is seeking to advance Green Hydrogen as "a low-carbon, scalable fuel source for the heavy transportation sectors in Los Angeles and Phoenix along the I-10 corridor".
- **New Energies Service Station:** On March 1, 2022, the Australian Renewable Energy Agency (**ARENA**) announced that it is provide funding support for Viva Energy Australia (**VEA**), to allow **VEA** to develop, build and operate a New Energies Service Station (**NESS**) located at a site in Geelong, Victoria.
The **VEA NESS** will provide recharging facilities for **BEVs** and refuelling facilities for **FCEVs** over the road from **VEA's** petroleum refining facilities in Geelong. **VEA** will develop and deploy a 2 MW electrolyser to produce Green Hydrogen for use at the **NESS**.

ARENA is providing funding support to **VEA** to acquire 15 **FCEVs**, which will use the Green Hydrogen produced by **VEA**, thereby providing demand. The **NESS** will be the first of its kind, open to the public as a dedicated heavy goods vehicle recharging and refuelling station for **BEVs** and **FCEVs**.

In addition to demand from **VEA**, Barwon Water, Cleanaway Waste Management Group, ComfortDelGro, Australia, and Toll Group have committed to the purchase of **FCEVs**, including to power and to propel prime movers to transport municipal solid waste and waste water. This innovative approach to the development of supply and demand is significant, providing a model for like developments and deployments elsewhere.

- **Trains:**

Infinity Train: On March 1, 2022, it was reported widely that Dr Andrew Forrest, AO (chair of Fortescue Metals Group) had acquired Williams Advanced Engineering to enable FMG to develop a train power system that will not require any recharging – the so called Infinity Train.

As reported, the train power system will capture energy to recharge batteries on the declines along the route traversed by the trains. FMG has 54 locomotives and 16 train sets.

Ports Progress and Shipping Forecast:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use of carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland.*

Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.

- **Ferries:**

Within the news cycle covered by this **Edition 36** of Low Carbon Pulse, no news items have come to light on Ferries that may be regarded as significant for the purposes of Low Carbon Pulse.

- **Green Ports:**

- **H2 Gate to H2A:** On February 24, 2022, it was reported widely that H2 Gate (comprising Evos, Hydrogenious, Hysilabs, and Electric Global), with the Port of Amsterdam, is committed to the development and deployment of 100% a Green Hydrogen supply / value chain from the Port of Amsterdam. It is understood that the intention is to make use of multiple means of carriage / transportation of hydrogen.

- **By way of reminder:** As reported in **Edition 30** of Low Carbon Pulse, Amsterdam has launched a Hydrogen Hub (**AHH**). The **AHH** involves collaboration by the Port of Amsterdam, Amsterdam Airport, Schiphol, Vattenfall, Liander, NZKG, Gasunie, Oram Nobian and the province of North Holland and the municipalities of Amsterdam and Zaanstad. It is understood that the principal aim of the hub is achieve the large-scale transition of the Amsterdam Area and North Sea Canal Area into a hydrogen economy by 2050 through the import and export of hydrogen.

- **Green Shipping:**

- **FKAB Marine Design approved:** On February 21, 2022, [fuelcellworks.com](https://www.fuelcellworks.com) reported that Swedish ship designer, FKAB Marine Design had received Approval in Principle (**AiP**) for its hydrogen powered and propelled MR Tanker. As reported, this is the first **AiP** of a design using technology that is current and viable, and that achieves IMO 2050 targets. The design combines **CH₄** (present in LNG, and used as fuel) with steam to produce **CO₂** and **H₂**: using gas reforming technology of Helibo, **CH₄** molecules are split into **CO₂** and **H₂**, with the **H₂** used to fuel internal combustion engines and fuel cells using the hybrid marine power and propulsion system technology of ABB. The MR Tanker has been developed jointly by ABB and Helbio (as subsidiary of Metacon AB, a company specialized in development, manufacturing and marketing of Hydrogen and Energy Systems primarily from renewable sources).

- **ABB and Ballard – all aboard:** On February 23, 2022, Ballard Power Systems (at ballard.com, under **Ballard & ABB Approval in Principle for High-Power Fuel Cell Concept to Power Ships**) announced that ABB and Ballard Power System, working together, had received approval in principle (**AiP**) from DNV (leasing classification society, headquartered in Høvik, Norway) for fuel-cell concept developed jointly by ABB and Ballard Power Systems.

The **AiP** is in respect of a fuel-cell concept that is capable of generating 3 MW or 4,000 horse power of electrical energy. For ABB and Ballard Power Systems the **AiP** allows them to proceed to progress the further development of the concept to commercialisation.

Airports and Aviation:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

- **SAF in the knowledge:** **Edition 36** of Low Carbon Pulse was long on news on sustainable / synthetic aviation fuel (**SAF**), a fair amount of the news involving Neste.

On February 23, 2022, [Neste](https://www.neste.com) announced (under [Using waste as a resource to fight climate change](#)) that it was teaming Mahoney Environmental to source used cooking oil from 45,000 restaurants across the US to produce **SAF**. In passing, it is encouraging to understand the scale that is contemplated as being necessary.

Among other things, Neste and Mahoney are working with Dallas Fort Worth International Airport (**DFW IA**) for the purposes of helping **DFW IA** achieve its target of **NZE** by 2030.

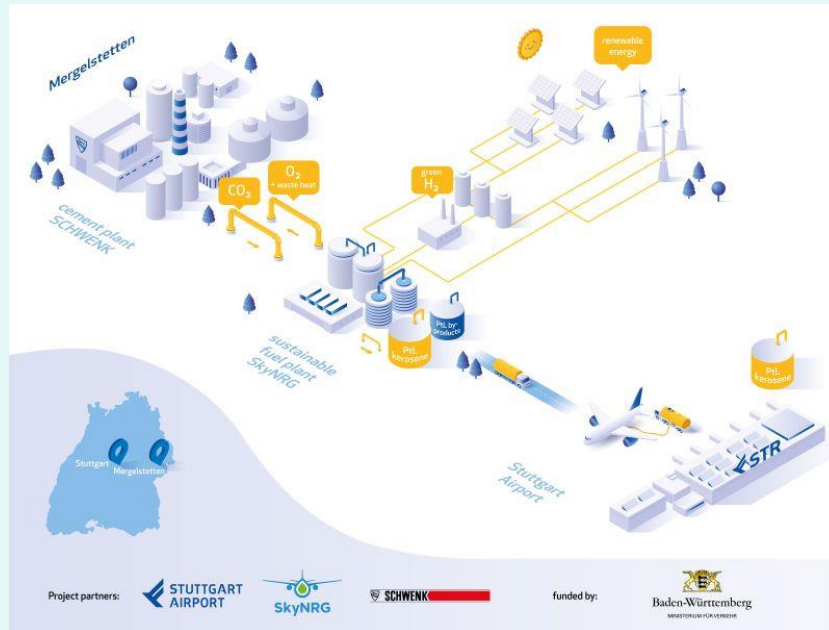
As a reminder, **Edition 35** of Low Carbon Pulse noted in respect of **SAF**:

1. commercial aircraft are not permitted to use **SAF** on its own to propel aircraft (a maximum blend ratio of 50% fossil fuel to 50% **SAF** is permitted);

2. the process to produce **SAF** – there is only one commercially scalable production process – the use of fatty acids and hydrogenated acids as feedstock to produce synthetic paraffinic kerosene. As such, while there are seven approved means of production of **SAF**, only one means is currently commercially scalable; and

3. there is limited available feedstock (i.e., fatty and hydrogenated acids) from which to produce **SAF**. The primary sources of feedstock are animal fats and used cooking oils. As a result, current supply (200,000 metric tonnes of **SAF** annually) is a drop in the ocean of demand for aviation fuel (300 million metric tonnes annually). There is a market for **SAF**, not least because the aviation industry gives rise to around 1 billion metric tonnes of **CO₂-e** each year.

In addition to the reports in **Edition 35** of Low Carbon Pulse on **SAF** on the use of animal fats and used cooking oil, Stuttgart Airport and Schwenk Zement and SkyNRG are progressing with plans to develop synthetic aviation fuel, in the form of synthetic kerosene. The feedstock to produce this **SAF** is **CO₂**, captured from the production of cement, combined with **H₂**. The following infographic provides an overview of the sources of feedstock and the technologies used in the production of synthetic kerosene.



• **Airbus moves to H2 engines:**

- **Edition 35** of Low Carbon Pulse, reported that Airbus Industries may manufacture engines powered by hydrogen. On February 23, 2022, it was reported widely that Airbus Industries and CFM International (a 50/50 joint venture between GE Aviation and Safran Aircraft Engines) are working together to test the use of hydrogen to power engines to propel aircraft.
- **Edition 32** of Low Carbon Pulse reported that Airbus Industries intends to develop a zero-emission hydrogen powered and propelled commercial aircraft by 2035. On February 22 and 23, 2022, it was reported widely that by 2035 Airbus Industries intends to fly a hydrogen-powered and propelled Airbus A380. The announcement that the Airbus A380 was to be the Airbus Industries aircraft resulted in multiple diagrams, the most helpful of which is as follows:



By way of reminder: Airbus Industries announced its thinking around progress to use of hydrogen to power and propel aircraft at the end of Q3 of 2020 ("Zero-e"). The announced thinking was accompanied by an outline of [three hydrogen powered aircraft concepts](#):

1. Turbofan;
2. Turboprop; and
3. Blended-Wing Body (BWB).

- **Update on ZeroAvia schedule: Edition 33** of Low Carbon Pulse reported as follows:

On February 21, 2022, hydrogen-central.com reported (in something of an update), that the first hydrogen powered and propelled flight from Rotterdam to London was expected in 2024. The report impressed on the reader that: "Together with ZeroAvia, Royal Schiphol Group and Rotterdam The Hague Airport are working hard so that the first zero-emission flights with hydrogen can depart from Rotterdam to London in 2024".

- **ANA and JAL commit to SAF:** On March 2, 2022, it was reported widely that All Nippon Airways Co (**ANA**) and Japan Airlines Co (**JAL**), and a further 14 corporations, had established **Act for Sky**. **Act for Sky** has been established to promote production of **SAF** using cooking oil, and other technologies to derive and to produce **SAF** from other sources of waste.
- **TotalEnergies producing SAF:** On March 3, 2022, TotalEnergies [announced](#) that it is producing **SAF** at its biojet fuel production facilities in La Mède (its biorefinery at Bouches-du-Rhône) and at Oudalle (Seine-Maritime). The production of **SAF** by TotalEnergies allows it to match the demand for **SAF** arising from the policy setting in France requiring the use of **SAF** to satisfy at least 1% of demand for aviation fuel.

Low Carbon Pulse - Edition 37 (short-form)

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading LinkedIn later in the week / on the weekend, welcome to the **Friday Short Form Version of Edition 37** of Low Carbon Pulse – sharing significant news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from **Monday March 7, 2022** to **Thursday March 31, 2022**. Click [here](#) to link to the **Long Form Version of Edition 37**, covering each news item in this **Short Form Version** in more detail, and other news items.

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1 to 28**, covering the period from October 6, 2020 to October 5, 2021) and click [here](#) for the **Second Compendium of Low Carbon Pulse** (containing **Editions 29 to 36**, covering October 7, 2021 to March 6, 2022, and containing the **January and February 2022 Report on Reports**).

Ill wind:

The impact of the conflict in Ukraine has resonated globally. In the energy sector, the resonance has been foundation shaking. As a result, energy security and energy transition have aligned, with a clear sighted view on natural gas (in the form of liquified natural gas (**LNG**)) as an energy transition fuel, and the need to accelerate development of renewable energy capacity and hydrogen and hydrogen-based fuel production capacity (the "two legs" of decarbonisation).

An element of this alignment has been the commitment between the European Union (**EU**) and the US on the supply and purchase of **LNG** (agreed on March 25, 2022) to the end of 2022. At a country level, the speed at which Germany has moved to procure floating storage and regasification units (**FSRUs**) to receive **LNG** has been telling, which when combined with the accelerated commitment to achieve decarbonisation of the electrical energy industry by 2035, and the commitment to develop a Green Hydrogen pipeline system across Germany, provides a clear strategy.

Burning platform recognised:

- On **March 24, 2022**, the International Energy Agency (**IEA**) released a [press release](#) outlining outcomes from the **IEA Ministerial Meeting** (a special event dedicated to how to adapt better policy, legal and regulatory frameworks to accelerate deployment of clean energy and low emission technologies);
- On **March 29, 2022**, the International Renewable Energy Agency (**IRENA**) published **World Energy Transitions Outlook (WETO) 2022**, "updating" the **IRENA WETO 2021** (see **Editions 21, 23, and 29** of Low Carbon Pulse), and outlining what needs to be done by 2030 to achieve **NZE** by 2050; and
- On **April 4, 2022**, the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report was published. A standalone **Edition 38** of Low Carbon Pulse will cover the key findings of **WETO 2022** and the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report – effectively, what needs to be done, and by when.

From a thorough read of **WETO 2022** and an early morning read of the **Summary for Policymakers** contained in the 17 Volume **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, these reports are complementary and their findings should be read together. Together they describe what needs to be done, and quickly.

Vale those lost:

Finally, condolences for those lost in the conflict in Ukraine, and safe-haven to those displaced.

Legal, Policy Setting and Regulatory highlights:

- **IEA support for Clean Energy Start-ups:** On **March 14, 2022**, the International Energy Agency (**IEA**) published [How Governments Support Clean Energy Start Ups – Insights from selected approaches around the world](#). The publication is excellent, providing both a summary and a guide.

- **IRENA:**

It has been a busy March 2022 for **IRENA**:

- **Coalition for Action:** On **March 11, 2022**, **IRENA** published [Decarbonising end-use sectors Green Hydrogen Certification](#).
- **Green Hydrogen:** On **March 20, 2022**, **IRENA** published [Green Hydrogen For Industry – A Guide to Policy Making](#) (considered in detail below under **A Guide to Policy Making**);
- **Collaborative Framework:** On **March 24, 2022**, launched the new [Collaborative Framework on Critical Materials For The Energy Transition](#), focusing on the need for cobalt, copper, lithium, nickel and reach earth elements (**REEs**), with the associated publication of [Collaborative Framework on Critical Materials For The Energy Transition](#). The [Collaborative Framework on Critical Materials For The Energy Transition](#), follows like-frameworks from **IRENA** on Hydropower, Ocean Energy / Offshore Renewable Energy, Green Hydrogen, Geopolitics of Energy Transformation, Just and Inclusive Energy Transition and Enhancing Dialogues of High Shares of Renewables in Energy Systems. The [Collaborative Framework on Critical Materials For The Energy Transition](#) will be considered in the **March and April Report on Report**;
- **IRENA Africa Report:** In **March, 2022**, the [Renewable Energy Market Analysis: Africa and its Regions](#) report was published; and
- **WETO 2022:** On **March 29, 2022**, **IRENA** published [World Energy Transitions Outlook: 1.5°C Pathway](#).
- **Australian Federal Court on duty of care: Edition 18** of Low Carbon Pulse reported that the Australian Federal Environment Minister had a duty to take account of the interests of younger generations in considering applications for and grants of approvals for new coal mine projects. **Edition 18** of Low Carbon Pulse reported as follows:

"In Australia, the Federal Court found that the Federal Environment Minister has a legal duty not to cause harm to the young people of Australia [i.e., Australians under the age of 18 years] by exacerbating climate change in the context of approving new or expanded coal mine projects. On the day of judgment, the concept of a legal duty of care was not determinative, but the concept may play a role in future decisions".

On **March 15, 2022** (on appeal from the Minister) the Federal Court of Appeal found that a duty of care was **not** owed (here is a [link](#) to the case).

Whatever the merits of those bringing the action (and the principles of inter-generational equity are sound), it is for the Australian Federal Government, rather than the courts, to develop policy settings and laws and regulations consistent with achieving **NZE**, including to have regard to matters of inter-generational equity.

- **Carbon Border Adjustment Mechanism (CBAM) progresses:** On **March 15, 2022**, the European Council of the European Union reached agreement on the Carbon Border Adjustment Mechanism and issued the draft [Carbon Border Adjustment Mechanism regulation \(CBAM Regulation\)](#) As noted in **Edition 22** of Low Carbon Pulse, **CBAM** is a key element of the **Fit for 55** policy settings announced by the European Commission (**EC**) in July 2021. The **CBAM** is designed to ensure that prescribed products imported into the **EU** (and as such are not subject to the **EU ETS**) have equivalent carbon pricing principles applied to them consistent with the **EU ETS**.

Under **CBAM**, prescribed products (see Annex I of the draft **CBAM Regulation**) from the following industry sectors will be regulated: aluminium, cement, electrical energy, fertiliser, iron and steel. Each of these industry sectors may be regarded as carbon intensive, with products produced across these industry sectors within the **EU** being subject to the policy settings, critically the **EU Emissions Trading Scheme (EU ETS)**.

- **Shell directors focus of Companies Act action:** On **March 15, 2022**, it was [reported](#) widely that thirteen directors of Shell plc are being sued by a shareholder, ClientEarth, on the basis that the directors have not discharged their duty to ensure that the business of Shell is undertaken in a way that promotes the success of the company, and to exercise reasonable care, diligence and skill of this purpose. (The reported basis of the claim suggests that this is an action under ss. 172 and 174 of the UK Companies Act.)
- **Disclosure requirements:** On **March 21, 2022**, the US Securities and Exchange Commission (**SEC**) released proposed climate change disclosure requirements, including required disclosure of climate risks (identification and mitigation) and emissions data. In broad terms, at a principled level, the proposed disclosure requirements are consistent with the **GHG Protocol** (see the [Realizing Reserves and Realising Capital](#) article) and **TCFD** (see **Edition 24** of Low Carbon Pulse). The **SEC** Fact Sheet, [Enhancement and Standardization of Climate-Related Disclosures](#), is an excellent overview of the proposed disclosure requirements over three, punchy, pages.

Climate change reported and explained:

- **More carbon in 2021 than ever before:** On **March 8, 2022**, the **IEA** released [Global Energy Review: CO₂ Emissions in 2021](#) (the **CO₂ 2021 Report**). The headlines arising from the **CO₂ 2021 Report** are that 15.3 billion metric tonnes of **CO₂** emissions arose from the use of coal and over 7.5 billion tonnes arose from the use of natural gas.
- **Energy Transitions Commission conclusions:** On **March 9, 2022**, the Energy Transitions Commission (**ETC**) published [Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive \(ETC Report\)](#).

The headline arising from the **ETC Report** is that to ensure that the average increase in global temperatures does not exceed **1.5°C** above pre-industrial times, **165 giga-tonnes** of **CO₂** will have to be removed from the atmosphere by 2050, and as a consequence of this finding, much deeper thinking is required around carbon credits and carbon off-sets and trading.

Middle East including GCC Countries

- **BEEAH Energy and Chinook Sciences busy:** On **March 7, 2022**, fuelcellworks.com reported that BEEAH Group (leading sustainability corporation) and Chinook Sciences (UK based technology corporation) had signed an agreement to produce "clean to green" hydrogen to provide hydrogen to power and to propel over 300 trucks and buses a day. The hydrogen is to be produced from waste at a waste-to-hydrogen facility, producing high-quality activated carbon as well as "clean to green" hydrogen. BEEAH Group will supply the non-recyclable waste streams (predominantly plastics and wood), and will process those waste streams using Chinook Sciences' gasification technology.
- **Busy day in paradise:** On **March 7, 2022**, it was reported widely that Acme Group (Indian renewable energy company) and Scatec (Norway based renewable power producer) are to develop a Green Ammonia production facility in Oman. The Green Ammonia production facility is world scale, with nameplate Green Ammonia production capacity of 1.2 million metric tonnes a year on completion of planned development and deployment.
- **DEWA Aquifer Storage and Recovery:** On **March 14, 2022**, Dubai Electricity and Water Authority (**DEWA**) announced that it had completed construction of the first stage of its Aquifer Storage and Recovery (**ASR**) project. While the thinking behind the **DEWA ASR** project focuses on it as a strategic reserve of water, it appears possible that **ASR** technology will be applied to store water as feedstock for Green Hydrogen production in due course.
- **UAE and Germany:**
 - **Working Group:** On **March 15, 2022**, it was reported widely that the **UAE** and Germany Working Group met in Dubai, **UAE**, to discuss future cooperation. (See **Edition 30** of Low Carbon Pulse in respect of the establishment of the Working Group.)
 - **UAE and Germany working all week:** The week-beginning **March 21, 2022**, saw considerable activity between the **UAE** and Germany, including on **March 22, 2022**, the [announcement](#) from ADNOC that it had signed a memorandum of understanding with the German Federal Minister for Economic Affairs and Climate Action, Dr Robert Habeck, with ADNOC and Germany to undertake studies jointly to strengthen the collaboration to develop clean hydrogen capacity, including work around hydrogen logistics and pilot cargoes, in addition to studies to be undertaken jointly on difficult to decarbonise sectors, including considering new uses of clean hydrogen.
- **NEOM progress continues:**
 - **Helios Green Light:** On **March 17, 2022**, it was reported widely that the USD 5 billion Helios Green Hydrogen production project (part of the development of the Neom project) is to commence construction. The Helios project is to be powered by 4 GW of renewable electrical energy. The Helios project is to deploy 120 electrolyzers supplied by thyssenkrupp AG. The commencement of construction is a landmark.
 - **ENOWA Green Utility:** On **March 21, 2022**, NEOM [announced](#) the launch of **ENOWA** which will lead the development and deployment of NEOM's world class sustainable energy and water systems, including [The Line](#), [OXAGON](#) (see **Editions 31** and **35** of Low Carbon Pulse) and [Trojena](#), and of course as a shareholder in the joint venture with Air Products to develop the Helios Green Hydrogen production project.
- **Masdar releases Sustainability Report:** On **March 22, 2022**, Masdar (the Abu Dhabi Future Energy Company) released its [ninth sustainability report](#). The Masdar Sustainability Report has become a reference work. The key headline from the Masdar Sustainability Report is that Masdar intends to accelerate 100 GW of installed renewable energy capacity, and then double that capacity again, to 200 GW.
- **UAE and the Netherlands sign MOU:** On **March 22, 2022**, hydrogen-central.com (under **UAE Could Be One Of The Biggest Suppliers of Hydrogen to Europe**) reported that the **UAE** and the Netherlands had signed a memorandum of understanding to work together to develop export-import corridors for clean hydrogen, between the **UAE** and the Netherlands as the gateway to Europe.

Africa:

- **Alignment in Egypt:**
 - On **March 10, 2022**, it was reported widely that Scatec (leading Norwegian renewable electrical energy corporation) had signed a memorandum of understanding (**MOU**) with the Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority. It is understood that the **MOU** provides for the development jointly of a 1 million metric tonnes per annum Green Ammonia production facility (with potential to expand to 3 million metric tonnes annually).
 - On **March 28, 2022**, it was reported widely that A.P. Moller – Maersk had entered into a memorandum of understanding (**MOU**) signed by the Prime Minister of Egypt, [Mr. Mostafa Madbouly](#), under which A.P. Moller will work with Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority to develop green energy and green fuel production capacity.
- **Renewable Energy Market Analysis:** As noted above, in March, 2022, the **IRENA Africa Report** was published. In addition to the **IRENA Africa Report**, at woodmac.com, Wood Mackenzie released a paper, [Utility 3.0: How Africa is remaking the grid](#). This will be considered in detail along with the **IRENA Africa Report** in the **March and April Report on Reports**, to be contained in the Appendix to the Second Compendium of Low Carbon Pulse.

India and Indonesia

- **Feasibility Study to decarbonise maritime industry:** On **March 10, 2022**, h2-view.com reported (under [Indonesian maritime industry to be decarbonised with hydrogen](#)) that the Asian Development Bank (**ADB**) supported by Longitude Engineering, is to undertake a feasibility study, jointly, with PT Pertamina. The purpose of undertaking the feasibility study is stated to be to develop a road map for the integration of low carbon fuels into the domestic shipping industry, with hydrogen (and hydrogen-based fuels), being key for these purposes.
- **India 50 GW of solar:** On **March 15, 2022**, pv-magazine-australia.com reported that to December 31, 2021, India had installed 50 GW of photovoltaic electrical energy capacity (40.4 GW utility scale, and 8.57 GW roof-top), having added 3.17 GW of installed capacity during Q4 of 2021, of which 2.5 GW was utility-scale and 520 MW roof-top.

- **ArcelorMittal and Greenko co-develop 975 MW:** On **March 22, 2022**, the [economic times.com](https://www.economic-times.com) reported (under *ArcelorMittal joins hands with Greenko for renewable energy projects*) that ArcelorMittal and Greenko had agreed to co-develop 975 MW of photovoltaic solar and wind renewable energy capacity as part of the progress being made by ArcelorMittal to decarbonise the production of iron and steel.
- **KPMG takes the pulse:** On **March 25, 2022**, KPMG India launched its *India Decarbonisation Hub*. To accompany the launch of the Indian Decarbonisation Hub, KPMG published *India's green hydrogen ambition - setting the wheels in motion*, which provides a helpful overview of the current state of play, and the road ahead.
- **USD 1.2 billion Green Hydrogen Project in Indonesia:** On **March 25, 2022**, it was reported widely that Hyundai and Samsung are to join with Global Green Growth Institute (**GGGI**) to develop a Green Hydrogen Project in Indonesia. It is understood that the intention is to derive renewable electrical energy from geothermal energy sources, with the Green Hydrogen to be supplied to the Sei Mangkei Industrial Zone, Sumatra, with the Green Hydrogen to be used to decarbonise industrial activities, including the difficult to decarbonise cement and iron and steel industry sectors. Further, it is understood that the Green Hydrogen Project will use Green Hydrogen to produce Green Ammonia, with the Green Ammonia to be exported, including to **ROK**, with Hyundai to provide the shipping for export, and KOGAS to import the Green Ammonia. Samsung Engineering will undertake the design and viability study for the project.
- **PT Pertamina investments plans:** On **March 25, 2022**, [energyvoice.com](https://www.energyvoice.com) reported that PT Pertamina plans to invest up to USD 11 billion on renewable energy projects over the period 2022 to 2026 so as to continue progress in energy transition.
- **India Hydrogen Alliance – March 2022:** Attached is the link to the March edition of *India H2 Monitor – March 2022*. As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the content of the *India H2 Monitor*.

Japan and Republic of Korea (ROK)

- **Japan's 11th solar auction:** On **March 9, 2022**, the **Green Investment Promotion Organisation** in Japan released the [results](#) (please see the original results in Japanese [here](#)) of the 11th solar auction for projects with an electrical energy dispatch rating of greater than 250KW. The outcome of the 11th solar auction is significant because the average bid was below ¥10 per kW/h for the first time, and as such the lowest in any preceding auction.
- **Japan to accelerate off-shore wind field development:** On **March 18, 2022**, it was reported widely that the Minister of Economy, Trade and Industry of Japan, Mr Kōichi Hagiuda, had announced that Japan will accelerate the development of off-shore wind field capacity.
- **POSCO in South America:** On **March 21, 2022**, [mining.com](https://www.mining.com) reported that POSCO (leading iron and steel producer head-quartered in **ROK**) is to invest USD 4 billion in a new lithium mining project in Argentina. The mining project is understood to be located on a salt flat, Salar del Hombre Muerto, which is located on the border between provinces of Catamarca and northern Salta. It is understood that production of 100,000 tonnes a year of lithium hydroxide is expected on completion of the development of the mine.

PRC and Russia

- **Sinopec continues progress on hydrogen:** On **March 17, 2022**, it was reported widely that Sinopec (one of the Big Three **PRC** NOCs) is to increase its investment in the development and deployment of Green Hydrogen facilities so as to develop 500,000 metric tonnes of Green Hydrogen in annual production capacity by 2025. As reported previously in Low Carbon Pulse, Sinopec intends to have deployed hydrogen refuelling infrastructure in 1,000 locations by 2025, which will have refuelling capacity of 200,000 metric tonnes a year.
- **PRC continues progress on hydrogen:** On **March 23, 2022**, [h2-view.com](https://www.h2-view.com) reported on the plans of the **PRC** for the development of hydrogen production capacity with the National Development and Reform Commission (**NDRC**) and the National Energy Administration (**NEA**) providing a roadmap to 2025, 2030 and to 2035. In the near term, the plan is to develop hydrogen production capacity so as to produce 200,000 metric tonnes of clean hydrogen by 2025. This sits well inside the aspirations of Sinopec to have developed 500,000 metric tonnes of Green Hydrogen production capacity by 2025. In the medium term (by 2030), the plan is to have developed a hydrogen production industry configured to produce clean hydrogen using integrated hydrogen technologies so as to maximise the reduction in **GHG** emissions arising from production, transportation, storage and use of hydrogen. In the near to medium term, the focus appears to be the decarbonisation of the mobility industry. In the medium to longer term (by 2035), the plan is to have developed hydrogen production capacity so as to support the decarbonisation of the difficult to decarbonise industries.

Europe and UK

- **Clearing Round in ScotWind:** On **March 7, 2022**, Crown Estate Scotland (**CES**) [indicated](#) that it will undertake a **Clearing Round** under which further lease areas will be auctioned, specifically lease area NE1 east off Shetland. It is understood that bidders in the *ScotWind Leasing Scheme* (see **Edition 33** of Low Carbon Pulse) process that were not successful (but scored highly applying assessment criteria) will be eligible to bid in the **Clearing Round**. It is understood that **CES** will outline its plans for a **Clearing Round** during **April 2022** (which will be covered in **Edition 39** of Low Carbon Pulse).
- **EU to accelerate decarbonisation initiatives:** **EC plans clear and hard:** On **March 8, 2022**, the European Commission (**EC**) outlined its plans to accelerate the development of renewable electrical energy capacity across the **EU**, and to increase fourfold the Green Hydrogen production capacity by 2030 (**REPowerEU**, including a **Hydrogen Accelerator**). In short, there are two legs to **RePowerEU**, first, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and, second, the dash to accelerate renewable electrical energy deployment.

Notably, Mr Timmermans included nuclear reactor electrical energy power generation in the thinking. The attached [link](#) links to the detail of **REPowerEU**. The **REPowerEU**, is consistent with (some may say follows) the progress that has been made in recent times in **EU** countries, in particular in northern Europe.

On **March 3, 2022**, the **IEA** published [A 10 Point Plan to Reduce EU Reliance on Russian Natural Gas](#). The first five points in the plan (dealing with macro issues) are entirely consistent with **REPowerEU**.

- **LNG receiving terminals as part of energy transition:**

- **Edition 36** of Low Carbon Pulse reported on the re-enlivening plans in Germany (under **LNG Terminals progressing**) to develop two LNG receiving terminals at Wilhelmshaven (Uniper) and at Brunsbüttel (Gasunie and Kreditanstalt für Wiederaufbau (**KfW**)) so as to ensure diversified sources of natural gas imported as **LNG**.

On **March 8, 2022**, it was reported widely that Enel, giant Italian utility, is to revisit plans to develop an **LNG** receiving terminal south of Rome, to allow it to source natural gas from diversified sources.

- **Continued progress in the development of LNG receiving terminals:**

- On **March 23, 2022**, Germany agreed a long-term contract with Qatar to take **LNG**.
- On **March 23, 2022**, **German LNG Terminal announced** that it had signed a memorandum of understanding under which it will contract long-term for capacity in the Brunsbüttel LNG receiving terminal project, having 165,000 m³ of storage capacity and two berths capable of accommodating Q-Max (266,000 m³) **LNG** carriers.
- On **March 25, 2022**, the German Federal Minister for Economic Affairs and Climate Action, Mr Robert Habeck announced that the German Federal Government had promoted securing three floating storage and regasification units (**FSRUs**) for use by RWE and Uniper.

- **Cluster sequencing Phase 2:** On **March 22, 2022**, the UK Department for Business, Energy & Industrial Sector issued a [notice](#) (entitled **Cluster sequencing Phase-2: eligible projects (power CCUS, hydrogen and ICC)** detailing the projects that had satisfied the eligibility criteria (outlined in [Phase-2 guidance](#)) for **Phase-2** progress.

The following table identifies the projects that have satisfied the eligibility criteria for **Phase-2**:

CO2 CLUSTER	POWER CCS	HYDROGEN	INDUSTRIAL CARBON CAPTURE
East Coast Cluster:	VPI Humber Zero; Whitetail Clean Energy; Net Zero Teesside Power; Alfanar CCGT Teesside; Keadby 3 CC Power Station and C.Gen Killingholme	N2NorthEast; Uniper Humber Hub Blue Project; bpH2 Teesside and Hydrogen to Humber (H2H) Saltend	STV 1,2 and 3 Energy from Waste CC projects; Tees Valley Energy Recovery Facility Project; Altalto Immingham waste to jet fuel project; Lighthouse Green Fuels; Redcar Energy Centre; Humber Zero Refinery; Prax Lindsey Refinery; ZerCal250; Teesside Hydrogen CC; Saint-Gobain Glass CC; Norsea CC; CF Fertilisers Billingham Ammonia CCS; Teesside Green Energy Park, and North Lincolnshire Green Energy Park
HyNet Northwest	Making Net Zero Possible – Grain	Project Cavendish & HyNet Hydrogen Production Project	Viridor Runcorn Industrial CCS; Protos Biofuels and Energy Recovery; Hanson Padeswood Cement CCS; CF Fertilisers Ince CC Plant; Buxton Lime Net Zero; EssarOil UK CCU; and Emerge CCS
Scottish Cluster	Peterhead Carbon Capture Power Station	Acorn Hydrogen & Fife Hydrogen Hub	CO2 Extraction form St Fergus Gas and SAGE Terminal and Acorn Capture

- **UK ETS Development Review:** On a busy week for the UK Department for Business, Energy & Industrial Sector, on **March 25, 2022**, it announced an [Open consultation - Developing the UK Emissions Trading Scheme \(UK ETS\)](#), with the link taking the reader to the document outlining the matters under consideration. The open consultation process closes at 11.45 pm on June 17, 2022.

- **All is well in the Kingdom of Denmark:**

- **Denmark Power-to-X:** In Denmark, the concept of **Power-to-X** is well-established, and becoming part of the framework for progress towards the achievement of **NZE**. In December 2021, the Danish Government launched a strategy to develop **Power-to-X** (see **December and January Report on Reports** in the [Second Compendium of Low Carbon Pulse](#)).

In this context, the Danish Government has earmarked funding support for the development of **Power-to-X** capacity development, critically the development of electrolyser capacity, with the policy setting target being the development and deployment of between 4 GW and 6 GW of production capacity.

- **Principal objectives:** There are four objectives to the promotion and development of **Power-to-X** capacity in Denmark, as follows: **1. Power-to-X** must contribute to achieving the objectives in the Danish Climate Act; **2.** It is necessary to develop the framework and infrastructure for the **Power-to-X** sector to develop; **3.** It is necessary to improve the interface between the current energy system and the **Power-to-X** sector; and **4.** Denmark must be able to export **Power-to-X** products and technologies.

Americas:

- **Stitching together renewable energy seams:** On **March 8, 2022**, [cleantechnica.com](#) published an article authored by Ms Tina Casey. The article is well-worth a read, both for the outline of plans and for the optimism that the plans engender. The article notes that the US' massive off-shore wind resources are "finally in the pipeline" (see **Editions 2, 7, 8, 20, 21, 26**, and **30** of Low Carbon Pulse) and the "land-based renewable energy profile is about to get a shot of adrenaline".

The "shot of adrenaline" is sourced from plans of two leading transmission system operators (the **Midcontinent Independent Power System Operator** or **MISO** and the **South West Power Pool** or **SPP**) "to stitch together" their systems, and in doing so "opening a bottleneck that has held back wind and solar developers for years".

The thinking (which is continuing to develop) is based on the [Interconnections Seam Study](#), with the core idea being the efficiency benefits of uniting the Eastern and Western US transmission systems. After further work by **MISO** and **SPP**, seven projects have been identified (having a combined cost of USD 1.65 billion) in a **Joint Interconnection Queue Study (JIQS)** that contemplates the stitching together of both systems.

• **Hubbub among the States:**

- **Edition 35** of Low Carbon Pulse reported that the US **DOE** had "gone-live" on the implementation of the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**. Going live involves rolling-out the initiatives in the **IIAJA**. The largest hydrogen program in the **IIAJA** provides the US **DOE** with USD 8 billion to provide support for **at least four hydrogen hubs** that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.
- **Edition 36** of Low Carbon Pulse reported (under **Mountain States Hub**) that **Colorado, New Mexico, Utah** and **Wyoming** had signed a memorandum of understanding to develop a regional clean Hydrogen Hub, and in so doing, position more effectively to seek funding from the **Infrastructure Investment and Jobs Act (IIAJA)**.
- **Mississippi States Hub: Arkansas, Louisiana and Oklahoma** are reported to be progressing with a like initiative to create a bipartisan three-state bloc to develop a **regional clean Hydrogen Hub**.
- **West Virginia gets in first:** On **March 22, 2022**, it was reported widely that the State of West Virginia, through the **West Virginia Hydrogen Hub Coalition** had submitted a proposal to the US **DOE** seeking funding to develop a hydrogen hub in the State.
- **Northeast Hydrogen Hub:** On **March 24, 2022**, the Governor of New York State, Ms Kathy Hochul indicated that New York, together with Connecticut, Massachusetts and New Jersey, and 40 hydrogen ecosystem partners, were combining for the purposes of seeking to become one of at least four regional clean hydrogen energy hubs.

For the **Mountain States Hub, Mississippi States Hub, West Virginia Hydrogen Hub** and **Northeast States Hub**, the development of a Hydrogen Hub represents an opportunity to take advantage of their natural advantages.

- **Canada Climate Change Report:** On **March 23, 2022**, Canada's [Changing Climate Report in Light of Latest Global Science Assessment \(Climate Change Report or CCR\)](#) was published. The **CCR** is a supplement to Canada's 2019 Changing Climate Report, updating the earlier report to take into account the findings of the [IPCC Working Group I Climate Change 2021: The Physical Science Basis](#).

France and Germany:

- **Germany earmarks €200 billion by 2026:** On **March 7, 2022**, the German Finance Minister, Mr Christian Linder, [announced](#) plans to provide funding to enable German industry to accelerate progress towards **NZE**, including funding to accelerate the development of hydrogen technology and to allow the build-out of battery electric vehicle (**BEV**) recharging infrastructure.
- **French State Support for Normand'Hy:**
 - **Funding support on time:** On **March 8, 2022**, it was reported widely (and announced by Air Liquide) that it had received funding support from the French Government. As noted below (under **France promotes 15 major H2 projects**), Normand'Hy is one of 15 projects in respect of which [Important Project of Common European Interest](#) is sought.
 - **Edition 29** of Low Carbon Pulse reported as follows (under **The road to Normand'Hy**):
"On October 20, 2021, Air Liquide increased its stake in H2V Normandy, renaming it **Air Liquide Normand'Hy**, so as to accelerate the 200 MW Green Hydrogen production facility at Port-Jerome, using a proton-exchange membrane (**PEM**) electrolyser. The Green Hydrogen production facility is located within the Normandy carbon cluster / industrial basin, with Air Liquide intending to supply Green Hydrogen to industrial customers and to the mobility / transport sector. The Green Hydrogen production facility will connect to Air Liquide's existing hydrogen pipeline network in Normandy."
It will be noted that a final investment decision of Air Liquide was dependent on the provision of funding support.
- **France promotes 15 major H2 projects:**
 - On **March 9, 2022**, the French Government announced a list of 15 major hydrogen projects to submit to the **EC** each to be designated as an [Important Project of Common European Interest \(IPCEI\)](#).
The map below provides detail of the location of each of the 15 projects. The 15 projects will require €7 billion in investment in the medium term, including €2 billion in funding support.
 - The **15 projects** may be **grouped into three categories**:
 - **Giga-factory developments for electrolysers:** Elogen, Genvia, John Cockerill and McPhy;
 - **Manufacture for mobility:** fuel cells (Alstom, HYVIA and Symbio), tanks (Faurecia and Plastic Omnium) and key components (Arkema); and
 - **Hydrogen production capacity:** Air Liquide's Normand'Hy project (see above) and the Dunkirk iron and steel project (see **Edition 34** of Low Carbon Pulse), Hynovi (Hynamics and VICAT) and Masshylia (Engie and TotalEnergies).
- **Germany and Norway aligned:** On **March 17, 2022**, it was reported widely that Germany and Norway had discussed the feasibility of the transportation of hydrogen produced in Norway, via pipeline, for delivery to Germany. It is understood that the use of Blue Hydrogen (near to medium term) and Green Hydrogen (medium to long term) is being considered.
- **RWE and OGE plan hydrogen backbone:** On **March 24, 2022**, it was reported widely that RWE (the German renewables electrical energy giant) and OGE (a German TSO) had outlined their plans to roll-out hydrogen

infrastructure to produce and transport hydrogen, including a 1 GW electrolyser and a 1,500 kilometre, hydrogen pipeline system (the *Hercules Project*).

Australia:

- **ACCUs and Emission Reduction Fund:** On **March 4, 2022**, Australian Federal Minister for Industry, Energy and Emissions Reduction, Mr Angus Taylor, announced that Australian Carbon Capture Units (**ACCUs**) could be sold to buyers of carbon credits seeking to deliver on voluntarily assumed commitments to achieve carbon neutrality (the **proposed change**).

During the week beginning **March 7, 2022**, the implications of the decision of the Australian Federal Energy Minister, Mr Angus Taylor became apparent, and for the balance of the month there was (and no doubt for some time to come, there will be) an increasing focus on the decision of Mr Taylor, and the legislative basis for the grant of **ACCUs**.

Unsurprisingly, the **proposed change** impacted the price of **ACCUs**. What has been surprising is the accompanying narrative, in particular from Professor Andrew Macintosh (chair of the Integrity Committee of the Emissions Reduction Fund for six years):

"The available data suggests that 70 to 80% of the ACCUs issued to these projects [i.e., under the Emissions Reduction Fund] are devoid of integrity – they do not represent real and additional abatement".

As might be expected, a number of industry participants and experts have suggested that the Federal Australian Government reconsiders the **proposed change**, including as part of a wider review.

- **NSW Ahead of the curve:** On **March 24, 2022**, it was reported widely that the Government of New South Wales (**NSW**) has announced an expression of interest process under which interested private sector parties could register interest to develop a standby 700 MW / 1,400 MWh Waratah Super Battery (a **Very Big BESS**).

The **Very Big BESS** is to be located on the Central Coast region of NSW and is critical to the maintenance of integrity and stability of electrical energy supply in response to the announcement by Origin Energy of its intention to shutter the 2,880 MW Eraring Coal-fired Power Station in August 2025 (see **Edition 35** of Low Carbon Pulse).

- **Eastern Sea-board States – Nation Building (again):** On **March 25, 2025**, it was reported widely that the Governments of the Australian States of New South Wales, Queensland and Victoria are to develop the **East Coast Hydrogen Refuelling Network**.

The timing and the thinking behind the **East Coast Hydrogen Refuelling Network** is clear for all to see, but it is not often that Governments take a lead that works at so many levels, critically to allow the development of supply to satisfy domestic demand that will be encouraged by the development of the Network.

Blue and Green Carbon Initiatives and Biodiversity

- **Blue Carbon, Sindh Province, Pakistan:** On **March 10, 2022**, Respira International [announced](#) that it had purchased some of the first tranche of carbon credits (Delta Blue Carbon Project (DBC-1)), together with Carbon Growth Partners and Trafigura. The source of the carbon credits are the world's largest mangrove swamp restoration project, and as such a leading Blue Carbon project: it is understood that the Delta Blue Carbon Project is restoring more than 73,000 hectares of degraded mangrove swamps and tidal wetlands.
- **Bioplastic whitepaper:** On **March 15, 2022**, Carbone and TotalEnergies published [Sustainable sourcing of feedstocks for bioplastics](#) – Clarifying sustainability aspects around feedstock use for the production of bioplastics. For those interested in plastics generally, and bioplastics in particular, the publication is excellent.
- **Blueprint For Nature:** From **March 14 to March 29, 2022**, the **Open-ended Working Group on the Post-2020 Global Biodiversity Framework** met in Geneva, Switzerland. The purpose of the meeting was to advance work on the development of the **Global Diversity Framework**, with the purposes of the **Global Diversity Framework** to address the loss of habitat and resulting loss of biodiversity.

As noted in **Editions 33** and **34** of Low Carbon Pulse, later in 2022, the second part of **COP 15** will take place in the **PRC**. During the first part of **COP-15** the [Kunming Declaration](#) was adopted, addressing bio-diversity loss.

As might be expected, the **Open-ended Working Group** was accompanied by multiple narratives – for example, Wetland International continued to emphasise the importance of wetlands (covering 7% of land mass, and home to 40% of the world's diversity). On **March 23, 2022**, Wetland International published an [article](#) on the key issues for wetlands in the context of the development of the **Global Diversity Framework**.

On **March 29, 2022**, a [press release](#) was published, noting progress around targets and supporting mechanisms. It is clear however that a good deal of work needs to be done ahead of, and at, the second part of **COP 15**.

Bioenergy and heat-recovery

- **Biogas and Biomethane:** As noted above, there are two legs to the **RePowerEU** policy settings, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquefied natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and the dash into renewables.

The role that biogas and biomethane has to play is likely to increase, and to do so dramatically in the near to medium term as renewable sources of feedstock are sought and used to derive or to produce biogas / biomethane as part of the means of assuring near to medium term energy security in the **EU**. By some estimates, by 2030 up to 35 billion m³ of biogas / biomethane may be derived or produced, and by 2050 up to 100 billion m³.

- **Fortum and Microsoft – world first:** On **March 17, 2022**, Fortum [announced](#) that it had entered into a unique project with Microsoft, with Fortum (Finnish state-owned utility company) to capture excess heat generated by a new data centre region to be built by Microsoft in Helsinki, Finland. The data centres will use electrical energy from renewable sources, and the clean heat arising from the data centres will be used to heat premises that are connected to the Fortum district heating system. The location for the data centres was chosen to allow the capture of clean heat, and its use in the district heating system.

BESS and HESS (and energy storage)

- **RWE develops HESS:** On **March 7, 2022**, it was reported widely that RWE (the German electrical energy giant), through RWE Gas Storage West, plans to develop a **HESS** at Kottiger Hook in Gronau, Germany by 2027. The **HESS** will use an underground salt cavern, with connection to above ground dispatch storage.
- **AGL Energy gets green light for green project:** On **March 8, 2022**, it was reported widely that AGL Energy (one of the three large integrated energy corporations in Australia), had been given approval to develop and to deploy a 500 MW / 2000 MWh **BESS** at the site of the Liddell coal-fired power station in the Hunter Valley, New South Wales (the Liddell coal-fired power station to be shuttered completely by 2023, with shut-down of units having commenced).
- **Quidet Energy:** On **March 9, 2022**, [cleantechnica.com](https://www.cleantechnica.com) reported (under [High Pressure Water Energy Storage Coming to San Antonio](#)) that it intends to develop a Geothermal Pumped Storage (**GPS**) facility in San Antonio, Texas, having signed a 15 year agreement with **CPS Energy** (the municipal electric utility serving the city of San Antonio).
- **CIP and Alcemi make gold:** On **March 15, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) and Alcemi had combined to develop 4 GW of **BESS** across the UK. It has been reported that **CIP** will lead procurement and development activities, with the first **BESS** to be energised in 2023.
- **EDF Pivot Power BESS:** On **March 22, 2022**, it was reported widely that Pivot Power (a subsidiary of EDF) has been granted approval to develop and to deploy two **BESSs** (each of 50 MW / 100 MWh) in the UK – one at Sundon, Luton (to go live in 2023), and the other at Indian Queens, Cornwall (to go live in 2024).

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR

- **CCS Databases:**
 - During the **week beginning March 14, 2022**, the author of Low Carbon Pulse came across the US **DOE** National Renewable Energy Laboratory (**NREL**) **Carbon Capture and Storage Database**. The **NREL Carbon Capture and Storage Database** has been developed from publicly available information globally, and includes details of the evaluation of sites for **CO₂** storage, estimated project development and operation costs, mass of **CO₂** captured / stored and the technologies deployed.
 - On **March 24, 2022**, [CO₂ Value](#) launched a [New CCU Project Database](#). The New CCU Project Database is available publicly (hence the link), and provides a reference for CCS / CCUS projects across Europe.
 - On **March 24, 2022**, the [Clean Air Task Force](#) launched its **Carbon Management Tracker**, mapping carbon capture projects in the Middle East and North Africa.
- **First BECCS:** On **March 22, 2022**, [Bellona.org](#) reported (under **Oslo leading by example: world's first CO₂ capture and storage on waste incinerator to become reality in 2026**) that the Klemetsrud **CO₂** capture and storage project will be the world's first waste-to-energy plant with full scale CCS (BECCS depending on one's view). The Bellona Foundation is working with City of Oslo and Fortum Oslo Varme for seven years to realise this outcome.
- **Pulling up DACs to capture CO₂:** On **March 23, 2022**, Occidental Petroleum Corp announced that it intends to develop and to deploy up to 70 carbon capture facilities globally by 2035, with each CC facility to capture as much as 1 million metric tonnes of **CO₂** directly from the atmosphere (and otherwise from the climate system).

Carbon Credits and Hydrogen Markets and Trading

- **CIX partners with Carbonplace:** On **March 25, 2022**, The [Business Times.com](#) reported that CIX had partnered with Carbonplace (a carbon credit settlement platform, developed by seven banks - BNP Paribas, CIBC, Itau Unibanco, National Australia Bank, NatWest Group, Standard Chartered and UBS). The purpose of the partnership is to lower the cost of entry to corporations seeking to acquire high-quality carbon credits in the voluntary carbon market which CIX is to facilitate.
- **MENA Voluntary Carbon Markets:**
 - On **March 25, 2022**, Ms Riham ElGizy reported (on LinkedIn) that it had been a Big Day for the MENA regional Voluntary Carbon Market (**VCM**), with the announcement of the first five potential partners in the market, Aramco, Saudi Airlines, ACWA Power, Maaden and ENOWA. Low Carbon Pulse will follow the development of the market.
 - On **March 24, 2022**, the PIF announced that the **VCM** will provide the means to connect corporations and institutions (and investors) with a supply of quality carbon credits, so as to allow those corporations and institutions to achieve progress to carbon neutrality ahead of achieving **NZE**, providing the following graphic.
 - On **March 29, 2022**, the Abu Dhabi Global Market (the UAE's financial free zone) [announced](#) that it was partnering with AirCarbon Exchange to create the "world's first fully integrated" carbon trading exchange and clearing house.
- **Mandatory Markets as a contrast:** On **March 30, 2022**, the **ICAP Status Report 2022** was [published](#), with the headlines being that there 25 emissions trading schemes globally, covering 17% of global **GHG** emissions (9 Gt of **CO₂-e**). The **ICAP Status Report** is well-worth a read, and provides a helpful contrast the developing momentum in respect of the Voluntary Carbon Markets, and the development of trading platforms to market carbon credits.

E-fuels & feedstocks / Future Fuels & Feedstocks / Now Fuels & Feedstocks

- **AP Moller – Maersk and Ørsted aligned:**
 - **Edition 26** of Low Carbon Pulse reported on the decision of A.P. Moller - Maersk to order eight dual fuel container vessels (with an option for a further four), capable of being powered and propelled by methanol. In reporting on this decision it was noted that A.P. Moller – Maersk was aware of the need to continue to procure supplies of methanol. As noted in editions of Low Carbon Pulse then and since, one of the key risks for A.P. Moller - Maersk in procuring dual fuel container ships was the supply of sufficient clean or low carbon methanol.
 - **Methanol supply:**
 - On **March 10, 2022**, Ørsted announced that it had signed a letter of intent with A.P. Moller - Maersk to develop a Power-to-X-facility on the US Gulf Coast to produce e-methanol to fuel A.P. Moller -Maersk's dual

fuel container vessels. The Power-to-X-facility contemplated will be world scale – a 675 MW Power-to-X-facility able to produce 300,000 metric tonnes of e-methanol a year. The Power-to-X-facility will be powered by 1.2 GW of renewable electrical energy from off-shore wind fields and photovoltaic solar farms to be developed by Ørsted.

- On **March 10, 2022**, Proman [announced](#) that it had signed a cooperation agreement under which, among other things, Proman will aim to supply A.P. Moller - Maersk with between 150,000 to 200,000 metric tonnes of bio-methanol from its 200,000 metric tonne a year facility. (Proman has an existing methanol facility in Pampa, Texas.)
- On **March 10, 2022**, A.P. Moller - Maersk [announced](#) (by way of something of a summary) that it had entered into six strategic partnerships globally to scale Green Methanol production by 2025, with partners CIMIC, ENRIC, European Energy (see below), Green Technology Bank, Ørsted (see above), Proman (see above) and WasteFuel (see [Edition 32](#) of Low Carbon Pulse).

• **Petronas and ENEOS making progress:** On **March 11, 2022**, it was reported widely that Petronas (the national oil company of Malaysia) and ENEOS (leading hydrocarbon importer into, and refiner in, Japan) are undertaking a feasibility study jointly to assess hydrogen production and a conversion project to use hydrogen as a feedstock to produce a clean / low carbon energy carrier / vector.

• **A Guide to Policy Making:** On **March 20, 2022**, [IRENA](#) published [Green Hydrogen For Industry – A Guide to Policy Making](#). The publication is both a summary and reference guide, and is well-worth a read.

There is nothing new in [Green Hydrogen For Industry – A Guide to Policy Making](#), but there are helpful points of reference; touchstones for those developing and implementing policy settings as follows:

- **Policy makers have a number of solutions to effect energy transition** "with Green Hydrogen being one of them alongside electrification, energy efficiency, greater material efficiency, a circular economy approach, higher energy efficiency and carbon capture measures. These solutions are not in competition with each other. Instead, they can complement each other when proactive policy making is in place".
- **Policy setting for Green Hydrogen strategy relies on the assessment of different factors**, critically "technological readiness of the decarbonisation solutions and the potential size of the local hydrogen demand".
- **Policy makers can devise policy settings to support Green Hydrogen and the energy transition** in the difficult to decarbonise industry sectors and can do so "through a careful assessment of the experiences in the renewable energy sector as well as by considering the distinctive nature of the [applicable] industrial sector".

As noted, this is nothing new in this, rather it is a synthesis of good sense, a guide to thinking, not a tool-kit.

• **bp Energy Outlook out:** On **March 14, 2022**, bp released its [Energy Outlook 2022](#). The key takeaways for the author from the [bp Energy Outlook 2022](#) edition are as follows (tying to the three current scenarios described):

- **Accelerated:** There has been an increase in the ambition and acceleration of policy settings among some countries, but more ambition and acceleration is required;
- **Net Zero:** There has been an acceleration in the level of installation of photovoltaic solar and wind capacity, increased sales of EVs and the rate of progress of CCS / CCUS projects contemplated has increased markedly;
- **New Momentum:** There has been new momentum broadly across progress to addressing climate change, including decarbonisation and as such **NZE**.

The key takeaways need to be considered against the realities of increasing mass of **GHG** emissions year-on-year (with the exception of 2020), and as such the increased rate of consumption of the finite carbon budget.

• **Hyzon and Raven SR progressing:** [Edition 16](#) of Low Carbon Pulse and [Hydrogen for Industry – Hydrogen from Waste](#) reported on the joint venture between Hyzon and Raven SR to derive and to produce hydrogen from waste.

- On **March 15, 2022**, it was reported widely that Samsung Ventures had joined Chevron Corporation, Itochu Corporation and Ascent H2 Fund in backing Raven SR in respect of its first waste to hydrogen plant in northern California.
- On **March 30, 2022**, it was reported widely that Raven SR was to develop a hydrogen from waste facility in Aragon, Spain. As reported, the facility will treat 75 metric tonnes of organic waste a day to produce 1,600 metric tonnes of hydrogen a year.

• **Moorburg, Hamburg:** On **March 23, 2022**, [hydrogen-central.com](#) reported (*under Former Coal Plant Site Moorburg in Hamburg Could Produce Green Hydrogen by 2026*) that a feasibility study had concluded that the Moorburg site would be used to house a 500 MW electrolyser to produce Green Hydrogen.

• **Sunfire GmbH scaling production:**

- On **March 23, 2022**, it was reported widely that Sunfire GmbH (Dresden head-quartered electrolysis technology corporation) had contracted with P2X Solutions Oy (Finnish headquartered circular economy solutions corporation) to supply a 20 MW alkaline electrolyser to allow P2X Solutions to produce Green Hydrogen.
- On **March 24, 2022**, it was reported widely that Sunfire GmbH had partnered with Blue Earth Capital AG and Copenhagen Infrastructure Partners (**CIP**), raising €195 million to allow it to scale up the production of its alkaline electrolysers, with a clear line of sight to supply up to 640 MW of electrolysers to **CIP**.
- On **March 28, 2022**, Sunfire GmbH [announced](#) that it had commissioned successfully an alkaline electrolyser in Völs, Austria.

• **EON and FFI ink in green:** On **March 29, 2022**, it was reported widely that E.ON SE and Fortescue Future Industries (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO) had signed a supply and distribution agreement, with the two leading corporations combining to deliver 5 million metric tonnes a year of Green Hydrogen into the European market by 2030.

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

- **UN Environment Program (UNEP) reports on cities:** On **March 4, 2022**, the **UNEP** published [*Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions*](#). The report will be considered in the **March and April Report on Reports**.
- **NEL plans expansion of capacity to 2 GW:** On **March 9, 2022**, [fuelcellsworks.com](#) reported that NEL ASA (leading electrolyser technology provider) is planning to increase its electrolyser production capacity. While this increase in capacity is driven by demand it is also informed by the policy settings from the **EU** to accelerate the development of hydrogen production capacity in the **EU**.
- **Elogen to establish giga-factory:** On **March 9, 2022**, [h2-view.com](#) reported that Elogen is to establish an electrolyser stack giga-factory at the Les Ulis site, in Vendôme, France.
Subject to achieving IPCEI status, the production capacity will reach 1 GW by 2030: IPCEI connotes Important Project of Common European Interest.
- **Basque Hydrogen Corridor:** The Basque Energy Agency (**EVE**) has developed a **Basque Hydrogen Strategy (BHS)** and key part of the **BHS** is the development of the **Basque Hydrogen Corridor (BHC)**, which comprises 78 corporations and institutions, including CIC energiGUNE.
- **Electrolyser technology development:**
 - On **March 14, 2022**, it was reported widely that the US **DOE** National Renewable Energy Laboratory (**NREL**) is developing new, and improving existing, electrolyser technologies to improve the efficiency of the electrolysers. The **NREL** is an Energy Efficiency and Renewable Energy part of the US **DOE**. The work of the **NREL** fits within the work streams arising from the Hydrogen at Scale (**H2@Scale**) initiative of the US **DOE**.
 - On **March 15, 2022**, [nature](#) published [*A high-performance capillary-fed electrolysis cell promises more cost competitive renewable hydrogen*](#). For those interested in differing electrolyser technologies the article in [nature](#) is clear and informative. On **March 16, 2022**, at [cefc.com](#) (under **CEFC congratulates Hysata on recognition in scientific journal Nature Communications**) Australia's Clean Energy Finance Corporation congratulated Hysata as a recipient of funding from the Clean Energy Innovation Fund of the Clean Energy Finance Corporation (**CEFC**).
- **Northvolt charging ahead:**
 - **Edition 36** of Low Carbon Pulse reported that [northvolt](#) (under [*Northvolt to transform closed paper mill in Sweden into new Gigafactory*](#)) had announced that it plans to develop the Kvarnsveden Mill and the area surrounding it at Borlänge, Sweden.
 - On **March 15, 2022**, Northvolt announced plans to construct the Northvolt Drei at Heide, Schleswig-Holstein, Germany, to manufacture battery cells – up to 60 GWh annually: in context, 60 GWh of battery cells is sufficient for 1 million **BEVs**.
- **Tesla Opens in Berlin:** On **March 22, 2022**, [dw.com](#) reported (under **Tesla opens Giga Berlin factory in Germany**) that Mr Elon Musk (Chief Executive of Tesla) delivered Tesla BEVs to customers personally to mark the opening of Tesla's Giga Berlin plant, the largest EV plant in Europe.
- **VinFast Vast-Giga-Factory for North Carolina, USA:** On **March 29, 2022**, The White House released a [statement](#) (**Statement by President Biden on Electric Vehicle and Battery Manufacturing Investments in North Carolina**) outlining the plans of electric vehicle maker VinFast (Vietnamese headquartered BEV manufacturer) to build a USD 4 billion electric vehicle and battery manufacturing facility in North Carolina.
- **Siemens Energy plans to produce electrolysers on industrial scale:** On **March 31, 2022**, it was reported widely that Siemens Energy (leading global energy transition technology corporation) is to develop an electrolyser manufacturing plant in Berlin, Germany.

Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

- **Green Steel Tracker:** On **March 14, 2022**, the **Green Steel Tracker** was released. The **Green Steel Tracker** has been developed by the Stockholm Environment Institute and the Leadit Secretariat. A link to the internet site with the **Green Steel Tracker** is included [here](#) (at the website of Leadit – Leadership Group for Industry Transition). The **Green Steel Tracker** is a helpful tool for those wishing to follow green iron and steel projects globally.
- **Anglo American and EDF plan big:** On **March 18, 2022**, [rechargenews.com](#) reported (under **Anglo American and EDF plan 5 GW "renewables ecosystem" for South African mining**) that Anglo American plans to develop a "regional renewable energy ecosystem" (**RREE**). The **RREE** will comprise photovoltaic solar and wind, and storage facilities. It is understood that Anglo American is to work with EDF to install between 3 and 5 GW of renewable electrical energy capacity by 2030.
- **thyssenkrupp Steel and STEAG partner:** On **March 21, 2022**, it was reported widely that thyssenkrupp Steel and STEAG (to produce and to supply Green Hydrogen) were combining to integrate hydrogen at the large steelmaking facility in Europe. The integrated steelmaking facility is at Duisburg, and will deploy a 520 MW electrolyser to produce Green Hydrogen for use in the high heat temperature processes required for the production of iron and steel.

Wind round-up, on-shore and off-shore:

- **Danish Downunder:** On **March 7 and 8, 2022**, it was reported widely that Copenhagen Energy A/S, through Leeuwin Offshore Wind Pty Ltd, intends to develop up to 3 GW of off-shore wind field capacity in **Geographe Bay** off of south west, Western Australia. The proposed **Geographe Bay** development is around 130 kms south of Perth, between the towns of Mandurah and Bunbury, within both Commonwealth of Australia and Western Australia waters.
- **Danish in Columbia:** On **March 8, 2022**, it was reported widely that **Copenhagen Infrastructure Partners** or **CIP** (leading global renewable energy developer and investor) and the Mayor of Barranquilla, Mr Jaime Pumarejo, were to sign an agreement (during CERAWeek, Houston, Texas) to allow the development of a 350 MW off-shore wind field development off the coast of Columbia.

- **Danish off-shore ROK:** On **March 8, 2022**, it was reported widely that Vestas had signed a memorandum of understanding with Sejin Heavy Industries and Construction, Ulsan City and Ulsan Port Authority to cooperate in the development of the 9 GW off-shore floating wind field complex.
- **BlueFloat and Falck Renewables progress:**
 - **Orda Energia Concession Granted:** On **March 8, 2022**, it was reported widely that BlueFloat Energy and Falck Renewables had been granted a 40 year maritime concession to allow the development of the 1.35 GW Orda Energia floating off-shore wind field project (**Orda Energia OWP**).
- **The Netherlands progresses to next auction:**
 - **Regulations issued:** On **March 10, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported that the Ministry of Economic Affairs and Climate Policy had issued regulations detailing rules for the upcoming licensing of Hollandse Kust (west) Wind Farm Zone, which comprises Hollandse Kust (west) VI and Hollandse Kust (west) VII in the Dutch sector of the North Sea. The licence areas are located 53 kms off the west coast of the Netherlands. The auction for the two licenses open on April 12, 2022 and will close on May 12, 2022.
 - **Double Dutch:** On **March 18, 2021**, it was reported widely that the Dutch Government had doubled its forecasts for off-shore wind field capacity: an additional 10.7 GW of off-shore wind field capacity is to be installed, doubling current planned capacity, to 21 GW of installed capacity by 2030. The capacity will be installed in five zones in the Dutch sector of the North Sea.
- **Swedish Fair Wind Continues for OX2 in the Baltic Sea:** On **March 14, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported that OX2 had applied for a Natura 2000 permit to develop the 5.5 GW Aurora off-shore wind field, located 20 kilometres south of Gotland and 30 kilometres east of Öland, within the Swedish Baltic Sea Exclusive Economic Zone.
- **Taiwan reviewing EIAs:** On **March 15, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported that the Environmental Protection Agency in Taiwan was in the process of reviewing Environmental Impact Statements (**EIAs**) in respect of nine off-shore wind field developments, together projected to comprise 9.1 GW of installed capacity. The majority of the developments are proposed by developers head-quartered in Europe.
- **Shell's ROK Floating plans:** On **March 15, 2022**, it was reported widely that Shell Gas & Power Developments B.V. had signed a memorandum of understanding (**MOU**) with Korea Southern Power Co., Ltd (**KOSPO**) for the purposes of exploring opportunities to work together in the context of energy transition.
- **Portugal moves to auction:** On **March 16, 2022**, [Reuters](https://www.reuters.com) (under [Portugal to auction 3-4 GW of floating offshore wind farms in summer](https://www.reuters.com)) reported that the Energy Transition Minister, Mr João Matos Fernandes, had indicated that 3 to 4 GW of offshore wind field capacity was intended to be installed by 2026.
- **bp and Marubeni joint venture:** On **March 23, 2022**, The Marubeni Corporation [announcement](https://www.marubeni.com) provided further detail, stating that it had signed a Cooperation Agreement and a Participation Agreement with BP Alternative Energy Investments Limited (**BPAEI**, a wholly owned subsidiary of BP plc). The first stage of the strategic partnership involves the establishment of a joint venture (51% Marubeni Corporation, 49% **BPAEI**) for the purposes of pursuing selected off-shore wind field development opportunities.
- **Carolinas Greenlighted:** On **March 25, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported (under **US Greenlights Wind Auction Offshore the Carolinas**) that the Bureau of Ocean Energy Management (**BOEM**) had completed its environmental review, and will hold an off-shore wind field energy auction for two lease areas off-shore North Carolina and South Carolina on May 11, 2022.
- **New Zealand off-shore wind – world class fundamentals:** On **March 28, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) has joined forces with NZ Super Fund to develop a 1 GW off-shore wind field development off Aotearoa, New Zealand in the South Taranki Bight.

Solar and Sustainability (including NZE Waste)

- **Heliogen and Woodside CS demonstration project:** On **March 28, 2022**, it was reported widely the Woodside Energy (USA) Inc., is to deploy Heliogen AI-enabled concentrated solar technology for the purposes of a demonstration project. The CS demonstration project is to be built in the Mojave, California.
- **First sovereign sustainability linked bond:** On **March 29, 2022**, the London Stock Exchange [congratulated](https://www.lse.com) The Republic of Chile on the issue of the world's first sustainability-linked bond (a USD 2 billion 4.35% note due March 2042) listed on the London Stock Exchange's International Securities Market and Sustainable Bond Market.
- **MENA Climate Week:** From **March 28 to March 31, 2022**, the first-ever Middle East and North Africa Climate Week (**MENACW**) conference took place in Dubai, United Arab Emirates, under the auspices of the UNFCCC. On **March 31, 2022**, the UN released the following [press release](https://www.un.org) (titled **MENACW Galvanises Regional Momentum for COP-27**). As the **MENACW 2022** report on outcomes is published, a future edition of Low Carbon Pulse will report on them.
- **Cepsa steps up – "Small enough to move, big enough to lead":** On **March 30, 2021**, it was reported widely that Cepsa (multinational oil and gas corporation) plans to invest between USD 7.8 billion and USD 8.9 billion in the development of 2 GW of Green Hydrogen capacity and 7 GW of renewable electrical energy capacity.

Land Mobility / Transport

- **Buses and coaches:**
 - **Houston, Texas, Bussing:** On **March 14, 2022**, [houston.culturemap.com](https://www.houston.culturemap.com) reported that the Metropolitan Transit Authority of Harris County had awarded a contract for 20 battery electric buses for Nova Bus (Canadian headquartered technology corporation, Saint-Eustache), with an option for a further battery electric buses. The first buses are expected to be in operation by late 2022, early 2023.
 - **Bratislava, Slovakia, Trolley-bussing:** On **March 16, 2022**, Solaris Bus & Coach [announced](https://www.solarisbusandcoach.com) that its Solaris Trollino 24 trolleybuses would be deployed in Bratislava by mid-2023. Solaris is supplying 16 bi-articulated trolleybuses to operator Dopravný podnik Bratislava.

- **Wroclaw, Poland, electric:** On **March 18, 2022**, Daimler Truck AG [announced](#) that 11 of its eCitaro G electric buses had been ordered by the City of Wroclaw, and would be deployed in the third quarter of 2023.
- **UK on Track to Reach 4000 Zero Emission Bus Pledge:** On **March 28, 2022**, [hydrogen-central.com](#) reported that the UK was on track to deploy 4000 Zero Emission Buses by 2050. This follows a GBP 198 million funding commitment that will provide sufficient funding for the deployment of 943 buses.
- **Industrial Vehicles and Trucks:**
 - **First hydrogen truck in Australia:** On **March 21, 2022**, it was reported widely that JJ Waste & Recycling had contracted with Pure Hydrogen for a wet-lease of a hydrogen-powered and propelled garbage truck, with Pure Hydrogen providing the truck and the hydrogen for the truck.
 - **A.P. Moller – Maersk to deploy 300 electric trucks:** On **March 24, 2024**, A.P. Moller – Maersk [announced](#) that it add 300 electric trucks to its North America network. The electric trucks will be delivered between 2023 and 2025. Einride (a technology corporation that provides freight mobility solutions) will supply the e-trucks, assembled to specification in the US.
- **Recharging and refuelling infrastructure:**

In addition to the news items covered above in respect of the development of an East Coast of Australia recharging and refuelling network, the following news items are both material and significant:

 - **World's largest biomethane refuelling station opens:** On **March 9, 2022**, it was reported that the world's largest biomethane refuelling station had opened at Avonmouth in the UK, capable of refuelling up to 80 heavy goods vehicles / trucks per hour, using 14 high-speed dispensers.
 - **KOGAS to roll-out hydrogen refuelling stations:** On **March 24, 2022**, the Korea Gas Corporation (**KOGAS**) stated that by 2030 it planned to establish 152 hydrogen refuelling stations around South Korea, with 90 of the HRS's to be liquid hydrogen.
 - **BP to Invest GBP 1 billion:** On **March 25, 2022**, bp [announced](#) that it intended to invest GBP 1 billion over 10 years to expand its EV charging capacity across the UK.
- **Trains:**
 - **Wales of a time:** On **March 9, 2022**, it was reported widely that Ballard Motive Solutions is leading a study in respect of the deployment of hydrogen-powered and propelled trains in Wales, in particular the feasibility of their use to displace diesel powered and propelled trains.
 - **Scotland on time:** On **March 13, 2022**, [The Scotsman](#) reported on routes within Scotland that were expected to be first to benefit from battery powered and propelled trains. The progress reported in The Scotsman reflects the commitment of the Scottish Government to phase out ScotRail's diesel fleet by 2025.
 - **East Japan Railway is testing hydrogen train:** In **March 2022** the testing of the two car hydrogen-powered hybrid (**Hybari**) trainset commenced. The **Hybari** trainset, developed by Hitachi Ltd and Toyota Motor Corporation, is able to travel 140 km at its top speed of 100 km/h between refuelling.
 - **Bavaria is procuring hydrogen trainset:** On **March 16, 2022**, it was reported widely that the Siemens Mobility and Bayerische Regiobahn had signed a lease of a two car hydrogen-powered Mireo Plus trainset, developed by Siemens Mobility. The Mireo Plus trainset is to be tested on the Augsburg-Füssen route.

Ports Progress and Shipping Forecast:

- **Ferries and other craft:**

Sembcorp Marine completes fabrication: On **March 16, 2022**, Sembcorp Marine announced that it had completed the fabrication of the first of three zero-emission battery powered Ropax Ferries for Norled AS. The design of each of the Ropax Ferries has been optimised for the requirements of Norled A/S, with each ferry to be powered and propelled by lithium-ion batteries, and having a back-up battery-diesel hybrid mode.
- **Green Shipping:**

In addition to the news items covered above in respect of the ADB and Pertamina and A.P. Moller – Maersk, the following news items are both material and significant:

 - **Egil Ulvan Rederi H2 vessel gets AiP:** In early March, and then throughout March, 2022, it was reported that Egil Ulvan Rederi AS has received Approval in Principle (**AiP**) from Lloyds Register for its zero-emission self-discharging hydrogen-fuelled bulk carrier – the **With Orca**. The With Orca is designed by Norwegian Ship Design. As reported the **With Orca** will be powered and propelled by hydrogen, with propulsion and energy capture provided by two rotor sails as well as hydrogen. The hydrogen is to be supplied by Statkraft (global leader in hydropower and Europe's largest generator of renewable electrical energy).
 - **MAN B&W Engines ordered: Edition 29** of Low Carbon Pulse reported that Dalian Shipbuilding Industry Co. Ltd was to build two 7,500 m³ liquid **CO₂** carriers to transport **CO₂** captured and liquified as part of the Longships project, with the **CO₂** to be stored in the Northern Lights project. On **March 9, 2022**, MAN Energy Solutions [announced](#) that Dalian Shipping had ordered two MAN B&W 7S5ME-GI dual-fuel engines.

Airports and Aviation:

- **A world of sunlight:** On **March 7 and 8, 2022**, it was reported widely that Lufthansa Group and Swiss International Airlines (**SAL**) and Synhelion had established a strategic collaboration to allow progress to the realisation of "sun-to-liquid fuel (**STF**)".
- **A world of flight:**
 - On **March 7, 2022**, it was reported widely that Airbus Industries and Fortescue Future Industries had established a basis for the development of a partnership under a memorandum of understanding (**MOU**), to work together to progress development of zero emissions aircraft powered and propelled by hydrogen. A link to the joint announcement is [attached](#).

- On **March 17, 2022**, it was reported widely that [Airbus Industries](#) and [Delta Airlines](#) had agreed to work together to accelerate the development of hydrogen-powered and propelled aircraft. For these purposes, Delta Airlines will work with Airbus Industries to identify fleet and network expectations and requirements to enable it to progress to the use of commercial aircraft powered and propelled by hydrogen.
- **FlyZero spot-on:** In **March 2022**, FlyZero, led by the Aerospace Technology Institute published [Hydrogen Infrastructure and Operation, Airports, Airlines and Aerospace](#) (backed by the UK Government). The publication is excellent.
- **Neste's fund continues:** On **March 21, 2022**, [Neste](#) announced that it had contracted with DHL for the supply of 320,000 metric tonnes (or around 400 million litres) of **Neste MY Sustainable Aviation Fuel**. This is the largest **SAF** supply agreement to date for Neste.
- **Rolls Royce Trent 900 engines fuelled by SAF:** On **March 28, 2022**, it was reported widely that an Airbus A380 powered by Rolls Royce Trent 900 engines, had completed its first flight using **SAF**.
- **HyPoint – another high point:** On **March 29, 2022**, it was reported widely that HyPoint (technology corporation) had developed a new technology that would allow the carriage of liquid hydrogen (**LH2**) using ultra-light weight fuel tanks.

Low Carbon Pulse - Edition 37 (Long-form)

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



For those reading LinkedIn later in the week / on the weekend, welcome to the **Friday Long Form Version of Edition 37** of Low Carbon Pulse – sharing significant news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from **Monday March 7, 2022** to **Thursday March 31, 2022**.

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1** to **28**, covering the period from October 6, 2020 to October 5, 2021) and click [here](#) for the **Second Compendium of Low Carbon Pulse** (containing **Editions 29** to **36**, covering October 7, 2021 to March 6, 2022, and containing the **January and February 2022 Report on Reports**).

Headlines:

Ill wind:

The impact of the conflict in Ukraine has resonated globally. In the energy sector, the resonance has been foundation shaking. As a result, energy security and energy transition have aligned, with a clear sighted view on natural gas (in the form of liquified natural gas (**LNG**)) as an energy transition fuel, and the need to accelerate development of renewable energy capacity and hydrogen and hydrogen-based fuel production capacity (the "two legs" of decarbonisation).

An element of this alignment has been the commitment between the European Union (**EU**) and the US on the supply and purchase of **LNG** (agreed on March 25, 2022) to the end of 2022. At a country level, the speed at which Germany has moved to procure floating storage and regasification units (**FSRUs**) to receive **LNG** has been telling, which when combined with the accelerated commitment to achieve decarbonisation of the electrical energy industry by 2035, and the commitment to develop a Green Hydrogen pipeline system across Germany, provides a clear strategy.

Burning platform recognised:

- On **March 24, 2022**, the International Energy Agency (**IEA**) released a [press release](#) outlining outcomes from the **IEA** Ministerial Meeting (a special event dedicated to how to adapt better policy, legal and regulatory frameworks to accelerate deployment of clean energy and low emission technologies);
- On **March 29, 2022**, the International Renewable Energy Agency (**IRENA**) published **World Energy Transitions Outlook (WETO) 2022**, "updating" the **IRENA WETO 2021** (see **Editions 21, 23, and 29** of Low Carbon Pulse), and outlining what needs to be done by 2030 to achieve **NZE** by 2050; and
- On **April 4, 2022**, the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report was published.

A standalone **Edition 38** of Low Carbon Pulse will cover the key findings of **WETO 2022** and the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report – effectively, what needs to be done, and by when.

From a thorough read of **WETO 2022** and an early morning read of the **Summary for Policymakers** contained in the 17 Volume **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, these reports are complementary and their findings should be read together. Together they describe what needs to be done, and quickly.

Vale those lost:

Finally, condolences for those lost in the conflict in Ukraine, and safe-haven to those displaced.

Content of this Edition 37:

Clicking on the contents list will take the reader to the section clicked:

LIST OF CONTENTS: EDITION 37 OF LOW CARBON PULSE			
Pages 2 to 3	Timeline for March, April and May 2022	Page 25:	Carbon Accounting, Carbon Capture, Carbon Capture and Use and CDR
Pages 3 to 4	Legal, Policy Setting and Regulatory highlights	Pages 26:	Carbon Credits, Hydrogen Markets and Trading
Pages 4 to 7:	Climate change reported and explained	Pages 27 to 30:	E-fuels / Future Fuels / Now Fuels
Pages 7 to 9	Middle East including GCC Countries	Page 31 to 34:	Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories
Pages 9 to 11:	Africa, India and Indonesia; Japan & ROK	Page 35:	Green Metals / Minerals, Mining and Difficult to Decarbonise Industries
Pages 11 to 12:	PRC and Russia	Pages 35 to 38:	Wind round-up, on-shore and off-shore
Pages 12 to 16:	Europe and UK; and Americas	Pages 38 to 39:	Solar, Sustainability and NZE Waste;
Pages 16 to 20	France and Germany; and Australia	Pages 39 to 41:	Land Mobility / Transport
Pages 21 to 22:	Blue Green Carbon Initiatives & Biodiversity	Pages 41 to 43:	Ports Progress and Shipping Forecast: Airports and Aviation
Pages 22 to 23:	Bioenergy and heat-recovery	Pages 43 to 44:	Quote of the Month; Reference Materials
Page 24:	BESS and HESS (and other energy storage)	Pages 44 to 45:	NZE Publications

Timeline for March, April and May 2022:

- **IPCC WGIII conference and publication:**

- **Climate Change 2022: Mitigation** arrived on **April 4, 2022:**

- **On February 28, 2022** the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report was published. The key findings of the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report were covered in **Edition 36** of Low Carbon Pulse.

- **From March 21 to April 1, 2022**, meeting virtually, the **IPCC** considered the **IPCC WGIII** contribution to the Sixth Assessment Report (**AR6**). The meeting was the 14th session of **IPCC WGIII** (and the 56th session of the **IPCC**). As with the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report, the **IPCC** considered, line-by-line, the **Summary of Policy Makers** of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report.

On approval of the **Summary of Policy Makers**, the **IPCC** formally accepted the entirety of the **IPCC WGIII** report.

The contribution of the **IPCC WGIII** is to climate change mitigation, assessing methods for the reduction of **GHG** emissions, and removing **GHG** from the atmosphere. As reported in various editions of Low Carbon Pulse (and sibling publications), **GHG** emissions arise from many human activities and sectors, including agriculture and forestry and other land use (**AFOLU**), buildings and the built environment, energy, industry (including cement, chemical and iron and steel production), and waste and waste management.

To the author, the **IPCC WGIII** is the most important of the reports produced by the three **IPCC Working Groups** because it provides the "how" to the description of the "what" arising from the **IPCC WGI** (August 2021) and **IPCC WGII** (February 2022) reports (which cover the extent of climate change and its impacts).

- **On April 4, 2022** the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report was published. As noted above, a standalone **Edition 38** of Low Carbon Pulse cover its key findings.

- **Facts and stats:** As with the lead up to the publication of the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report, during the lead up to the publication of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, there was a narrative from the **IPCC** around the numbers of comments received, document reviewed, and experts involved in the drafting and review of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, including a total of 59,000 review comments received (including 21,500 comments on the first draft, and 32,500 comments on the second draft), 271 scientists from 65 countries involved in writing the report, and 18,000 publications assessed.

- **IPCC reports – next steps:**

- The **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report is the third of three Assessment reports from each **IPCC** Working Group forming part of **AR6**.

- In **September 2022**, the **IPCC** will publish the **Synthesis Report** for the purposes of **AR6**.

The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each **IPCC** Working Group, and in three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**).

Following the tried and tested format, the **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**.

- Just as the **IPCC Working Group I Climate Change 2021: The Physical Science Basis** report (in particular the Summary of Policy Makers contained in it) informed discussions at and outcomes from **COP-26** held in Glasgow, Scotland (in October and November 2021), the **SPM** and the **Longer Report** contained in the **Syntheses Report** for the purposes of **AR6** will inform **COP-27** to be held in Sharm el-Sheikh, South Sinai, Egypt from November 7 to November 18, 2022.

- **By the end of May 2022:**

- **Carbon Credits, Article 6 and the Paris Rulebook:**

The demand for carbon credits is increasing at pace in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**. In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions and, in the longer term, **NZE**, on the basis of carbon neutrality.

In a stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of carbon credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and possible regulation of the **Voluntary Carbon Markets / Voluntary Carbon Credit Markets**.

- **E-Fuels / Future Fuels, including derived from biomass and bioenergy:**

The focus on fuels that are not derived or produced from fossil fuels is increasing. Low Carbon Pulse covers E-Fuels / Future Fuels and bio-energy. In addition to the focus on hydrogen and hydrogen based fuels (including ammonia and methanol), including hydrogen derived from biomass, there is a focus on the derivation and production of Renewable Natural Gas (**RNG**), derived from biomass, including biogas / biomethane, both for use as pipeline gas and for use as bio-compressed natural gas (**Bio-CNG**) and bio-liquified natural gas (**Bio-LNG**).

In a stand-alone article, Michael Harrison and Richard Guit will outline the sources of fossil fuels and non-biomass fuels (including crop fuels), and the feedstocks and technologies used to produce each E-Fuel / Future Fuel, and each form of bio-energy, and of course the **GHG** arising from their derivation and production, and use.

Legal, Policy Setting and Regulatory highlights:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.*

- **IEA support for Clean Energy Start-ups:** On **March 14, 2022**, the International Energy Agency (**IEA**) published [**How Governments Support Clean Energy Start Ups – Insights from selected approaches around the world.**](#) The publication is excellent, providing both a summary and a guide.

- **IRENA:**

It has been a busy March 2022 for **IRENA**:

- **Coalition for Action:** On **March 11, 2022**, **IRENA** published [**Decarbonising end-use sectors Green Hydrogen Certification.**](#)

- **Green Hydrogen:** On **March 20, 2022**, **IRENA** published [**Green Hydrogen For Industry – A Guide to Policy Making**](#) (considered in detail below under **A Guide to Policy Making**);

- **Collaborative Framework:** On **March 24, 2022**, launched the new [**Collaborative Framework on Critical Materials For The Energy Transition**](#), focusing on the need for cobalt, copper, lithium, nickel and rare earth elements (**REEs**), with the associated publication of [**Collaborative Framework on Critical Materials For The Energy Transition**](#). The [**Collaborative Framework on Critical Materials For The Energy Transition**](#), follows like-frameworks from **IRENA** on Hydropower, Ocean Energy / Offshore Renewable Energy, Green Hydrogen, Geopolitics of Energy Transformation, Just and Inclusive Energy Transition and Enhancing Dialogues of High Shares of Renewables in Energy Systems. The [**Collaborative Framework on Critical Materials For The Energy Transition**](#) will be considered in the **March and April Report on Report**;

- **IRENA Africa Report:** In **March, 2022**, the [**Renewable Energy Market Analysis: Africa and its Regions**](#) report was published; and

- **WETO 2022:** On **March 29, 2022**, **IRENA** published [**World Energy Transitions Outlook: 1.5°C Pathway.**](#)

- **Australian Federal Court on duty of care:** **Edition 18** of Low Carbon Pulse reported that the Australian Federal Environment Minister had a duty to take account of the interests of younger generations in considering applications for and grants of approvals for new coal mine projects. **Edition 18** of Low Carbon Pulse reported as follows:

"In Australia, the Federal Court found that the Federal Environment Minister has a legal duty not to cause harm to the young people of Australia [i.e., Australians under the age of 18 years] by exacerbating climate change in the context of approving new or expanded coal mine projects. On the day of judgment, the concept of a legal duty of care was not determinative, but the concept may play a role in future decisions".

On **March 15, 2022** (on appeal from the Minister) the Federal Court of Appeal found that a duty of care was **not** owed (here is a [link](#) to the case). The three judges in the Federal Court of Appeal had differing reasons, but all reached the same conclusion, no duty of care was owed, two judges on the basis that a duty of care did not arise (and in concluding this, applying well-established principles of law). Chief Justice Alsup found that a duty did not arise on three main bases, the first of which was that the content and scope of any duty of care would require the court to evaluate, change or maintain matters of policy, an assessment for which courts are not suited.

Whatever the merits of those bringing the action (and the principles of inter-generational equity are sound), it is for the Australian Federal Government, rather than the courts, to develop policy settings and laws and regulations consistent with achieving **NZE**, including to have regard to matters of inter-generational equity.

Preem CCS project report: During **March 2022** the author came across the Project [report](#) (entitled **Legal and regulatory framework Swedish / Norwegian CCS cooperation**). The report is excellent, both as to the specific plans of Preem AB (the largest fuel corporation in Sweden) and general considerations that arise in respect of the capture, transportation and storage of **CO₂**.

Preem wants to capture **CO₂** from its refineries in Sweden, and ship **CO₂** to Norway for storage in the Northern Lights project (part of the Longship Project), off the west coast of Norway.

In this context, the report addresses the legal and regulatory barriers and solutions, including for **BECCS** (bioenergy carbon capture and storage of Bio-CCS) and for the shipping of **CO₂** across borders.

- **Carbon Border Adjustment Mechanism (CBAM) progresses:** On **March 15, 2022**, the European Council of the European Union reached agreement on the Carbon Border Adjustment Mechanism and issued the draft [Carbon Border Adjustment Mechanism regulation \(CBAM Regulation\)](#) As noted in **Edition 22** of Low Carbon Pulse, **CBAM** is a key element of the **Fit for 55** policy settings announced by the European Commission (**EC**) in July 2021.

While the principles underpinning **CBAM** are outlined in **Edition 22** of Low Carbon Pulse, by way of reminder: the key objective of **CBAM** is to avoid carbon leakage, described in the box below.

CARBON LEAKAGE

Carbon leakage is a phrase that is used to describe a situation in which a carbon price in one country may result in a shift in production of goods to another country (with a lower or no carbon price) with the result that there is an increase in total **GHG** emissions in respect of the production of goods.

The risk of carbon leakage is higher in industries and sectors that are fossil fuel (and feedstock) intensive and other carbon intensive fuel (and feedstock) industries and sectors.

Under **CBAM**, prescribed products (see Annex I of the draft **CBAM Regulation**) from the following industry sectors will be regulated: aluminium, cement, electrical energy, fertiliser, iron and steel. Each of these industry sectors may be regarded as carbon intensive, with products produced across these industry sectors within the **EU** being subject to the policy settings, critically the **EU** Emissions Trading Scheme (**EU ETS**).

The **CBAM** is designed to ensure that prescribed products imported into the **EU** (and as such are not subject to the **EU ETS**) have equivalent carbon pricing principles applied to them consistent with the **EU ETS**.

- **Shell directors focus of Companies Act action:** On **March 15, 2022**, it was [reported](#) widely that thirteen directors of Shell plc are being sued by a shareholder, ClientEarth, on the basis that the directors have not discharged their duty to ensure that the business of Shell is undertaken in a way that promotes the success of the company, and to exercise reasonable care, diligence and skill of this purpose. (The reported basis of the claim suggests that this is an action under ss. 172 and 174 of the UK Companies Act.)

By way of reminder: **Edition 18** of Low Carbon Pulse reported on the outcome of an action brought in the District Court in The Hague against Royal Dutch Shell plc as follows:

"On May 26, 2021, the District Court in The Hague, in the Netherlands, delivered its judgment in a case brought against Royal Dutch Shell plc (**RDS**) by Mileudefensie (et al). This judgment required **RDS** to reduce the net **CO₂** emissions of the **RDS** group by at least 45% by 2030, compared to 2019. The required reduction is across Scope 1, 2 and 3 emissions, not in respect of each Scope. The judgment is founded on **RDS** owing a duty of care to all Dutch citizens. It is expected that **RDS** will appeal the judgment."

RDS appealed this decision of the District Court (**Edition 18** of Low Carbon Pulse suggest that it would, and the [Realizing Reserves and Realising Capital](#) article from Ashurst confirmed that **RDS** had appealed).

The author of Low Carbon Pulse noted at the time, and has noted since (including above), that policy settings going to the achievement of **NZE** and progress towards it, are matters for governments, not courts. Once again, Shell finds itself targeted by an action, which if successful, will impose a duty on the directors of Shell, not on all directors of all corporations. This is neither appropriate, nor helpful.

- **Disclosure requirements:** On **March 21, 2022**, the US Securities and Exchange Commission (**SEC**) released proposed climate change disclosure requirements, including required disclosure of climate risks (identification and mitigation) and emissions data. In broad terms, at a principled level, the proposed disclosure requirements are consistent with the **GHG Protocol** (see the [Realizing Reserves and Realising Capital](#) article) and **TCFD** (see **Edition 24** of Low Carbon Pulse). The **SEC** Fact Sheet, [Enhancement and Standardization of Climate-Related Disclosures](#) an excellent overview of the proposed disclosure requirements over three, punchy, pages.

On **March 24, 2022**, the standards boards of IFRS Foundation and Global Reporting Initiative agreed to coordinate their work around reporting on sustainability.

On **March 31, 2022**, the International Sustainability Standards Board (see **Edition 30** of Low Carbon Pulse, under **ISSB in Frankfurt am Main**) published its [proposals](#) for disclosure.

A future stand-alone issue of Low Carbon Pulse will bring together the tenets of the principles of disclosure.

- **Standalone article about EU Green Taxonomy:**

The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**. In anticipation of the expiry of the four month scrutiny and objection period (which started at the end of January 2022) expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article hopefully by the end of June 2022.

Climate change reported and explained:

*This section considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.*

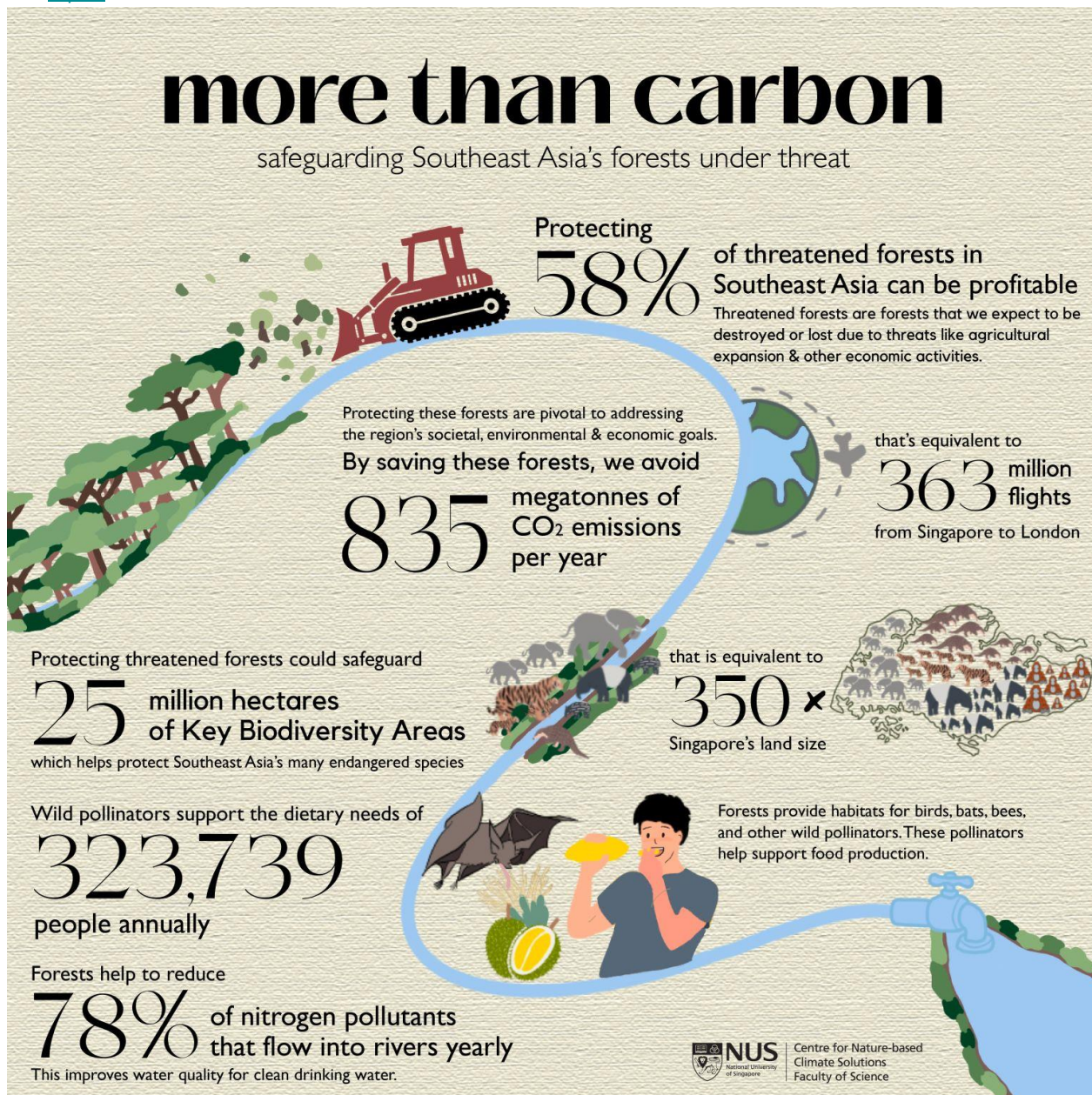
- **Preservation and conversation a pressing issue:**
 - **Edition 36** of Low Carbon Pulse noted the report published by [nature](#) report (entitled [Observed poleward freshwater transport since 1970](#)), the headline from which is that the global water cycle is 7.4% (having been estimated to be between 2% and 4% previously). Increased global temperatures are accelerating or intensifying (depending on how one views the water cycle). In summary, the result of this acceleration / intensification is that

freshwater moves to wet regions, with the result that, as a general statement, and overtime, drier regions, critically, sub-tropical regions become drier. The implications of this are many and varied.

- On **March 7, 2022**, it was reported widely that one of the implications is that untouched forest loses its stability as a result of drier conditions, and its ability to grow back after drought and wildfire is reduced, and as a result takes longer. The loss of stability is most marked closer to farms, roads and urban areas, and regions that are becoming drier – resulting in dieback. In the Amazon, where all contributing factors are present, the risk of dieback is heightened. In a [study](#) published around **March 7, 2022** (entitled [Pronounced loss of Amazon rainforest resilience since the early 2000s](#)), Mr Tim Lenton, of the University of Exeter studied satellite data, considering the implications of that data after drought and fire.

In an article in the [New Scientist](#) (under [Amazon rainforest nears tipping point that may see it become savannah](#)) it is noted that, "More than three-quarters of the world's largest rainforest has become less resilient to drought since the early 2000s, with areas near humans and with lower rainfall being the worst hit".

- More than carbon:** On **March 7, 2022**, the **NUS Centre for Nature-based Climate Solutions** published a helpful graphic in the context of the preservation and conservation of land mass in Southeast Asia: the graphic is taken from a report produced by the **NUS Centre**, led by Tasya Vadya Sarira, and Centre Members Yiwen Zeng and Lian Pin Koh. The [report](#) considers on all of the matters touched on above.



- More carbon in 2021 than ever before:** On **March 8, 2022**, the **IEA** released [Global Energy Review: CO₂ Emissions in 2021](#) (the **CO₂ 2021 Report**). The headlines arising from the **CO₂ 2021 Report** are that 15.3 billion metric tonnes of **CO₂** emissions arose from the use of coal and over 7.5 billion tonnes arose from the use of natural gas. While some of the increase in **CO₂** emissions can be explained by the unusual circumstances in Europe and the US, necessitating increased use of fossil fuels, the overall growth in **CO₂** emissions is a function of the continued economic development of a limited number of countries, including India and the **PRC**.

As regular readers of Low Carbon Pulse will know, both India and the **PRC** are making progress in the development and deployment of renewable electrical energy and clean-to-low carbon energy carrier production, but it takes time to displace existing capacity. As such any adverse headlines emerging from the **CO₂ 2021 Report** directed at either India or the **PRC** need to be viewed in this context.

- **Energy Transitions Commission conclusions:** On **March 9, 2022**, the Energy Transitions Commission (**ETC**) published **Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive** (**ETC Report**).

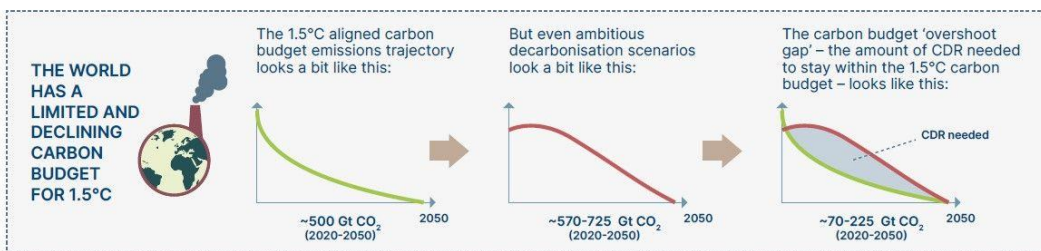
The headline arising from the **ETC Report** is that to ensure that the average increase in global temperatures does not exceed **1.5°C** above pre-industrial times, **165 giga-tonnes** of **CO₂** will have to be removed from the atmosphere by 2050, and as a consequence of this finding, much deeper thinking is required around carbon credits and carbon off-sets and trading. This is a long-standing theme of Low Carbon Pulse, critically the need to move to negative **GHG** emission initiatives sooner rather than later. The following infographic conveys the key finding of the **ETC Report**:



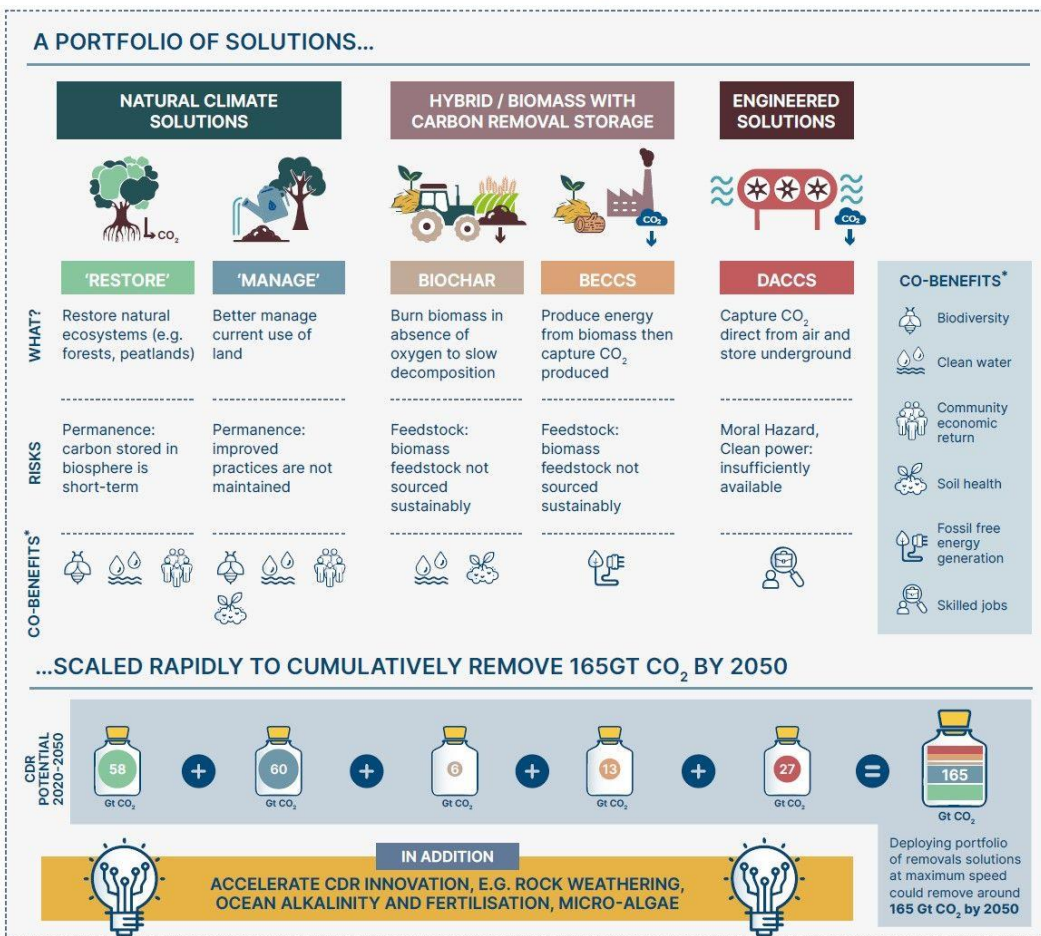
MIND THE GAP: CARBON DIOXIDE REMOVAL (CDR)



CDR is needed in addition to deep and rapid decarbonisation



What will it take to scale CDR to keep 1.5°C alive?



Energy Transitions Commission - March 2022

- **A gathering of world days:**

- **World Water Day: March 22, 2022**, was **World Water Day**. As with International Day of Forests on March 21, 2022, (see below at **International Day of Forests / International Forest Day**) there was considerable coverage of environmental and sustainability issues as they relate to water. There was however a particular focus in the coverage of groundwater, its importance (accounting for 99% of the freshwater globally) and that its importance was not understood, and as a result over-exploited and mismanaged.

UN Water and UNESCO (World Water Assessment Program) published a [report](#) (entitled **United Nations World Water Development Report 2022: Groundwater: making the invisible visible**).

The headline from the report is that water use is to grow by 1%, year on year, for the next 30 years. In this context, water sourced from ground water supplies over 50% (by volume) of current water used for domestic and drinking water. The question posed by the report is how to satisfy the projected growth in the use of water, with sustainable practices, critically avoiding over exploitation and mismanagement.

The **March and April Report on Reports** will cover the report in detail.

- **World Meteorological Day: March 23, 2022**, was **World Meteorological Day**. The World Meteorological Organisation (**WMO**) provided a number of publications and posts to mark the Day.

As might be expected, the focus of the narrative from the **WMO** was climate change. In an article, [Early Warning, Early Action](#), key issues were summarised, and the need for impact-based forecasting practices.

Middle East including GCC Countries:

*This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.*

- **Electric Corp and Energroup align:** On **March 6, 2022**, Energroup (**UAE** sustainable investment corporation) and Israel Electric Corporation (state-owned electrical energy corporation) [announced](#) that they had entered into a preliminary agreement intended to develop Blue and Green Hydrogen projects.

- **Roll-out new H2 trucks:** On **March 7, 2022**, [hydrogenfuelnews.com](#) reported that Colmobil (Israeli vehicle dealer) is to import hydrogen fuelled, fuel cell electric vehicles (**FCEVs**), manufactured by Hyundai, collaborating with Bazan (Israeli petrochemical giant), to produce and to supply the hydrogen, and Sonol (Israel's third largest gas station chain), to develop and to deploy hydrogen refuelling infrastructure.

A trend identified in previous editions of Low Carbon Pulse is that those involved in the hydrogen value chain will support the development of the hydrogen value chain by committing to use **FCEVs** themselves.

- **BEEAH Energy and Chinook Sciences busy:** On **March 7, 2022**, [fuelcellworks.com](#) reported that BEEAH Group (leading sustainability corporation) and Chinook Sciences (UK based technology corporation) had signed an agreement to produce "clean to green" hydrogen to provide hydrogen to power and to propel over 300 trucks and buses a day.

The hydrogen is to be produced from waste at a waste-to-hydrogen facility, producing high-quality activated carbon as well as "clean to green" hydrogen. BEEAH Group will supply the non-recyclable waste streams (predominantly plastics and wood), and will process those waste streams using Chinook Sciences' gasification technology.

It is understood that the waste-to-hydrogen facility will be able to process up to 18 metric tonnes (or 18,000 kilograms) of waste streams a day. As reported, the cost of production of clean hydrogen will be less than the cost of the diesel fuel that the clean hydrogen will displace.

- **Busy day in paradise:** On **March 7, 2022**, it was reported widely that Acme Group (Indian renewable energy company) and Scatec (Norway based renewable power producer) are to develop a Green Ammonia production facility in Oman. The Green Ammonia production facility is world scale, with nameplate Green Ammonia production capacity of 1.2 million metric tonnes a year on completion of planned development and deployment.

It is understood that the Green Ammonia production capacity is to be developed on a phased basis, with the first phase the development and deployment of 500 MW of photovoltaic solar capacity to power 300 MW of electrolyser capacity, to produce Green Hydrogen which in turn will be used as feedstock to produce Green Ammonia.

By way of reminder – something of a feature on Oman:

- **Oman goes Green by Blue: Edition 18** of Low Carbon Pulse reported that: "On May 22, 2021, plans to develop a USD 30 billion, 25 GW, Oman Green Energy Hub (**OGEH**) were announced. The **OGEH** is to be located close to the Arabian Sea. The development of the **OGEH** is to be spear-headed by InterContinental Energy, in partnership with OQ (state owned Omani oil and gas company) and EnerTech (Kuwaiti based investor). The renewable electrical energy produced from on-shore photovoltaic solar and wind farms, will allow the production of 1.8 million metric tonnes per annum of Green Hydrogen and, as reported, 10 mpta of Green Ammonia.

Construction of **OGEH** is to be undertaken in phases, and is scheduled to commence in 2028, with completion of the final phase scheduled for 2038. On full development, the **OGEH** is to be powered by 25 GW of photovoltaic solar and wind.

InterContinental Energy is a name that will be familiar to those following the **Asian Renewable Energy Hub** being developed in the Pilbara Region of Western Australia (see [Edition 2](#) of Low Carbon Pulse) and the **Western Green Energy Hub** in Western Australia (see [Edition 22](#) of Low Carbon Pulse).

- **Oman's aim is true: Edition 20** of Low Carbon Pulse reported that: "On June 16, 2021, the scale of the plans for Oman became clearer, in light of an interview given to S&P Global Platts, by CEO of OQ (a state owned oil and gas company), Mr Salim al-Huthaili.

Mr Salim al-Huthaili brought together the economics of using electrical energy from solar sources (the cheapest electrical energy in history in the **GCC** countries) rather than using natural gas molecules to produce electrical

energy: "We are looking at solar projects and combined solar and wind on our plants ... That will free up gas molecules that we are burning to employ into much more valuable processes rather than burning ...".

This is at the heart of the electrons versus molecules debate broadly. (Leaving to one side any discussion around energy security, if one turns around the thinking, this informs the efficiency debate around the use of hydrogen (in particular Green Hydrogen) as a fuel to generate base-load dispatchable energy.)

The clarity of thinking and the policy setting of moving to use renewable electrical energy to preserve molecules to produce hydrogen and hydrogen-based energy carriers is compelling.

Mr Salim al-Huthaili went on to state that OQ is developing projects to produce: "... both Blue Ammonia and Blue Hydrogen .. The Blue Ammonia project can be accelerated ... it is a matter of capturing the CO₂ and obtaining certification that it qualifies [as Blue Hydrogen and as such] as Blue Ammonia and can be sold to the market as Blue Ammonia".

In addition to Blue Hydrogen and Blue Ammonia, OQ is considering the development of Green Hydrogen, Green Ammonia, Green Methanol and Green Steel projects. It is anticipated that these projects will be developed with international partners, as is the case with the **Oman Green Energy Hub**."

- **Common sense from Fitch: Edition 21** of Low Carbon Pulse reported that: "On June 28, 2021, Fitch Solutions Country Risk & Industry Research published some themes that have emerged or are emerging.
The [publication](#) covers 4.5 pages or so, but packs a fair punch, providing cogent perspectives and clarity around emerging themes. Building on one of the themes noted in recent editions of Low Carbon Pulse is viewing **CO₂** as a resource, and in this context looking to accelerate CCS / CCUS technology as having long term benefits.
The publication provides real clarity in noting that in the context of the use of CCS:
 - for **FOR** (and **EGR**): "On a net basis, the overall CO₂ released both from production and consumption) is less, assuming the additional oil recovered would have been recovered and consumed regardless of the injection of CO₂"; and
 - has one key challenge, and that is the need for favourable local geology, and that in this context emphasising the development of CCUS technology was critical so as to make use of **CO₂** as a resource, and have the means of doing so." [Note: Oman has favourable geology]
- **Self-fulfilling dynamics in Oman: Edition 22** of Low Carbon Pulse reported that: "On July 19, 2021, it was reported that Uniper (leading international energy company) has signed a cooperation agreement with the shareholders in **Hyport DUQM** to develop the business case for the off-take of Green Hydrogen through the negotiation of an exclusive off-take agreement for Green Ammonia and to provide related engineering services.
As noted in previous editions of Low Carbon Pulse, there is palpable progress across the **Gulf Cooperation Council (GCC)** countries towards the development of Green Hydrogen and Green Ammonia (and Blue Hydrogen and Ammonia). **Edition 20** of Low Carbon Pulse included a narrative around the highly prospective, world-class resources that exist in the **GCC** countries."
- **Oman building on progress: Edition 25** of Low Carbon Pulse reported that: "Uniper (leading international energy company) had signed a cooperation agreement with the shareholders in **Hyport DUQM** to develop the business case for the off-take of Green Hydrogen through the negotiation of an exclusive off-take agreement for Green Ammonia and to provide related engineering services.
On August 13, 2021, it was announced that the Oman Ministry of Energy had established an alliance (**Hy-Fly**) of thirteen public and private sector organisations (including Oman LNG, OQ, BP, Shell and TotalEnergies) to work together to develop initiatives for the purposes of the production, transportation, use and export of clean hydrogen, and clean hydrogen-based fuels.
- **OQ signs JDA: Edition 29** of Low Carbon Pulse reported that: "On October 17, 2021, OQ (the Omani state-owned energy company) had signed a Joint Development Agreement with Dutco, Linde and Marubeni to undertake feasibility studies to assess the development of a 400 MW Green Hydrogen and Green Ammonia production facility (**SalalahH2 Project**) in Oman's Salalah Free Zone. The **SalalahH2 Project** will make use of OQ's existing ammonia production plant at Salalah".
- **Oman and Siemens mapping a way forward: Edition 30** of Low Carbon Pulse reported that: "On November 11, 2021, the Oman Hydrogen Centre (**OHC**) signed a memorandum of understanding (**MOU**) with Siemens Energy Oman to collaborate on the development and deployment of hydrogen energy projects and on hydrogen initiatives in the Sultanate of Oman".
- **Oman and BP committed to multiple GWs: Edition 33** of Low Carbon Pulse reported that: "On January 17, 2022, the Oman Ministry of Energy and Minerals had signed an agreement with BP (leading international energy corporation) to progress with the development of a combined renewable electrical energy and Green Hydrogen production project by 2030. In the near term, BP will assess the solar and wind resources in a 8,000 km² area of land that would be used to locate photovoltaic solar and wind generation capacity to provide renewable electrical energy for the production of Green Hydrogen".
- **Consolidation of ownership to expand capacity**; On **March 9, 2022**, [gulfnews.com](#) (under [EGA, TAQA, Dubal Holding and EWEC to expand clean energy generation](#)) reported on the plans of the Abu Dhabi National Energy Company (**TAQA**), Dubal Holding, Emirates Global Aluminium (**EGA**) and Emirates Water and Electricity Company (**EWEC**) to enhance generation optimisation, and in this context, to decarbonise the production of aluminium by **EGA**.
- **KSA signals 15 GW push**: On **March 8, 2022**, [pv.magazine.com](#) reported (under [Saudi minister appears to signal 15 GW, two year clean energy push](#)) that Crown Prince Abdulaziz bin Salman bin Abdulaziz Al Saud had indicated that the Kingdom of Saudi Arabia (**KSA**) was planning a massive renewable energy drive by the end of 2023.
In the context of the execution of the power supply agreement for the 700 MW Al-Rass photovoltaic solar project (see **Edition 29** of Low Carbon Pulse) by ACWA Power (a corporation based in Saudi Arabia), ACWA Power released the following announcement:

"During the signing ceremony, the Minister of Energy announced that the energy sector aims to launch several renewable energy projects to produce approximately 15,000 MW of clean energy between the years 2022 and 2023, with the aim of diversifying the energy mix and achieving its designated targets".

- **UAE and Austria align:** On **March 11, 2022**, it was reported widely that the **UAE** and Austria had signed an agreement to provide a framework to provide for collaboration across hydrogen technology. This agreement is reported to build on the agreement signed by **UAE** and Austria in 2021 (see **Edition 23** of Low Carbon Pulse). Sulatan al-Jaber, Minister of Industry and Advanced Technology and the managing director of ADNOC stated that the agreement aims to "**establish a comprehensive collaboration in hydrogen technology, which will build on the strengths of each [country] and contribute to the UAE's position as a leading global energy producer**".
- **DEWA Aquifer Storage and Recovery:** On **March 14, 2022**, Dubai Electricity and Water Authority (**DEWA**) announced that it had completed construction of the first stage of its Aquifer Storage and Recovery (**ASR**) project. While the thinking behind the **DEWA ASR** project focuses on it as a strategic reserve of water, it appears possible that **ASR** technology will be applied to store water as feedstock for Green Hydrogen production in due course.
- **UAE and Germany:**
 - **Working Group:** On **March 15, 2022**, it was reported widely that the **UAE** and Germany Working Group met in Dubai, **UAE**, to discuss future cooperation. (See **Edition 30** of Low Carbon Pulse in respect of the establishment of the Working Group.)
It is understood that the first meeting of the Working Group focused on the development of hydrogen business opportunities and hydrogen technology.
 - **UAE and Germany working all week:** The week-beginning **March 21, 2022**, saw considerable activity between the **UAE** and Germany, including on **March 22, 2022**, the [announcement](#) from ADNOC that it had signed a memorandum of understanding with the German Federal Minister for Economic Affairs and Climate Action, Dr Robert Habeck, with ADNOC and Germany to undertake studies jointly to strengthen the collaboration to develop clean hydrogen capacity, including work around hydrogen logistics and pilot cargoes, in addition to studies to be undertaken jointly on difficult to decarbonise sectors, including considering new uses of clean hydrogen.
It is reported that Uniper and JERA Americas, working with Hydrogenious LOHC Technologies, will be working on the use of LOHC technology to transport hydrogen and hydrogen-based fuels.
- **NEOM progress continues:**
 - **Helios Green Light:** On **March 17, 2022**, it was reported widely that the USD 5 billion Helios Green Hydrogen production project (part of the development of the Neom project) is to commence construction. The Helios project is to be powered by 4 GW of renewable electrical energy. It is expected that the Helios project will be producing Green Hydrogen by 2026. The Helios project is to deploy 120 electrolysers supplied by thyssenkrupp AG. The commencement of construction is a landmark.
 - **ENOWA Green Utility:** On **March 21, 2022**, NEOM [announced](#) the launch of **ENOWA** which will lead the development and deployment of NEOM's world class sustainable energy and water systems, including [The Line](#), [OXAGON](#) (see **Editions 31** and **35** of Low Carbon Pulse) and [Trojena](#), and of course as a shareholder in the joint venture with Air Products to develop the Helios Green Hydrogen production project.
- **Masdar releases Sustainability Report:** On **March 22, 2022**, Masdar (the Abu Dhabi Future Energy Company) released its [ninth sustainability report](#). The Masdar Sustainability Report has become a reference work.
The key headline from the Masdar Sustainability Report is that Masdar intends to accelerate 100 GW of installed renewable energy capacity, and then double that capacity again, to 200 GW.
- **UAE and the Netherlands sign MOU:** On **March 22, 2022**, [hydrogen-central.com](#) (under **UAE Could Be One Of The Biggest Suppliers of Hydrogen to Europe**) reported that the **UAE** and the Netherlands had signed a memorandum of understanding to work together to develop export-import corridors for clean hydrogen, between the **UAE** and the Netherlands as the gateway to Europe.
- **ACWA Power suspends investments in fossil fuels:** On **March 24, 2022**, [arab-news.com](#) reported that ACWA Power (owned by PIF) "is steady working toward achieving the Kingdom's mission of reaching net zero carbons by 2060, as the company has decided not to invest in oil- or coal-fired power plants going forward".

Africa:

*This section considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to Africa. Africa remains the continent with the most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.*

- **Alignment in Egypt:**
 - On **March 10, 2022**, it was reported widely that Scatec (leading Norwegian renewable electrical energy corporation) had signed a memorandum of understanding (**MOU**) with the Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority. It is understood that the **MOU** provides for the development jointly a 1 million metric tonnes per annum Green Ammonia production facility (with potential to expand to 3 million metric tonnes annually).
The Green Hydrogen and Green Ammonia production facility is to be located in the Ain Sokhna Industrial Zone within the Suez Canal Economic Zone. The New and Renewable Energy Authority will allocate land proximate to the production facility on which renewable electrical energy capacity will be installed to power the production facility.
 - On **March 28, 2022**, it was reported widely that A.P. Moller – Maersk had entered into a memorandum of understanding (**MOU**) signed by the Prime Minister of Egypt, [Mr. Mostafa Madbouly](#), under which A.P. Moller will work with Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority to develop green energy and green fuel production capacity.

- **Use of PPP delivery in forestry:** On **March 17, 2022**, blogs.worldbank.org (the World Bank Blog) reported on the use of a public private partnership (**PPP**) in Ghana for the purposes of AFOLU (i.e., Agriculture, Forestry and Other Land Use) projects. The Ghana Forestry Commission (**GFC**) contracted with the private sector to develop and to operate AFOLU projects located on land managed by the **GFC** on a sustainable basis, using private sector capital and expertise, while at the same time involving local communities and the resources of the **GFC**.
- **Nigeria launches updated energy and emissions model:** On **March 21, 2022**, mottmac.com reported (under **Nigeria becomes the first African country to launch an updated 2050 Calculator to support low-carbon development**) that the Energy Commission of Nigeria (**ECN**), the Federal Ministry of Environment and the British Embassy in Abuja had launched jointly an updated version of the Nigeria Energy Calculator 2050 (**NECAL 2050**). The updated version includes updates across industry sectors as follows: bio-energy and waste, buildings, **CO₂** removal, electricity, industry, land and transport. Dr Abdulwaheed Ahmed of **ECN** noted that "... **NECAL 2050** will support Nigeria's reporting to UNFCCC, the National Biennial Update Report, the National Inventory Report in addition to [achieving] alignment with the NDCs and the Nigeria Energy Transitional Plan ...".
- **Eni water PPPs:** On **March 23, 2022**, eni.com announced that its subsidiary corporations, Nigerian Agip Exploration and Agip Energy and Natural Resources, and the Food and Agriculture Organisation of the UN (FAO) had commissioned 11 water schemes in Borno and Yobe States, North East Nigeria. Each water scheme is integrated: comprising sourcing raw water from boreholes, use of electrical energy sourced from photovoltaic solar panels to pump water and to power water treatment facilities, providing water for domestic use and drinking, and for micro-irrigation purposes.
- **Renewable Energy Market Analysis:** As noted above, in March, 2022, the **IRENA Africa Report** was published. In addition to the **IRENA Africa Report**, at woodmac.com, Wood Mackenzie released a paper, **Utility 3.0: How Africa is remaking the grid**. This will be considered in detail along with the **IRENA Africa Report** in the **March and April Report on Reports**, to be contained in the Appendix to the Second Compendium of Low Carbon Pulse.

India and Indonesia:

*This section considers news items within the news cycle of **Edition 37** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.*

- **Feasibility Study to decarbonise maritime industry:** On **March 10, 2022**, h2-view.com reported (under **Indonesian maritime industry to be decarbonised with hydrogen**) that the Asian Development Bank (**ADB**) supported by Longitude Engineering, is to undertake a feasibility study, jointly, with PT Pertamina. The purpose of undertaking the feasibility study is stated to be to develop a road map for the integration of low carbon fuels into the domestic shipping industry, with hydrogen (and hydrogen-based fuels), being key for these purposes.
- **India 50 GW of solar:** On **March 15, 2022**, pv-magazine-australia.com reported that to December 31, 2021, India had installed 50 GW of photovoltaic electrical energy capacity (40.4 GW utility scale, and 8.57 GW roof-top), having added 3.17 GW of installed capacity during Q4 of 2021, of which 2.5 GW was utility-scale and 520 MW roof-top.
- **ArcelorMittal and Greenko co-develop 975 MW:** On **March 22, 2022**, the economic-times.com reported (under **ArcelorMittal joins hands with Greenko for renewable energy projects**) that ArcelorMittal and Greenko had agreed to co-develop 975 MW of photovoltaic solar and wind renewable energy capacity as part of the progress being made by ArcelorMittal to decarbonise the production of iron and steel. The co-development will be located in Andhra Pradesh and will provide "round-the-clock" renewable electrical energy, and is to be funded by ArcelorMittal and designed, constructed, operated and maintained by Greenko.
- **KPMG takes the pulse:** On **March 25, 2022**, KPMG India launched its **India Decarbonisation Hub**. To accompany the launch of the Indian Decarbonisation Hub, KPMG published **India's green hydrogen ambition - setting the wheels in motion**, which provides a helpful overview of the current state of play, and the road ahead.
- **USD 1.2 billion Green Hydrogen Project in Indonesia:** On **March 25, 2022**, it was reported widely that Hyundai and Samsung are to join with Global Green Growth Institute (**GGGI**) to develop a Green Hydrogen Project in Indonesia. It is understood that the intention is to derive renewable electrical energy from geothermal energy sources, with the Green Hydrogen to be supplied to the Sei Mangkei Industrial Zone, Sumatra, with the Green Hydrogen to be used to decarbonise industrial activities, including the difficult to decarbonise cement and iron and steel industry sectors. Further, it is understood that the Green Hydrogen Project will use Green Hydrogen to produce Green Ammonia, with the Green Ammonia to be exported, including to **ROK**, with Hyundai to provide the shipping for export, and KOGAS to import the Green Ammonia. Samsung Engineering will undertake the design and viability study for the project.
- **India SAF:** On **March 26, 2022**, Axens [announced](https://axens.com) that Axens, Airbus, GMR Airports (an airport operator), Groupe ADP (also and airport operator) and Safran had signed a memorandum of understanding to collaborate in making Indian aviation future ready by undertaking a study in respect of sustainable aviation fuel (**SAF**) to assess the potential of **SAF** in India.
- **PT Pertamina investments plans:** On **March 25, 2022**, energyvoice.com reported that PT Pertamina plans to invest up to USD 11 billion on renewable energy projects over the period 2022 to 2026 so as to continue progress in energy transition.
- **OIES updates Report:** Towards the end of March 2022, the Oxford Institute for Energy Studies updated its [publication](https://oies.org) **India's Progress on its Climate Action Plan – An Update in Early 2022**. The publication is well-worth a read.
- **India Hydrogen Alliance – March 2022:** Attached is the link to the March edition of **India H2 Monitor - March 2022**. As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the content of the **India H2 Monitor**.

Japan and Republic of Korea (ROK):

*This section considers news items within the news cycle of this **Edition 37** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

- **Japan's 11th solar auction:** On **March 9, 2022**, the **Green Investment Promotion Organisation** in Japan released the [results](#) (please see the original results in Japanese [here](#)) of the 11th solar auction for projects with an electrical energy dispatch rating of greater than 250KW.
As reported, 273 photovoltaic solar projects had bids accepted, with bids accepted in respect of 268.7 MW of installed capacity. The outcome of the 11th solar auction is significant because the average bid was below ¥10 per kW/h for the first time, and as such the lowest in any preceding auction.
The 11th solar auction is the last that will be undertaken using fixed tariffs. The next auction will award bids on the basis of a feed-in premium tariff.
- **Japan to accelerate off-shore wind field development:** On **March 18, 2022**, it was reported widely that the Minister of Economy, Trade and Industry of Japan, Mr Kōichi Hagiuda, had announced that Japan will accelerate the development of off-shore wind field capacity.
- **POSCO in South America:** On **March 21, 2022**, [mining.com](#) reported that POSCO (leading iron and steel producer head-quartered in **ROK**) is to invest USD 4 billion in a new lithium mining project in Argentina. The mining project is understood to be located on a salt flat, Salar del Hombre Muerto, which is located on the border between provinces of Catamarca and northern Salta. It is understood that production of 100,000 tonnes a year of lithium hydroxide is expected on completion of the development of the mine.
Argentina, Bolivia and Chile form the "lithium triangle", each home to large reserves of lithium. On **March 29, 2022**, Rio Tinto announced plans to acquire the Rincon lithium mine project within the lithium triangle (in Argentina).

PRC and Russia:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the **PRC** and **Russia**, being countries that give rise to the most and the fourth most **GHG** emissions.*

- **Sinopec continues progress on hydrogen:** On **March 17, 2022**, it was reported widely that Sinopec (one of the Big Three **PRC** NOCs) is to increase its investment in the development and deployment of Green Hydrogen facilities so as to develop 500,000 metric tonnes of Green Hydrogen annual production capacity by 2025.
As reported previously in Low Carbon Pulse, Sinopec intends to have deployed hydrogen refuelling infrastructure in 1,000 locations by 2025, which will have refuelling capacity of 200,000 metric tonnes a year.
A reminder of Sinopec Plans: To regular readers of Low Carbon Pulse, this news item may jog the memory - **Edition 19** of Low Carbon Pulse reported as follows:
"Sinopec plans to produce 500,000 tonnes of Green Hydrogen by 2025:
 - **From Grey to Green: Edition 5** of Low Carbon Pulse outlined the position of Sinopec as a producer of hydrogen using traditional technologies, producing over 3 million metric tonnes per annum (**mmtpa**) of hydrogen. **Edition 18** of Low Carbon Pulse outlined the development by Sinopec of its first Green Hydrogen facility in Ordos, Inner Mongolia, which is to start producing Green Hydrogen by the end of 2022.
While Sinopec is the world's largest refiner of petroleum products, it has recognised for some time that there is a need to shift to low and no carbon, including to align with achieving peak **GHG** emissions by 2030, and net-zero **GHG** emissions by 2060. Sinopec is not alone among Chinese companies in responding to this imperative.
 - **From production to distribution:** Chinese state owned enterprise, Sinopec, has been focused on its strategic shift to Green Hydrogen, and its wholly-owned subsidiary, Sinopec Star Co., Ltd (**Sinopec Star**), is working towards the achievement of this shift. It is planned that **Sinopec Star** will develop projects to produce 500,000 metric tonnes per annum of Green Hydrogen by the end of 2025.
In the context of developing supply and demand in tandem, at the same time as Sinopec is developing its Green Hydrogen production capacity, through **Sinopec Star**, it is developing hydrogen refuelling infrastructure and stations (**HRI/Ss**). It is reported that Sinopec is working with Air Liquide in the roll-out of **HRI/Ss**."
For completeness, attached are links to each other edition of Low Carbon Pulse in which a news item was included relating to Sinopec: **Editions 5, 9, 13, 18, 21, 26, 32, 33** and **34**. For those with the time, the telling take-away will be the consistency between what was planned, and what has been implemented.
- **PRC continues progress on hydrogen:** On **March 23, 2022**, [h2-view.com](#) reported on the plans of the **PRC** for the development of hydrogen production capacity with the National Development and Reform Commission (**NDRC**) and the National Energy Administration (**NEA**) providing a roadmap to 2025, 2030 and to 2035.
In the near term, the plan is to develop hydrogen production capacity so as to produce 200,000 metric tonnes of clean hydrogen by 2025. This sits well inside the aspirations of Sinopec to have developed 500,000 metric tonnes of Green Hydrogen production capacity by 2025.
In the medium term (by 2030), the plan is to have developed a hydrogen production industry configured to produce clean hydrogen using integrated hydrogen technologies so as to maximise the reduction in **GHG** emissions arising from production, transportation, storage and use of hydrogen. In the near to medium term, the focus appears to be the decarbonisation of the mobility industry.
In the medium to longer term (by 2035), the plan is to have developed hydrogen production capacity so as to support the decarbonisation of the difficult to decarbonise industries.

- **A reminder of PRC plans:**

On **March 5, 2022**: [Reuters](#) reported that the **PRC** had firmed-up plans to develop and to deploy 450 GW of new photovoltaic solar and wind capacity in the Gobi Desert, and other desert regions: Director of **NDRC**, Mr He Lifeng said:

"China is going to build the biggest scale of solar and wind power generation capacity on the Gobi desert in history, at 450 GW".

While the development and deployment of photovoltaic solar and wind power in the Gobi Desert has been flagged (for example, see [Edition 21](#) of Low Carbon Pulse) for some time, the confirmation from **NDRC** at the National People's Congress can be viewed as a firm policy setting. It is understood that the construction of 100 GW of photovoltaic solar capacity is already underway in the Gobi Desert. As noted in previous editions of Low Carbon Pulse, the renewable electrical energy generated in the Gobi Desert, and other desert regions, will be transmitted to the load for that electrical energy using ultra-high voltage direct current transmission systems.

During the week beginning February 28, 2022: it was reported widely that the **PRC** plans to develop and to deploy hydrogen refuelling infrastructure at 2,000 sites across China, and for 1 million FCEV in China, by 2035.

Europe and UK:

This section considers news items that have arisen within the news cycle of this [Edition 37](#) of Low Carbon Pulse relating to countries within the European Union (EU) and the EU itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards NZE. In combination, countries comprising the EU give rise to the most GHG emissions after the Peoples Republic of China (PRC) and the US. The UK is a top-twenty GHG emitter, but has been a front-runner in progress towards NZE.

- **Clearing Round in ScotWind:** On **March 7, 2022**, Crown Estate Scotland (**CES**) [indicated](#) that it will undertake a **Clearing Round** under which further lease areas will be auctioned, specifically lease area NE1 east off Shetland.

It is understood that bidders in the **ScotWind Leasing Scheme** (see [Edition 33](#) of Low Carbon Pulse) process that were not successful (but scored highly applying assessment criteria) will be eligible to bid in the **Clearing Round**.

It is understood that **CES** will outline its plans for a **Clearing Round** during **April 2022** (which will be covered in [Edition 39](#) of Low Carbon Pulse). This may be regarded as timely in the context of plans across Europe and the UK to accelerate the development of hydrogen production capacity in the context of an accelerated move towards renewable electrical energy development and the attendant ability to produce Green Hydrogen as a result.

By way of reminder: [Edition 33](#) of Low Carbon Pulse reported on the outcome of the **ScotWind Leasing Scheme**, and [Edition 22](#) of Low Carbon Pulse reported on the process.

- **EU to accelerate decarbonisation initiatives:**

- **Edition 36** of Low Carbon Pulse reported:

"During the week commencing February 28, 2022, it became apparent that the **EU** intends to seek to reduce exposure to volatile hydrocarbon prices (coal and natural gas) by accelerating progress to increased renewable electrical energy and the production and use of Green Hydrogen (**Hydrogen Accelerator**), and in the near to medium term, to access more varied sources of natural gas supply, principally in the form of LNG.

During the next two quarters of 2022, the expectation is that there will be a focus on maximising gas in storage, to at least 80% by September 30, 2022. At the same time, it is understood that the **Hydrogen Accelerator** policy setting will be implemented.

By way of rare editorial comment, the **EU** needs to be clear to the market, committing to the market to ensure that term contracts are concluded for LNG to allow the development of further LNG supply sources globally by underpinning the economics of those developments. Germany is doing this already."

- **EC plans clear and hard:** On **March 8, 2022**, the European Commission (**EC**) outlined its plans to accelerate the development of renewable electrical energy capacity across the **EU**, and to increase fourfold the Green Hydrogen production capacity by 2030 (**REPowerEU**, including a **Hydrogen Accelerator**).

EC Vice-President, Mr Frans Timmermans said (in echoes of a by-gone age, of the dash for gas):

"Let's dash into renewables at lightning speed. Renewables are cheap, clean, and potentially an endless course of energy instead of funding the fossil fuel industry elsewhere, they create jobs here ... It's hard, bloody hard. But it's possible".

In short, there are two legs to **REPowerEU**, first, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and, second, the dash to accelerate renewable electrical energy deployment.

Notably, Mr Timmermans included nuclear reactor electrical energy power generation in the thinking. This is consistent with the **Green Taxonomy** and the positions of both France and the Netherlands since the start of 2022. The attached [link](#) links to the detail of **REPowerEU**.

The **REPowerEU**, is consistent with (some may say follows) the progress that has been made in recent times in **EU** countries, in particular in northern Europe.

On **March 3, 2022**, the **IEA** published [A 10 Point Plan to Reduce EU Reliance on Russian Natural Gas](#). The first five points in the plan (dealing with macro issues) are entirely consistent with **REPowerEU**.

On **March 11, 2022**, The Oxford Institute For Energy Studies published [Potential development of renewable hydrogen imports to European markets until 2030](#). The OIES publication is both timely and thought provoking, and, as ever with publication from **OIES**, well-worth a read.

- **Energy Transition in action:**

As noted in recent editions of Low Carbon Pulse (and above) the German Federal Government is progressing a multi-stream strategy to accelerate to 100% renewable electrical energy by 2035 while at the same time diversifying the sources of natural gas (critically, the importation of LNG from diverse sources). The Dutch

Government has a €35 billion transition fund, including €15 billion for "advanced renewable energy carriers", with a working assumption that the Dutch Government will earmark around €5 billion of the €15 billion for Green Hydrogen production. Germany and the Netherlands continue to lead the European hydrogen race.

• **LNG receiving terminals as part of energy transition:**

- **Edition 36** of Low Carbon Pulse reported on the re-enlivening plans in Germany (under **LNG Terminals progressing**) to develop two LNG receiving terminals at Wilhelmshaven (Uniper) and at Brunsbüttel (Gasunie and Kreditanstalt für Wiederaufbau (**KfW**)) so as to ensure diversified sources of natural gas imported as **LNG**. On **March 8, 2022**, it was reported widely that Enel, giant Italian utility, is to revisit plans to develop **LNG** receiving terminal south of Rome, to allow it to source natural gas from diversified sources.

As noted above, the development and deployment of LNG receiving terminals offers a medium term means of energy transition, and energy security. As noted in various editions of Low Carbon Pulse, energy transition, and progress to **NZE**, requires natural gas, and policy settings that recognise this will allow the development of sufficient natural gas resources, and as such mitigate against energy cost / price variability that has become the norm absent policy settings of this kind.

• **Continued progress in the development of LNG receiving terminals:**

- On **March 23, 2022**, Germany agreed a long-term contract with Qatar to take **LNG**.
- On **March 23, 2022**, **German LNG Terminal announced** that it had signed a memorandum of understanding under which it will contract long-term for capacity in the Brunsbüttel LNG receiving terminal project, having 165,000 m³ of storage capacity and two berths capable of accommodating Q-Max (266,000 m³) **LNG** carriers.
- On **March 25, 2022**, the German Federal Minister for Economic Affairs and Climate Action, Mr Robert Habeck announced that the German Federal Government had promoted securing three floating storage and regasification units (**FSRUs**) for use by RWE and Uniper (each corporation contracting under time-charterparties for the **FSRUs**).

The speed with which the German Federal Government has continued to act to secure alternative supplies of LNG has been exemplary.

- **Policy settings proceeding at the same rate as the practical:** On **March 25, 2022**, the German Federal Government issued a report entitled **Energy Security Progress**. In the report, the German Federal Minister for Economic Affairs and Climate Action states:

"The Federal Government has opted for three floating LNG terminals ... via the companies RWE and Uniper in order to increase [further] security of supply in Germany. The companies are currently in contract negotiations for the leasing of these floating LNG terminals. These negotiations are in the home stretch".

In summary, since the end of February 2022: Gasunie and **KfW** (acting on behalf of the German Federal Government) have agreed in principle to develop an LNG receiving terminal at Brunsbüttel; Uniper is developing an LNG receiving terminal at Wilhelmshaven; and RWE has announced that it will develop an ammonia import facility at Brunsbüttel.

- **Cluster sequencing Phase 2:** On **March 22, 2022**, the UK Department for Business, Energy & Industrial Sector issued a **notice** (entitled **Cluster sequencing Phase-2: eligible projects (power CCUS, hydrogen and ICC)** detailing the projects that had satisfied the eligibility criteria (outlined in **Phase-2 guidance**) for **Phase-2** progress. As outlined in previous editions of Low Carbon Pulse, on May 7, 2021, the UK Government launched its carbon capture, usage and storage (CCUS) cluster sequencing process to identify and to sequence CCUS clusters suitable for deployment in the mid-2020s. The East Coast Cluster and HyNet Northwest were selected and sequenced into Track-1 clusters. The Scottish Cluster was announced as the Reserve Cluster. See **Edition 29** of Low Carbon Pulse for summary. **Edition 30** of Low Carbon Pulse reported that: "On November 8, 2021, the UK Government called for submissions from organisations wanting to take part in **Phase 2 of the CCUS Cluster Sequencing Process**. Phase-2 is stated to be "open to Power, Industrial Carbon Capture and Hydrogen production projects which meet the technology specific eligibility criteria."

Edition 33 of Low Carbon Pulse reported on the process for, and progress of, submissions to apply for Power Carbon Capture (CC), Hydrogen and Industrial Carbon Capture (ICC), to connect either to Track-1 cluster or to the Reserve Cluster or as part of the Phase-2 cluster sequencing process. **Edition 33** also noted that as the Phase-2 cluster sequencing process progressed, Low Carbon Pulse would report on that progress.

The following table identifies the projects that have satisfied the eligibility criteria for **Phase-2**:

CO2 CLUSTER	POWER CCS	HYDROGEN	INDUSTRIAL CARBON CAPTURE
East Coast Cluster:	VPI Humber Zero; Whitetail Clean Energy; Net Zero Teesside Power; Alfanar CCGT Teesside; Keadby 3 CC Power Station and C.Gen Killingholme	N2NorthEast; Uniper Humber Hub Blue Project; bpH2 Teesside and Hydrogen to Humber (H2H) Saltend	STV 1,2 and 3 Energy from Waste CC projects; Tees Valley Energy Recovery Facility Project; Altalto Immingham waste to jet fuel project; Lighthouse Green Fuels; Redcar Energy Centre; Humber Zero Refinery; Prax Lindsey Refinery; ZerCal250; Teesside Hydrogen CC; Saint-Gobain Glass CC; Norsesea CC; CF Fertilisers Billingham Ammonia CCS; Teesside Green Energy Park, and North Lincolnshire Green Energy Park
HyNet Northwest	Making Net Zero Possible – Grain	Project Cavendish & HyNet Hydrogen Production Project	Viridor Runcorn Industrial CCS; Protos Biofuels and Energy Recovery; Hanson Padeswood Cement CCS; CF Fertilisers Ince CC Plant; Buxton Lime Net Zero; EssarOil UK CCU; and Emerge CCS

Scottish Cluster	Peterhead Carbon Capture Power Station	Acorn Hydrogen & Fife Hydrogen Hub	CO2 Extraction from St Fergus Gas and SAGE Terminal and Acorn Capture
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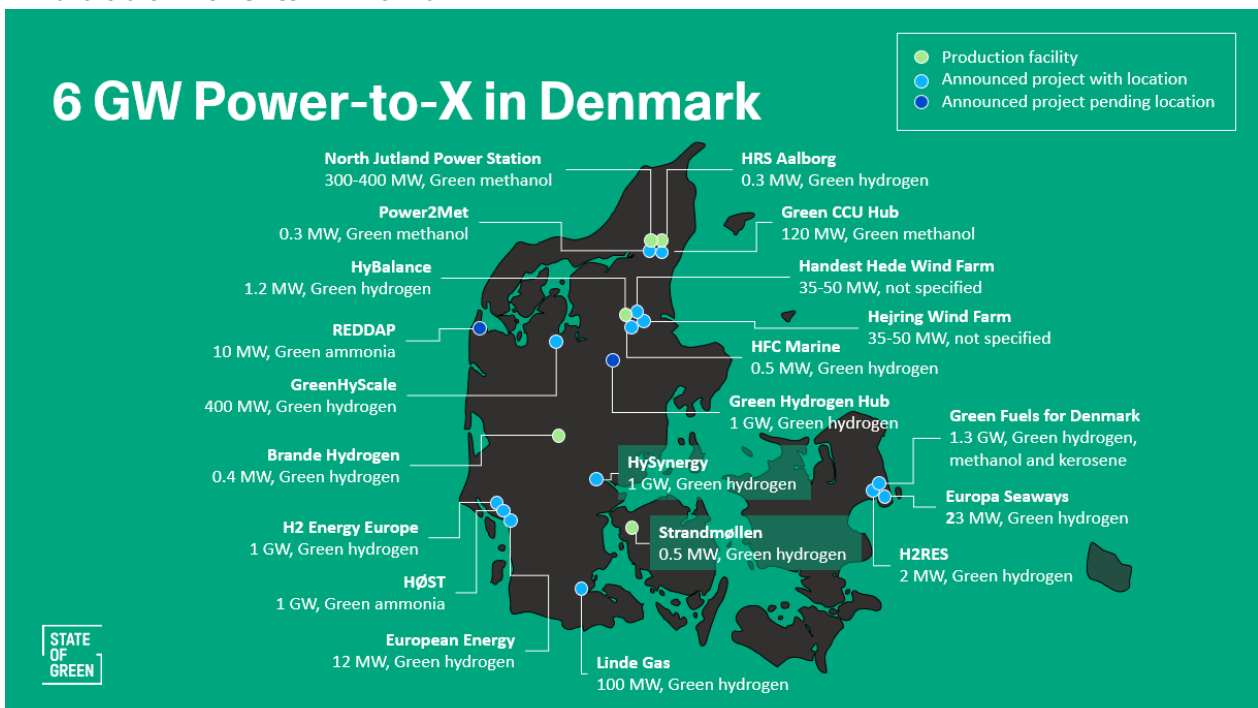
- **UK ETS Development Review:** On a busy week for the UK Department for Business, Energy & Industrial Sector, on **March 25, 2022**, it announced an [Open consultation - Developing the UK Emissions Trading Scheme \(UK ETS\)](#), with the link taking the reader to the document outlining the matters under consideration. As the title suggests, the consultation is open to all, with the UK Government announcing that the consultation will be of particular interest to corporations in the agricultural, aviation, maritime, power, and waste sectors, and those involved in **GHG** abatement and removal. The open consultation process closes at 11.45 pm on June 17, 2022.

- **All is well in the Kingdom of Denmark:**

- **Denmark Power-to-X:** In Denmark, the concept of **Power-to-X** is well-established, and becoming part of the framework for progress towards the achievement of **NZE**. In December 2021, the Danish Government launched a strategy to develop **Power-to-X** (see **December and January Report on Reports** in the [Second Compendium of Low Carbon Pulse](#)).

In this context, the Danish Government has earmarked funding support for the development of **Power-to-X** capacity development, critically the development of electrolyser capacity, with the policy setting target being the development and deployment of between 4 GW and 6 GW of production capacity.

- **Principal objectives:** There are four objectives to the promotion and development of **Power-to-X** capacity in Denmark, as follows: **1. Power-to-X** must contribute to achieving the objectives in the Danish Climate Act; **2.** It is necessary to develop the framework and infrastructure for the **Power-to-X** sector to develop; **3.** It is necessary to improve the interface between the current energy system and the **Power-to-X** sector; and **4.** Denmark must be able to export **Power-to-X** products and technologies. The following map provides an overview of the 6 GW **Power-to-X** in Denmark.



Americas:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.*

- **Stitching together renewable energy seams:** On **March 8, 2022**, [cleantechnica.com](#) published an article authored by Ms Tina Casey. The article is well-worth a read, both for the outline of plans and for the optimism that the plans engender. The article notes that the US' massive off-shore wind resources are "finally in the pipeline" (see **Editions 2, 7, 8, 20, 21, 26**, and **30** of Low Carbon Pulse) and the "land-based renewable energy profile is about to get a shot of adrenaline".

The "shot of adrenaline" is sourced from plans of two leading transmission system operators (the **Midcontinent Independent Power System Operator** or **MISO** and the **South West Power Pool** or **SPP**) "to stitch together" their systems, and in doing so "opening a bottleneck that has held back wind and solar developers for years".

The thinking (which is continuing to develop) is based on the [Interconnections Seam Study](#), with the core idea being the efficiency benefits of uniting the Eastern and Western US transmission systems. After further work by **MISO** and **SPP**, seven projects have been identified (having a combined cost of USD 1.65 billion) in a **Joint Interconnection Queue Study (JIQS)** that contemplates the stitching together of both systems.

The headline from the **JIQS** is that between 28 and 53 GW of "interregional generation enablement" will arise, and will likely encourage further renewable electrical energy installation.

In a letter penned by the CEO of **MISO**, Mr John Bear, and the President of **SPP**, Ms Barbara Sugg, it is emphasized that: "**consumer preferences and public policy goals have increased the demand for renewable energy, and, increasingly, our member utilities are moving the progress of those needs**".

- **Louisiana Energy Law:** On **March 9, 2022**, it was reported widely that the Louisiana State Legislature was considering the basis to increase the scale and size of off-shore wind field leases, including how to collect royalties on power generation.
- **Massachusetts Energy Law:** On **March 9, 2022**, it was reported widely that the Massachusetts House of Representatives had passed [Bill H415 \(An Act Advancing Offshore Wind and Clean Energy\)](#) that requires State utilities to enter into long-term contracts for electrical energy generated by off-shore wind fields in an amount "**equal to ... 5,600 megawatts of aggregate nameplate capacity not later than June 30, 2027**".

Having passed through the House of Representatives, the Bill needs to be signed by the Governor of Massachusetts before becoming law.

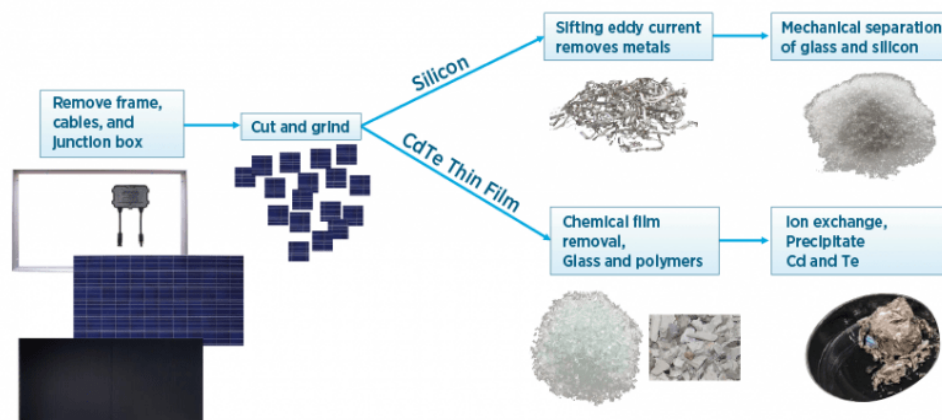
As might be expected, the Bill establishes an **Off-shore Wind Transmission Working Group** that will allow the augmentation and expansion of the transmission grid to realise the benefits of this initiative. As noted in previous editions of Low Carbon Pulse, transmission systems need to be augmented and expanded well-ahead of the generation of renewable electrical energy coming on-line.

- **Hubbub among the States:**
 - **Edition 35** of Low Carbon Pulse reported that the US **DOE** had "gone-live" on the implementation of the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**. Going live involves rolling-out the initiatives in the **IIAJA**. The largest hydrogen program in the **IIAJA** provides the US **DOE** with USD 8 billion to provide support for **at least four hydrogen hubs** that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.
 - **Edition 36** of Low Carbon Pulse reported (under **Mountain States Hub**) that **Colorado, New Mexico, Utah** and **Wyoming** had signed a memorandum of understanding to develop a regional clean Hydrogen Hub, and in so doing, position more effectively to seek funding from the **Infrastructure Investment and Jobs Act (IIAJA)**.
 - **Mississippi States Hub:** **Arkansas, Louisiana and Oklahoma** are reported to be progressing with a like initiative to create a bipartisan three-state bloc to develop a **regional clean Hydrogen Hub**.
 - **West Virginia gets in first:** On **March 22, 2022**, it was reported widely that the State of West Virginia, through the **West Virginia Hydrogen Hub Coalition** had submitted a proposal to the US **DOE** seeking funding to develop a hydrogen hub in the State.
 - **Northeast Hydrogen Hub:** On **March 24, 2022**, the Governor of New York State, Ms Kathy Hochul indicated that New York, together with Connecticut, Massachusetts and New Jersey, and 40 hydrogen ecosystem partners, were combining for the purposes of seeking to become one of at least four regional clean hydrogen energy hubs.

For the **Mountain States Hub, Mississippi States Hub, West Virginia Hydrogen Hub** and **Northeast States Hub**, the development of a Hydrogen Hub represents an opportunity to take advantage of their natural advantages.

- **Peru H2:** On **March 11, 2022**, **H2 Peru** (the **Hydrogen Industry Association in Peru**) presented its hydrogen strategy roadmap entitled [Bases and Recommendations for the elaboration of the green hydrogen strategy for Peru \(HSR\)](#) (the roadmap report is in Spanish). The **HSR** provides a roadmap for Peru to become a global scale producer of hydrogen.
- **US DOE five-year plan for NZE Waste from PV:** On **March 18, 2022**, the US **DOE** had released an [action plan](#) for the safe and responsible handling of photovoltaic solar panel end-of-life (**EOL**) materials. While the design-life of photovoltaic panel **EOL** materials is 30 years, photovoltaic solar panels have been installed for some time, and getting ahead with a plan for their **EOL** is well-timed.

Commercial Module Recycling Processes



Photovoltaic solar panels comprise cadmium telluride and silicon. Around 95% of each solar panel is recyclable, with the cost between 9 and 15 times the cost of disposing to landfill.

- **Canada Climate Change Report:** On **March 23, 2022**, Canada's [Changing Climate Report in Light of Latest Global Science Assessment \(Climate Change Report or CCR\)](#) was published. The **CCR** is a supplement to

Canada's 2019 Changing Climate Report, updating the earlier report to take into account the findings of the [IPCC Working Group I Climate Change 2021: The Physical Science Basis](#).

- **Alberta picks six:** On **March 31, 2022**, it was reported widely that the province of Alberta, Canada, had selected six proposals to progress in the process to develop the first carbon storage hubs in Canada. It is understood that proposals from the follow are to progress: Bison Low Carbon Ventures, Enbridge Inc., (see [Editions 23](#) and [34](#) of Low Carbon Pulse), Enhance Energy, Pembina Pipeline Corporation and TC Energy (in joint venture), Shell and Wolf Carbons Solutions.

France and Germany:

This section considers news items within the news cycle of this [Edition 37](#) of Low Carbon Pulse relating to France and Germany. Within the news-cycle for this [Edition 37](#), the news-items have come thick and fast.

- **Germany earmarks €200 billion by 2026:** On **March 7, 2022**, the German Finance Minister, Mr Christian Linder, [announced](#) plans to provide funding to enable German industry to accelerate progress towards **NZE**, including funding to accelerate the development of hydrogen technology and to allow the build-out of battery electric vehicle (**BEV**) recharging infrastructure.

By way of reminder: [Edition 36](#) of Low Carbon Pulse reported as follows:

"The German Federal Government wants to progress to 100% renewable electrical energy by 2035. The accelerated target contrasts with the previous target of moving away from fossil fuels "well before 2040".

To achieve this goal the German Federal Government is understood to be progressing amendments to the Renewable Energy Sources Act (**EEG**). It is understood that the **EEG** is ready, and that it will contemplate (and provide a path to) the achievement of photovoltaic solar and wind power reaching 80% of electrical energy used by 2030.

By 2030, it is expected that Germany's on-shore wind farm capacity will have doubled to 110 GW of installed capacity, with off-shore wind field capacity to reach at least 30 GW of installed capacity (equivalent to the output of 10 nuclear energy power stations). Photovoltaic solar installed capacity is planned to reach 200 GW by 2030."

- **Germany and Australia open incubator:** On **March 8, 2022**, Germany and Australia progressed their combined policy settings and as a result opened the [Innovation and Technology Incubator \(HyGate\)](#). It is hoped that **HyGate** will promote Australian and German participants to work together to develop new, and to improve existing, technologies, with the ultimate purpose of reducing the cost of production of hydrogen.

By way of reminder: [Edition 20](#) of Low Carbon Pulse reported on the bi-lateral alliance agreement signed by Germany and Australia relating to hydrogen production, trade in hydrogen, and the facilitation of a renewable energy-based hydrogen supply chain between the two countries. [Edition 31](#) of Low Carbon Pulse discussed the formation of **HyGATE**; **HyGATE** being one of three initiatives contemplated in the [Australia-Germany Hydrogen Accord](#) that signed in June 2021.

- **French State Support for Normand'Hy:**

- **Funding support on time:**

On **March 8, 2022**, it was reported widely (and announced by Air Liquide) that it had received funding support from the French Government.

The **CEO and Chair of Air Liquide, Mr Benoît Potier** said:

"Air Liquide Normand'Hy is at the heart of a vast ecosystem whose ambition is to decarbonise the Normandy industrial basin, notably by giving access to a low-carbon hydrogen network to major industrial companies such as TotalEnergies, but also contributing to the development of low-carbon heavy duty mobility on the Axe Seine".

As noted below (under **France promotes 15 major H2 projects**), Normand'Hy is one of 15 projects in respect of which [Important Project of Common European Interest](#) is sought.

- [Edition 29](#) of Low Carbon Pulse reported as follows (under **The road to Normand'Hy**):

"On October 20, 2021, Air Liquide increased its stake in H2V Normandy, renaming it **Air Liquide Normand'Hy**, so as to accelerate the 200 MW Green Hydrogen production facility at Port-Jerome, using a proton-exchange membrane (**PEM**) electrolyser.

The Green Hydrogen production facility is located within the Normandy carbon cluster / industrial basin, with Air Liquide intending to supply Green Hydrogen to industrial customers and to the mobility / transport sector.

The Green Hydrogen production facility will connect to Air Liquide's existing hydrogen pipeline network in Normandy."

It will be noted that a final investment decision of Air Liquide was dependent on the provision of funding support.

- **France promotes 15 major H2 projects:**

- On **March 9, 2022**, the French Government announced a list of 15 major hydrogen projects to submit to the **EC** each to be designated as an [Important Project of Common European Interest \(IPCEI\)](#).

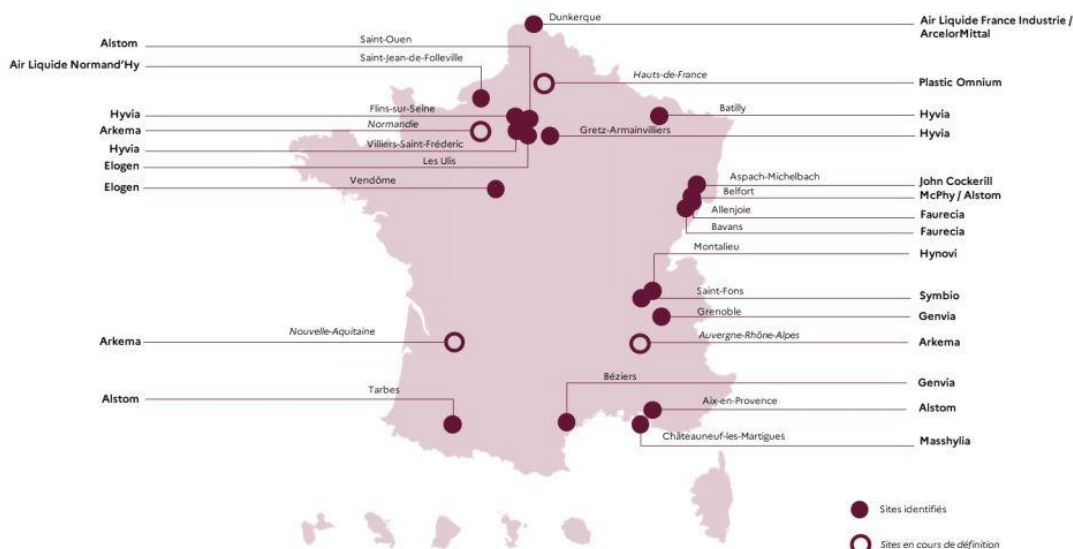
The map below provides detail of the location of each of the 15 projects. The 15 projects will require €7 billion in investment in the medium term, including €2 billion in funding support.

- The **15 projects** may be **grouped into three categories:**

- **Giga-factory developments for electrolysers:** Elogen (see below under **Elogen to establish giga-factory**), Genvia, John Cockerill and McPhy;
- **Manufacture for mobility:** fuel cells (Alstom, HYVIA and Symbio), tanks (Faurecia and Plastic Omnium) and key components (Arkema); and
- **Hydrogen production capacity:** Air Liquide's Normand'Hy project (see above) and the Dunkirk iron and steel project (see [Edition 34](#) of Low Carbon Pulse), Hynovi (Hynamics and VICAT) and Masshlylia (Engie and TotalEnergies).

Les 15 grands projets hydrogène que la France soumet à la Commission européenne dans le cadre du PIIEC

(en jeu, un total de près de 7 milliards d'euros d'investissements,
dont près de 2 Md€ de subventions publiques)



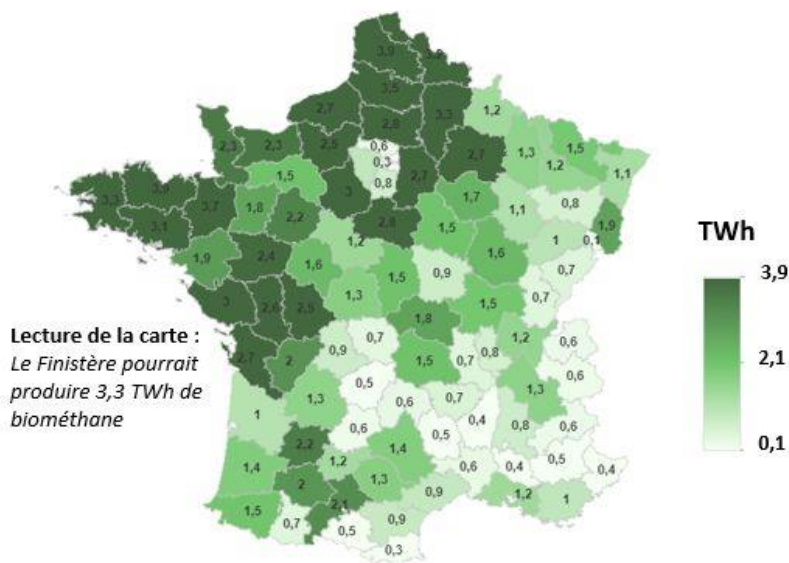
- **France's role in bio-gas and bio-methane production:** As noted above, there are two legs to **RePowerEU**, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and the dash into renewables. As regular readers of Low Carbon Pulse will have noted, biogas and biomethane production has received increasing coverage.

On **March 10, 2022**, the author came across a map of France providing an indication of the potential for France to produce biogas and bio-methane. The headline notes that France could derive up to 320 TWh of electrical energy a year from the use of various technologies to derive and to produce biogas and biomethane as follows: Methanization – 130 TWh; Pyro-gasification – 90 TWh; Hydrothermal gasification – 50 TWh; and Methanation 50 TWh. It is understood that current natural gas energy use equates to 475 TWh a year.

The sources of feedstock for the derivation and production of bigas / biomethane are organic, including from municipal solid waste, crop residues, livestock manure, agri-food industry waste, biowaste, and sludge from waste water.

Potentiel de gaz pouvant provenir de méthanisation en France

Potentiel réaliste de biométhane (en TWh) pouvant être produit par département (hors culture énergétique). Le cumul est égal à 130 TWh.



SOURCE : OPEN DATA RESEAU ENERGIE, 2022

[**Note:** For further information and background, please connect to the [Ashurst Waste Compendium](#)]

- **Germany and Norway aligned:**

- On **March 17, 2022**, it was reported widely that Germany and Norway had discussed the feasibility of the transportation of hydrogen produced in Norway, via pipeline, for delivery to Germany. It is understood that the use of Blue Hydrogen (near to medium term) and Green Hydrogen (medium to long term) is being considered.
- On **March 16, 2022**, a Joint Statement was released as follows:

"Norway wants to [contribute actively] to the rapid development of the hydrogen market in Germany and the EU. To this end, it has been agreed that a joint review will be conducted with a view to make large-scale transport, including via pipeline, of hydrogen from Norway to Germany possible.

We plan to [commission rapidly] a joint feasibility study on this. Germany would like to see Norway become a future partner for the production and supply of hydrogen. In order to realise the fastest possible high-volume imports of hydrogen and ensure rapid availability thereof, [also jointly] we will plan the use of Blue Hydrogen for a transition period.

In this context, we will ensure environmental and climate integrity by establishing for example the highest possible standards of Carbon Capture and Storage".

For the author, this is an early contender for a definitive statement for the theme and trends of 2022 – acceleration and pragmatism.

- **ICE on ice:** On **March 15, 2022**, it was reported widely that Germany had agreed to align with the **EU** to cease the sale of internal combustion engine (**ICE**) vehicles (cars and vans) fuelled by motor spirit (gasoline / petrol) and diesel by 2035, and like e-Fuels.

The following [link](#) provides the **EU** policy setting on the cessation of the sale of **ICEs**.

- **RWE and OGE plan hydrogen backbone:** On **March 24, 2022**, it was reported widely that RWE (the German renewables electrical energy giant) and OGE (a German TSO) had outlined their plans to roll-out hydrogen infrastructure to produce and transport hydrogen, including a 1 GW electrolyser and a 1,500 kilometre, hydrogen pipeline system (the **H₂ercules Project**).

It is reported the **H₂ercules Project** will cost around €3.5 billion.



Source: [Hydrogen fast track: OGE and RWE present national infrastructure concept "H₂ercules"](#)

The **H₂ercules Project** will import Green Hydrogen from Belgium, the Netherlands and Norway. With the developments during March 2022, it is estimated that by 2030, Germany may have 30 GW of Green Hydrogen capacity, around three times as that contemplated in July 2020 by the German Federal Government.

- **French Government back development LNG terminal at Le Havre:** On **March 26, 2022**, it was reported by Les Echos that the French Government is considering, with TotalEnergies, the development of facilities at Le Havre, a northern sea port in France, using an **FSRU**.
- **Italy 2, Poland 1:**
 - On **March 28, 2022**, it was reported widely that Italy is considering the deployment of two **FSRUs**.
 - On **March 31, 2022**, it was reported widely that PGNiG (leading natural gas corporation in Poland) had placed an order for an **FSRU** for deployment in Gdansk Bay, Gdansk, Poland.

It is to be expected that the move to LNG and **FSRUs** will continue, and more likely than not, gather pace.

- **Eni SpA CEO on the mark:** Edition 28 of Low Carbon Pulse reported that Eni SpA Chief Executive, Mr Claudio Descalzi, was promoting the need for energy security policy. On **March 29, 2022**, Mr Descalzi revisited the issue, saying that Europe is "an empty box", saying that it has never had a well thought-out energy strategy.
- **Germany and the Netherlands aligned:** The Federal Government of Germany, North Rhine-Westphalia and the Federal Ministry for Economic Affairs and Climate Action for the Netherlands commissioned the **Hy3 Project (Decarbonising the Dutch and German Industry through Hydrogen)** involving consideration of what a transnational hydrogen economy may look like in 2050. On **March 31, 2022**, it was reported that the **Hy3 Project** study had been published jointly by Forschungszentrum Julich, Dena, and TNO. As might be expected, the key finding of the **Hy3 Project** study is that cooperation between Germany and the Netherlands, in developing a common hydrogen market and common infrastructure, will boost opportunities to realise a decarbonised regional economy. The **March and April Report on Reports** will consider the **Hy3 Project** study.

Australia:

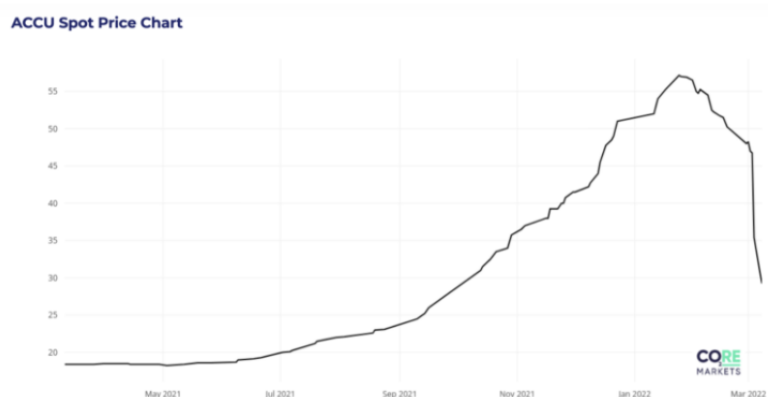
*This section considers news items that have arisen within the news cycle of this **Edition 37** Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita.*

*Australia is however progressing to **NZE** at a faster rate than many other developed countries, and, along with the GCC Countries, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.*

- **ACCUs and Emission Reduction Fund:** On **March 4, 2022**, Australian Federal Minister for Industry, Energy and Emissions Reduction, Mr Angus Taylor, announced that Australian Carbon Capture Units (**ACCUs**) could be sold to buyers of carbon credits seeking to deliver on voluntarily assumed commitments to achieve carbon neutrality (the **proposed change**). (The centre piece of the Australian Federal Government's policy settings to achieve **GHG** emission reductions is the [Emission Reduction Fund](#)).

During the week beginning **March 7, 2022**, the implications of the decision of the Australian Federal Energy Minister, Mr Angus Taylor became apparent, and for the balance of the month there was (and no doubt for some time to come, there will be) an increasing focus on the decision of Mr Taylor, and the legislative basis for the grant of **ACCUs**.

The impact on the price of **ACCUs** is illustrated in the following graph (source: [Australia's carbon market in disrepute, attacked from within and without – pv magazine Australia \(pv-magazine-australia.com\)](#))



The impact on the price of **ACCUs** may be regarded as unsurprising given the announcement made by Minister Taylor. What has been surprising is the accompanying narrative, in particular from Professor Andrew Macintosh (chair of the Integrity Committee of the Emissions Reduction Fund for six years):

"The available data suggests that 70 to 80% of the ACCUs issued to these projects [i.e., under the Emissions Reduction Fund] are devoid of integrity – they do not represent real and additional abatement".

As might be expected, a number of industry participants and experts have suggested that the Federal Australian Government reconsiders the **proposed change**, including as part of a wider review.

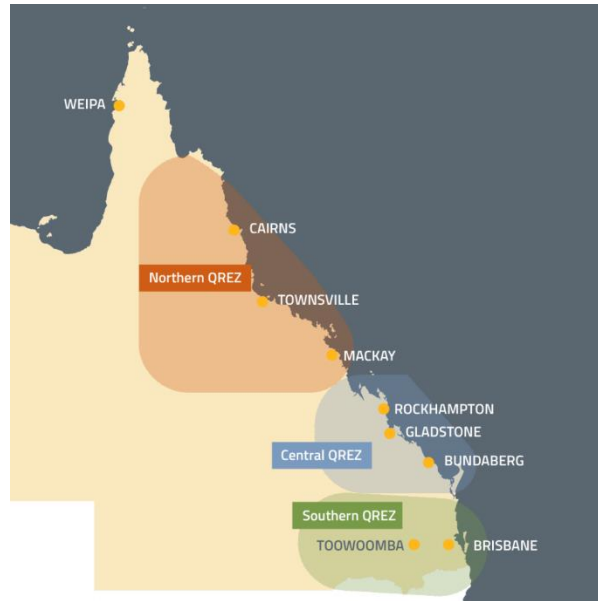
- **Western Australia Legislation:** On **March 9, 2022**, the Western Australian Government [announced](#) that it is drafting the Greenhouse Gas Storage and Transport Bill to help Western Australian to transition to **NZE** by 2050.
- **Port Bonython Hydrogen Hub:** On **March 11, 2022**, the South Australian Government [announced](#) partners for the development of the Port Bonython Hydrogen Hub.
- **Queensland Government confirms thinking on Queensland Renewable Energy Zones:**
 - **Edition 31** of Low Carbon Pulse reported as follows:

"**Queensland continuing to deliver:** In November 2021, the Queensland Government released [Consultation on the model for QREZ design and access – Delivering Queensland Renewable Energy Zones](#). The consultation is being undertaken to develop the models for the delivery of the three Queensland Renewable Energy Zones (**QREZs**), Northern, Central and Southern, with the delivery of the **QREZs** being aligned with the achievement of Queensland's commitment to reduce **GHG** emissions by 50% by 2030.

There has been a good deal of comment about the consultation paper, with an apparent consensus that more than 3.3 GW of renewable electrical energy contemplated will be required."

The **November and December Report on Reports** considered the consultation paper in more detail.

- On **March 14, 2022**, the Queensland Government confirmed the **Central QREZ**, **Northern QREZ** and the Southern **QREZ** as follows:



- NSW Ahead of the curve:** On **March 24, 2022**, it was reported widely that the Government of New South Wales (NSW) has announced an expression of interest process under which interested private sector parties could register interest to develop a standby 700 MW / 1,400 MWh Waratah Super Battery (a **Very Big BESS**).

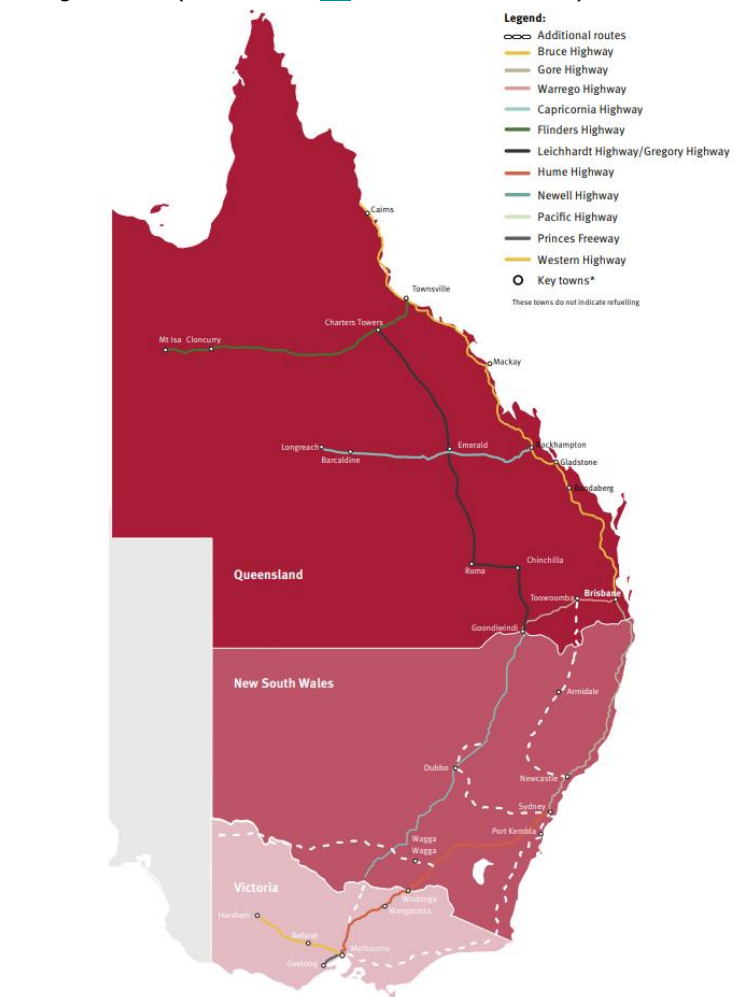
The **Very Big BESS** is to be located on the Central Coast region of NSW and is critical to the maintenance of integrity and stability of electrical energy supply in response to the announcement by Origin Energy of its intention to shutter the 2,880 MW Eraring Coal-fired Power Station in August 2025 (see **Edition 35** of Low Carbon Pulse).

- Eastern Sea-board States – Nation Building (again):** On **March 25, 2025**, it was reported widely that the Governments of the Australian States of New South Wales, Queensland and Victoria are to develop the **East Coast Hydrogen Refuelling Network**.

The timing and the thinking behind the **East Coast Hydrogen Refuelling Network** is clear for all to see, but it is not often that Governments take a lead that works at so many levels, critically to allow the development of supply to satisfy domestic demand that will be encouraged by the development of the Network.

Australia has world class renewable energy resources, and as such the ability to produce hydrogen, but scale is needed, and in the first instance this scale will be achieved through domestic demand.

(Source: [East Coast Renewable Hydrogen Refuelling Network \(hpw.qld.gov.au\)](https://www.hpw.qld.gov.au/))



Blue and Green Carbon Initiatives and Biodiversity:

This section considers news items that have arisen within the news cycle of this **Edition 37** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.

- **Blue Carbon report:** On **March 9, 2022**, the [Blue Marine Foundation](#), working with the University of Exeter and support of DP World (global leading cargo logistics, port terminal operations and maritime and landside services) published a report entitled [Blue Carbon In the United Kingdom](#). The report is well-worth a read.
- **Blue Carbon, Sindh Province, Pakistan:** On **March 10, 2022**, Respira International [announced](#) that it had purchased some of the first tranche of carbon credits (Delta Blue Carbon Project (DBC-1)), together with Carbon Growth Partners and Trafigura. The source of the carbon credits are the world's largest mangrove swamp restoration project, and as such a leading Blue Carbon project: it is understood that the Delta Blue Carbon Project is restoring more than 73,000 hectares of degraded mangrove swamps and tidal wetlands.

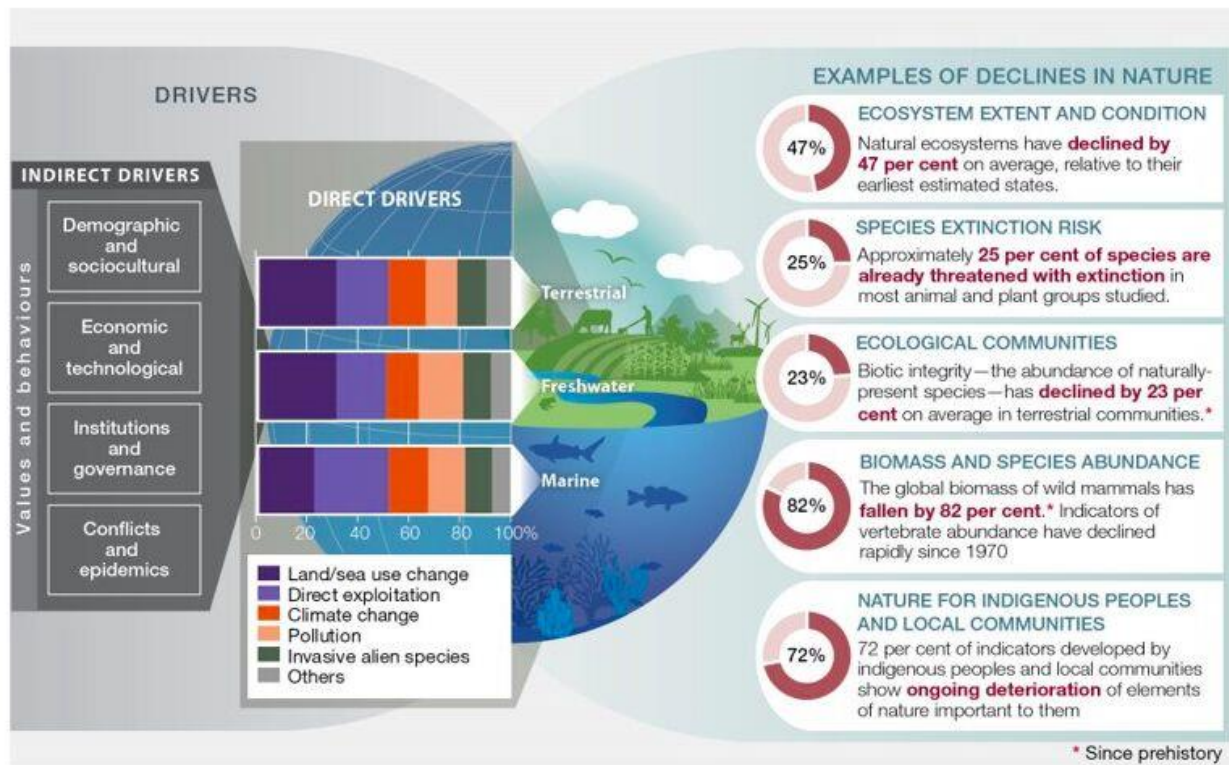
The Delta Blue Carbon Project has been developed by [Delta Capital](#), the Government of Sindh and [Pollination Group](#).

Soil loss: In a [study](#) (from the University of Massachusetts Amherst) published in the [Earth's Future](#) journal, it is stated that since the mid-1900s in the mid-west US, on average, two millimetres of soil has been lost each year (the **Soil Loss Study**). Stated by mass, this is 56 billion tonnes of soil in total.

While some of the findings in the study continue to be tested, it seems that the cause of soil loss is clear, the use of ploughing technology has contributed materially and significantly.

If one sits the findings of the **Soil Loss Study** alongside the finding from a study from [Nature.com](#) (entitled **Relocation croplands could drastically reduce the environmental impacts of global food production**) it is possible to discern patterns, and to develop thinking around longer-term planning.

- **Bioplastic whitepaper:** On **March 15, 2022**, Carbion and TotalEnergies published [Sustainable sourcing of feedstocks for bioplastics](#) – Clarifying sustainability aspects around feedstock use for the production of bioplastics. For those interested in plastics generally, and bioplastics in particular, the publication is excellent.
- **Biodiversity paper:** On **March 15, 2022**, **UNEP-WCMC** published the following infographic. The infographic provides a helpful snap-shot summary of the factors that impact biodiversity, directly and indirectly.

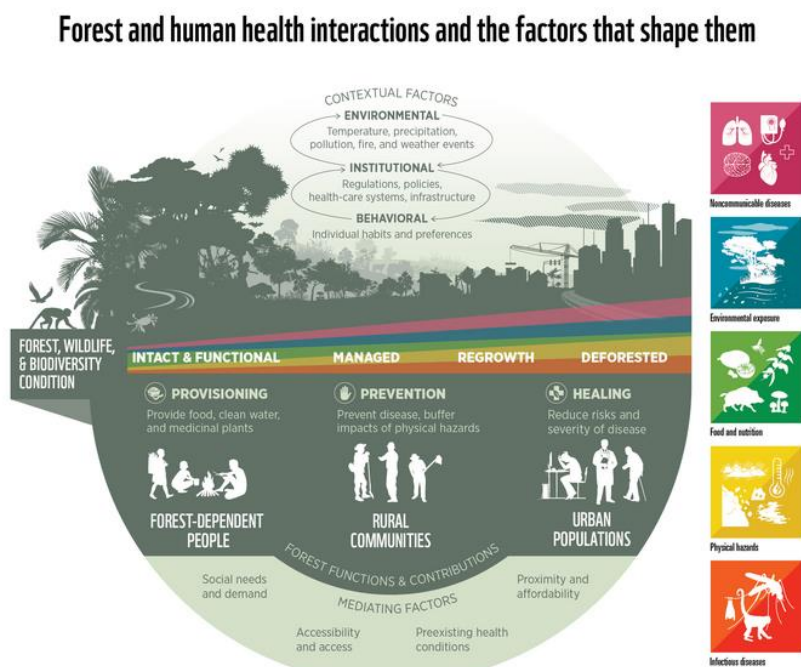


Examples of global declines in nature, emphasizing declines in biodiversity, that have been and are being caused by direct and indirect drivers of change (IPBES, 2019)

- **Blue Carbon in Indonesia:** On **March 16, 2022**, [EcoShape](#) published [Building with Nature in Indonesia: Restoring an eroding coastline and inspiring action at scale \(2015-2021\)](#). The publication outlines the action taken to restore coastline in Central Java that has been eroded. The action taken allows the stabilization of coastline so as to allow mangroves to seed and to grow, and, overtime, to develop (to some, to restore) aquaculture options. The publication is well-worth a read, in particular for countries in South East Asia and across the Pacific.
- **30% of land preservation:** In recent months, there has been a growing acceptance of the need to preserve at least 30% of land mass of each country to its natural or wild condition, or to restore land mass so as to achieve this goal. The thinking on this policy setting is not new, but it appears to have become a plank of policy setting. The thinking on this policy setting, and the 30% goal, will allow conservation of biodiversity and contribute to the capture of **CO₂**, and in so doing mitigate the effect of climate change. The preservation of at least 30% of land mass will safeguard the **CO₂** stored in the biosphere and over time increase the **CO₂** stored (see the United Nations Environment Programme World Conservation Monitoring Centre (**UNEP-WCMC**) report entitled [Strengthening](#)

Synergies: How action to achieve post-2020 global biodiversity conservation targets can contribute to mitigating climate change).

- **International Day of Forests (or International Forest Day): March 21, 2022**, was International Day of Forests. As noted in **Edition 33** of Low Carbon Pulse, life on earth is a result of forests, and as such the preservation of forests, stopping deforestation, and progressing afforestation and reforestation are existential. As might be expected, an array of publications arose to mark the day, including UN Climate Change publication, **Why Forests are our biggest ally in tackling the climate crisis – And why we should begin to treat them like one**, and the **Respira International** publication, **Why invest in forest conservation first**. The following graphic provides a helpful reminder:



(Source: World Wildlife Fund, **How Forests Provide, Prevent and Heal | Blog Posts**)

By way of background, attached is a [link](#) to the **Global Biodiversity Outlook 5** (the flagship publication of the Global Biodiversity Outlook) that summarises data on biodiversity, noting that forests provide one of frameworks for biodiversity – Land and Forests.

- **Blueprint For Nature:** From **March 14 to March 29, 2022**, the **Open-ended Working Group on the Post-2020 Global Biodiversity Framework** met in Geneva, Switzerland. The purpose of the meeting was to advance work on the development of the **Global Diversity Framework**, with the purposes of the **Global Diversity Framework** to address the loss of habitat and resulting loss of biodiversity. As noted in **Editions 33 and 34** of Low Carbon Pulse, later in 2022, the second part of **COP 15** will take place in the **PRC**. During the first part of **COP-15** the **Kunming Declaration** was adopted, addressing bio-diversity loss. As might be expected, the **Open-ended Working Group** was accompanied by multiple narratives – for example, Wetland International continued to emphasise the importance of wetlands (covering 7% of land mass, and home to 40% of the world's diversity). On **March 23, 2022**, Wetland International published an [article](#) on the key issues for wetlands in the context of the development of the **Global Diversity Framework**. On **March 29, 2022**, a [press release](#) was published, noting progress around targets and supporting mechanisms. It is clear however that a good deal of work needs to be done ahead of, and at, the second part of **COP 15**.

Bioenergy and heat-recovery:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass. **Bioenergy** includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form. In addition, recovered heat and waste heat (derived from any source, including waste water) has been added to this section. From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted. The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.*

- **Biogas and Biomethane:** As noted above, there are two legs to the **RePowerEU** policy settings, near to medium term energy security (through diverse sources of natural gas supply, delivered into the EU as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and the dash into renewables.

The role that biogas and biomethane has to play is likely to increase, and to do so dramatically in the near to medium term as renewable sources of feedstock are sought and used to derive or to produce biogas / biomethane as part of the means of assuring near to medium term energy security in the **EU**. By some estimates, by 2030 up to 35 billion m³ of biogas / biomethane may be derived or produced, and by 2050 up to 100 billion m³.

Continuing the theme of clear policy settings, it would make sense for the Renewable Energy Directive to contemplate the role of biogas / biomethane specifically.

- **Fortum and Microsoft – world first:** On **March 17, 2022**, Fortum [announced](#) that it had entered into a unique project with Microsoft, with Fortum (Finnish state-owned utility company) to capture excess heat generated by a new data centre region to be built by Microsoft in Helsinki, Finland.

The data centres will use electrical energy from renewable sources, and the clean heat arising from the data centres will be used to heat premises that are connected to the Fortum district heating system. The location for the data centres was chosen to allow the capture of clean heat, and its use in the district heating system.

As President and CEO of Fortum, Mr Markus Rauramo said:

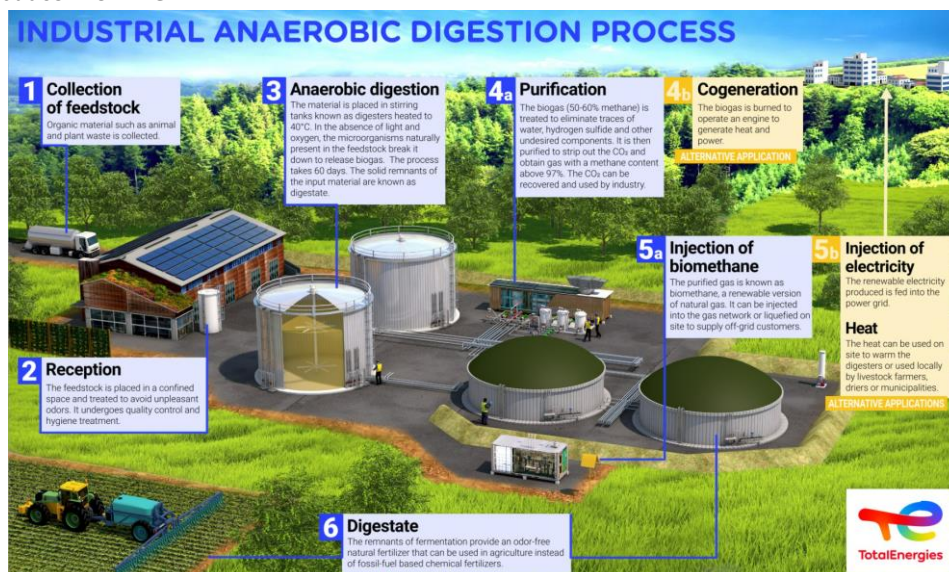
"Sometimes the most sustainable solutions are the simple ones: by tapping into waste heat from data centres, we can provide clean heat for homes, businesses and public buildings in Espoo's and the neighbouring communities district heating network in Finland, and reduce about 400,000 tonnes of CO₂ emissions annually".

- **Repeat of TotalEnergies' infographic:** It would not be an edition of Low Carbon Pulse without an excellent infographic from the good folk at TotalEnergies.

Edition 34 included an infographic entitled [TotalEnergies' Aerobic Digestion Ecosystem infographic](#). **Edition 35** of Low Carbon Pulse included an infographic entitled [Hydrogen Production Ecosystem](#).

As a sibling to the **TotalEnergies' Aerobic Digestion Ecosystem infographic**, the infographic below provides an excellent overview of a biogas plant using anaerobic digestion technology to derive biogas from organic biomass (feedstock). Given the increased focus of bioenergy (including biogas and biomethane, we have repeated it.

The biogas produced from the plant is itself feedstock for the production of biomethane (in the US referred to as **Renewable Natural Gas** or **RNG**), which can be compressed to produce compressed natural gas or **Bio-CNG** or liquified to produce **Bio-LNG**.



Attached is a [link](#) to the Ashurst Waste to Wealth Compendium including articles on waste, waste technologies, and anaerobic digestion.

BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "**BESS** storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events". The **November and December Report on Report** provides a summary of the LDES Council and McKinsey report from November 2021 (see [Second Compendium of Low Carbon Pulse](#))

- **RWE develops HESS:** On **March 7, 2022**, it was reported widely that RWE (the German electrical energy giant), through RWE Gas Storage West, plans to develop a **HESS** at Kottiger Hook in Gronau, Germany by 2027. The **HESS** will use an underground salt cavern, with connection to above ground dispatch storage.

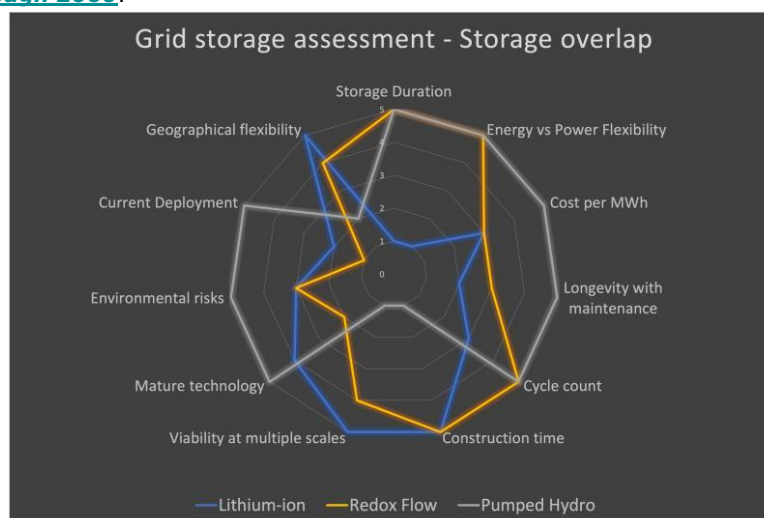
As noted in previous editions of Low Carbon Pulse, the development of **HESS** is key to the development of the hydrogen ecosystem. By way of background, the following link is to a [British Geological Survey](#) article (entitled **Safe storage of hydrogen in porous rocks: the challenges and the knowledge gaps**), which is an excellent primer.

- **AGL Energy gets green light for green project:** On **March 8, 2022**, it was reported widely that AGL Energy (one of the three large integrated energy corporations in Australia), had been given approval to develop and to deploy a 500 MW / 2000 MWh **BESS** at the site of the Liddell coal-fired power station in the Hunter Valley, New South Wales (the Liddell coal-fired power station to be shuttered completely by 2023, with shut-down of units having commenced).
- **Quidnet Energy:** On **March 9, 2022**, [cleantechnica.com](#) reported (under [High Pressure Water Energy Storage Coming to San Antonio](#)) that it intends to develop a Geothermal Pumped Storage (**GPS**) facility in San Antonio, Texas, having signed a 15 year agreement with **CPS Energy** (the municipal electric utility serving the city of San Antonio).

GPS uses Quidnet Energy technology (based on technology developed by the oil and gas industry), with water pumped underground, for these purposes using excess renewable electrical energy, which water is stored under pressure, with the water then released from storage to drive hydroelectric turbines to generate renewable electrical energy. (Quidnet Energy has backing from [Breakthrough Energy](#).)

- **Grid Storage Assessment:** On **March 15, 2022**, the author came across the following graphic providing a basis for the assessment of storage means and solutions across a grid.

The graphic is taken from an excellent article by Michael Bernard entitled [Longer term grid storage is a massive growth market through 2060](#).



Source: [illuminem.com](#)

- **CIP and Alcemi make gold:** On **March 15, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) and Alcemi had combined to develop 4 GW of **BESS** across the UK. It has been reported that **CIP** will lead procurement and development activities, with the first **BESS** to be energised in 2023.
- **EDF Pivot Power BESS:** On **March 22, 2022**, it was reported widely that Pivot Power (a subsidiary of EDF) has been granted approval to develop and to deploy two **BESSs** (each of 50 MW / 100 MWh) in the UK – one at Sundon, Luton (to go live in 2023), and the other at Indian Queens, Cornwall (to go live in 2024).

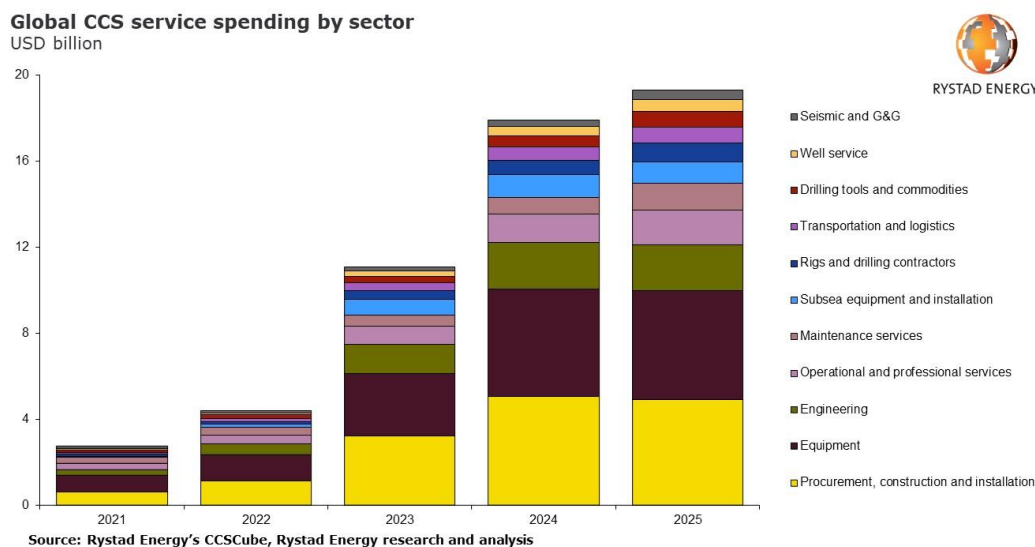
The two **BESSs** are part of the Pivot Power Energy Superhub project to roll-out up to 2 GW of **BESS** capacity across the UK: to date Pivot Power has gone live with **BESSs** in West Midlands (two 50 MW / 100 MWh) and Oxford.

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

This section considers news items that have arisen within the news cycle of this **Edition 37** of *Low Carbon Pulse* relating to carbon accounting and carbon dioxide removal (CDR), including bioenergy carbon capture (BECCS), bioenergy carbon capture use and storage (BECCUS), carbon capture and storage (CCS), carbon capture use and storage (CCUS) and direct air capture (DACs). Effective accounting for carbon arising and CDR go hand-in-hand. By way of background CDR is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (BECCS), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (DACs) are all means of CO₂ removal. The IEA pathway to NZE estimates that in order to achieve NZE it will be necessary to capture and to remove up to 7.6 giga-tonnes of CO₂ each year through CCS, CCUS and CDR. CCS and CCUS (and BECCS and BECCUS) involve the capture at the source of CO₂, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.

- **Talos Energy Good to Go:** On **March 16, 2022**, it was reported widely that Talos Energy had executed lease documentation with the Texas General Lease Office in respect of the previously announced carbon capture and sequestration site located off-shore Jefferson County, Texas. (**Edition 35** of *Low Carbon Pulse* has earlier coverage.)
- **Rystad Energy presses CCS:** On **March 17, 2022**, the good folk at Rystad Energy made a press release in respect of their findings about the increased use of CCS.

The Rystad Energy analysis in the near term is detailed in the following bar chart:



• CCS Databases:

- During the **week beginning March 14, 2022**, the author of *Low Carbon Pulse* came across the US **DOE** National Renewable Energy Laboratory (**NREL**) **Carbon Capture and Storage Database**, which includes information on active, proposed and discontinued CCS projects around the world.

The **NREL Carbon Capture and Storage Database** has been developed from publicly available information globally, and includes details of the evaluation of sites for CO₂ storage, estimated project development and operation costs, mass of CO₂ captured / stored and the technologies deployed.

For those active in CCS, the **NREL Carbon Capture and Storage Database** is both a helpful summary and tool.

- On **March 24, 2022**, **CO₂ Value** launched a **New CCU Project Database**. The New CCU Project Database is available publicly (hence the link), and provides a reference for CCS / CCUS projects across Europe.
- On **March 24, 2022**, the **Clean Air Task Force** launched its **Carbon Management Tracker**, mapping carbon capture projects in the Middle East and North Africa.

The accompanying narrative from the Clean Air Task Force notes that the number of projects (ten in total, five of which are already in operation) is relatively small compared to the US and Europe, and very small given the estimated capacity of the Middle East and North Africa to store CO₂ (estimated to be at least 492 billion tonnes (or 492 giga-tonnes) of CO₂, or around 10 times the aggregate mass of CO₂-e emissions arising globally each year.

By way of a reminder, under **Mapping CO₂ storage in the US**, **Edition 34** of *Low Carbon Pulse* reported on the **Atlas of Carbon and Hydrogen Hubs from the Great Plains Institute** and the US DOE **Carbon Storage Atlas**.

- **First BECCS:** On **March 22, 2022**, **Bellona.org** reported (under **Oslo leading by example: world's first CO₂ capture and storage on waste incinerator to become reality in 2026**) that the Klemetsrud CO₂ capture and storage project will be the world's first waste-to-energy plant with full scale CCS (BECCS depending on one's view). The Bellona Foundation is working with City of Oslo and Fortum Oslo Varme for seven years to realise this outcome.
- **Pulling up DACs to capture CO₂:** On **March 23, 2022**, Occidental Petroleum Corp announced that it intends to develop and to deploy up to 70 carbon capture facilities globally by 2035, with each CC facility to capture as much as 1 million metric tonnes of CO₂ directly from the atmosphere (and otherwise from the climate system).

The construction of the first CC DAC plant (located in the Permian Basin, West Texas) is expected to start during the second half of 2022, with operational completion scheduled for Q4 of 2024.

Carbon Credits and Hydrogen Markets and Trading:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development of hydrogen markets and trading (bilateral and likely wholesale).

• Climate Impact X:

- **CIX partners with Carbonplace:** On **March 25, 2022**, The [Business Times.com](https://www.businesstimes.com) reported that CIX had partnered with Carbonplace (a carbon credit settlement platform, developed by seven banks - BNP Paribas, CIBC, Itau Unibanco, National Australia Bank, NatWest Group, Standard Chartered and UBS).

The purpose of the partnership is to lower the cost of entry to corporations seeking to acquire high-quality carbon credits in the voluntary carbon market which CIX is to facilitate.

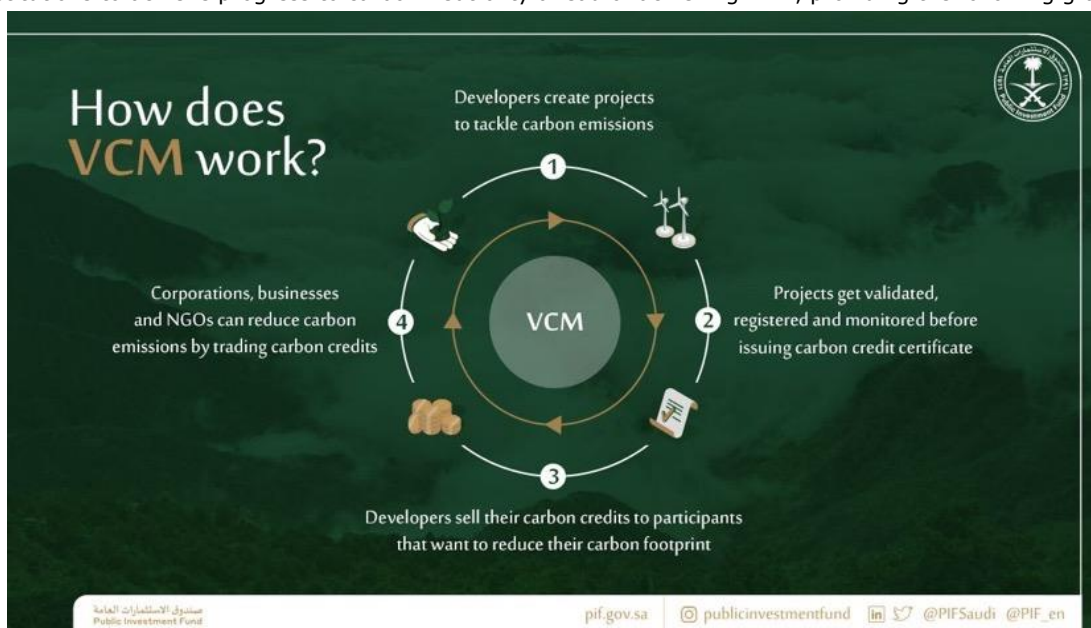
- **By way of reminder:** As reported in **Edition 18** of Low Carbon Pulse, "On May 20, 2021, plans for a new global carbon exchange were announced. The global carbon exchange is to be located in Singapore. DBS Bank, Singapore Exchange, Standard Chartered Bank and Temasek have established a joint venture, **Climate Impact X (CIX)**, for this purpose". The stated intention of the **CIX** is to provide "high-quality carbon credits to address hard-to-abate emissions".

Managing Director of the Monetary Authority of Singapore, Mr Ravi Menon, noted that the **CIX** represented the adoption of a "twin strategy" of the reduction of **GHG** emissions and the off-set of **GHG** emissions, which provides a "practical and effective" way to achieve the Paris Agreement Goals.

On **March 3, 2022**, it was reported widely that DBS Bank, Standard Chartered Bank, and Temasek are continuing to put in place the arrangements to allow the development of **CIX**. It has become increasingly clear that **CIX** will provide a trading platform for high quality carbon credits / carbon offsets. The standalone article entitled **Carbon Credits, Article 6 and the Paris Rulebook** will provide a detailed perspective on the importance of effective trading platforms.

• MENA Voluntary Carbon Markets:

- On **March 25, 2022**, Ms Riham ElGizy reported (on LinkedIn) that it had been a Big Day for the MENA regional Voluntary Carbon Market (**VCM**), with the announcement of the first five potential partners in the market, Aramco, Saudi Airlines, ACWA Power, Maaden and ENOWA. Low Carbon Pulse will follow the development of the market.
- On **March 24, 2022**, the PIF announced that the **VCM** will provide the means to connect corporations and institutions (and investors) with a supply of quality carbon credits, so as to allow those corporations and institutions to achieve progress to carbon neutrality ahead of achieving **NZE**, providing the following graphic.



(Source: [Public Investment Fund \(PIF\)](https://www.pif.gov.sa) | [LinkedIn](https://www.linkedin.com/company/public-investment-fund))

- On **March 29, 2022**, the Abu Dhabi Global Market (the UAE's financial free zone) [announced](https://www.adgm.com) that it was partnering with AirCarbon Exchange to create the "world's first fully integrated" carbon trading exchange and clearing house.
- **Mandatory Markets as a contrast:** On **March 30, 2022**, the **ICAP Status Report 2022** was [published](https://www.icap.com), with the headlines being that there 25 emissions trading schemes globally, covering 17% of global GHG emissions (9 Gt of **CO₂-e**).

The **ICAP Status Report** is well-worth a read, and provides a helpful contrast the developing momentum in respect of the Voluntary Carbon Markets, and the development of trading platforms to market carbon credits.

E-fuels & feedstocks / Future Fuels & Feedstocks / Now Fuels & Feedstocks:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and **Future Fuels** (energy carriers derived and produced that are characterised as clean carbon or low carbon fuels). **E-fuels** include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.

- **EDF Renewables and Hynamics Tees Green Hydrogen:** On **March 9, 2022**, it was reported widely that EDF Renewables (a subsidiary of Electricite de France) and Hynamics (Electricite de France's hydrogen subsidiary) are to develop a new photovoltaic solar farm (EDF Renewables) that will supply renewable electrical energy to produce Green Hydrogen using an electrolyser (from Hynamics), the sizing of which is 50 MW, but with expansion to 500 MW over time to allow supply to develop in line with demand. The renewable electrical energy to power the electrolyser will be sourced from the photovoltaic solar farm, and from the off-shore wind field that EDF Renewables is developing. The Green Hydrogen produced by the [Tees Green Hydrogen](#) project will assist in the decarbonisation of industrial activities on Teesside, including the production of iron and steel by British Steel.
- **AP Moller – Maersk and Ørsted aligned:**
 - **Edition 26** of Low Carbon Pulse reported on the decision of A.P. Moller - Maersk to order eight dual fuel container vessels (with an option for a further four), capable of being powered and propelled by methanol. In reporting on this decision it was noted that A.P. Moller – Maersk was aware of the need to continue to procure supplies of methanol. As noted in editions of Low Carbon Pulse then and since, one of the key risks for A.P. Moller - Maersk in procuring dual fuel container ships was the supply of sufficient clean or low carbon methanol.
 - **Methanol supply:**
 - On **March 10, 2022**, Ørsted announced that it had signed a letter of intent with A.P. Moller - Maersk to develop a Power-to-X-facility on the US Gulf Coast to produce e-methanol to fuel A.P. Moller -Maersk's dual fuel container vessels.
The Power-to-X-facility contemplated will be world scale – a 675 MW Power-to-X-facility able to produce 300,000 metric tonnes of e-methanol a year. The Power-to-X-facility will be powered by 1.2 GW of renewable electrical energy from off-shore wind fields and photovoltaic solar farms to be developed by Ørsted.
 - On **March 10, 2022**, Proman [announced](#) that it had signed a cooperation agreement under which, among other things, Proman will aim to supply A.P. Moller - Maersk with between 150,000 to 200,000 metric tonnes of bio-methanol from its 200,000 metric tonne a year facility. The feedstock for the production of the bio-methanol is stated to be otherwise non-recyclable forest residues and municipal solid waste. (Proman has an existing methanol facility in Pampa, Texas.)
 - On **March 10, 2022**, A.P. Moller - Maersk [announced](#) (by way of something of a summary) that it had entered into six strategic partnerships globally to scale Green Methanol production by 2025, with partners CIMIC, ENRIC, European Energy (see below), Green Technology Bank, Ørsted (see above), Proman (see above) and WasteFuel (see **Edition 32** of Low Carbon Pulse).
CEO of Fleet & Strategic Brands, A.P. Moller – Maersk, Ms Henriette Hallberg Thygesen said: *"To transition towards decarbonisation, we need a significant and timely acceleration in the production of green fuels. Green Methanol is the only market-ready and scalable available solution today for shipping. Production must be increased through collaboration across the eco-system around the world. That is why these partnerships mark an important milestone to get the transition to green energy underway"*.
 - **Business to Business:** While clear policy settings are needed from governments globally to provide assurance or at least guide rails in the development of supply and demand in making progress towards the achievement of **NZE**, it is clear that major corporations are able to develop supply on the basis of a clear line of sight to demand. A.P. Moller – Maersk continues in the vanguard of leading corporations making decisions that will reduce **GHG** emissions arising from shipping.
One of the privileges of writing Low Carbon Pulse is following the progress that is made by leading corporations in progress to achieving **NZE**, as the following **By way of reminder** illustrates.
- **By way of reminder:**
 - **Edition 26** of Low Carbon Pulse covered in detail the decision by A.P. Moller – Maersk to accelerate "the rate of its fleet decarbonisation with an order for eight container vessels capable of being powered and propelled using carbon neutral methanol. With each container vessel costing USD 175 million, this is a USD 1.4 billion commitment. The eight container vessels are to be built by Hyundai Heavy Industries (**HHI**) and delivered in 2024. The multi-vessel shipbuilding contract with **HHI** gives Maersk an option for four additional container vessels. As would be expected, the engines will be dual fuel, to allow the use of both low carbon methanol and low sulphur heavy fuel oil. As noted in previous editions of Low Carbon Pulse, **HHI** has been working on the dual fuel technology for some time with MAN ES and Alfa Laval (see **Edition 21** of Low Carbon Pulse)".
 - **Edition 26** of Low Carbon Pulse noted that: "Possibly the most stated and restated theme in Low Carbon Pulse (and sibling publications relating to hydrogen and hydrogen-based fuels) is the need for supply and demand for hydrogen and hydrogen based energy carriers to develop in tandem.
In the announcement of the order for the eight container vessels, Mr Soren Skou noted that: " .. *this is a firm signal to fuel producers that sizeable market demand for the green fuels of the future is emerging at speed*". It is understood that Maersk will use **carbon neutral e-methanol or sustainable bio-methanol** as soon as possible. Also it is understood that in the near to medium term, the supply of low carbon methanol is likely to be challenging. To address this challenge, it should be expected that A.P. Moller – Maersk will increase demand from corporations with which it has existing supply arrangements, and contract with other corporations for supply".

- **Petronas and ENEOS making progress:** On **March 11, 2022**, it was reported widely that Petronas (the national oil company of Malaysia) and ENEOS (leading hydrocarbon importer into, and refiner in, Japan) are undertaking a feasibility study jointly to assess hydrogen production and a conversion project to use hydrogen as a feedstock to produce a clean / low carbon energy carrier / vector. Also it is understood that the feasibility study will consider the production of Green Hydrogen.

By way of reminder: Edition [27](#) of Low Carbon Pulse reported that **ENEOS** and **Petronas** (the national oil company of Malaysia) signed a memorandum of understanding for the development, jointly, of a clean hydrogen supply chain between Malaysia and Japan.

- **A Guide to Policy Making:**

- On **March 20, 2022**, **IRENA** published [Green Hydrogen For Industry – A Guide to Policy Making](#). The publication is both a summary and reference guide, and is well-worth a read.

There is nothing new in **Green Hydrogen For Industry – A Guide to Policy Making**, but there are helpful points of reference; touchstones for those developing and implementing policy settings as follows:

- **Policy makers have a number of solutions to effect energy transition** "with Green Hydrogen being one of them alongside electrification, energy efficiency, greater material efficiency, a circular economy approach, higher energy efficiency and carbon capture measures. These solutions are not in competition with each other. Instead, they can complement each other when proactive policy making is in place".
- **Policy setting for Green Hydrogen strategy relies on the assessment of different factors**, critically "technological readiness of the decarbonisation solutions and the potential size of the local hydrogen demand";
- **Policy makers can devise policy settings to support Green Hydrogen and the energy transition** in the difficult to decarbonise industry sectors and can do so "through a careful assessment of the experiences in the renewable energy sector as well as by considering the distinctive nature of the [applicable] industrial sector".

As noted, this is nothing new in this, rather it is a synthesis of good sense, a guide to thinking, not a tool-kit.

- **By way of reminder:** In 2020, **IRENA** published an initial report considering Green Hydrogen policy settings: [Green Hydrogen: A Guide to policy setting](#), followed by [Green Hydrogen Supply: A guide to policy making](#) in 2021. In addition, **IRENA** has published the following on Green Hydrogen since 2018: [Hydrogen from renewable power: Technology outlook for the energy transition](#) (2018), [Hydrogen: A renewable energy perspective](#) (2019), [Reaching zero with renewables](#) (2020), [Green Hydrogen Cost reduction: Scaling up electrolyzers to meet the 1.5°C climate goal](#) (2020), [Renewable energy policies in a time of transition: Heating and Cooling](#) (2020), [Enabling Measures Roadmap for Green Hydrogen](#) (2021) (with the World Economic Forum), and [Geopolitics of the Energy Transformation: The Hydrogen Factor](#) (2022).
- **bp Energy Outlook out:** On **March 14, 2022**, bp released its [Energy Outlook 2022](#).

The key takeaways for the author from the **bp Energy Outlook 2022** edition are as follows (tying to the three current scenarios described):

- **Accelerated:** There has been an increase in the ambition and acceleration of policy settings among some countries, but more ambition and acceleration is required;
- **Net Zero:** There has been an acceleration in the level of installation of photovoltaic solar and wind capacity, increased sales of EVs and the rate of progress of CCS / CCUS projects contemplated has increased markedly;
- **New Momentum:** There has been new momentum broadly across progress to addressing climate change, including decarbonisation and as such **NZE**.

The key takeaways need to be considered against the realities of increasing mass of **GHG** emissions year-on-year (with the exception of 2020), and as such the increased rate of consumption of the finite carbon budget.

- **Hyzon and Raven SR progressing:** Edition [16](#) of Low Carbon Pulse and [Hydrogen for Industry – Hydrogen from Waste](#) reported on the joint venture between Hyzon and Raven SR to derive and to produce hydrogen from waste. From the level of reporting, it would have been apparent to the reader that the writer of Low Carbon Pulse considered the development as both material and significant.

On **March 15, 2022**, it was reported widely that Samsung Ventures had joined Chevron Corporation, Itochu Corporation and Ascent H2 Fund in backing Raven SR in respect of its first waste to hydrogen plant in northern California. Under the deal between Samsung Ventures and Raven SR, Raven SR is to work with Samsung C&T (as sibling corporation of Samsung Ventures) to "advance the scalability" of the Raven SR technology to develop and to deploy it in the Asian market.

On **March 30, 2022**, it was reported widely that Raven SR was to develop a hydrogen from waste facility in Aragon, Spain. As reported, the facility will treat 75 metric tonnes of organic waste a day to produce 1,600 metric tonnes of hydrogen a year.

- **CH4, H2 and NH3 Terminal News:**

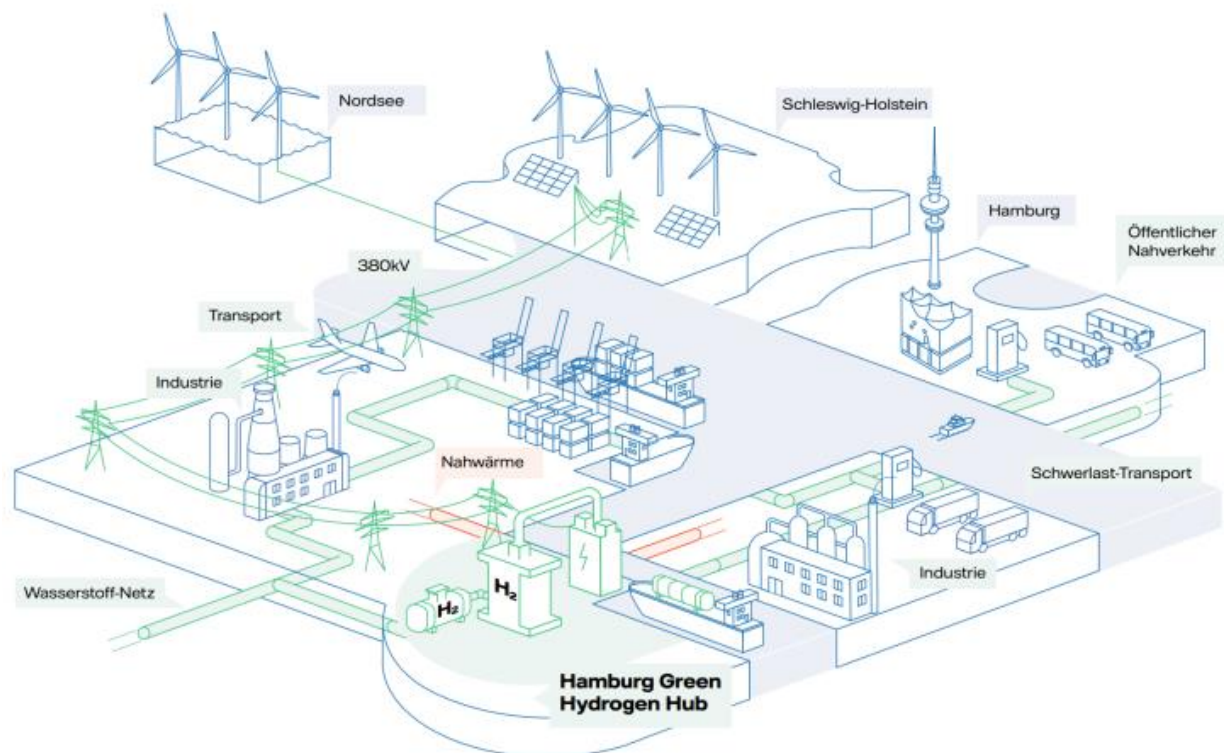
- **LNG Terminals progressing:** Edition [36](#) of Low Carbon Pulse reported that "the German Federal Government had asked Uniper to resume its plans to develop an LNG receiving terminal in Wilhelmshaven as the Federal German Government develops its thinking around energy security. As originally planned, Uniper intended to develop a 7.3 million metric tonnes per annum floating storage receiving terminal (**FSRU**).

In addition to an **FSRU** at Wilhelmshaven, the Federal German Government wants to develop and deploy an LNG receiving terminal at the North Sea Port town of Brunsbüttel. The LNG receiving terminal at Brunsbüttel had been planned for a while by joint venturers Gasunie (a Dutch natural gas infrastructure and transportation company) and Oiltanking (a logistics service provider of tank terminals for petroleum products, chemicals, and gases), a subsidiary of Marquard & Bahls AG), with Vopak reported as passive in the joint venture."

Edition [36](#) of Low Carbon Pulse reported that it was "understood that RWE expressed interest in use of the LNG receiving terminal at Brunsbüttel to re-gasify LNG imported from Australia".

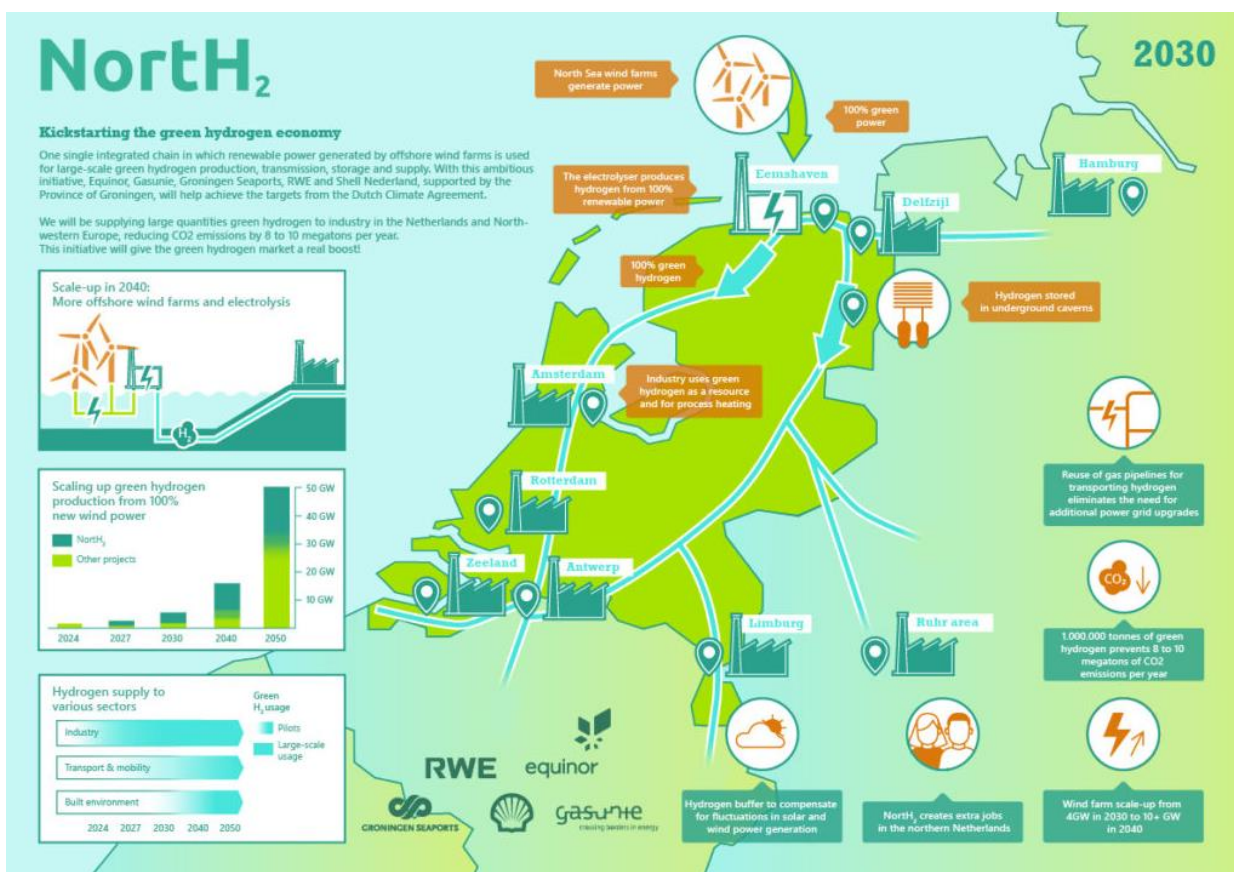
- On **March 18, 2022**, RWE [announced](#) that it will develop an ammonia terminal, capable of taking delivery of up to 300,000 metric tonnes of ammonia by 2026. It is expected that RWE will work with the shareholders of German LNG Terminal GmbH, Gasunie, Kreditanstalt für Wiederaufbau (**KfW**), and RWE, with RWE to be a key user of the LNG regasification terminal, importing LNG from around the world. The LNG and ammonia terminal projects are both supported by Brunsbüttel Ports GmbH.
- On **March 30, 2022**, it was reported widely that E.ON and Tree Free Solutions (**TES**) had partnered to investigate how they will work together to import liquified e-methane (combining Green Hydrogen with captured **CO₂** using renewable electrical energy (hence the "e")) from the Middle East to Germany (**TES's broader plans** and AiP were also reported on in **Edition 36** of Low Carbon Pulse.) The thinking involves the likely development of a green gas terminal in Wilhelmshaven, which would accept **LNG** in the first instance and progress to e-methane over time.
- **Motive clear:** On **March 23, 2022**, ITM Power (leading electrolyser technology corporation) [announced](#) that it had concluded a strategic partnership agreement with Vitol Holding SARL under which ITM Motive Limited (trading as Motive) could become a 50/50 joint venture of ITM Power and Vitol. Under arrangements for the joint venture, Motive has contracted with ITM Power (as preferred supplier) for up to 240 MW of electrolyser capacity to produce Green Hydrogen at the location of hydrogen refuelling infrastructure.
- **Moorburg, Hamburg:** On **March 23, 2022**, [hydrogen-central.com](#) reported (under **Former Coal Plant Site Moorburg in Hamburg Could Produce Green Hydrogen by 2026**) that a feasibility study had concluded that the Moorburg site would be used to house a 500 MW electrolyser to produce Green Hydrogen. The Moorburg site will require funding support, ideally with the project designated as an Infrastructure Project of Common European Interest.

Hamburg Green Hydrogen Hub



- **CS Energy, Kogan Creek:** On **March 24, 2022**, it was reported widely that CS Energy is to develop and to deploy a 50 metric tonne a year hydrogen production demonstration facility near Chinchilla, Queensland, Australia (the **Kogan Renewable Hydrogen Demonstration Plant** or **KRHDP**). The **KRHDP** is to be constructed by IHI Engineering Australia (a subsidiary of IHI Corporation). On **March 30, 2022**, it was reported widely that a 100 MW / 200 MWh BESS (using Tesla Megapack Technology) would be co-located at Kogan.
- **Sunfire GmbH scaling production:**
 - On **March 23, 2022**, it was reported widely that Sunfire GmbH (Dresden head-quartered electrolysis technology corporation) had contracted with P2X Solutions Oy (Finnish head-quartered circular economy solutions corporation – see **Edition 25** of Low Carbon Pulse) to supply a 20 MW alkaline electrolyser to allow P2X Solutions to produce Green Hydrogen. Previous editions of Low Carbon Pulse have covered both Sunfire GmbH and P2X Solutions.
 - On **March 24, 2022**, it was reported widely that Sunfire GmbH had partnered with Blue Earth Capital AG and Copenhagen Infrastructure Partners (**CIP**), raising €195 million to allow it to scale up the production of its alkaline electrolysers, with a clear line of sight to supply up to 640 MW of electrolysers to **CIP**.

- On **March 28, 2022**, Sunfire GmbH [announced](#) that it had commissioned successfully an alkaline electrolyser in Völs, Austria.
- Considerable industry interest in Carbon Clusters and Hydrogen Hubs: Editions 32 and 36** of Low Carbon Pulse reported on the plans to develop Carbon Clusters and Hydrogen Hubs in the Hunter Valley and the Illawarra regions of New South Wales, Australia. On **March 28, 2022**, it was reported widely that expressions of interest (**EOIs**) had been received, providing for investment of up to AUD 4 billion, reflecting considerable interest of the private sector into the development of each Cluster and Hub, with the **EOIs** reported to include proposals to develop 5.9 GW of renewable electrical energy capacity (more than eight times the target), and 268,000 metric tonnes of Green Hydrogen (enough to fuel 26,000 heavy goods vehicles / trucks).
- Global Energy Ventures Tiwi Islands project progresses: Edition 33** of Low Carbon Pulse reported on the planned development of a Green Hydrogen production facility on Grootte Eylandt (Tiwi Islands) off the Northern Territory, Australia. On **March 28, 2022**, [pv-magazine](#) reported that traditional landowners had granted permission to conduct onsite environmental and engineering studies.
- EON and FFI ink in green:** On **March 29, 2022**, it was reported widely that E.ON SE and Fortescue Future Industries (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO) had signed a supply and distribution agreement, with the two leading corporations combining to deliver 5 million metric tonnes a year of Green Hydrogen into the European market by 2030.
It is understood that that EON and FFI will work with the German and Australian Federal Governments to ensure that Green Hydrogen is delivered as contemplated. A "shout out" again to Dr Forrest, and his team. As ever, Dr Forrest sets what may appear to be stretch targets, and then bends them to his considerable will.
- Oracle Green Hydrogen Project Advance: On March 30, 2022**, it was reported widely that Pakistan's Green Hydrogen Project (see **Editions 29 and 35** of Low Carbon Pulse) has advanced with the conclusion of a joint venture agreement with Kaheel Energy (100% owned by His Highness Shaikh Ahmed Dalmook Al Maktoum).
- Eneco and OCI join North2:** A number of editions of Low Carbon Pulse have reported on North2 (see **Editions 5, 8, 16, 30 and 31** of Low Carbon Pulse). On **March 31, 2022**, it was reported widely that Eneco (producer and supplier of natural gas, electricity and heat in the Netherlands) and OCI NV (leading producer and supplier of hydrogen-based feedstocks) had joined Equinor, Gasunie, RWE and Shell in North2. It is understood that OCI NV is committed to purchasing up 40% of the Green Hydrogen produced by North2.



(Source: <https://www.offshorewind.biz/2022/03/31/eneco-and-oci-join-north2-offshore-wind-to-hydrogen-consortium/>)

Cities, Clusters, and Hubs and Corridors and Valleys, and Giga-Factories:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of:

- areas in which: **1.** infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and **2.** technologies facilitating energy transition will be concentrated and supported (**Hydrogen Corridors and Valleys**); and
- **giga-factories** that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).

Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.

- **UN Environment Program (UNEP) reports on cities:** On **March 4, 2022**, the **UNEP** published [Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions](#). The report will be considered in the **March and April Report on Reports**.
- **NEL plans expansion of capacity to 2 GW:** On **March 9, 2022**, [fuelcellsworks.com](#) reported that NEL ASA (leading electrolyser technology provider) is planning to increase its electrolyser production capacity. While this increase in capacity is driven by demand it is also informed by the policy settings from the **EU** to accelerate the development of hydrogen production capacity in the **EU**. The current electrolyser production capacity at NEL's Herøya plant is understood to be 500 MW, with the ability to increase production capacity to 2 GW.

As noted above (under **EU to accelerate decarbonisation initiatives**), the **EC** announced **RePowerEU** on March 8, 2022, providing strong policy signals to both supply and demand side to participate in the Green Hydrogen Value Chain. It is to be expected that other electrolyser technology providers will expand their production capacity in the near term. Apart from the significance for NEL and the electrolyser supply chain globally, this announcement illustrates the supply side response to clear policy settings within the **EU**. Clear policy settings remain critical to the development, and now the acceleration, of supply and demand for Green Hydrogen.

- **Elogen to establish giga-factory:** On **March 9, 2022**, [h2-view.com](#) reported that Elogen is to establish an electrolyser stack giga-factory at the Les Ulis site, in Vendôme, France.

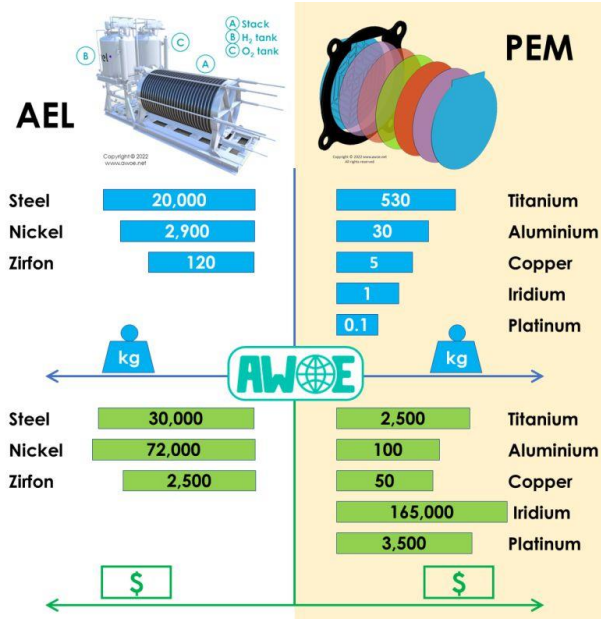
Subject to achieving IPCEI status, the production capacity will reach 1 GW by 2030: IPCEI connotes Important Project of Common European Interest.

- **Background on electrolysers:**

At the moment around 61% of electrolysers use **AE** technology and around 30% use **PEM** technology.

ANATOMY OF AN ELECTROLYSER	
Alkaline electrolysers (AE) produce H ₂ using a liquid electrolyte, using nickel electrodes and stainless steel for the stack.	AEs and PEMs have similar electrical energy efficiency, with the consumption of electrical energy being almost the same. PEM's operate at a higher electrical current, and as such are more productive per unit of stack mass.
Polymer Electrolyte Membrane or Proton-Exchange Membrane (PEM) electrolysers operate in an acidic environment, using iridium coated anodes and platinum coated cathodes, both the anode and cathode are made from titanium.	

The graphic below illustrates the current metal and mineral use of both **AEs** and **PEMs**:



In addition to **AE** and **PEM** electrolyser technologies, there are what may be regarded as emerging technologies of anion exchange membranes (**AEM**) and solid oxide electrolysis cells (**SOEC**). It is fair to say that **SOEC** electrolysers are emerging more quickly, and more developed, than **AEM**.

SOLID OXIDE ELECTROLYSER CELLS (SOECS)

SOECs operate at high temperatures and with high electrical efficiencies of 79-84% (LHV), and require a heat source to produce steam. Therefore if **SOEC** hydrogen were used to produce synthetic hydrocarbons (power to liquid and power to gas) it would be possible to recover waste heat from the synthesis processes to produce steam for further **SOEC** electrolysis. Nuclear power, solar thermal and geothermal heat systems, as well as industrial waste heat, could provide heat sources for **SOECs**.

SOEC electrolysers can be operated in reverse mode as fuel cells, to convert hydrogen back into electrical energy (again, distinct from **AE** and **PEM**.) Combined with hydrogen energy storage systems (**HESS**), **SOECs** can provide balancing services to grids, increasing the overall use of the **SOEC**. **SOEC** can be used for co-electrolysis of steam and **CO₂** so as to create a synthetic gas mix comprising **CO** and **H₂** for conversion into synthetic fuel.

- **Basque Hydrogen Corridor:** The Basque Energy Agency (**EVE**) has developed a **Basque Hydrogen Strategy (BHS)** and key part of the **BHS** is the development of the **Basque Hydrogen Corridor (BHC)**, which comprises 78 corporations and institutions, including CIC energiGUNE.

In an [article](#) published on **March 10, 2022**, CIC energiGUNE outlines the **BHS** and the role of the **BHC**. The article is well-worth a read.

- **Electrolyser technology development:**

- On **March 14, 2022**, it was reported widely that the US **DOE** National Renewable Energy Laboratory (**NREL**) is developing new, and improving existing, electrolyser technologies to improve the efficiency of the electrolysers. The **NREL** is an Energy Efficiency and Renewable Energy part of the US **DOE**. The work of the **NREL** fits within the work streams arising from the Hydrogen at Scale (**H2@Scale**) initiative of the US **DOE**.

By way of background, two key issues going to the unit cost of production of hydrogen using an electrolyser are as follows:

- **the electrical efficiency (EE) of the electrolyser used:** how much renewable electrical energy is required to produce one kg hydrogen, determined by the following calculation energy capable of use / (divided by) energy used to produce that energy x 100%, for example: $33.3 / 50 \times 100\% = 66.6\%$, $33.3 / 40 \times 100\% = 83.25\%$, and theoretically $33.3 / 33.3 \times 100\% = 100\%$; and
- **the utilisation of the electrolyser used:** being the percentage of time that an electrolyser can be used to produce hydrogen. The intermittent / variable nature of renewable electrical energy (**REE**) results in lower levels of utilisation, and higher unit costs of production than would arise if there was 24/7 **REE** supply. This is where use of **BESS** can help or, in time, a 100% renewable grid, or both.

In passing, for the author, all work of the **NREL** has become compulsory reading – keep it simple findings, supported by understandable modelling.

- On **March 15, 2022**, [nature](#) published [A high-performance capillary-fed electrolysis cell promises more cost competitive renewable hydrogen](#).

For those interested in differing electrolyser technologies the article in [nature](#) is clear and informative. On **March 16, 2022**, at [cefc.com](#) (under **CEFC congratulates Hysata on recognition in scientific journal Nature Communications**) Australia's Clean Energy Finance Corporation congratulated Hysata as a recipient of funding from the Clean Energy Innovation Fund of the Clean Energy Finance Corporation (**CEFC**).

The headline from the article is that the alkaline capillary-fed electrolysis cell technology outlined achieves an energy efficiency of 98%, with an energy consumption of 40.4 kWh/kg of hydrogen production.

If this level of energy efficiency is achievable at scale, the key operating cost of the production of Green Hydrogen, renewable electrical energy, will be reduced dramatically on a unit cost of production basis.

Further, given the nature of the alkaline capillary-fed electrolysis cell technology, the cost of the balance of the plant (being those parts of the Green Hydrogen plant other than the electrolyser) will be less than current electrolyser technologies.

A shout out to the CEFC: As at March 2022, the **CEFC** had provided funding support of AUD 10.5 billion, supporting projects with an investment value of AUD 36.6 billion. The **CEFC** is a model funding support agency.

- **Green Hydrogen from Gippsland Clean Energy Park:** On **March 15, 2022**, it was reported widely that the Clean Energy Finance Corporation (**CEFC**), Hostplus and Octopus Australia had combined to develop the Gippsland Clean Energy Park (**GCEP**).

While it is early days for the **GCEP**, the **GCEP** has a 3,000 hectare site (which is located within the Gippsland Renewable Energy Zone), and it is expected that the **GCEP** will be developed on a staged basis. Low Carbon Pulse will report on the development of the **GCEP** as its staged development continues.

- **Northvolt charging ahead:**

- **Edition 36** of Low Carbon Pulse reported that [northvolt](#) (under [Northvolt to transform closed paper mill in Sweden into new Gigafactory](#)) had announced that it plans to develop the Kvarnsveden Mill and the area surrounding it at Borlange, Sweden.

As announced, northvolt is to use the site to manufacture battery cells - up to 100 GWh of cathode material annually.

- On **March 15, 2022**, Northvolt announced plans to construct the Northvolt Drei at Heide, Schleswig-Holstein, Germany, to manufacture battery cells – up to 60 GWh annually: in context, 60 GWh of battery cells is sufficient for 1 million **BEVs**.

In addition to battery cell manufacture, Northvolt intends to construct a battery recycling facility at the site.

- **Tesla:**

- **Opens in Berlin:** On **March 22, 2022**, [dw.com](https://www.dw.com) reported (under **Tesla opens Giga Berlin factory in Germany**) that Mr Elon Musk (Chief Executive of Tesla) delivered Tesla BEVs to customers personally to mark the opening of Tesla's Giga Berlin plant, the largest EV plant in Europe.

On **March 16, 2022**, the opening of the Tesla Giga-Factory in Berlin was flagged by Forbes in the context of reporting on the plans of Volkswagen to develop six new Giga-Factories for the purposes of achieving its target of 240 GWh of production capacity by 2030.

- **Open to FCEV technology?** On **April 1, 2022**, [whichev.net](https://www.whichev.net) reported on a Mr Elon Musk tweet in which Mr Musk had indicated that Tesla was to develop the Model H (a fuel cell electric vehicle), which would use fuel cell technology to power and to propel the Model H.

To the author, there remains the risk that this is an April Fool's joke about fuel cells.

- **HyPoint opens in Sandwich:** On **March 22, 2022**, [hydrogenfuelnews](https://www.hydrogenfuelnews.com) reported (under **Hypoint opens hydrogen fuel cell plant in the United Kingdom**) on the formal opening of the HyPoint new fuel cell plant for R&D and production facility located in Sandwich, Kent.

The facility will undertake R&D and production of fuel cells for aviation, including ZeroAvia and Piasecki.

- **Inauguration of ACC Nersac plant:** On **March 11, 2022**, the [ACC Nersac plant](https://www.acc-nersac.com) was inaugurated in Nersac, France. On March 23, 2023, Mercedes Benz AG joined TotalEnergies and Stellantis in the ACC joint venture.

For the purposes of achieving its target of 120 GWh of production capacity by 2030, ACC plans to develop a third production site at Termoli, Italy.

- **VinFast Vast-Giga-Factory for North Carolina, USA:** On **March 29, 2022**, The White House released a [statement](https://www.whitehouse.gov) (**Statement by President Biden on Electric Vehicle and Battery Manufacturing Investments in North Carolina**) outlining the plans of electric vehicle maker VinFast (Vietnamese headquartered BEV manufacturer) to build a USD 4 billion electric vehicle and battery manufacturing facility in North Carolina.

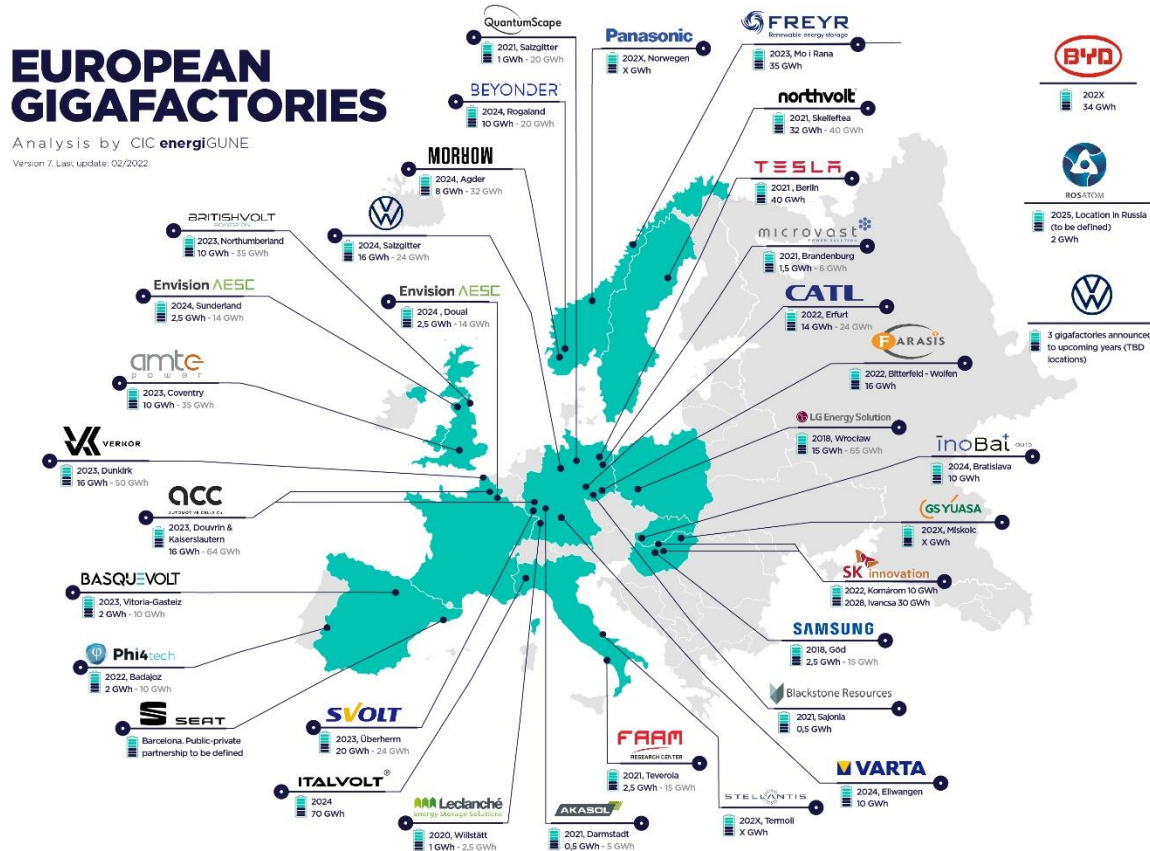
- **Siemens Energy plans to produce electrolyzers on industrial scale:** On **March 31, 2022**, it was reported widely the Siemens Energy (leading global energy transition technology corporation) is to develop an electrolyser manufacturing plant in Berlin, Germany.

It is understood that the plant will be the first giga-watt manufacturing plant for complete electrolyser systems.

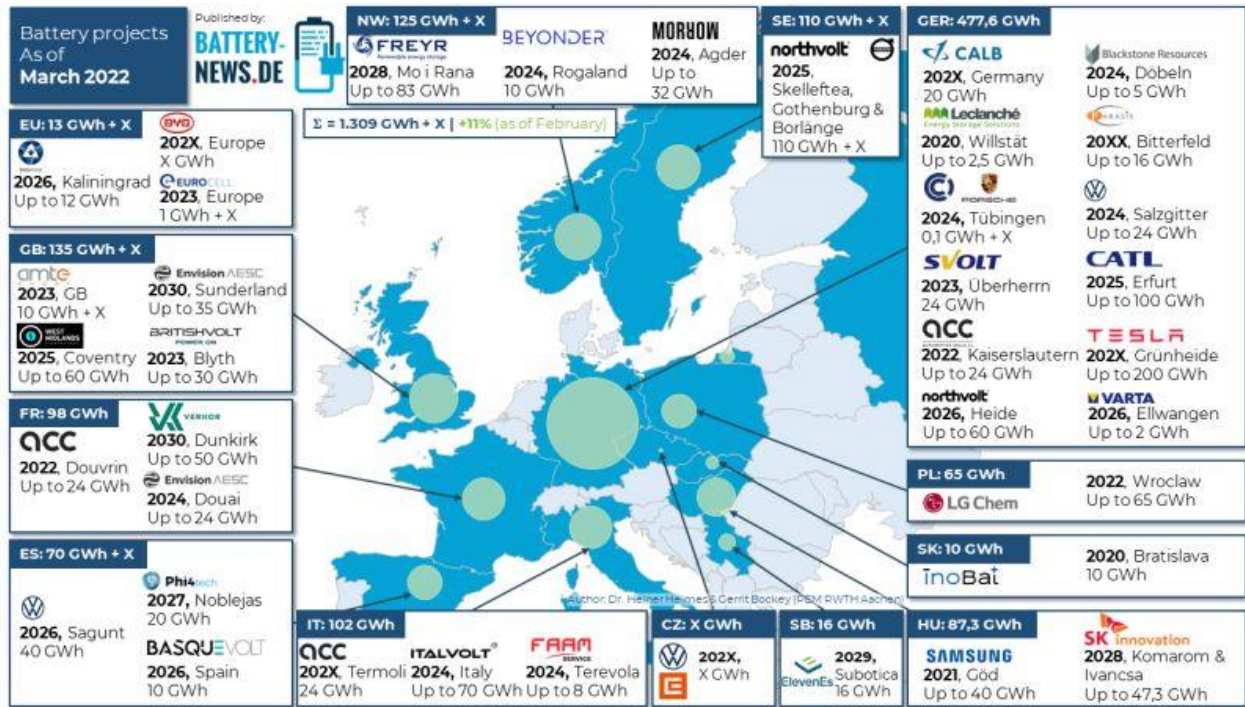
The reporting picks up the need for the cost of electrolyser manufacture to fall so as to contribute to a reduction in the cost of Green Hydrogen production.

- **Updated European Giga-factories map: Edition 33** of Low Carbon Pulse included a map showing the location and size of giga-factories across Europe.

With thanks again to **CIC energiGUNE**, the most recent map is included below:

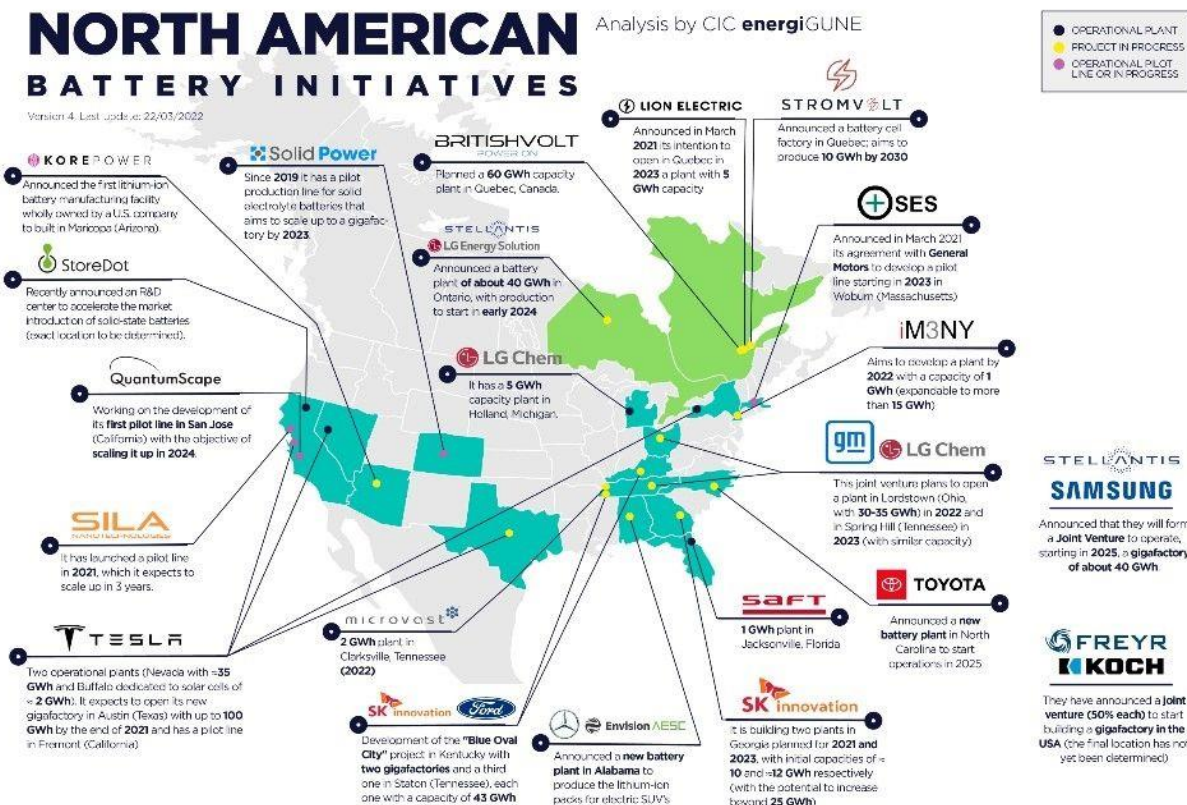


- **Battery project in Europe as of March 22, 2022:** [Battery-News.de](https://www.battery-news.de) has published the following infographic to detail battery production projects in Europe.



- **Updated US Giga-Factories Map: Edition 32** of Low Carbon Pulse included an infographic detailing Giga-Factories across the US.

On **March 24, 2022**, CIC energiGUNE published an updated map which is set out below:



Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of **E-fuels** and **Future Fuels** to process and to treat those metals and minerals. Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.*

- Green Steel Tracker:** On **March 14, 2022**, the **Green Steel Tracker** was released. The **Green Steel Tracker** has been developed by the Stockholm Environment Institute and the Leadit Secretariat. A link to the internet site with the **Green Steel Tracker** is included [here](#) (at the website of Leadit – Leadership Group for Industry Transition). The **Green Steel Tracker** is a helpful tool for those wishing to follow green iron and steel projects globally.
- **Anglo American and EDF plan big:** On **March 18, 2022**, rechargenews.com reported (under **Anglo American and EDF plan 5 GW "renewables ecosystem" for South African mining**) that Anglo American plans to develop a "regional renewable energy ecosystem" (**RREE**). The **RREE** will comprise photovoltaic solar and wind, and storage facilities. It is understood that Anglo American is to work with EDF to install between 3 and 5 GW of renewable electrical energy capacity by 2030.
 - **thyssenkrupp Steel and STEAG partner:** On **March 21, 2022**, it was reported widely that thyssenkrupp Steel and STEAG (to produce and to supply Green Hydrogen) were combining to integrate hydrogen at the large steelmaking facility in Europe. The integrated steelmaking facility is at Duisburg, and will deploy a 520 MW electrolyser to produce Green Hydrogen for use in the high heat temperature processes required for the production of iron and steel.
- By way of reminder:** Editions **5** and **11** of Low Carbon Pulse reported on the early stage thinking to develop a Green Steel facility at Duisburg, reporting as follows:
- **Edition 5** of Low Carbon Pulse reported that: In Duisburg, Germany, it is proposed to use Green Hydrogen to manufacture Green Steel. The proposal is at feasibility study stage at the moment, with an electrolysis plant, with capacity of up to 500 MW, to produce Green Hydrogen and oxygen for use at the thyssenkrupp steel mill. The feasibility study is being undertaken by STEAG (an energy company based in Essen) and thyssenkrupp (technology and iron and steel). For a technology provider and steel producer like thyssenkrupp there is an ability to create supply and demand, and as such not to wait on the development of a hydrogen supply market."
 - **Edition 11** of Low Carbon Pulse reported that: "The proposed thyssenkrupp upgrade to its existing Duisburg steel works by undertaking the HydrOxy Hub Walsum project (reported upon in **Edition 5** of Low Carbon Pulse), continues to be reported upon. On **February 26, 2021**, it was reported that the HydrOxy Hub Walsum project is seeking recognition as an Important Project of European Common Interest (**IPCEI**) for the purposes of obtaining funding. The current contemplated scale of electrolysis plant is 500 MW to produce Green Hydrogen".

Wind round-up, on-shore and off-shore:

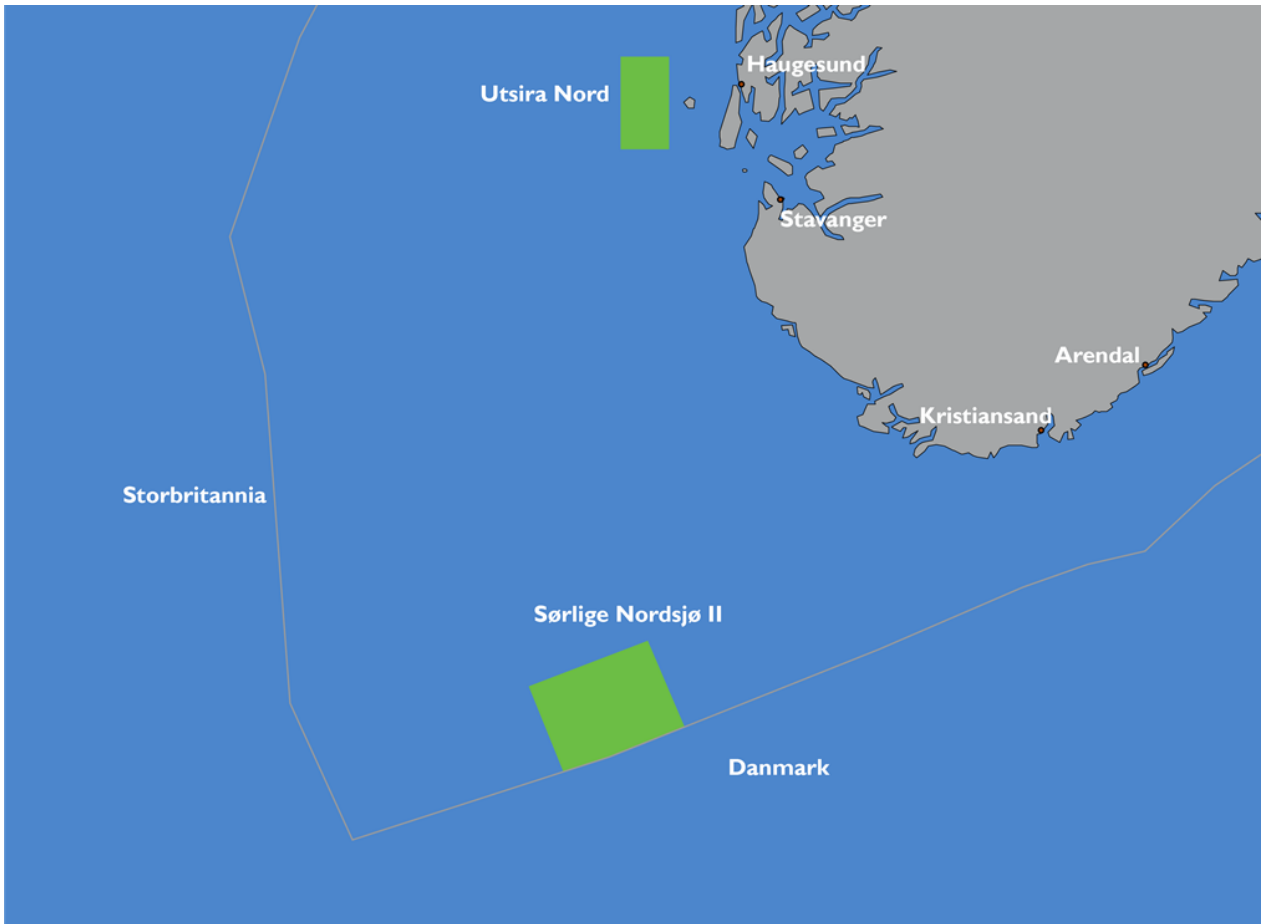
*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).*

- **Danish Downunder:** On **March 7 and 8, 2022**, it was reported widely that Copenhagen Energy A/S, through Leeuwin Offshore Wind Pty Ltd, intends to develop up to 3 GW of off-shore wind field capacity in **Geographe Bay** off of south west, Western Australia. The proposed **Geographe Bay** development is around 130 kms south of Perth, between the towns of Mandurah and Bunbury, within both Commonwealth of Australia and Western Australia waters. As reported, the development will comprise 200 turbines, each having a capacity range of between 15 to 20 MW, and up to six off-shore substations. Construction will start in 2026 and on completion Geographe Bay will produce up to 11 TWh of renewable electrical energy a year.
- **Danish in Columbia:** On **March 8, 2022**, it was reported widely that **Copenhagen Infrastructure Partners** or **CIP** (leading global renewable energy developer and investor) and the Mayor of Barranquilla, Mr Jaime Pumarejo, were to sign an agreement (during CERAWeek, Houston, Texas) to allow the development of a 350 MW off-shore wind field development off the coast of Columbia. In a press release from the Columbian Ministry of Mining and Energy, Minister Mr Diego Mesa noted the commitment of the Columbian Government to the development of off-shore wind field capacity and hydrogen production, including, critically, the **Offshore Wind Roadmap** in the process of development with the World Bank Group, and **the Hydrogen Roadmap**. In this context, it is understood that Columbia has off-shore wind resources that will allow the installation of up to 50 GW of off-shore wind field capacity by 2050. The **Hydrogen Roadmap** contemplates the development of between 1 GW and 3 GW of clean / low emission hydrogen production capacity in the medium term.
- **Danish off-shore ROK:** On **March 8, 2022**, it was reported widely that Vestas had signed a memorandum of understanding with Sejin Heavy Industries and Construction, Ulsan City and Ulsan Port Authority to cooperate in the development of the 9 GW off-shore floating wind field complex. Ulsan City has signed memorandums of understanding with a number of leading off-shore wind field developers, including BayWare (global renewable energy developer), Equinor (international energy company), Green Investment Group (global leading renewable energy group) and RWE (the German renewables electrical energy giant).
- **BlueFloat and Falck Renewables progress:**
 - **Orda Energia Concession Granted:** On **March 8, 2022**, it was reported widely that BlueFloat Energy and Falck Renewables had been granted a 40 year maritime concession to allow the development of the 1.35 GW Orda Energia floating off-shore wind field project (**Orda Energia OWP**). The **Orda Energia OWP** is to comprise 90 turbines located in waters with depths of 100 to 200 metres. As will be apparent from the below, this is the fifth off-shore wind field development of BlueFloat Energy and Falck Renewables in off-shore Italy.

- **By way of reminder:** Previous editions of Low Carbon Pulse have reported on the plans of BlueFloat (leading renewable energy corporation) and Falck Renewables to develop off-shore wind field capacity off the coast of Italy as follows:
 - **Edition 29** reported that the first project between Falck and BlueFloat was the 1.2 GW OWF project off Brindisi (Kailia Energia Project), with projected annual generation dispatch of up to 3.5 TWh. On October 26, 2021, it was reported widely that the joint venturers are not seeking a permit in respect of a further 1.3 GW of OWF projects off the southern coast of the province of Lecce. For the projects to proceed, authorisations will have to be obtained from the Ministero per la Transizione Ecologica and maritime concessions granted by the Ministero delle Infrastrutture and the Port Authority of the Southern Adriatic Sea.
 - **Edition 28** of Low Carbon Pulse reported that Falck Renewables (leading Italian renewable energy developer) and BlueFloat Energy (leading off-shore wind developer) had announced that they have entered into a 50:50 joint venture for the purposes of developing off-shore wind field (OWF) projects off the coast of Italy.
 - **Current projects progressing:** By the reckoning of the author, the following off-shore wind field progress are progressing: the 675 MW Minervia Energia project in the Gulf of Squillace, 1.4 GW Nora Energia 1 and 2 wind fields in Gulf of Cagliari and 1.2 GW Kailia Energia of Brindisi.
- **The Netherlands progresses to next auction:**
 - **Regulations issued:** On **March 10, 2022**, offshorewind.biz reported that the Ministry of Economic Affairs and Climate Policy had issued regulations detailing rules for the upcoming licensing of Hollandse Kust (west) Wind Farm Zone, which comprises Hollandse Kust (west) VI and Hollandse Kust (west) VII in the Dutch sector of the North Sea. The licence areas are located 53 kms off the west coast of the Netherlands. The auction for the two licenses open on April 12, 2022 and will close on May 12, 2022.
 - **Double Dutch:** On **March 18, 2021**, it was reported widely that the Dutch Government had doubled its forecasts for off-shore wind field capacity: an additional 10.7 GW of off-shore wind field capacity is to be installed, doubling current planned capacity, to 21 GW of installed capacity by 2030. The capacity will be installed in five zones in the Dutch sector of the North Sea. The Dutch Climate and Energy Minister, Mr Rob Jetten, is reported to have said: "*This is an important step in the transition to more sustainable energy ... to produce much more sustainable energy so that it no longer has to import carbon, gas and oil from other countries ...*". **Edition 32** of Low Carbon Pulse (under **Dutch off-shore wind progress**) reported that: "During the second week of December 2021 it was reported that the Dutch Government intends to expand its off-shore wind capacity, possibly through the development of a further 10.7 GW by 2030, from 11.5 GW to 22.2 GW, with newly designated zones in 1, 2 and 5-East (to accommodate an additional 8 GW), the Ijmuiden Ver North (2 GW) and Hollandse Kust (700 MW)".
 - **By way of further reminder:**
 - **Edition 36** of Low Carbon Pulse reported that Rijksdienst voor Ondernemend (**RVO**) Nederland published a [report](#) (entitled the **Netherlands System Integration Offshore Wind 2030-2040**). The **RVO** is proceeding on that basis that by 2040 there will be 38.5 GW of installed off-shore wind field capacity, moving to 72 GW by 2050 (under one scenario – the national scenario) and 31 GW, moving to 38, 42 GW or 43 GW of installed capacity by 2050 (under three other scenarios).
 - **Edition 29** of Low Carbon Pulse noted that on October 6, 2021, it was reported that the **RVO** is procuring the undertaking of met-ocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the Ijmuiden Ver Investigation Area (**IVIA**). The **IVIA** is one of three off-shore areas identified in the Dutch Offshore Wind Energy Roadmap 2030. The **IVIA** is 62 kms off the west coast of the Netherlands, having an area of 400 km². The **IVIA** has four lots in all, with **IVOA** I and II to be tendered in to 2023, and **IVOA** III and IV to be tendered in to 2025.
- **Global Wind Energy Council (GWEC) highlights five countries:** On **March 11, 2022**, the **GWEC** published [Floating Offshore Wind – a Global Opportunity](#) identifying five countries as comprising the chasing pack (in the sense of chasing to catch France, Japan, **ROK** and the UK), Ireland, Italy, Morocco, the Philippines and the US, being five countries that are likely to spearhead the next wave of floating off-shore wind field developments.
- **Swedish Fair Wind :**
 - **Continues for OX2 in the Baltic Sea:** On **March 14, 2022**, offshorewind.biz reported that OX2 had applied for a Natura 2000 permit to develop the 5.5 GW Aurora off-shore wind field, located 20 kilometres south of Gotland and 30 kilometres east of Öland, within the Swedish Baltic Sea Exclusive Economic Zone. The application by OX2 marks its continued progress, with three major off-shore wind field developments at various stages of development / progress.
 - **By way of reminder:**
 - **On December 30, 2021**, offshorewind.biz reported that OX2 had applied for a Natura 2000 permit to develop the 1.8 GW Triton off-shore wind field, located within the economic zone off the coast of Skåne, Sweden.
 - **On January 17, 2021**, offshorewind.biz reported that OX2 had been granted exploration permits for two off-shore wind fields in the Gulf of Bothnia Exclusive Economic Zone (**EEZ**): the permits were granted at a plenary session of the Finnish Government, and are in respect to the Halla project (approximately 35 km off-shore of the city of Raahé) and Laine project (approximately 30 km off-shore of the adjacent cities of Kokkola and Pietarsaari).
 - **On February 22, 2022**, offshorewind.biz reported that OX2 has applied for a permit to construct the 1.8 GW Triton off-shore wind field project. On grant of the permit, the 1.8 GW Triton project will be constructed 30 kilometres south of Ystad, comprising 129 wind turbines, each with a maximum height of 370 metres. As

reported, the 1.8 GW Triton project will be able to generate up to 7.5 TWh of renewable electrical energy a year. This will represent great progress in the context of the plans and policy settings of the Swedish Government outlined below (under **By way of reminder**).

- **Edition 35** of Low Carbon Pulse reported that the Swedish Government is to identify suitable areas to develop off-shore wind fields for the purposes of generating 120 TWh annually from sources of renewable electrical energy (noting that the electrical energy consumption of Sweden is 140 TWh annually). It is understood that the Swedish Energy Agency (**SEA**) has identified, and reported on, three areas – located in the Baltic Sea, the Gulf of Bothnia and the North Sea having wind resources of between 20 to 30 TWh annually. The **SEA** will work with the Swedish Maritime Administration (**SMA**) to identify areas from which 90 TWh annually can be generated. The **SEA** is to report on progress by no later than March 2023, and the **SMA** no later than December 2024.
- **Taiwan reviewing EIAs:** On **March 15, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported that the Environmental Protection Agency in Taiwan was in the process of reviewing Environmental Impact Statements (**EIAs**) in respect of nine off-shore wind field developments, together projected to comprise 9.1 GW of installed capacity. The majority of the developments are proposed by developers head-quartered in Europe.
- **Shell to ROK:**
 - **Floating plans:** On **March 15, 2022**, it was reported widely that Shell Gas & Power Developments B.V. had signed a memorandum of understanding (**MOU**) with Korea Southern Power Co., Ltd (**KOSPO**) for the purposes of exploring opportunities to work together in the context of energy transition (**KOSPO** is one of the six power generation subsidiaries of Korea Electric Power Corp – see **Edition 30** of Low Carbon Pulse). These opportunities may include off-take of renewable electrical energy from the **MunmuBaram Project** (understood to be progressing to a final investment decision) or future floating off-shore wind field developments, or both.
 - **By way of reminder:**
 - **Edition 26** of Low Carbon Pulse reported that Shell Overseas Investment B.V. had announced its joint venture with CoensHexicon Co. Ltd, with Shell an 80% equity participant, CoensHexicon, a 20%, equity participant, to develop and then to operate the 1.4 GW Ulsan **OWF** project (the **MunmuBaram Project**).
 - **Edition 32** of Low Carbon (under **MunmuBaram licensed**), the **MunmuBaram Project** has been granted an Electricity Business Licence (**EBL**), for its floating off-shore wind field project development.
- **Portugal moves to auction:** On **March 16, 2022**, [Reuters](https://www.reuters.com) (under **Portugal to auction 3-4 GW of floating offshore wind farms in summer**) reported that the Energy Transition Minister, Mr João Matos Fernandes, had indicated that 3 to 4 GW of offshore wind field capacity was intended to be installed by 2026.
- **bp and Marubeni joint venture:** On **March 23, 2022**, bp (leading international energy corporation) [announced](https://www.bp.com) that it had agreed to partner with Marubeni Corporation (leading Japanese integrated investment and trading conglomerate) to explore selected off-shore wind field development opportunities off-shore Japan. The Marubeni Corporation [announcement](https://www.marubeni.com) provided further detail, stating that it had signed a Cooperation Agreement and a Participation Agreement with BP Alternative Energy Investments Limited (**BPAEI**, a wholly owned subsidiary of BP plc). The first stage of the strategic partnership involves the establishment of a joint venture (51% Marubeni Corporation, 49% **BPAEI**) for the purposes of pursuing selected off-shore wind field development opportunities. In addition to off-shore wind field development, the strategic partnership may extend to other decarbonisation projects, including hydrogen.
- **By way of reminder: Edition 35** of Low Carbon Pulse (under **Auction Process**) reported that: The Norwegian Government intended to auction the 3 GW **Sørlige Nordsjø II** in two phases. The auction model is under-development, with legislation required to support the off-shore wind development. It was reported widely that the [Norwegian Offshore Wind Cluster](https://www.norwegianoffshorewindcluster.com), met to debate the off-shore auction model with the Norwegian Prime Minister, Mr Jonas Gahr Støre. On February 10, 2022, Prime Minister Støre outlined first phase (comprising 1.5 GW) of the **Sørlige Nordsjø II** off-shore wind field development: the first phase was to be completed in the second half of the current decade, providing up to 7 TWh per annum of renewable electrical energy. Prime Minister Støre did not rule out the provision of government funding support (through subsidies of the electrical energy price). In respect of the second phase of the development of **Sørlige Nordsjø II** project the Prime Minister contemplated that 1.5 GW of renewable electrical energy from this off-shore wind field development may find a market in northern Europe, rather than Norway". For news items relating to the Utsira leases see the following editions of Low Carbon Pulse: **Editions 18, 20** and **35**.
- **Carolinas Greenlighted:** On **March 25, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported (under **US Greenlights Wind Auction Offshore the Carolinas**) that the Bureau of Ocean Energy Management (**BOEM**) had completed its environmental review, and will hold an off-shore wind field energy auction for two lease areas off-shore North Carolina and South Carolina on May 11, 2022. It has been reported that the acreage of the off-shore wind field lease areas will result in the installation of at least 1.3 GW of off-shore wind field capacity.
- **New Zealand off-shore wind – world class fundamentals:** On **March 28, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) has joined forces with NZ Super Fund to develop a 1 GW off-shore wind field development off Aotearoa, New Zealand in the South Taranki Bight.
- This is an exciting development, noting that the off-shore wind resources of New Zealand are world class. The issue for off-shore wind field development will be the cost of development, and the load that the renewable electrical energy dispatched matches.
- **Norway moves to qualitative model:** On **March 24, 2022**, it was reported that the Norwegian Government had proposed to use a qualitative procurement model in respect of the Utsira Nord Lease.



Solar and Sustainability (including NZE Waste):

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers news items relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.

- **ZEBRA crossing:** On **March 17, 2022**, offshorewind.biz reported that the Zero waste Blade ReseArch (ZEBRA) consortium had produced the first prototype wind turbine blade that is 100% recyclable. The blade has been manufactured in Spain: the 62 metre blade is made of Arkema Elium® resin, which is a thermoplastic resin, and glass fabrics.
- **A reminder:** On **March 26, 2022**, the author of Low Carbon Pulse came across the following simple reminder of the nomenclature of carbon neutrality and net zero:

Net-zero WHAT?

Net-zero carbon (CO₂)

Net-zero carbon emissions =

only CO₂

Carbon neutrality

Balancing the emissions and removals of CO₂

Net-zero GHG

Net-zero GHG emissions =

all greenhouse gases

Climate neutrality

Balancing the emissions and removals of all GHGs

GHG – greenhouse gas



The simple reminder is taken from an excellent article written by Ms Eve Tamme.

- **Sustainable City: Edition 17** of Low Carbon Pulse reported on the Woven City as follows:

"Woven City – City of the Future: On May 10, 2021, it was announced that Japanese corporations ENEOS and Toyota Motor Company had combined resources to consider how they may work together to help in the development of Susono City, Shizuoka Prefecture, Japan – "the city of the future" or the Woven City. In a statement about the combination of ENEOS and Toyota to develop the Woven City, Toyota indicated that the plan is to test the basis of the development and implementation of a hydrogen-based supply chain, in and around (and, if you will, woven into the fabric of) the Woven City."

On **March 23, 2022**, it was reported that ENEOS and Toyota have agreed to consider production of "**CO₂-free**" hydrogen production and use within the Woven City.

- **Heliogen and Woodside CS demonstration project:** On **March 28, 2022**, it was reported widely the Woodside Energy (USA) Inc., is to deploy Heliogen AI-enabled concentrated solar technology for the purposes of a demonstration project. The CS demonstration project is to be built in the Mojave, California. While the scale of the CS demonstration project is small, it is telling that Woodside Energy is progressing with it.
- **First sovereign sustainability linked bond:** On **March 29, 2022**, the London Stock Exchange [congratulated](#) The Republic of Chile on the issue of the world's first sustainability-linked bond (a USD 2 billion 4.35% note due March 2042) listed on the London Stock Exchange's International Securities Market and Sustainable Bond Market.
- **MENA Climate Week:** From **March 28 to March 31, 2022**, the first-ever Middle East and North Africa Climate Week (**MENACW**) conference took place in Dubai, United Arab Emirates, under the auspices of the UNFCCC.

On **March 31, 2022**, the UN released the following [press release](#) (titled **MENACW Galvanises Regional Momentum for COP-27**). At the half way point between **COP-26** and **COP-27**, **MENACW** is reported to have built on one (held in Glasgow, Scotland), and prepared for the next (to be held in Sharm El Sheikh, South Sanai, Egypt).

In the context of **COP-27**, the Foreign Minister of Egypt, and incoming **COP-27** President, Mr Sameh Shoukry said:

"Holding the Climate Week for the first time in the Arab region has been clear evidence of the priority that the countries in the region give to international climate action and ways to combat the negative effects of a phenomenon that has seen its repercussions and impacts extend to multiple aspects of life in our countries. Egypt seeks to make the twenty-seventh session of the United Nations Framework Convention on Climate Change a milestone in the field of international climate action, in which pledges and promises are transformed into actual implementation on the ground".

The press release provides the facts and stats around the number of participants, meetings and sessions.

Edition 30 of Low Carbon Pulse reported on the **UN High Level Climate Action Champions** initiative, and in Dubai the **COP-26** Champion, Mr Nigel Topping, and the **COP-27** champion, Mr Mahmoud Mohieldin, announced their [vision](#). As the **MENACW 2022** report on outcomes is published, a future edition of Low Carbon Pulse will report on them.

- **Over 10% of electrical load matched by solar and wind, 38% from all clean power sources:** On **March 30, 2022**, the BBC [reported](#) on analysis in the [ember-climate.org report](#) which concluded that in 2021 (for the first time) renewable electrical energy generated by photovoltaic solar and wind sources had been dispatched to match 10% of electrical load, and electrical energy generated by clean power sources dispatched to match 38% of electrical load. The ember report is well-worth a read.
- **Cepsa steps up – "Small enough to move, big enough to lead":** On **March 30, 2021**, it was reported widely that Cepsa (multinational oil and gas corporation) plans to invest between USD 7.8 billion and USD 8.9 billion in the development of 2 GW of Green Hydrogen capacity and 7 GW of renewable electrical energy capacity. In addition, Cepsa is considering investing in the development of 2.5 million metric tonnes of second-generation biofuel production capacity, and 800,000 metric tonnes of **SAF** production capacity.
- **"Its' take to end the model of "take, make, break and throw away' that is so harmful to our planet":** On **March 30, 2022**, the European Commission (**EC**) presented proposals as part of the **European Green Deal** (see [Editions 14, 16, 22, 23 and 32](#) of Low Carbon Pulse) initiatives of the **EU**.

With the presentation of the **Circular Economy Action Plan**, the **EC** is proposing [new regulations and rules](#) in respect of good and products, including to addressing energy efficiency over the life-cycle of those goods and products, and to design their recycling and repurposing at the end of their design life. In addition, the EC presented proposals in respect of textiles, construction materials and products, and to ensure that customers are informed fully as to the sustainability of the goods and products.

- **CleanCo to go:** On **March 31, 2022**, it was reported widely that CleanCo (the Queensland government-owned clean energy generator) was to supply 100% of the load to retail giants Bunnings, Kmart, Officeworks and Target across Queensland Australia.

Land Mobility / Transport:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.*

• Buses and coaches:

- **Air Products to develop mobility facility:** On March 9, 2022, it was reported widely that Air Products (one of the Big Three Industrial Gas producers globally, with Air Liquide and Linde) is to develop a 10 metric tonne a day liquid hydrogen (**LH₂**) production facility in Casa Grande, Arizona, with the **LH₂** to be used in the California mobility market. The **LH₂** production facility will comprise two thyssenkrupp nucera electrolyzers to produce gaseous hydrogen and Air Products technology to liquify to produce **LH₂**.
- **Houston, Texas, Bussing:** On **March 14, 2022**, [houston.culturemap.com](#) reported that the Metropolitan Transit Authority of Harris County had awarded a contract for 20 battery electric buses for Nova Bus (Canadian

headquartered technology corporation, Saint-Eustache), with an option for a further battery electric buses. The first buses are expected to be in operation by late 2022, early 2023.

- **Bratislava, Slovakia, Trolley-bussing:** On **March 16, 2022**, Solaris Bus & Coach [announced](#) that its Solaris Trollino 24 trolleybuses would be deployed in Bratislava by mid-2023. Solaris is supplying 16 bi-articulated trolleybuses to operator Dopravný podnik Bratislava.
- **Wroclaw, Poland, electric:** On **March 18, 2022**, Daimler Truck AG [announced](#) that 11 of its eCitaro G electric buses had been ordered by the City of Wroclaw, and would be deployed in the third quarter of 2023.
- **UK on Track to Reach 4000 Zero Emission Bus Pledge:** On **March 28, 2022**, [hydrogen-central.com](#) reported that the UK was on track to deploy 4000 Zero Emission Buses by 2050. This follows a GBP 198 million funding commitment that will provide sufficient funding for the deployment of 943 buses.

The funding is provided in the Zero Emission Buses Regional Area scheme. The funding will support the procurement of both battery electric and hydrogen-powered and propelled buses.

- **Cars (including taxis):**

Other than the commitment of Germany to phase out ICE powered and propelled by fossil fuels by 2035 (see **Energy transition in action** above), there have been no material or significant news items that have come to the attention of the author in the news cycle for this **Edition 37** of Low Carbon Pulse.

- **Fuel Cell and Battery Supply and Technology:**

On **March 22, 2022**, [Wood Mackenzie](#) released its analysis of the supply of batteries. The analysis is excellent, and well worth a read.

- **Industrial Vehicles and Trucks:**

- **Gaussin again:** On **March 17, 2022**, it was reported that Gaussin had revealed the world's automated first hydrogen-powered and propelled fuel cell electric vehicle. The vehicle is to be deployed port side.
- **First hydrogen truck in Australia:** On **March 21, 2022**, it was reported widely that JJ Waste & Recycling had contracted with Pure Hydrogen for a wet-lease of a hydrogen-powered and propelled garbage truck, with Pure Hydrogen providing the truck and the hydrogen for the truck.
- **A.P. Moller – Maersk to deploy 300 electric trucks:** On **March 24, 2024**, A.P. Moller – Maersk [announced](#) that it add 300 electric trucks to its North America network. The electric trucks will be delivered between 2023 and 2025. Einride (a technology corporation that provides freight mobility solutions) will supply the e-trucks, assembled to specification in the US.
- **OCI NV – another first:** On **March 29, 2022**, OCI NV announced that Europe's first Power-to-X truck powered and propelled by green methanol supplied by OCI NV had been driven by the Danish Transport Minister, Trine Bramsen, in Aalborg, Denmark. OCI NV is supplying green methanol to Circle K, to be used in its trucks.

- **Recharging and refuelling infrastructure:**

In addition to the news items covered above in respect of the development of an East Coast of Australia recharging and refuelling network, the following news items are both material and significant:

- **World's largest biomethane refuelling station opens:** On **March 9, 2022**, it was reported that the world's largest biomethane refuelling station had opened at Avonmouth in the UK, capable of refuelling up to 80 heavy goods vehicles / trucks per hour, using 14 high-speed dispensers.
- **Everfuel hydrogen refuelling station opens:** On **March 11, 2022**, [Everfuel](#) announced that the Heinenoord HRS, in the Netherlands, had opened, providing hydrogen refuelling services to Connexion's fuel-cell powered and propelled buses.

The development and deployment of the Heinenoord HRS is the result of the efforts of Province Zuid-Holland, Gemeente Hoeksche Ward, and the European Climate, Infrastructure and Environment Executive Agency (CINEA), the Clean Hydrogen Partnership and the Ministre van Infrastructuur en Waterstaat, and commercial partners Connexion Nel Hydrogen, Rebel and VIRO.

- **KOGAS to roll-out hydrogen refuelling stations:** On **March 24, 2022**, the Korea Gas Corporation (**KOGAS**) stated that by 2030 it planned to establish 152 hydrogen refuelling stations around South Korea, with 90 of the HRS's to be liquid hydrogen.
- **BP to Invest GBP 1 billion:** On **March 25, 2022**, bp [announced](#) that it intended to invest GBP 1 billion over 10 years to expand its EV charging capacity across the UK.

- **Trains:**

- **Wales of a time:** On **March 9, 2022**, it was reported widely that Ballard Motive Solutions is leading a study in respect of the deployment of hydrogen-powered and propelled trains in Wales, in particular the feasibility of their use to displace diesel powered and propelled trains.
- **Scotland on time:** On **March 13, 2022**, [The Scotsman](#) reported on routes within Scotland that were expected to be first to benefit from battery powered and propelled trains, being the Borders Railway between Edinburgh and Tweedbank, and the Fife Circle and Glasgow-East Kilbride. The progress reported in The Scotsman reflects the commitment of the Scottish Government to phase out ScotRail's diesel fleet by 2025.
- **East Japan Railway is testing hydrogen train:** In **March 2022** the testing of the two car hydrogen-powered hybrid (**Hybari**) trainset commenced. The **Hybari** trainset, developed by Hitachi Ltd and Toyota Motor Corporation, is able to travel 140 km at its top speed of 100 km/h between refuelling.

By way of reminder: **Edition 35** of Low Carbon Pulse reported that: "**JR East Hybrid running:** On February 19, 2022, [asia.nikkei.com](#) reported that East Japan Railway (**JR East**) had unveiled Japan's first hydrogen-powered hybrid train (**Hybari**) on February 18, 2022, using technologies developed by Hitachi Corporation and Toyota Motor Corporation – hydrogen fuel cells and electric battery technologies. **JR East** is to commence testing of the **Hybari** in March 2022".

- Bavaria is procuring hydrogen trainset:** On **March 16, 2022**, it was reported widely that the Siemens Mobility and Bayerische Regiobahn had signed a lease of a two car hydrogen-powered Mireo Plus trainset, developed by Siemens Mobility. The Mireo Plus trainset is to be tested on the Augsburg-Füssen route, starting in mid-2023.
By way of reminder: Edition 22 of Low Carbon Pulse reported that: "For some time, Ballard Power Systems (**BPS**) has been making progress across a number of sectors. On July 15, 2021, it was reported widely that **BPS** is to supply 200 kw fuel cell modules under arrangement with Siemens Mobility GmbH to power a two car Mireo Plus H passenger train trials in Bavaria, Germany (one of the hydrogen hot spots in the **EU**). The fuel cell modules are located on the roof of the passenger train, and power and propel the train with electric battery technology located underneath the floor of the train. It is reported that the trials will start in 2022. The Mireo Plus H passenger train is designed for use on non-electrified lines at speeds of up to 160 kph."

Ports Progress and Shipping Forecast:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland.*

Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.

Ferries and other craft:

- Energy Observer observed in Singapore:** On **March 10, 2022**, it was reported that the Energy Observer (the world's first hydrogen powered and propelled vessel) had arrived in Singapore, moored at ONE⁰15 Marina Sentosa Cove.
 The Energy Observer is powered and propelled by photovoltaic solar and wind, which produce hydrogen from seawater.
- Sembcorp Marine completes fabrication:** On **March 16, 2022**, Sembcorp Marine announced that it had completed the fabrication of the first of three zero-emission battery powered Ropax Ferries for Norled AS.
 The design of each of the Ropax Ferries has been optimised for the requirements of Norled A/S, with each ferry to be powered and propelled by lithium-ion batteries, and having a back-up battery-diesel hybrid mode. Each battery is to be charged / recharged using renewable electrical energy from hydroelectric sources.
By way of reminder: As reported in **Editions 23** and **30**, in late July 2021, Norled As is the owner of the **MF Hydra** (styled as the first liquid hydrogen powered ferry). As reported, the **MF Hydra** is 82.4 metres in length, with capacity for 300 passengers and 80 motor cars. On February 2, 2022, it was reported widely that Ballard Power Systems is to supply two of its 200KW FCwave fuel cell modules to Norled A/S, the owner of the **MF Hydra**. As will be apparent from the previous new items, during 2022 the **MF Hydra** will start to serve the Hjelmeland-Skipavik-Nesvik route in Rogaland.
- Green Ports:** The following map-graphic illustrates the role of ports and shipping in the context of the planned developments at the Port of Wilhelmshaven.



(Source: <https://www.offshore-energy.biz/tes-pushes-wilhelmshaven-green-energy-hub-development/>)

- **Green Shipping:**

In addition to the news items covered above in respect of the ADB and Pertamina and A.P. Moller – Maersk, the following news items are both material and significant:

- **Egil Ulvan Rederi H2 vessel gets AiP:** In early March, and then throughout March, 2022, it was reported that Egil Ulvan Rederi AS has received Approval in Principle (**AiP**) from Lloyds Register for its zero-emission self-discharging hydrogen-fuelled bulk carrier – the **With Orca**. The With Orca is designed by Norwegian Ship Design. It is understood that a long-term transport contract is to be firm up with Felleskjøpet Agri and Heidelberg Cement for the use of the **With Orca**, a 88 metre, 5,500 metric tonne bulk carrier.
As reported the **With Orca** will be powered and propelled by hydrogen, with propulsion and energy capture provided by two rotor sails as well as hydrogen. The hydrogen will be stored in the **With Orca** in compressed form and a hydrogen combustion engine for use in higher load conditions, and a fuel cell electric system for use in lower load conditions. The hydrogen is to be supplied by Statkraft (global leader in hydropower and Europe's largest generator of renewable electrical energy).
- **MAN B&W Engines ordered: Edition 29** of Low Carbon Pulse reported that Dalian Shipbuilding Industry Co. Ltd was to build two 7,500 m³ liquid **CO₂** carriers to transport **CO₂** captured and liquified as part of the Longships project, with the **CO₂** to be stored in the Northern Lights project (part of the Longship Project).
On **March 9, 2022**, MAN Energy Solutions [announced](#) that Dalian Shipping had ordered two MAN B&W 7S5ME-GI dual-fuel engines.
- **Power Transfer Vessel:** On **March 10, 2022**, it was reported widely that **ClassNK** (Japanese classification society) had signed a memorandum of understanding with **PowerX Inc.**, providing for their collaboration in respect of the development of the Power ARK, a power transfer vessel. The concept of the Power ARK is that electrical energy is transferred to it, charging 100 grid batteries on board the Power Ark.

Airports and Aviation:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

- **A world of sunlight:** On **March 7 and 8, 2022**, it was reported widely that Lufthansa Group and Swiss International Airlines (**SAL**) and Synhelion had established a strategic collaboration to allow progress to the realisation of "sun-to-liquid fuel (**STF**).
As reported, Synhelion is developing a technology that uses "concentrated solar heat" to derive synthetic gas (syngas, as contrasted with natural gas), which is then synthesised to produce e-kerosene. The production of e-kerosene from the syngas uses long established technology. Synhelion has received funding support from the German Federal Government to enable it to develop its "sun to fuels plant" in North Rhine-Westphalia, Germany. It is understood that by 2023, **SAL** will be using the **STF**.
- **A world of flight:**
 - On **March 7, 2022**, it was reported widely that Airbus Industries and Fortescue Future Industries (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO) had established a basis for the development of a partnership under a memorandum of understanding (**MOU**), with the intention for the corporations to work together to progress development of zero emissions aircraft powered and propelled by hydrogen. A link to the joint announcement is [attached](#).
It is understood that the MOU contemplates that the corporations will identify, and work to remove, any constraints on the use of Green Hydrogen, and the development of Green Hydrogen supply chains. In this context, it is understood that Airbus Industries will assess energy and fuelling needs of the aviation industry, and FFI will develop the hydrogen supply chains.
 - On **March 17, 2022**, it was reported widely that [Airbus Industries](#) and [Delta Airlines](#) had agreed (as part of its aim to Fly to Net Zero) to work together to accelerate the development of hydrogen-powered and propelled aircraft. For these purposes, Delta Airlines will work with Airbus Industries to identify fleet and network expectations and requirements to enable it to progress to the use of commercial aircraft powered and propelled by hydrogen.

By way of reminder:

- **Edition 35** of Low Carbon Pulse, reported that Airbus Industries may manufacture engines powered by hydrogen. On February 23, 2022, it was reported widely that Airbus Industries and CFM International (a 50/50 joint venture between GE Aviation and Safran Aircraft Engines) are working together to test the use of hydrogen to power engines to propel aircraft.
- **Edition 32** of Low Carbon Pulse reported that Airbus Industries intends to develop a zero-emission hydrogen powered and propelled commercial aircraft by 2035.
On February 22 and 23, 2022, it was reported widely that by 2035 Airbus Industries intends to fly a hydrogen-powered and propelled Airbus A380.
The announcement that the Airbus A380 was to be the Airbus Industries aircraft resulted in multiple diagrams, the most helpful of which is as follows:
- **Zero-e since Q3 of 2020:** Airbus Industries announced its thinking around progress to use hydrogen to power and propel aircraft at the end of Q3 of 2020 ("**Zero-e**"). The announced thinking was accompanied by an outline of [three hydrogen powered aircraft concepts](#): Turbofan; Turboprop; and Blended-Wing Body (BWB).
- **FlyZero spot-on:** In **March 2022**, FlyZero, led by the Aerospace Technology Institute published [Hydrogen Infrastructure and Operation, Airports, Airlines and Aerospace](#) (backed by the UK Government). The publication is excellent.

The headline conclusion from the publication is that "green liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft utilising fuel cell gas turbine and hybrid systems". The balance of the publication report is aligned around this conclusion.

While the publication has a UK focus, it has global application, and it points out key (and to many) salutary facts:

- Production of Green Hydrogen requires "unprecedented renewable energy capacity, transporting hydrogen to airports will require gaseous pipelines of liquid tanker deliveries, and the refuelling of aircraft ... will need to take place safely and efficiently alongside conventional aircraft";
- Initially, most airports will be supplied with liquid hydrogen produced and liquified off-site, and transported by tanker;
- As demand increases, particularly at large airports, supplying liquid hydrogen by tanker will cease to be feasible, and hydrogen supply via gaseous pipeline with on-site liquefaction at the airport likely to become the norm;
- While most of the technology required to store liquified hydrogen and to fuel and to refuel aircraft with liquid hydrogen exists, the development of storage and fuelling / refuelling infrastructure at the required scale is likely to prove challenging.
- **Neste's fund continues:** On **March 21, 2022**, [Neste](#) announced that it had contracted with DHL for the supply of 320,000 metric tonnes (or around 400 million litres) of **Neste MY Sustainable Aviation Fuel**. This is the largest **SAF** supply agreement to date for Neste;
- **Rolls Royce Trent 900 engines fuelled by SAF:** On **March 28, 2022**, it was reported widely that an Airbus A380 powered by Rolls Royce Trent 900 engines, had completed its first flight using **SAF**. As noted in previous editions of Low Carbon Pulse, **SAF** is at the early stages of use (effectively an e-kerosene), but with the market for aviation fuel at close to 300 million metric tonnes a year, considerable **SAF** productions capacity needs to be developed to make significant progress to the use of **SAF** as a percentage of aviation fuel.
- **HyPoint – another high point:** On **March 29, 2022**, it was reported widely that HyPoint (technology corporation) had developed a need technology that would allow the carriage of liquid hydrogen (**LH2**) using ultra-light weight fuel tanks.

Quote of the month:

It has been clear since March 7, 2022, the (truth) telling quotes arise reasonably frequently, and stay with the reader. During the news cycle from March 7, 2022, the most telling quote to the author was that Dr Kimberley R. Miner, Climate Scientist at NASA, Professor of Climate Risk:

"Despite all of our accomplishments we owe our existence to a six-inch layer of topsoil and that fact that it rains".

This summarises more powerfully and succinctly many publications on the substance of this quote.

Reference Material:

The purposes of this Reference Material section is keep live, reference material that readers may find most useful on an ongoing basis without the need to search for that material:

- **A reminder of countries with Hydrogen Plans, Roadmaps and Strategies:**



- **S&P Global Platts – Atlas of Energy Transition:** On **February 22, 2022**, S&P Global Platts published its [Hydrogen Price Wall](#), mapping hydrogen prices across means of production and regions of use. The [Hydrogen Price Wall](#) is to be found in the updated [Atlas of Energy Transition](#).

While Low Carbon Pulse does not report on the cost or price of hydrogen, the S&P Global Platts [Hydrogen Price Wall](#) (as part of the [Atlas of Energy Transition](#)) provides a helpful point of reference.

Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

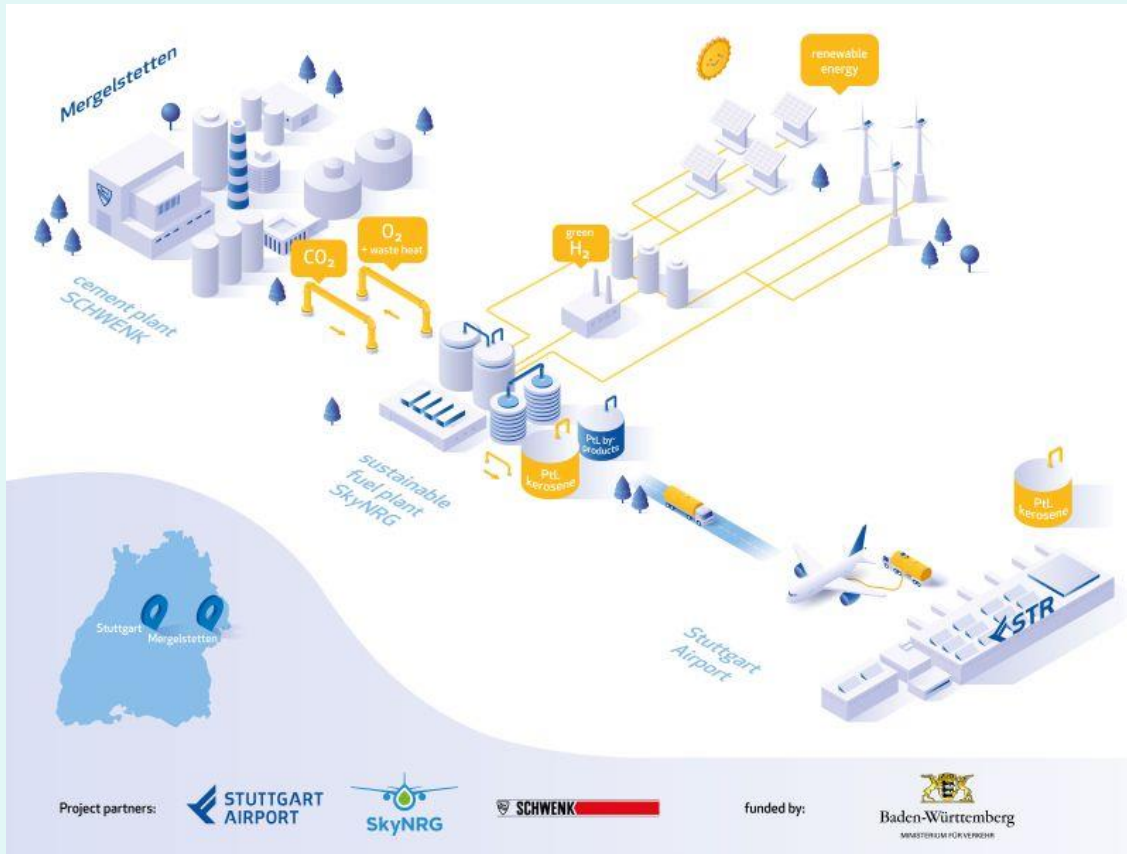
As a reminder, **Edition 35** of Low Carbon Pulse noted in respect of **SAF**:

1. commercial aircraft are not permitted to use **SAF** on its own to propel aircraft (a maximum blend ratio of 50% fossil fuel to 50% **SAF** is permitted);

2. the process to produce **SAF** – there is only one commercially scalable production process – the use of fatty acids and hydrogenated acids as feedstock to produce synthetic paraffinic kerosene. As such, while there are seven approved means of production of **SAF**, only one means is currently commercially scalable; and

3. there is limited available feedstock (i.e. fatty and hydrogenated acids) from which to produce **SAF**. The primary sources of feedstock are animal fats and used cooking oils. As a result, current supply (200,000 metric tonnes of **SAF** annually) is a drop in the ocean of demand for aviation fuel (300 million metric tonnes annually). There is a market for **SAF**, not least because the aviation industry gives rise to around 1 billion metric tonnes of **CO₂-e** each year.

In addition to the reports in **Edition 35** of Low Carbon Pulse on **SAF** on the use of animal fats and used cooking oil, Stuttgart Airport and Schwenk Zement and SkyNRG are progressing with plans to develop synthetic aviation fuel, in the form of synthetic kerosene. The feedstock to produce this **SAF** is **CO₂**, captured from the production of cement, combined with **H₂**. The following infographic provides an overview of the sources of feedstock and the technologies used in the production of synthetic kerosene.



Low Carbon Pulse - Edition 38

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to the **Edition 38** of Low Carbon Pulse. This edition reports on the third part of the Intergovernmental Panel on Climate Change (**IPCC**) **Sixth Assessment Report** - the **Climate Change 2022, Mitigation of Climate Change** report (**IPCC WGIII Report**). Also this edition reports on IRENA's **World Energy Transitions Outlook 2022 (WETO 2022)**. This **Edition 38** provides a high level summary of key findings in the **IPCC WGIII Report**, and **WETO 2022** report, and is divided as follows: **1.** Introduction; **2.** What the reader needs to know; **3.** The Headlines; **4.** What is past is prologue; and **5.** What needs to be done.

Section 1: Introduction:

1.1: Background:

IPCC AR6: On **April 4, 2022**, the **IPCC Working Group III (Mitigation of Climate Change)** published the **Climate Change 2022 Mitigation of Climate Change** report (the **IPCC WGIII Report**).

The **IPCC WGIII Report** is the final report from three **IPCC Working Groups, I, II and III**. The three reports comprise, together, the **IPCC Sixth Assessment Report (AR6)**. The **IPCC WGI Climate Change 2021, The Physical Science Basis** report was published on August 9, 2021 (which was covered in **Edition 24** of Low Carbon Pulse) and the **IPCC WGII Climate Change 2022: Impacts, Adaptation and Vulnerability** report was published on February 28, 2022 (which was covered in **Edition 36** of the Low Carbon Pulse).

As noted in previous editions of Low Carbon Pulse, in **September 2022** the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** will synthesise findings from the three reports, and from three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**) that have also been undertaken for the purposes of **AR6**. The **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**. It is not anticipated that either part of the **Synthesis Report (SPM or Longer Report)** will be anywhere near the length of the reports from **IPCC Working Groups, I, II and III**.

The **Synthesis Report** is expected to inform the agenda for the 27th session of the Conference of the Parties (**COP-27**), which will take place in Sharm El-Sheikh, South Sinai, Egypt from **November 7 to 18, 2022**. Without wishing to assume the agenda, or the dynamics in the lead up to, and at, **COP-27**, the nationally determined commitments (**NDCs**) of each country that is party to the Paris Agreement need to be increased and accelerated.

IRENA WETO 2022: On **March 29, 2022**, the International Renewable Energy Agency (**IRENA**) published **World Energy Transitions Outlook 2022 (WETO 2022)**. In 2021, **IRENA** published its World Energy Transitions Outlook 2021 (**WETO 2021**) which considered how to achieve net-zero **GHG** emissions by 2050. **WETO 2022** focuses on the near to medium term, critically, "the steps needed by 2030 to deliver climate and near term energy solutions, simultaneously and urgently", consistent with achieving net-zero by 2050. **WETO 2022** "positions justice and fairness at the heart of planning and actions so that energy transition will have a truly positive impact".

1.2: Why consider the IPCC WGIII Report and WETO 2022 together?

Edition 29 of Low Carbon Pulse described the themes that emerged in the lead up to **COP-26**, including as follows:

- By 2030, **GHG** emissions need to reduce by 45% (at least) to limit the increase in global warming to within the **1.5°C to 2°C** range, and by at least 50 to 52% to limit to a **1.5°C** increase; and

- Without increased and accelerated reductions in **GHG** emissions, critically, increased reductions and accelerated rates of reductions under **NDCs**, as warned by United Nations Secretary General, Mr Antonio Guterres, we are tracking to a **2.7°C** increase. What Mr Guterres warned as a **Catastrophic Pathway**.

1.2: The perspective of the author:

In the context of reviewing the **IPCC WGIII Report**, the author had the benefit of the sage advice shared by Ms Roberta Boscolo (the advice having originated from Joeri Rogeli) on how to interpret the findings in the **IPCC WGIII Report**.

The advice helps assess both the **IPCC WGIII Report** and the assessments of it, since its publication on April 4, 2022. The advice is as follows:

- Do not interpret the findings (including in the form of the scenarios) as a statistical sample, rather take them as representing agreement across the literature considered for the purposes of the **IPCC WGIII Report**;
- Do not focus on the median, consider the full range of findings (and as such each scenario);
- Do not cherry-pick individual findings (and the attendant scenario or scenarios) to make general conclusions;
- Do not over-interpret any finding (and the attendant scenario or scenarios), and do not venture too far from the original purpose of the **IPCC WGIII Report**, this will make it easier to avoid extrapolation; and
- Finally, do not conclude that the absence of any scenario does not mean that that scenario is not possible.

1.3: By way of a reminder:

Greenhouse Gases (GHG):

In this **Edition 38** of Low Carbon Pulse, **GHG** refers to the following well-mixed greenhouse gases, the basis for **IPCC WGI Climate Change 2021, The Physical Science Basis** report.

CONCENTRATIONS OF WELL MIXED GHG			
Average concentration	CO ₂	CH ₄	N ₂ O
2019	410 ppm	1866 ppb	331 ppb
JUNE 2020	416.60 ppm	1876 ppb	332.7 ppb
JUNE 2021	418.54 ppm	1891 ppb	334.1 ppb
MARCH 2022	418.81 ppm	1900 ppb	334.3 ppb

Every tonne of well mixed **GHG** emitted contributes to an increase in average global atmospheric temperature. Stated another way, the root cause of climate change is the increase in temperature caused by increased mass of **GHGs** in the climate system, increasing the concentration of **GHGs** in the climate system, principally **CO₂**, **CH₄** and **N₂O**.

The **CO₂** concentrations are higher than at any time in the last two million years, and concentrations of **CH₄** and **N₂O** are higher than at any time in at least 800,000 years.

The Paris Agreement:

CO₂-e (carbon dioxide equivalent) recognises that different **GHGs** have different global warming effects, with the use of **CO₂-e** allowing a like-for-like comparison taking account of potency and time retained in the climate system. What is clear however is that **CO₂** is the **GHG** on which **GHG** reduction and **GHG** removal initiatives need to concentrate because globally, by mass, it is, by far, the most emitted **GHG**. At the same time, there needs to be a near term concentration on the reduction of **CH₄**.

The key provisions of the Paris Agreement are as follows:

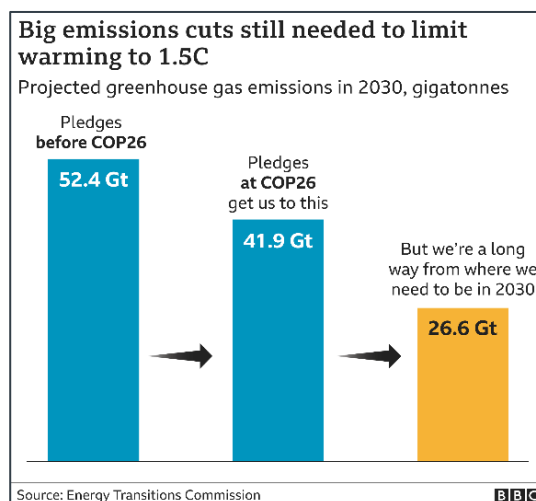
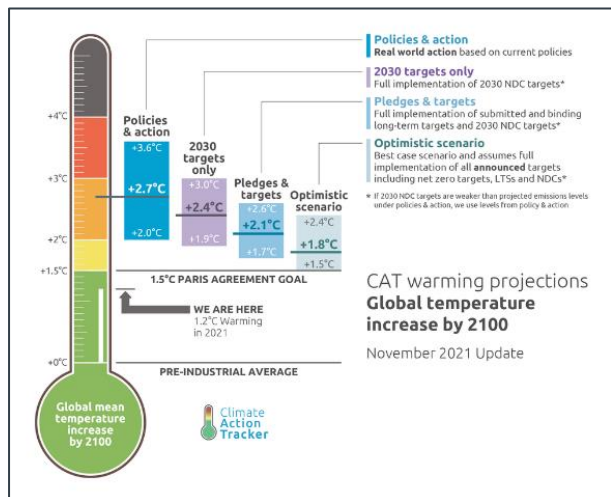
KEY PROVISIONS OF THE PARIS AGREEMENT FOR COP-26	
<p>Article 2.1:</p> <p>This Agreement ... aims to strengthen the global response to the threat of climate change ... including by:</p> <p>(a) Holding the increase in global average temperatures to well below 2°C [Stabilisation Goal] above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C [Stretch Goal] above pre-industrial levels, recognising that this would significantly reduce the risk and impacts of climate change;</p> <p>(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and</p> <p>(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.</p>	<p>Article 4:</p> <p>In order to achieve the long-term temperature goal set in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, ... and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals to sinks in greenhouse gas in the second half of this century</p> <p>Article 6:</p> <p>1. Parties recognise that some Parties choose to pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity.</p> <p>2. Parties shall, where engaging on a voluntary basis ... promote sustainable development, and ensure ... integrity and transparency ... and shall apply <i>robust accounting</i> ... to ensure .. avoidance of double counting consistent with guidance adopted by the Conference of Parties</p>

2: What the reader needs to know:

2.1 Overarching theme:

In the weeks leading up to **COP-26** some countries increased and accelerated their **NDCs**. During **COP-26** further commitments were made. **Edition 30** of Low Carbon Pulse reported on the work and conclusions of the good folk at Climate Tracker to model the impact of those further commitments.

After **COP-26**, as reported by Climate Tracker, the best case scenario arising from the announced increased **NDCs** would be to hold the increase in global warming to **1.8°C**, assuming implementation of those increased **NDCs**. This was positive, certainly more positive than the **Catastrophic Pathway**. It did not, however, and it does not, provide certainty of a 45% reduction in **GHG** emissions by 2030.



From **COP-26** a number of themes emerged (see **Edition 30** of Low Carbon Pulse), but the overarching theme was the need to increase levels of action to address climate change, and to accelerate the reduction in **GHG** emissions.

The overarching theme from **COP-26** is carried forward in both the **IPCC WGIII Report** and **WETO 2022**, each emphasising that by the end of the current decade considerably more action needs to have been taken than is represented by the current combined **NDCs** of each country party to the Paris Agreement.

2.2: Fundamental choices need to be made, quickly:

Each of the **IPCC WGIII Report** and **WETO 2022** are clear – the world faces fundamental choices that will determine whether global warming is limited to **1.5°C** or **2°C**, or not. The **IPCC WGIII Report** contemplates a worst case outcome of a **3.2°C** increase, beyond the **Catastrophic Pathway**. Time is a luxury, and collectively our carbon budget does not allow any luxuries.

2.3: Increased and accelerated reductions in NDCs are required, quickly:

It is known that increased and accelerated reductions in **GHG** emissions by 2030 and 2040 are required, particularly reductions in methane (**CH₄**), to achieve lower peak **GHG** emissions, and lower peak warming (which will happen after peak **GHG** emissions). This will place less reliance on **GHG** removal (including negative **GHG** emission initiatives).

2.4: None of this is new:

It is important to note that none of this is new. What is new is the increasing realisation that the choices available to us are narrowing, and there is a real risk that neither the **1.5°C** nor **2°C** limit on global warming will be achieved.

Section 3: The Headlines:

3.1: Peaking GHG emissions:

Many of the headlines reporting on the **IPCC WGIII Report** do not seem to reflect the sage advice described in **Section 1.2** above. In context, as reported in previous editions of Low Carbon Pulse, and as noted above, there is a gap between the **NDCs** of countries that are party to the Paris Agreement and the level, and rate, of reductions in **GHG** emissions required to limit global warming to **1.5°C** or **2°C**. At the moment, **GHG** emissions are increasing, as is the rate of increase, and as such it is difficult to discern when peak **GHG** emissions will be reached.

Given the current rate of **GHG** emissions, we can discern the mass of **GHG** emissions in the atmosphere that will result in a **1.5°C** increase in average temperature compared to pre-industrial times. Below, a simple scenario (under section 4.1.7) is provided that would allow us to limit the temperature increase to **1.5°C** by 2100, assuming reductions of a level and at a rate consistent with achieving net-zero by 2050. Depending on the mass of **GHGs** emitted, by 2100 the increase may exceed **3°C** compared to pre-industrial time (a worst case scenario is a **3.2°C** increase).

3.2: Key message:

The key message from the **IPCC WGIII Report** is that, starting now, increased and accelerated reductions in **GHG** emissions are required across all sectors, using multiple means. It is imperative that this happens. If it does not happen it seems highly unlikely that keeping the increase in average global temperatures to **1.5°C** will be achieved.

As Mr Bill Gates said, in **How to Avoid A Climate Disaster**, reducing **GHGs** to net-zero by 2050 "will be hardest thing humanity's ever done". But it is technically feasible. The basis for Mr Gate's book is that: "There are two numbers you need to know about climate change. The first is 51 billion. The other is zero". The **IPCC WGIII Report** increases the first number to between 54 and 66 GtCO₂ (reflecting the mass of **GHG** emissions emitted in 2019). It is harder!

3.3: What needs to be done is known:

The scale of the task is known, the degree of difficulty is known. Objectively viewed, the fundamental choices are clear, and decisions should be easy, but execution is the hardest thing humanity's ever done.

In short, in the words of the Co-Chair of the **IPCC WGIII**, Mr Jim Skea: "**It's now or never**" to make and to act upon those fundamental choices.

In a quote used on a number of occasions in *Low Carbon Pulse*, "**What's past is prologue**", taken, without any intended cynicism or irony, from *The Tempest*, by William Shakespeare. The phrase is emblematic.

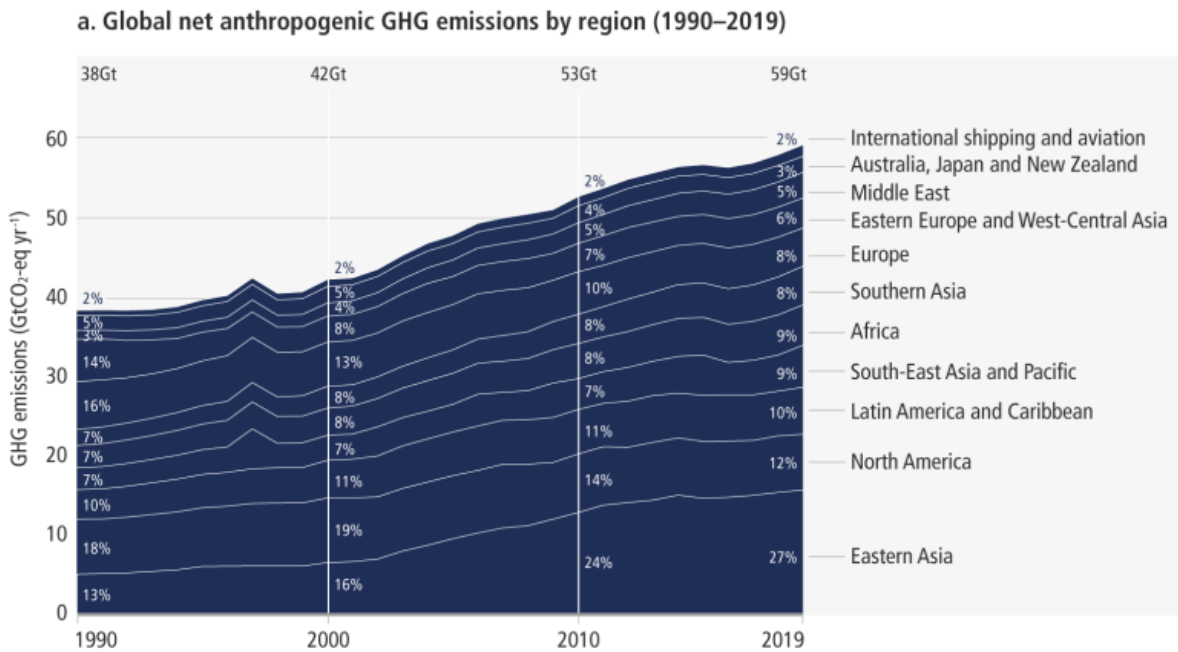
To the ever-optimistic author, this means that it is time to draw a line under the past, and move on, as quickly as possible, to increase the level and to accelerate the rate of reductions in **GHG** emission by all means practicable.

Section 4: What is past is prologue

4.1.1: Carbon budget to the end of 2019:

The **IPCC WGIII Report** states that:

"Historical cumulative net CO₂ emissions from 1850 to 2019 were 2,400 ± 240 GtCO₂ (high confidence). Of these, more than half (58%) occurred between 1850 and 1989 [1,400 ± 195] GtCO₂, and about 42% between 1990 and 2019 1,000 ± 90 GtCO₂".



The focus of the **IRENA WETO 2022** is **GHG** emissions arising from the energy sector. The following pie-chart and infographic illustrate the mass of **GHG** emissions arising (36.9 GtCO₂) and the means by which those emissions are

FIGURE ES.1 Reducing emissions by 2050 through six technological avenues

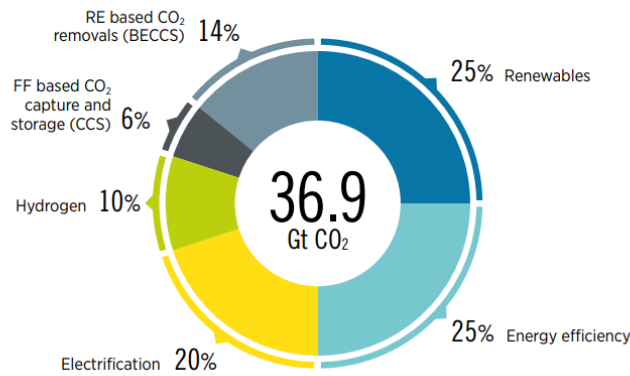
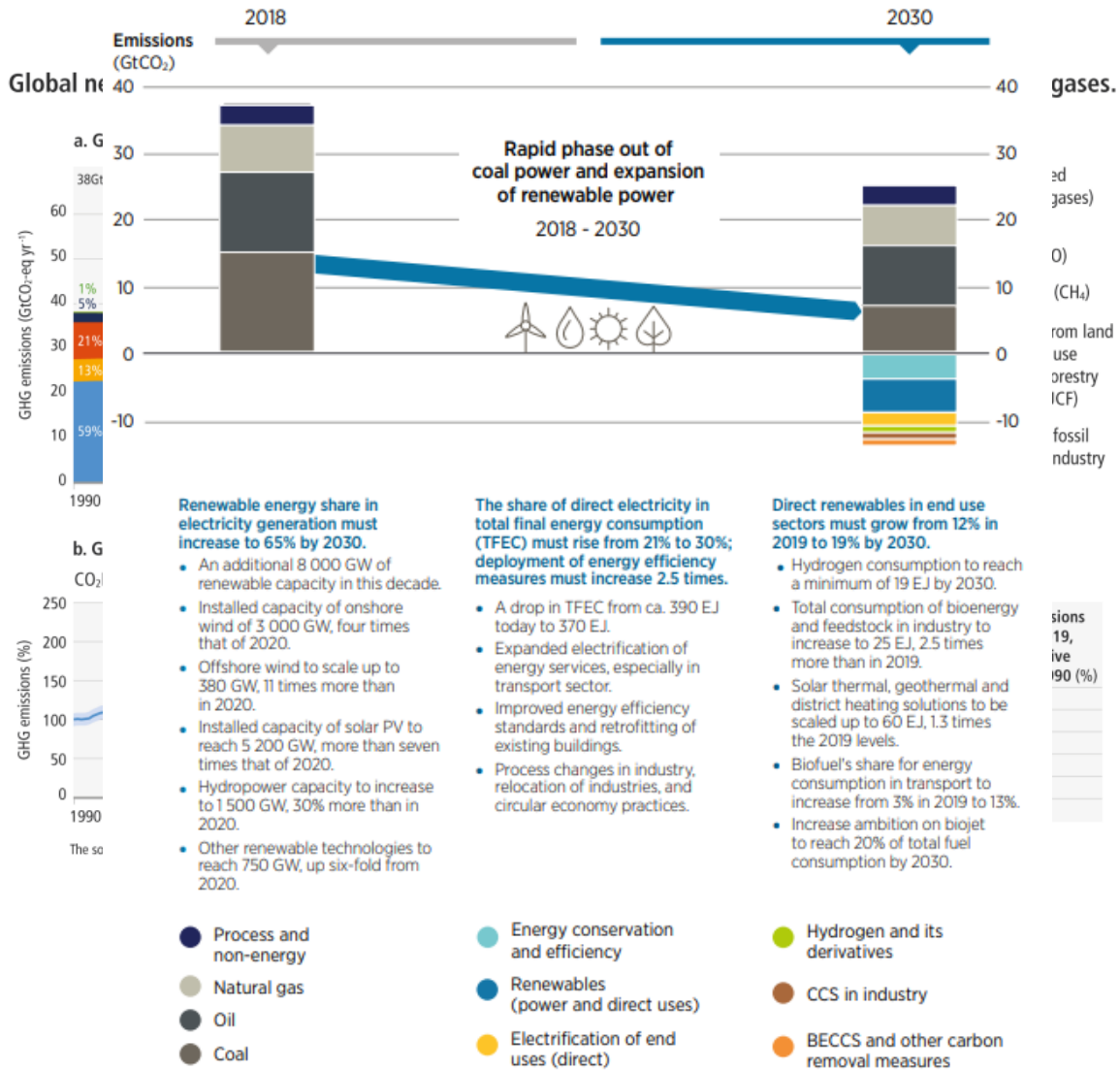


FIGURE ES.2 Emission reductions 2018-2030



to be reduced. The infographic and accompanying narrative represents the required reduction in the mass of **GHG** emissions by 2030.

4.1.2: Reduction in GHG emissions and impact:

The mass of **GHG** emissions arising each year, and more importantly the global warming potential of those **GHG's**, will inform the rate at which global warming occurs, and as such at what point we will reach a **1.5°C** increase and, possibly, a **2°C** increase in global average temperatures around which the Paris Agreement is framed.

In this context, considerable work has been done to determine the rate at which **GHG** emissions can be emitted before the **1.5°C** limit or **2°C** limit is reached. The **IPCC WGIII Report** indicates that in 2019, 59 GtCO₂ (plus or minus 6.6 Gt) of **GHG** emissions arose. This is relevant for the purposes of the carbon budget.

4.1.3: Carbon budget from 2020 onwards:

The **IPCC WGIII Report** states that:

"Remaining carbon budgets depend on the amount of non-CO₂ mitigation (± 220 GtCO₂) and are further subject to geophysical uncertainties. Based on central estimates only, cumulative net CO₂ emissions between 2010-2019 compared to about four fifths of the size of the remaining carbon budget from 2020 onwards for a 50% probability of limiting global warming to 1.5°C and about one third of the remaining carbon budget for a 67% probability to limit global warming to 2°C. Based on central estimates only, historical cumulative net CO₂ emissions between 1850-2019 amount to about four fifths of the total carbon budget for a 50% probability of limiting global warming to 1.5°C (central estimate 2,900 GtCO₂, and to about two thirds of the total carbon budget for a 67% probability to limit global warming to 2°C (central estimate about 3,350 GtCO₂)."

What emerged clearly from **COP-26** was an understanding of the criticality of staying as close as possible to a **1.5°C** increase in average global temperatures (see **Editions 29** and **30** of Low Carbon Pulse).

What has emerged since **COP-26** is that the rate of **GHG** emissions is increasing at a faster rate than was thought (including because of an under-recognition of **CH₄** emissions), and the point of peak **GHG** emissions, and the level of the peak, is further into the future, and at a higher mass of **GHG** emissions at peak level, than thought. These dynamics explain the reason for the expression of urgency.

4.1.4: Where we are now - in summary:

Based on an assumed mass of **GHG** emissions of say 60 GtCO₂ a year, it is possible to estimate how much is left in the carbon budget before we reach global warming of **1.5°C** (or **2°C**), but, as will be explained, is not possible to determine exactly when the carbon budget will be depleted, because this depends on the mass of net **GHG** emissions. Various models and reports indicate that four fifths of the carbon budget is 2,400 GtCO₂ to limit global warming to **1.5°C** has been used. Leaving a fifth remaining, or 600 GtCO₂. Once the remaining fifth is used, we will need to remove **CO₂** from the atmosphere to be able limit global warming to **1.5°C**. This is not new (see Article 4 of the [Paris Agreement](#)).

In simple terms, at the current rate of **GHG** emissions during 2019, by 2030 we will have depleted the carbon budget. This is one part of the equation.

The other parts of the equation include knowing when peak **GHG** emissions will occur, and at what level of **GHG** emissions, and the rate of reduction in **GHG** emissions after reaching peak **GHG** emissions. These other parts to the equation will determine the extent to which we "overdraw" from the carbon budget, and, as a result, the mass of **CO₂** that will need to be removed from the atmosphere, and the rate at which this will have to occur.

4.1.5: Understanding peak emissions and the level of peak emissions:

It is not simple to determine is when **GHG** emissions will peak, and at what mass of **GHG** emissions will peak. More than this, it is critical to note that once peak **GHG** emissions are reached, the aggregate of all **GHG** emissions emitted to peak **GHG** emissions, and the rate of the decrease in **GHG** emissions after reaching peak **GHG** emissions, will determine the peak of global warming.

As such, assuming that we reach net zero **GHG** emissions by 2050, this does not mean that the rate of global warming will slow, or that global warming will reverse, this will depend upon the period of time taken for the global warming effect of **GHGs** emitted to dissipate, and the use of carbon removal (including negative greenhouse emission reduction initiatives).

4.1.6: Recurring headline illustrates the core issue:

One of the recurring headlines arising from the **IPCC WGIII Report** has been that to be able to have a chance of limiting global warming to **1.5°C** it will be necessary to achieve peak **GHG** emissions by the end of 2025.

The basis for this headline is that if we were to achieve peak **GHG** emissions by 2025 (assuming no increase in the mass of **GHG** emissions arising each year before 2025), this will leave 300 GtCO₂ left in the carbon budget (at the current assumed rate of GHG emission, 60 GtCO₂ a year). Clearly if the level of **GHG** emissions increase, we will use up the carbon budget at a faster rate.

But, and it is a big but, for global warming not to exceed **1.5°C**, the cumulative mass of **GHG** emissions arising from the end of 2025 (assuming the peak **GHG** emissions arise then) to the time at which we achieve net-zero emissions should not exceed 300 GtCO₂.

This is not going to happen, but what is?

While headlines are intended to capture our attention, the recurring headline described above leads us to the core of the issue, and, it is hoped, explains why policy makers are adamant that steep reductions in **GHG** emissions are required by 2030 and 2040. To explain this thinking, the following simple scenario may help.

4.1.7: A simple scenario (from the author):

If a 50% reduction in **GHG** emissions was to be achieved by 2030, **GHG** emissions would have to have reduced to 30 GtCO₂ in 2030. If the rate of reduction was say 6 GtCO₂ a year from an assumed peaking of **GHG** emissions in 2025 at 60 GtCO₂. This would result in 280 GtCO₂ being emitted (from 2025 to 2030). Out of the 300 GtCO₂ carbon budget, about 90 GtCO₂ would be left i.e. 300 GtCO₂ less 210 GtCO₂ of **GHG** emissions (noting that this takes no account of dissipation of **GHG** emission in the atmosphere). (This would not guarantee limiting global warming to **1.5°C**, but it would make the task of removing **CO₂** a lesser task than might otherwise be the case.)

Continuing with the simple scenario. If during the period 2030 to 2040, **GHG** emissions could be reduced at a rate of 2 GtCO₂ a year, by 2040 the carbon budget of 300 GtCO₂ carbon budget would have been used, and it would be 70

GtCO₂ "overdrawn" (i.e. positive integer 90 GtCO₂ less 160 GtCO₂ of **GHG** emissions) against the carbon budget that would limit global warming to a **1.5°C** increase.

Assuming that from 2040 to 2050 **GHG** emissions are reduced at a rate of 1.2 GtCO₂ a year to reach net zero **GHG** emissions by 2050, we would be 105 GtCO₂ "overdrawn" by (i.e. negative integer 70 GtCO₂ plus 35 GtCO₂ of **GHG** emissions) against the **1.5°C** carbon budget, but the task of removing **CO₂** from the atmosphere would be a lesser task than what might otherwise be the case, and, more likely than not, would allow us to limit global warming to **1.5°C** by the end of the 21st century.

In putting numbers to a concept, it is hoped that this simple scenario provides a firm basis for what follows. From one simple scenario, to multiple scenarios.

The **IPCC WGIII Report** and the **WETO 2022** provide a range of scenarios, some of which will allow us to limit global warming to **1.5°C** by the end of the 21st century, others that will not.

4.2 What might the future hold:

4.2.1: From 2020 to peak **GHG** emissions:

Of course, the mathematics in the simple scenario work only if **GHG** emissions start to slow before and decrease at an appropriate rate after peak **GHG** emissions are reached.

The **IPCC WGIII Report** notes that the mathematics will not work given the announced **NDCs** pre-**COP-26**, and, as noted above, the best scenario immediately post-**COP-26** (taking into account increased **NDCs**) is a **1.8°C** increase in average global temperatures.

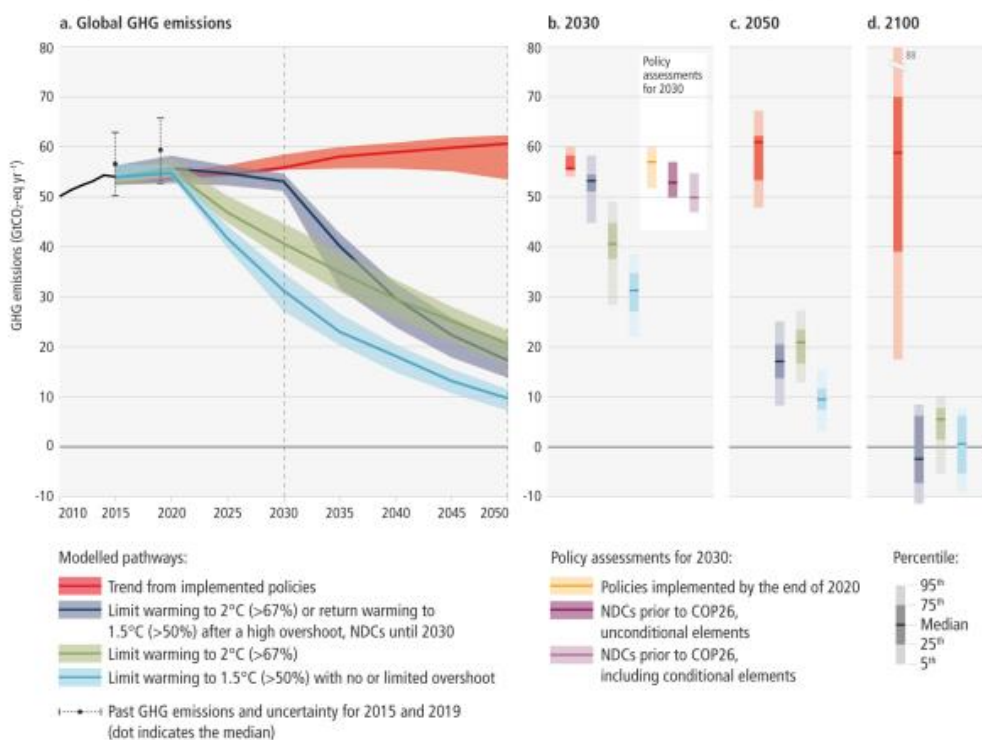
The **IPCC WGIII Report** states that based on pre-**COP-26 NDCs** it is likely that global warming will exceed **1.5°C** during the 21st century, and that limiting global warming to below **2°C** would require accelerated mitigation efforts after 2030.

Even allowing for the increased **NDCs** before, during and after **COP-26**, the rate of **GHG** emissions is increasing, not decreasing.

It is accepted broadly that **GHG** emissions need to reduce by between 45 to 50% by 2030 for there to be a chance of limiting global warming to **1.5°C**. This is not new, and the core of the issue is explained above.

The graphic below, and accompanying analysis, provides a good sense of the **GHG** reductions that need to be achieved, and the range of outcomes that may arise if those **GHG** reductions are not achieved.

Projected global GHG emissions from NDCs announced prior to COP26 would make it likely that warming will exceed 1.5°C and also make it harder after 2030 to limit warming to below 2°C.



4.2.2: Fossil fuels:

Consistent with a plethora of reports finding that countries are not taking into account in setting their **NDCs** for continued use of fossil fuels (see **Editions 29** and **30** of Low Carbon Pulse), the **IPCC WGIII Report** notes that without additional reductions to take account of continued use of fossil fuels (both existing and currently planned) projected reductions will not be achieved. Again, this is not new.

The narrative and reporting around the phasing out of fossil fuels remains challenging, both in terms of a reduction in revenue (direct for national oil companies, indirect for Governments currently receiving royalties and taxes from the production and sale of fossil fuels, and customs and duties from downstream import and sale of fossil fuels, and indeed any carbon tax) and the level of revenue required to allow Governments to support the development of infrastructure to allow progress to the achievement of net-zero emissions, and the fiscal incentives that Governments

are giving, and are likely to have to continue to give, to allow continued progress to the achievement of net-zero emissions.

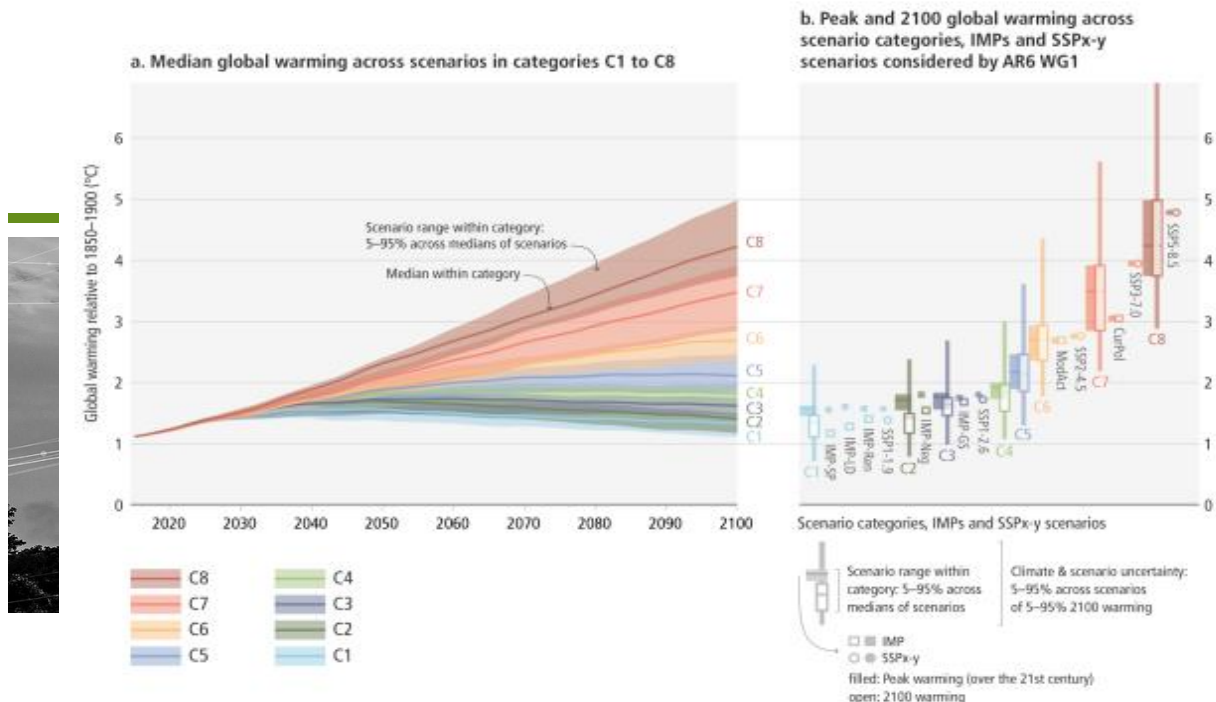
Governments in many countries are facing a "fiscal squeeze" (and will continue to do so), as the expectations of the funding support that Government will provide to achieve progress towards net-zero emissions increases, while at the same time the Governments face a diminishing lower fiscal base with the phase out of fossil fuel. This "fiscal squeeze" needs to be understood, and overcome.

Both the **IPCC WGIII Report** and the **WETO 2022** are clear about the need to phase out fossil fuels. The author notes that pragmatism, and good sense, is required in this context.

The table provides a summary on a page of a range of outcomes canvassed in the **IPCC WGIII Report**. To the author, it is pretty much an ideal summary.

p50 [p5-p95] (1)		GHG emissions: Gt CO ₂ -eq/yr (7)			GHG emissions: reductions from 2019 % (8)			Emissions milestones: (6)(9)				Cumulative CO ₂ emissions: Gt CO ₂ (12)		Cumulative net-negative CO ₂ emissions: Gt CO ₂	Global mean temperature change 50% probability (16) °C		Likelihood of peak global warming staying below (%) (15)					
Category (4)	Category / subset label	WG I SSP & WG III IP2/IMP2 alignment (5)			2030	2040	2050	2030	2040	2050	Peak CO ₂ emissions: (% peak before 2100)	Peak GHG emissions (% peak before 2100)	Net-zero CO ₂ (% net-zero pathways)	Net-zero GHG ₂ (13) (% net-zero pathways)	2020 to net-zero CO ₂	2020-2100	Year of net-zero CO ₂ to 2100	at peak warming	2100	<1.5°C	<2.0°C	<3.0°C
		2030	2040	2050																		
<p>Modelled global emissions pathways categorised by projected global warming levels (GWL). Detailed likelihood definitions are provided in SPM Box 1.</p> <p>The five illustrative scenarios (SSP2-5) considered by AR6 WGI and the Illustrative (Mitigation) Pathways assessed in WGIII are aligned with the temperature categories and are indicated in a separate column. Global emission pathways contain regionally differentiated information. This assessment focuses on their global characteristics.</p> <p>Projected median annual GHG emissions in the year across the scenarios, with the 5th-95th percentile in brackets. Modelled GHG emissions in 2019: 55 [53-58] Gt CO₂-eq</p> <p>Projected median GHG emissions reductions of pathways in the year across the scenarios compared to modelled 2019, with the 5th-95th percentile in brackets. Negative numbers indicate increase in emissions compared to 2019</p> <p>Median 3-year intervals at which projected CO₂ & GHG emissions peak, with the 5th-95th percentile interval in square brackets. Percentage of peaking pathways is denoted in round brackets. Three dots (...) denotes emissions peak in 2100 or beyond for that percentile.</p> <p>Median 5-year intervals at which projected CO₂ & GHG emissions of pathways in this category reach net-zero, with the 5th-95th percentile interval in square brackets. Percentage of net zero pathways is denoted in round brackets. Three dots (...) denotes net zero not reached for that percentile.</p> <p>Median cumulative net CO₂ emissions across the projected scenarios in this category until reaching net-zero or until 2100, with the 5th-95th percentile interval in square brackets.</p> <p>Median cumulative net-negative CO₂ emissions between the year of net-zero CO₂ and 2100. More net-negative results in greater temperature declines after peak</p> <p>Projected temperature change of pathways in this category (50% probability across the range of climate uncertainties), relative to 1850-1900, at peak warming and in 2100, for the median value across the scenarios and the 5th-95th percentile interval in square brackets.</p> <p>Median likelihood that the projected pathways in this category stay below a given global warming level, with the 5th-95th percentile interval in square brackets.</p>																						
C1 [97]	limit warming to 1.5°C (>50%) with no or limited overshoot	SSP1-1.9, SP	31	17	9	43	69	84				2095-2100 (52%) [2050-...]	510	320	-220	1.6	1.3	38	90	100		
C1a [50]	... with net-zero GHGs	LD	33	18	8	41	66	85	2020-2025 (100%) [2020-2025]	2050-2055 (100%) [2035-2070]	2070-2075 (100%) [2050-2090]	550	160	-360	1.6	1.2	38	90	100			
C1b [47]	... without net-zero GHGs	Rem	29	16	9	48	70	84				... [0%] [...]	460	360	-60	1.6	1.4	37	89	100		
C2 [133]	return warming to 1.5°C (>50%) after a high overshoot	Net	42	25	14	23	55	75	2020-2025 (100%) [2020-2030]	2055-2060 (100%) [2045-2070]	2070-2075 (87%) [2065-...]	720	400	-360	1.7	1.4	24	82	100			
C3 [311]	limit warming to 2°C (>67%)		44	29	20	21	46	64	2020-2025 (100%) [2020-2030]	2070-2075 (93%) [2055-...]	... (30%) [2075-...]	890	800	-40	1.7	1.6	20	76	99			
C3a [264]	... with action starting in 2020	SSP1-2.6	40	29	20	27	47	63	2020-2025 (100%) [2020-2025]	2070-2075 (91%) [2055-...]	... (24%) [2080-...]	860	790	-30	1.7	1.6	21	78	100			
C3b [97]	... NDCs until 2030	GS	52	29	18	5	46	68		2065-2070 (97%) [2065-2090]	... (41%) [2075-...]	910	800	-60	1.8	1.6	17	73	99			
C4 [159]	limit warming to 2°C (>50%)		50	38	28	10	31	49	2020-2025 (100%) [2020-2030]	2080-2085 (86%) [2065-...]	... (31%) [2075-...]	1210	1160	-30	1.9	1.8	11	59	98			
C5 [212]	limit warming to 2.5°C (>50%)		52	45	39	6	18	29		... (41%) [2080-...]	... (12%) [2090-...]	1780	1780	0	2.2	2.1	4	37	91			
C6 [97]	limit warming to 3°C (>50%)	SSP2-4.5 Mod-Act	54	53	52	2	3	5	2030-2035 (96%) [2020-2035]	2020-2025 (97%) [2020-2090]			2790	[2440-3620]		2.7	2.4	0	8	71		
C7 [164]	limit warming to 4°C (>50%)	SSP3-7.0 Cur-Pol	62	67	70	-11	-19	-24	2085-2090 (57%) [2040-...]	2090-2095 (56%) [2040-...]	no net-zero	no net-zero	4220	[3160-5000]	no net-zero	3.5	[2.8-3.9]	0	0	22		
C8 [29]	exceed warming of 4°C (>>50%)	SSP5-8.5	71	80	88	-20	-35	-46	2080-2085 (90%) [2070-...]				5600	[4910-7450]		4.2	[3.7-5.0]	0	0	4		

The range of assessed scenarios results in a range of 21st century projected global warming.



Section 5: What needs to be done:

5.1: What needs to be done in a general sense?

The **IPCC WIIII Report** notes that all models that limit global warming to **1.5°C** assume that peak **GHG** emissions will be achieved by 2025, and that all models that limit global warming to **2°C** assume immediate action to achieve the model **GHG** emission reductions.

5.2: What will the consequences be if what needs to be done is not done?

Without implementing policy settings that address the short-comings of the pre-**COP-26 NDCs**, peaking **GHG** emissions will not be achieved by 2025, rather **GHG** emissions will continue to increase after 2025. Again, this is not new, nor is the projection that global warming may reach **3.2°C** if action is not taken to achieve appropriate levels and rates of reduction in **GHG** emissions.

As a general statement, the **IPCC WGIII Report** contemplates the need for immediate increased and accelerated **GHG** emission reductions across all sectors.

5.3: The means of reductions are known:

5.3.1: IPCC WGIII Report:

The **IPCC WGIII Report** provides considerable narrative on the following needs: to develop and to deploy renewable electrical energy; to transition from fossil fuels (that do not use CCS) to transition to very low or no carbon energy fuels; to achieve effective demand management, including to achieve efficient use of energy and reduced use of energy; to reduce **CH₄** emissions; and to develop and to deploy carbon dioxide removal (**CDR**) methods.

In this context, the **IPCC WGIII Report** provides Illustrative Mitigation Pathways (**IMPs**)

5.3.2: WETO 2022:

In addition to the ubiquitous need for countries that are parties to the Paris Agreement to increase the level and rate of **GHG** emission reductions, **WETO 2022** builds on the six technological means to reducing emissions identified in **WETO 2021**: those means being renewable electrical energy, energy efficiency, electrification, hydrogen and hydrogen-based fuels, fossil fuel based CCS and bio-energy based CCS. These means are covered in detail in **WETO 2021**, and summarised, amongst others, in **Edition 21** of Low Carbon Pulse.

The focus of **WETO 2022** is the **2030 priorities** are as follows:

1. replacing coal-fired power stations with clean power generation;
2. phasing out fossil fuels in tandem with market development and reform to incentivise net-zero transition;
3. increasing the rate of development and deployment of renewable electrical energy and "aggressive energy efficiency" strategies;
4. infrastructure development and expansion, and upgrading, to assure, or to increase infrastructure and system, integrity and reliability to allow timely deployment of renewable electrical energy;
5. green hydrogen to become mainstream by 2030;
6. triple the supply and demand for bio-energy by 2030, requiring considerable work to collect and to allow use of bio-energy feedstock arising from waste streams;
7. the majority of car sales should be electric by 2030;
8. new buildings must be energy efficient and renovation rates of existing buildings must be increased (including to avoid production of cement for concrete and iron and steel for construction);

9. demand side management initiatives to ensure efficiency, including recycling and repurposing; and
10. policy settings that cover all avenues that technology development may take.

5.4: Nothing new under the sun:

There is nothing new in the *IPCC WGI* Report or the *WETO 2022*. This said, were one reading news items and commentary on each report, one could be forgiven for concluding that carbon dioxide removal was new, and that conclusions in respect of it were new.

As is apparent from Article 4 of the Paris Agreement, *CDR* has always been contemplated. The issue now is that *CDR* should be accelerated.

While not new (see [Editions 28](#) of Low Carbon Pulse, under *NZE not enough CDR required now*), there is a new emphasis on the need for *CDR* now: boiling down to the essentials, there is a need to commence *CDR* (including negative *GHG* emission initiatives (*NGHGEIs*)) as soon as possible.

In the blur of headlines, a number of commentators and participants have expressed a range of views on *CDR*, and its role in *IMPs*. *CDR* is used in a broad sense to include carbon capture arising from Bioenergy with CCS (BECCS) and Direct Air Carbon Capture and Storage (DACCS), and negative emission reduction initiatives in the AFOLU sector.

While understandable, some commentators and participants have overstated the findings in the *IPCC WGI* Report on the use of particular means of achieving *CDR*.

The good thing is that it is recognised that *CDR* needs to be developed and deployed at the same time as *GHG* emission reductions. This recognises the reordering of the three means of achieving the outcomes contemplated in the Paris Agreement: from *RPR* – Reduction, Peaking and Removal, to *RRP* – Reduction, Removal and Peaking. (See the [Anniversary Edition](#) of Low Carbon Pulse.)

5.5: Means to reduce GHG emissions: The following graphic illustrates the range of means for reducing *GHG* emissions identified by the *IPCC WGI*.

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.

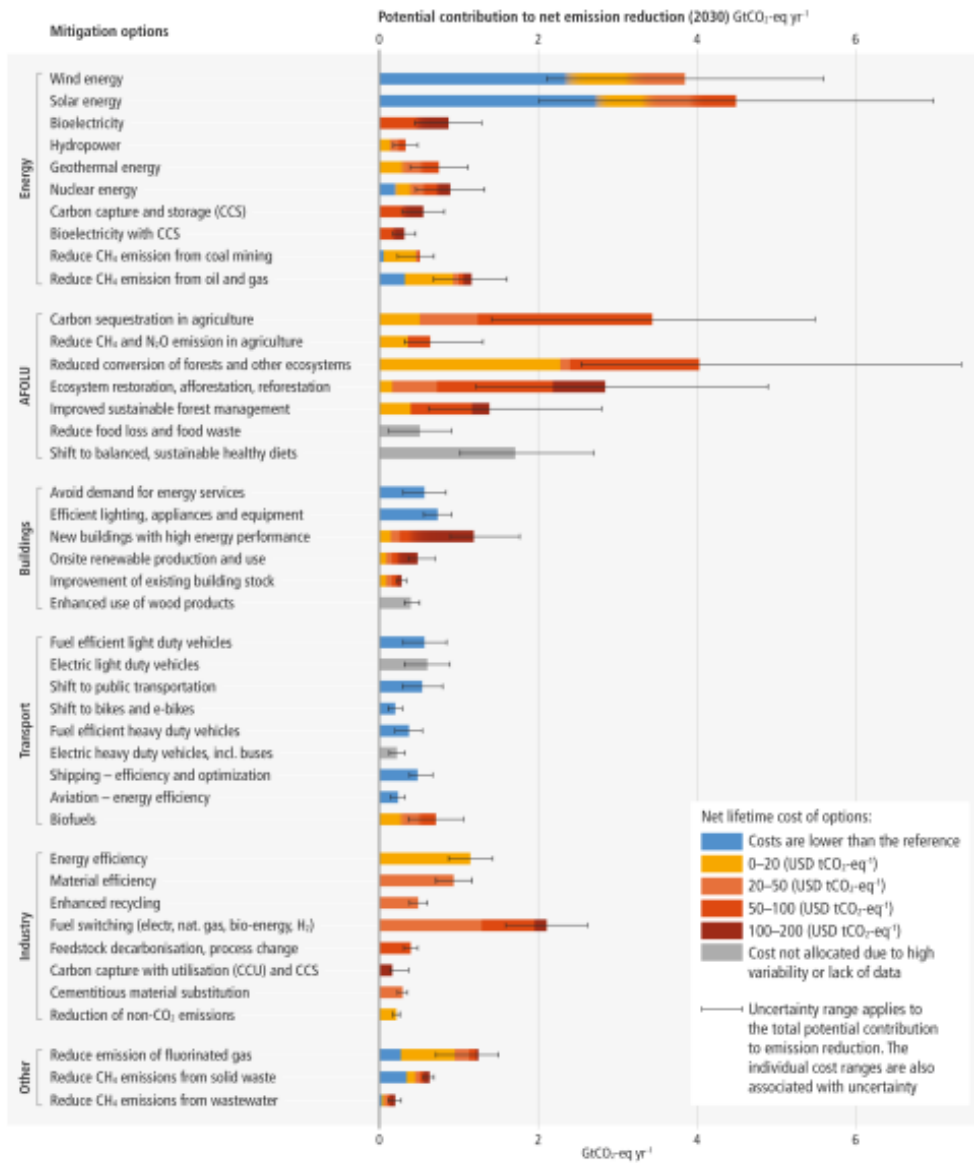
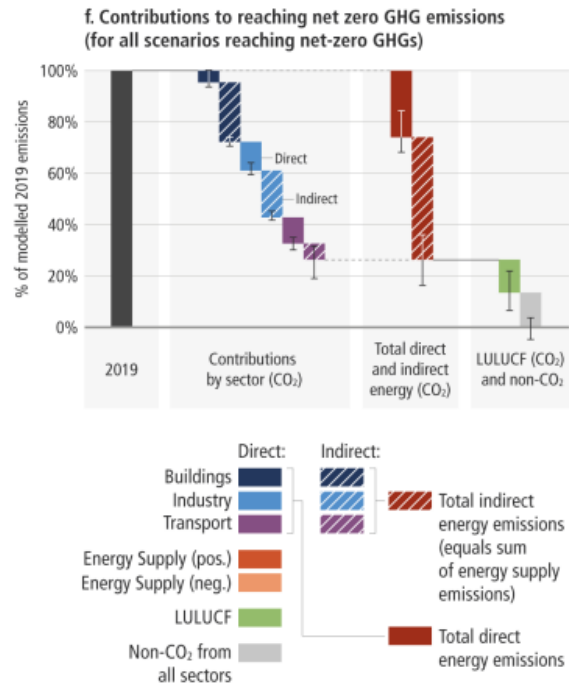
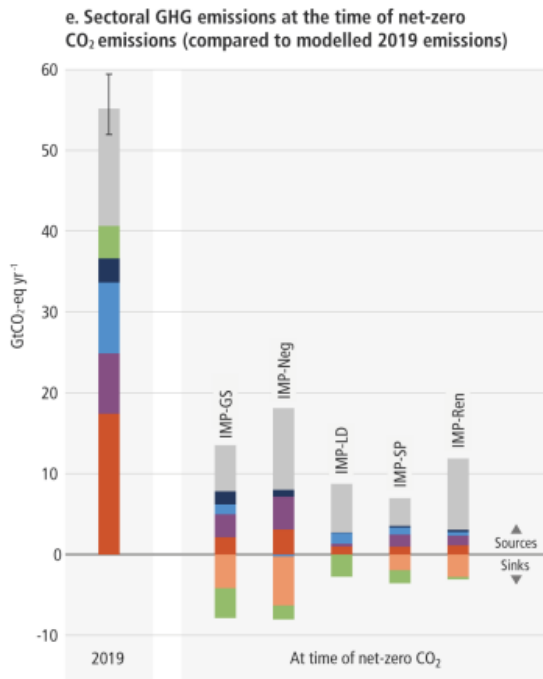


Figure SPM.7: Overview of mitigation options and their estimated ranges of costs and potentials in 2030.

Net zero CO₂ and net zero GHG emissions are possible through different modelled mitigation pathways.



5.7: Reductions in GHG emissions sector by sector:

In the context of the following sectors the **IPCC WGIII Report** identifies the following principal means of mitigation by sector:

- **AFOLU:** the greatest mitigation will arise from conservation and preservation, reforestation, restoration of grasslands, peatlands, savannas and wetlands, reduced and then cessation of deforestation. In the context of cultivated or farmed land, improved and sustainable crop and livestock management, and carbon sequestration in agriculture, including soil carbon management, agroforestry and biochar use, will be key. It is noted that AFOLU mitigation actions cannot compensate for delayed reductions in **GHG** emissions across other sectors. This is a key theme from both the **IPCC WGIII Report**, and the **WETO 2022** – all policy settings, all means of mitigation need to be developed and deployed as quickly as possible and as broadly as possible.
- **Built environment:** In the context of the continued growth in population and increasing urbanisation, changing and reducing energy demand, increased electrification (using renewable electrical energy), and use of CCS are identified as key **IMPs**.
- **Industry:** demand side management, energy and materials efficiency, circular material flows, as well as abatement technologies and changes to production processes are required.
- **Transport:** electric vehicles, sustainable bio-fuels, low emission hydrogen and synthetic fuels may mitigate **CO₂** emissions arising in the aviation, heavy-vehicle land transport and shipping, but for wide, and timely, adoption require improved production processes, including to achieve reductions in cost.

NZE reports

Please see below a list of reports that have been reviewed for Editions 29 to 38 of Low Carbon Pulse. This list includes the publishing organisation, title/subject matter, and link.

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Airbus	<u>Hydrogen: An energy carrier to fuel the climate-neutral aviation of tomorrow</u>	29
BloombergNEF	<u>New Energy Outlook, 2021</u>	29
Euromia Research & Consulting	<u>CCUS Development Pathway for the EfW Sector</u>	29
IEA	<u>Global Hydrogen Review 2021</u>	29
IEA	<u>Curtailling Methane Emissions from Fossil Fuel Operations</u>	29
IEA	<u>World Energy Outlook 2021</u>	29
IEA	<u>Net Zero by 2050 – A Roadmap for Global Energy Sector</u>	29
IEA	<u>Achieving Net-Zero Electricity Sectors in G7 Members</u>	29
IEA	<u>Phasing Out Unabated Coal – Current status and three case studies</u>	29
IMF	<u>World Economic Outlook</u>	29
IRENA	<u>A Pathway to Decarbonize the Shipping Sector by 2050</u>	29
IRENA	<u>World Energy Transitions Outlook</u>	29
James Cook University	<u>The global value of coastal wetlands for storm protection</u>	29
Lancaster University and Small World Consulting	<u>The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations</u>	29
New South Wales Legislative Council	<u>Development of a hydrogen industry in New South Wales</u>	29
S&P Global Platts	<u>Platts Global Integrated Energy Model – Strategic Planning for a world in transition.</u>	29
Shell	<u>Exploring the Future of the Voluntary Carbon Market</u>	29
Shell and Deloitte	<u>Decarbonising Aviation: Cleared for Take-off, Industry Perspectives</u>	29
United Nations	<u>UNFCCC NDC Synthesis Report</u>	29
United Nations	<u>2021 Production Gap Report</u>	29
US EIA	<u>International Energy Outlook</u>	29
World Bank	<u>Key Factors For Successful Development of Offshore Wind in Emerging Markets</u>	29
Wood Mackenzie	<u>How to scale up carbon capture and storage</u>	29
Wood Mackenzie	<u>Global Energy Storage Outlook</u>	29

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Danish Maritime Authority, Oxford Research, and the Technical University of Denmark	<u><i>Innovation needs for decarbonization of shipping</i></u>	30
Global Carbon Project	<u><i>Global Carbon Budget 2021</i></u>	30
IEA	<u><i>Greenhouse Gas Emissions from Energy, Statistics Report</i></u>	30
Kruitwagen, L., Story, K.T., Friedrich, J. et al	<u><i>A global inventory of photovoltaic solar energy generating units</i></u>	30
Lazard Ltd	<u><i>Levelized Cost of Energy Analysis</i></u>	30
The Met Office	<u><i>One billion face heat-stress risk from 2°C rise</i></u>	30
Oxford Institute for Energy Studies	<u><i>Energy Transition in Japan and implications for gas</i></u>	30
Oxford Institute for Energy Studies	<u><i>The Russian Perspective on COP-26 and the Key Challenges of the Road to Net Zero</i></u>	30
Thunder Said Energy	<u><i>Small-scale CCS: transport liquid CO2?</i></u>	30
Tong, D., Farnham, D.J., Duan, L. et al.	<u><i>Geophysical constraints on the reliability of solar and wind power worldwide</i></u>	30
UAE Ministry of Energy & Infrastructure and the Federal Ministry for Economic Affairs of Germany	<u><i>The Role of Hydrogen for the Energy Transition in the UAE and Germany</i></u>	30
United Nations Development Programme	<u><i>A Guide to Carbon Pricing and Fossil Fuel Subsidy Reform</i></u>	30
Australian Renewable Energy Agency	<u><i>Australia's Bioenergy Roadmap Report</i></u>	31
Global Geothermal Alliance, IDB, and International Renewable Energy Agency (IRENA)	<u><i>Geothermal: The Solution Underneath</i></u>	31
Hydrogen Europe	<u><i>Reforming carbon markets to enable a liquid, sustainable and affordable hydrogen market</i></u>	31
HySupply	<u><i>The Case for an Australian Hydrogen Export Market to Germany: State of Play Version 1.0</i></u>	31
International Renewable Energy Agency (IRENA)	<u><i>Community Energy Toolkit: Best practices for broadening the ownership of renewables</i></u>	31
Journal of Geophysical Research: Biogeosciences	<u><i>Annual Tropical-Rainforest Productivity Through Two Decades: Complex Responses to Climatic Factors, [CO₂] and Storm Damage</i></u>	31
Long Duration Energy Storage Council and McKinsey & Co.	<u><i>Net-Zero Power: Long duration energy storage for a renewable grid</i></u>	31
Nature Sustainability	<u><i>Mapping the irrecoverable carbon in Earth's ecosystems</i></u>	31
Queensland Government	<u><i>Consultation on the model for QREZ design and access – Delivering Queensland Renewable Energy Zones</i></u>	31

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Alianza Energética Energiepartnerschaft – México – Deutschland and Cooperación Alemana – Deutsche Zusammrnarbeit	<u>Green Hydrogen in Mexico: towards a decarbonization of the economy</u> (Volumes <u>I</u> , <u>II</u> , <u>III</u> and <u>IV</u>)	32
BloombergNEF	<u>New Energy Outlook 2021</u>	32
Department of Industry, Science, Energy and Resources (DISER)	<u>State of Hydrogen 2021</u>	32
IEA	<u>Renewable Market Report</u>	32
IEA	<u>Renewable Energy Market Update 2021</u>	32
IEA	<u>France 2021 – Analysis</u>	32
National Intelligence Council	<u>Climate Change and International Responses Increasing Challenges to US National Security Through 2040</u>	32
The National Academies of Sciences Engineering Medicine	<u>A Research Strategy for Ocean-Based Carbon Dioxide Removal and Sequestration</u>	32
Science	<u>Strong Southern Ocean carbon uptake evident in airborne observations</u>	32
Copernicus Climate Change Service	<u>Annual findings for 2021</u>	33
Government of Denmark	<u>Power-To-X and Hydrogen Opportunities in Denmark</u>	33
IEA	<u>Canada 2022: Energy Policy Review</u>	33
Nature	<u>The global carbon sink potential of terrestrial vegetation can be increased substantially by optimal land management</u>	33
Nature	<u>A constraint on historic growth in global photosynthesis due to increasing CO2</u>	33
Renewable Energy	<u>Zero air pollution and zero carbon from all energy at low cost and without blackouts in variable weather throughout the U.S. with 100% wind-water-solar and storage</u>	33
Rethink Research	<u>Hydrogen will shake out industry laggards, warns Rethink</u>	33
UK Department for Business Energy & Industrial Strategy	<u>Transport and storage business model: January 2022 update</u>	33
UK Department for Business Energy & Industrial Strategy	<u>Transport and Storage – heads of terms: January 2022 update</u>	33
World Meteorological Organization (WMO)	<u>State of Global Climate in 2021 – WMO Provisional Report</u>	33
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	<u>Hydrogen in Australian natural gas: occurrences, sources and resources.</u>	34
Department for Business, Energy & Industrial Strategy	<u>Transport and storage business model: January 2022 update</u>	34
Department for Business, Energy & Industrial Strategy	<u>Transport and Storage – heads of terms: January 2022 update</u>	34

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Great Plains Institute	<u><i>An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization</i></u>	34
Nature	<u><i>The global carbon sink potential of terrestrial vegetation can be increased substantially by optimal land management</i></u>	34
National Renewable Energy Laboratory (NREL)	<u><i>Grid Operational Impacts of Widespread Storage Deployment</i></u>	34
Science	<u><i>Global assessment of oil and gas methane ultra-emitters</i></u>	34
ScienceDirect	<u><i>Zero air pollution and zero carbon from all energy at low cost and without blackouts in variable weather throughout the U.S. with 100% wind-water-solar and storage</i></u>	34
IEA	<u><i>Electricity Market Report – January 2022</i></u>	35
IRENA and State Grid Corporation of China	<u><i>Smart Electrification with Renewables: Driving the transformation of energy services.</i></u>	35
National Oceanic and Atmospheric Administration (NOAA)	<u><i>2022 Sea Level Rise Technical Report</i></u>	35
One Ocean Summit	<u><i>Brest Commitments for the Oceans</i></u>	35
ScienceDirect	<u><i>Economic analysis of the early market of centralized photovoltaic parks in Sweden</i></u>	35
UK Government Department of Business, Energy and Industrial Strategy (DBEIS)	<u><i>Decarbonising heat in homes</i></u>	35
World Forum Offshore Wind (WFO)	<u><i>Global Offshore Wind Report 2021</i></u>	35
India Hydrogen Alliance	<u><i>India H2 Monitor – February 2022</i></u>	36
International Panel on Climate Change (IPCC)	<u><i>Climate Change 2022: Impacts, Adaptation and Vulnerability</i></u>	36
International Energy Agency (IEA)	<u><i>Global Methane Tracker 2022</i></u>	36
IRENA and State Grid	<u><i>Smart Electrification with Renewables: Driving the transformation of energy services</i></u>	36
National Oceanic and Atmospheric Administration (NOAA)	<u><i>2022 Sea Level Rise Technical Report</i></u>	36
Nature	<u><i>Observed poleward freshwater transport since 1970</i></u>	36
Rijksdienst voor Ondernemend (RVO) Nederland	<u><i>Netherlands System Integration Offshore Wind 2030-2040</i></u>	36
S&P Global Platts	<u><i>Hydrogen Price Wall</i></u>	36
UNEP	<u><i>Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions</i></u>	36
Rijksdienst voor Ondernemend (RVO) Nederland	<u><i>Netherlands System Integration Offshore Wind 2030-2040</i></u>	36

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Aerospace Technology Institute and FlyZero	<u>Hydrogen Infrastructure and Operation, Airports, Airlines and Aerospace</u>	37
Blue Marine Foundation	<u>Blue Carbon In the United Kingdom</u>	37
Carbion and TotalEnergies	<u>Sustainable sourcing of feedstocks for bioplastics</u>	37
EcoShape	<u>Building with Nature in Indonesia: Restoring an eroding coastline and inspiring action at scale (2015-2021)</u>	37
Energy Transitions Commission	<u>Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive</u>	37
European Investment Bank (EIB)	<u>4th Climate Change Survey.</u>	37
Global Wind Energy Council (GWEC)	<u>Floating Offshore Wind – a Global Opportunity</u>	37
Government of Canada (Editors: E Bush and DS Lemmen)	<u>Changing Climate Report in Light of Latest Global Science Assessment</u>	37
International Carbon Action Partnership (ICAP)	<u>ICAP Status Report 2022</u>	37
International Energy Agency (IEA)	<u>How Governments Support Clean Energy Start Ups</u>	37
International Energy Agency (IEA)	<u>A 10 Point Plan to Reduce EU Reliance on Russian Natural Gas</u>	37
International Renewable Energy Agency (IRENA)	<u>World Energy Transitions Outlook (WETO) 2022</u>	37
International Renewable Energy Agency (IRENA)	<u>IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability Report</u>	37
International Renewable Energy Agency (IRENA)	<u>IPCC WGIII - Climate Change 2022: Mitigation of Climate Change Report</u>	37
International Renewable Energy Agency (IRENA)	<u>Green Hydrogen For Industry – A Guide to Policy Making</u>	37
International Renewable Energy Agency (IRENA)	<u>Decarbonising end-use sectors Green Hydrogen Certification.</u>	37
International Renewable Energy Agency (IRENA)	<u>Collaborative Framework on Critical Materials For The Energy Transition</u>	37
International Renewable Energy Agency (IRENA)	<u>Collaborative Framework on Critical Materials For The Energy Transition,</u>	37
International Renewable Energy Agency (IRENA)	<u>Renewable Energy Roadmap for Central America: Towards a Regional Energy Transition</u>	37
International Renewable Energy Agency (IRENA)	<u>World Energy Transitions Outlook: 1.5°C Pathway.</u>	37
KPMG	<u>India's green hydrogen ambition - setting the wheels in motion,</u>	37
Nature	<u>A high-performance capillary-fed electrolysis cell promises more cost competitive renewable hydrogen</u>	37

ORGANISATION	TITLE / SUBJECT MATTER	EDITION
Oxford Institute for Energy Studies	<u><i>Potential development of renewable hydrogen imports to European markets until 2030</i></u>	37
United Nations Environment Program	<u><i>Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions.</i></u>	37
University of Exeter (Mr Tim Lenton)	<u><i>Pronounced loss of Amazon rainforest resilience since the early 2000s</i></u>	37
UN Water and UNESCO	<u><i>United Nations World Water Development Report 2022: Groundwater: making the invisible visible</i></u>	37
International Panel on Climate Change (IPCC)	<u><i>Climate Change 2022 Mitigation of Climate Change</i></u>	38
International Renewable Energy Agency (IRENA)	<u><i>World Energy Transitions Outlook 2022</i></u>	38

Appendix

EDITION 3 – SEPTEMBER AND OCTOBER 2021, REPORT ON REPORTS



Welcome to **Edition 3** of **Report on Reports** – sharing summaries of papers, reports and studies published in respect of net-zero emissions (**NZE**), and related matters. **Editions 1** and **2** of Reports on Reports are to be found in **Edition 23** (July 2021 Report on Reports) and **Edition 27** (August Report on Reports).

This edition covers papers, reports and studies published during September and October 2021. As noted in recent editions of Low Carbon Pulse, each Report on Reports is intended to provide a summary of key findings of reports that appear to the author of Low Carbon Pulse to be both of interest and of significance.

All papers, reports, studies in this **Edition 3** of **Report on Reports**, were referred to in **Editions 26, 27** and **28** published during September and October July 2021: **Edition 26**, click [here](#), and **Edition 28**, click [here](#), noting that a link to **Edition 27** is included above.

The following table details each paper, report and study covered in this September and October Report on Reports, and has a link to it:

PAPERS, REPORTS AND STUDIES COVERED IN DETAIL SEPTEMBER AND OCTOBER REPORT ON REPORTS			
ORGANIZATION / AUTHOR	LINK	ORGANIZATION / AUTHOR	LINK
<i>HM Treasury</i>	Net Zero Review	<i>IEA</i>	World Energy Outlook
<i>IEA</i>	Achieving Net-Zero Electricity Sectors in G7 Members	<i>IRENA</i>	A Pathway to Decarbonise the Shipping Industry
<i>IEA</i>	Curtailling Methane Emissions from Fossil Fuel Operations	<i>NSW</i>	Development of a hydrogen industry in New South Wales
<i>IEA</i>	Global Hydrogen Review	<i>Shell</i>	Decarbonising Aviation – Cleared for Take-off

HM Treasury – Net Zero Review – Analysis exploring the key issues:

- **Title, and provenance, of report:** *Net Zero Review – Analysis exploring the key issues (NER)*: As the title of the **NER** suggests it is intended to explore key issues arising from progress towards **NZE** through decarbonisation. As the **NER** notes: "The majority of global GDP is now covered by net zero targets". After the further commitments given at **COP-26**, the majority has increased. Given that this is a HM Treasury publication its provenance is clear, and this explains its focus on the practical as well as the theoretical.

- **Background and Purpose:** The UK was the first G7 economy "to adopt a legally binding target to reduce greenhouse gas emissions to net zero by 2050". The overarching issue is how to achieve **NZE** by 2050. The purpose of the **NER** is to identify "areas of significant uncertainty over a 30-year transition, with major system wide decisions to be taken over the next decade on the UK's future mix of and the role of negative emission technologies in achieving net zero".

In April 2021, the UK reached the half way point to reduce **GHG** emissions to **NZE**. As such, the **NER** is best read knowing that the UK had made greater progress than any other G7 economy.

- **Looking on the bright side of life:** The **NER** notes that "Overall, a successful and orderly transition for the economy could realise more benefits – improved resource efficiency for businesses, lower household costs, and wider health co-benefits – than an economy based on fossil fuel consumption". While this may be a glass-half-empty view of the world, the **NER** does not continue in this vein, rather the **NER** is balanced and clear, if a little cautious.

- **Form of NER:** The **NER** is split into six Chapters, and four Annexures.

The six Chapters are as follows: **Chapter 1: Net Zero and the UK Economy; Chapter 2: Net Zero and international competitiveness; Chapter 3: Understanding households exposure to the net zero transition; Chapter 4: Factors affecting the degree of household exposure to the power, housing and electric vehicle transitions; Chapter 5: A low-cost transition; and Chapter 6: The fiscal implications of the net zero transition.**

The four Annexures A to D, cover Methodology; Net Zero Review Interim Report: Labour Market Analysis; Embedding the review; and Engagement.

- **Substance of NER - Findings:**

1. Chapter 1: Net Zero and the UK Economy: Higher levels of investment will be required, in both absolute and relative terms, to adapt infrastructure, businesses, homes and transport for an economy powered by clean energy compared to the status quo, i.e., an economy powered by fossil fuels. The investment in some areas is both upfront and ongoing, for example the development of carbon capture and storage capacity and greenhouse gas removal technologies (**GGRS**). Households will have to switch to decarbonised heating sources and to zero emission vehicles. There will be "a large increase" in the investment required across the UK.

Comment: While it is right to make these points, these are investments to be made over a period of 30 years, and once the transition has occurred, the investment is sunk, it is not ongoing. The ongoing costs of use of a decarbonised technology versus a fossil fuel technology may be different, but it will be different for all, although the differences across borders may differ, which leads into Chapter 2.

2. Chapter 2: Net Zero and international competitiveness: Carbon intensity (compared with other countries) and policy options that may be used by the UK Government to manage the risk of carbon leakage (i.e., ensuring that a policy setting in the UK is not "side-stepped" by locating an activity outside the UK in a jurisdiction that does not have the same, or a like, policy setting, including as a result of differing rates of progress to achieving **NZE**). In the context of carbon leakage, the use of the UK Emission Trading Scheme and a Carbon Border Adjustment Mechanism are considered in the **NER**.

Comment: The consideration of policy settings is helpful, in particular in assessing the advantages and disadvantages of some policy settings. Wisely, the **NER** concludes that "further work is required", before policy settings are locked-in, and that policy setting is going to be an ongoing, and iterative, process.

3. Chapter 3: Understanding households exposure to the net zero transition: The focus of Chapter 3 is the impact (i.e., costs and benefits) on "directly as bill payers, motorists, [and] homeowners, and indirectly as consumers, employees, business owners [and] taxpayers" (this is a broad definition of **households**). Chapter 3 concludes that policy settings intended to support **households** should "focus taxpayer support on specific groups and their abatement costs, rather than consider untargeted spending, or changes to the welfare system".

Comment: In many ways Chapter 3 is a "steady as we go" description of the policy settings "guard rails" within which the UK Government is to work, and is very much a prelude to Chapter 4 which looks at the cost and benefits that may arise at the **household level**.

4. Chapter 4: Factors affecting the degree of household exposure to the power, housing and electric vehicle transitions: The focus of Chapter 4, tying back to Chapter 1, is the capital costs and ongoing operating costs of transition to clean energy economy, in particular the costs of Electric Vehicles (**EVs**), Housing, and Power. In respect of **EVs** it is noted that the cost and benefit of owning and using an **EV** will change overtime. The description of the dynamics around **EVs** across households provide a basis for policy settings. In respect of Housing it is noted that the principal costs will involve installation of "energy efficiency measures and replace fossil fuel heat" equipment within the home. Again, the description of the dynamics provide a basis for policy settings. In respect of power, the need for increased renewable electrical energy is noted as is the likely continued fall in the cost of renewable electrical energy over time, noting however that the UK has not benefitted in the same way as other countries from historically low cost from photovoltaic solar, and its move to off-shore wind.

Comment: The long term cost of electrical energy in the UK over the longer term appears to be stable, which provides a good basis for policy settings around Power, and the costs of transitioning in respect of Housing and **EVs** is a matter of how quickly, and as such how soon before 2050.

5. Chapter 5: A low-cost transition: At the start of Chapter 5 it is noted that: "The transition to a clean economy is being driven by a clear commitment, enshrined in law, to achieve net zero by 2050. This is in contrast to previous economic transitions, such as those driven by technological change, globalisation or digitisation" (**Foundation**).

The **Foundation** allows planning and formulation of policy settings "to keep costs as low as possible, maximise the benefits for the economy, and to manage distributional consequences". It is recognised that a broad-based carbon pricing policy and regulation that is targeted to achieve decarbonisation where a particular activity is not responsive to a carbon price, are the central planks to policy settings in this regard. This is solid policy.

Comment: Without wishing to play-down any other part of the **NER**, the statement of the **Foundation** is the most profound part of the **NER**. In recent times, there has been a leave it to the market ("can do capitalism") versus private sector and public sector working with a price on carbon and regulation ("don't do" "nanny statism") "proposition". The UK is a long way down the road to achieving NZE applying the **Foundation**, and as such may be regarded as proof that policy settings based on the **Foundation** work. Technology is not enough.

6. Chapter 6: The fiscal implications of the net zero transition: If one takes the **Foundation** as the basis for policy setting, there is a role for Government, and any role for Government has fiscal consequences in terms of policy settings that the support cost progress towards **NZE**, but as importantly are the fiscal consequences on the revenue side of the equation. For example, in the UK, fossil fuels are heavily taxed and as such there is a need to support the revenue base with increased or new taxes to address loss of tax revenue arising from the sale of fossil fuel use falls.

Comment: The changed fiscal dynamics in the UK are complex, but not as challenging as in some countries. Each country will have its own particular dynamics to address. This is often overlooked.

IEA Reports:

The International Energy Agency (**IEA**) was established in 1974 as a response to the oil price crises during that year. The **IEA** now comprises 30 member countries, and 8 association countries.

The **IEA** has become one of the leading energy data collection and analysis organisations, and from this key to information provision and to research globally.

• **IEA Reports during September and October 2021:**

- [Achieving Net-Zero Electricity Sectors in G7 Members \(NZE G7\)](#);
- [Curtailing Methane Emissions from Fossil Fuel Operations \(CH4 Report\)](#);
- [Hydrogen in Latin America](#);
- [Key World Energy Statistics - 2021](#);
- [An Energy Sector Roadmap to Carbon Neutrality in China](#);
- [Global Hydrogen Review \(GH2 Review\)](#); and
- [World Energy Outlook \(WEO\)](#).

It is important to note that all of the **IEA** publications tie back to the **IEA's Net Zero by 2050 – A Roadmap for Global Energy Sector (IEA Roadmap)**, reported on in **Editions 17, 18, 20, 21, and 22** of Low Carbon Pulse.

• For the purposes of this September and October 2021 Report on Reports, the **NZE G7**, the **CH4 Report**, the **GH2 Review** and the **WEO** reported upon in more detail, with headlines for each of them included here for those who simply want to understand what each covers and its context:

- **NZE G7:** The **NZE GZ** was requested by the UK (under its G7 Presidency), flowing the G7 Leaders' Commitment (see **Edition 18** of Low Carbon Pulse) to decarbonise the power system in the 2030s and to achieve net zero emissions across all G7 economies no later than 2050. The **NZE GZ** was intended to inform policy makers, industry, investors and citizens ahead of **COP-26**.
- **CH4 Report:** As noted in the **Anniversary Edition** of Low Carbon Pulse, one of the areas in which particular progress has been made over the last 12 months or so has been commitments to the reduction on **CH4** emissions, culminating in the **Global Methane Pledge** (see **Edition 30** of Low Carbon Pulse **Global Methane Pledge – Continued Momentum**).

Editions 24, 26 and 27 of Low Carbon Pulse reported on the range of reductions in **CH4** that may be achieved, with the **Global Methane Pledge** settling on a reduction of a third by 2030. In the **NZE** the **IEA** contemplates pathways to a 75% reduction in **CH4** emissions from fossil fuel operations by 2030.

Reducing **CH4** emissions has an immediate and major impact on the rate of temperature increase: **CH4** has a much shorter life-time in the climate system than **CO2**, at around 12 to 20 years compared to two centuries (possibly more) of **CO2** emissions, and it absorbs more energy while it remains in the climate system.

As noted in previous editions of Low Carbon Pulse, over a 20 year period **CH4** absorbs more than 80 times the energy that a comparable volume of **CO2**.

- **GH2 Review:** Every once in a while a publication comes along that sets a benchmark; the **GH2 Review** is one of those publications. In 2019 the **IEA** released its landmark report, [The Future of Hydrogen](#) for G20. In combination the **GH2 Review** and [The Future of Hydrogen](#) provide essential source and reference material for anyone interested in or working in the area of hydrogen and hydrogen-based fuels. Both publications are highly recommended, not least because they provide a coherent narrative.

The **GH2 Review** is tied to the **IEA Roadmap** but builds on it, and reiterates points made in the **IEA Roadmap**. The **GH2 Review** report was published ahead of **COP-26**, and as such its messaging is thematic.

- **WEO:** Every year the **IEA** publishes its flagship report, the [World Energy Outlook](#). It is one of those publications to which a good number of folk look forward (including the author of Low Carbon Pulse). The **WEO** was published ahead of **COP-26**, and was designed as a guidebook for **COP-26**: "It spells out clearly what is

at stake ... And makes it clear that more needs to be done to move beyond announced pledges towards a pathway that would have a good chance of limiting global warming to a **1.5°C** [increase] ...".

• **NZE G7:**

- **Purpose:** It is recognised that the G7 countries have a key role to play in clean energy transition: the G7 countries, Canada, France, Germany, Italy, Japan, the UK and the US account for nearly "40-% of the global economy, 30% of global demand and 25% of global energy-related **CO₂**".

Given these facts and stats, the G7 countries have the means to decarbonise to clean energy, and in doing so will make a significant contribution. In this context, decarbonising electrical energy generation is key. Against this background (and in recognition of it), the **NZE G7** provides a pathway to achieving **NZE** by 2050.

- **Findings and key outcomes:** The **NZE G7** provides a clear pathway for the G7 countries, noting that the G7 countries have embarked on the pathway to **NZE**, and many are well progressed.

The key findings and outcomes for the G7 countries

- **G7 action must accelerate to reach key milestones on the path to net zero electricity by 2035:**

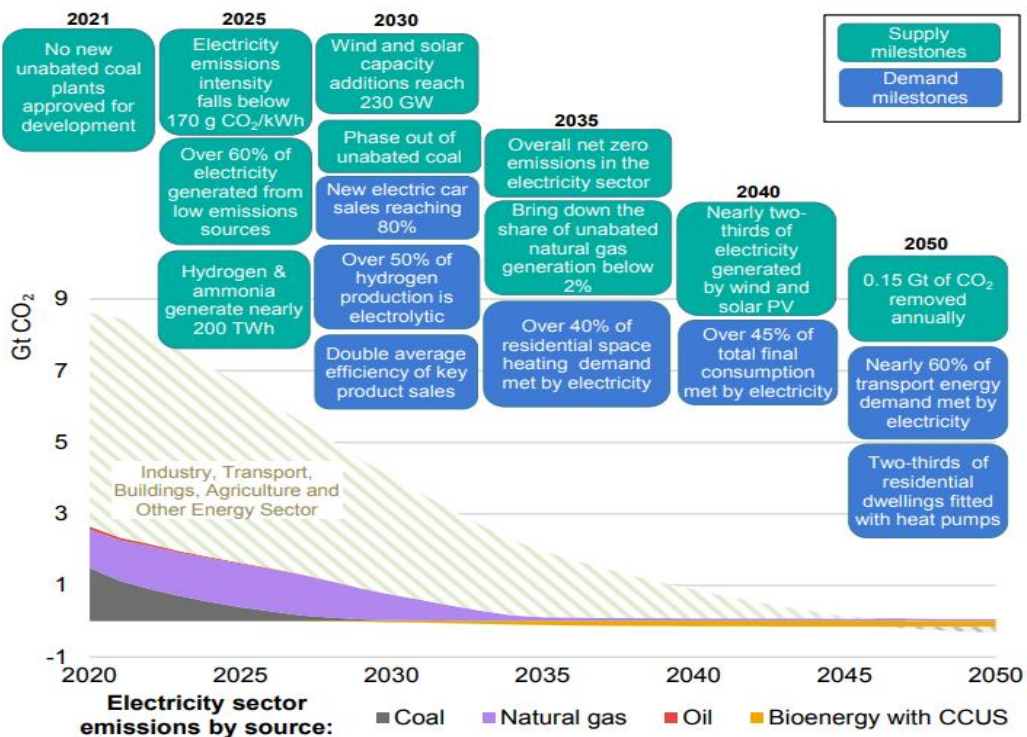
This finding is critical.

This finding is supported by the means of achieving this outcome:

1. Scale up low-carbon technologies so as to increase installed renewable electrical energy from 75 GW in 2020 to (at least) 230 GW by 2030;
2. Tie the expansion installed renewable electrical energy to the phasing out of unabated coal;
3. Rapid electrification of end-uses for electrical energy; and
4. Tie the progress towards net zero electrical emissions capacity to the **IEA Roadmap**.

In a mirror of one of the iconic **IEA Roadmap** graphics, **NZE G7** includes the following graphic that provides milestones towards the achievement of **NZE**, consistent with the **IEA Roadmap**.

G7 energy-related emissions and electricity sector milestones in the Net Zero Emissions by 2050 Scenario, 2020-2050



- **People-centred transitions can create opportunities:** In some ways the heading belies the content, which has harder edged actions than the concept of "people-centred transitions" may suggest:
 1. Investment in renewable electrical energy generation capacity should triple by 2030, and then stabilise at about twice that of current levels during the 2030's and 2040's;
 2. The decarbonisation of the electrical energy sector creates net employment; and
 3. The affordability of renewable electrical energy is crucial to ensuring a just and people-centred clean energy transition;
- **Electrical energy security takes centre stage:** The **NZE G7** was being written at the time that the energy markets around the world experienced record high prices. This experience has shaken policy makers out a complacency, with energy security becoming a key focus as part of a whole of system approach;

- **Innovation is essential to reach net zero electrical energy:** The **NZE G7** recognises that scaling up of technologies and innovation around technologies is required if **NZE** is to be achieved in the electrical energy sector. It is important that this is recognised and acted upon; and
- **G7 is a key enabler of global net zero:** In some ways this section of **NZE G7** reinforces what is noted above, i.e., that G7 countries have the means and opportunity not only to achieve net zero, but to do more, and to assist other countries to do so.

- **CH₄ Report:**

- **Purpose:** It is recognised that reducing **CH₄** emissions from fossil fuel operations represents one of the best near-term opportunities "to buy time" so as to allow decarbonisation of activities giving rise to other **GHG** emissions, principally **CO₂**.

The purpose of the **CH₄ Report** is to outline practical measures that can be undertaken by Governments and corporations to achieve a 75% reduction in **CH₄** emissions from fossil fuel operations by 2030.

As is the case with **NZE G7**, the **CH₄ Report** ties back to, and is consistent with the **IEA Roadmap**.

- **Form of the CH₄ Report:** The **CH₄ Report** comprises four sections as follows:

1. Introduction, including countries that have already made progress;
2. Domestic policies to mitigate oil and gas methane;
3. International supply chains for oil and gas; and
4. Coal.

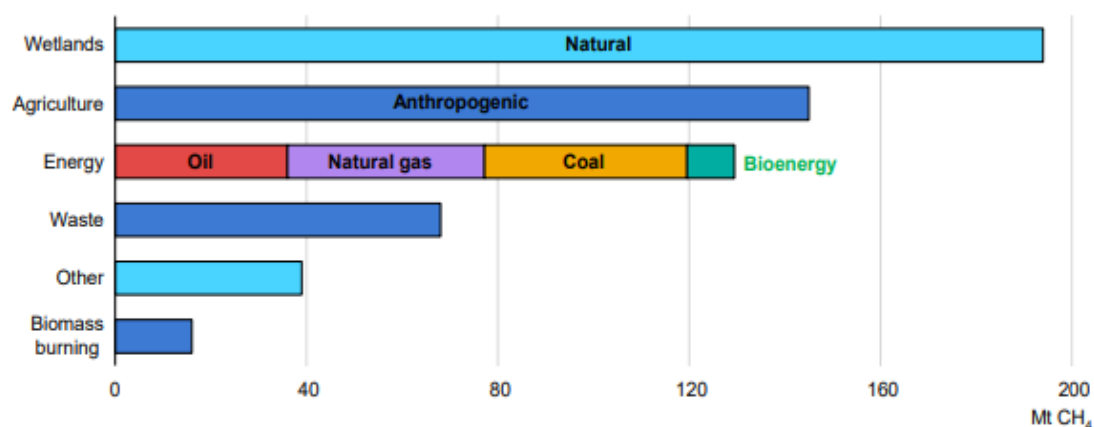
- **Sources of CH₄ emissions:**

The **CH₄ Report** contains many help facts and statistics. For this reason alone the **CH₄ Report** is well-worth a read.

While the focus is on the reduction of **CH₄**, it is helpful to understand the sources of **CH₄** both in the context of the reduction in **CH₄** emissions now, and in the context of being aware that more work needs to be done after **CH₄** emissions from fossil fuel operations are reduced, including in Agriculture, Forestry and Other Land Use (**AFOLU**), waste and waste water and biomass.

As will be apparent, a careful eye needs to be kept on the GHG emissions arising from bioenergy.

Figure 1.1 Sources of methane emissions



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Note: Energy sector emissions are for 2020 and based on the latest estimates from the Methane Tracker and the World Energy Outlook. Non-energy sector emissions are taken from the Global Methane Budget for the year 2017, with natural sources relying on top-down median estimates, and other anthropogenic sources relying on bottom-up median estimates.

- **Substance of the CH₄ Report:** The substance of the **CH₄ Report** is both historical, actual and practical as follows:

- **CH₄ is potent:**

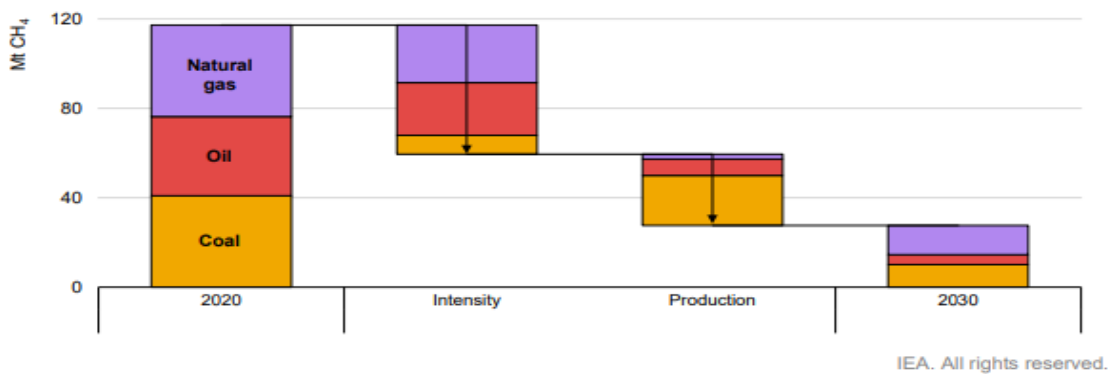
CH₄ has contributed to around 30% of the increase in average temperatures to date;

- **Abatement of CH₄ required:**

The reduction in demand for fossil fuels overtime will not reduce **CH₄** sufficiently, both in mass and rate, and as a result Governments and corporations need to act in concern quickly to abate **CH₄** emissions.

The required reductions are detailed in the following graphic:

Figure 1.2 Reductions in methane emissions from coal, oil and natural gas in the Net Zero Emissions by 2050 Scenario



The **Global Methane Pledge** has provided momentum on which to build.

- The real substance of the **CH₄ Report** arises through the following:

1. There are tried and tested means of reducing **CH₄** emissions – at their core they are regulatory – require reductions, measure those reductions and discourage / penalise (including through enforcement) non-achievement of reductions;
2. Countries that have committed to reduce, and are in fact, reducing **CH₄** emissions can "encourage their trading partners to step up abatement efforts";
3. The oil and gas industry has a critical role to play, working with, and complementing action by Governments;
4. And consistent with 1 above, Better and more transparent data is required both as to **CH₄** emissions and the abatement of them.

Methodology and approach: Intentionally, the **CH₄ Report** presents a non-prescriptive, high-level identification of the different approaches and policy settings that may be used to achieve a 75% reduction in **CH₄** emissions from fossil fuel operations by 2030.

The lack of prescription should not discourage the reader of the **CH₄ Report**.

As is the case with the **IEA Report**, the **CH₄ Report** provides a tool kit policies and regulations that may be used. The **CH₄ Report** should be approached and read on this basis.

- **GH₂ Review:**

- **Purpose:** It is recognised that clean hydrogen and hydrogen-based fuels have a key role to play in the decarbonisation of many activities globally, including in the difficult to decarbonise industries (including cement, chemicals, petrochemicals and refining, glass and iron and steel) and in the mobility and transport sectors, in particular road freight.

In this context, the **GH₂ Review** provides a stock-take of progress towards the development and deployment of clean hydrogen production capacity and the development of demand side.

- **Form of the GH₂ Review:** The **GH₂ Review** comprises seven substantive sections as follows:

1. Policy trends across key areas for hydrogen deployment;
2. Hydrogen demand;
3. Hydrogen supply;
4. Infrastructure and trade;
5. Investments and Innovation;
6. Regional Insights; and
7. Policy Recommendations.

- **Substance of the GH₂ Review:** For present purpose starting at the end of the **GH₂ Review** with the Policy Recommendations makes sense.

The Policy Recommendations have as their guiding objective the achievement of **NZE** consistent with the **IEA Roadmap**, and have to be read on this basis. To frame this basis for reading the **GH₂ Review**, the **GH₂ Review** provides Key milestones for the development of hydrogen production and use by 2030 as follows:

Key milestones to stay on track with the Net zero Emissions scenarios by 2030

	2020	NZE 2030	Development status
Total H₂ demand (Mt H ₂)	90	212	-
Electrolysis capacity (GW)	0.3	850	Mature
CO₂ captured and stored in H₂ production (Mt CO ₂)	10	410	Mature
Total road FCEVs (million vehicles)	0.035	15.3	Market scale-up
HRSs (1 000s of stations)	0.54	18	Market scale-up
NH₃ demand in shipping (Mt NH ₃)	0	47	Demonstration
H₂ demand in electricity generation (Mt H ₂)	0	43	Demonstration
Low carbon H₂ demand in DRI (Mt H ₂)	0.1	5.7	Demonstration
Synfuel demand in aviation (mb/y)	0	38	Prototype
Export terminals (number of terminals)	0	60	Prototype

In the context of achieving these near-term key milestones, the **GH₂ Review** recommends policy settings that centre on the following: **1.** Clear statement of the role of hydrogen in the energy system; **2.** Create long-term incentives for the use of clean / low-carbon hydrogen to displace fossil fuels; **3.** Mobilise investment in gigafactories and infrastructure; **4.** Provide support for innovation and scaling up of technologies; and **5.** Establish certification (including Guarantee of Origin), and regulation and standards regimes.

In many ways, the policy settings to achieve these outcomes speak for themselves.

The **GH₂ Review** makes a point that is particularly telling, and that is that policy settings are not stand-alone, they are interconnected, and those developing and implementing the policy settings need to be aware of this interconnectedness.

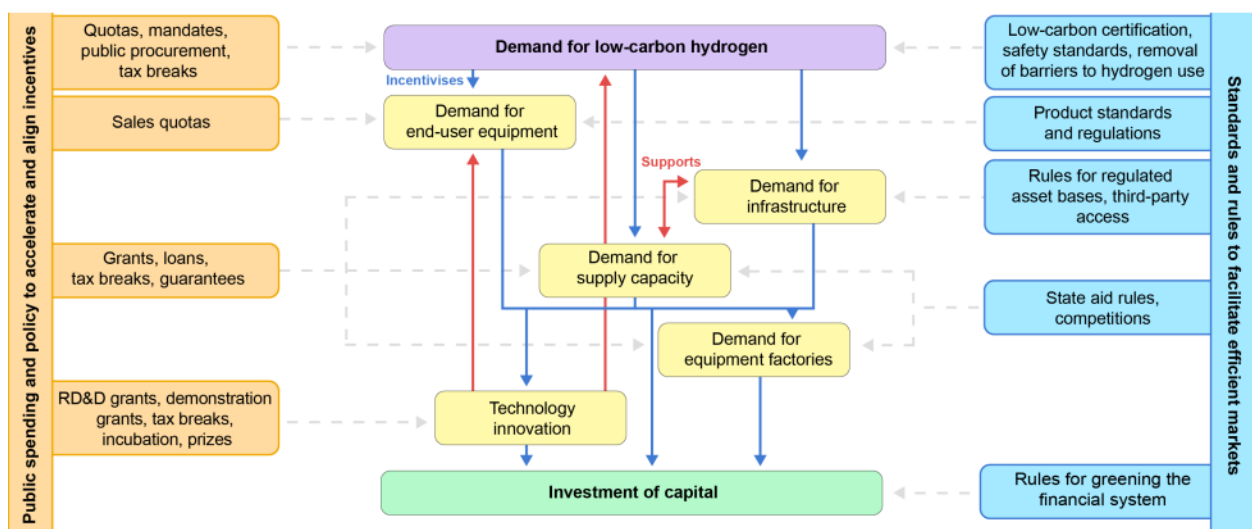
The **GH₂ Review** provides a helpful section addressing current policy trends which reflect the recommendations made on policy.

The policy settings identified include:

1. Establishing targets (including intermediate milestones to anchor long-term targets) and long-term policy signals;
2. Support demand creation for hydrogen, including the mobility and transport sector;
3. Bridge the gap in costs and mitigate investment risks;
4. Promote innovation, including through R&D support and demonstration and pilot projects; and
5. Harmonise standards and remove barriers.

The dynamic of interconnectedness is illustrated by the following graphic:

How policy and regulatory interventions can amplify and steer incentives across hydrogen value chains



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- **Supply and Demand side of the hydrogen economy:** One of the most repeated, if not the most repeated, theme in editions of Low Carbon Pulse (and its sibling publications) is that supply and demand need to develop in tandem, with supply a little ahead of demand.

Further, the point has been made frequently that there is a role for Government on both supply and demand side development.

Around half of the 220 pages of the **GH₂ Review** are devoted to the definition of supply and demand side for hydrogen.

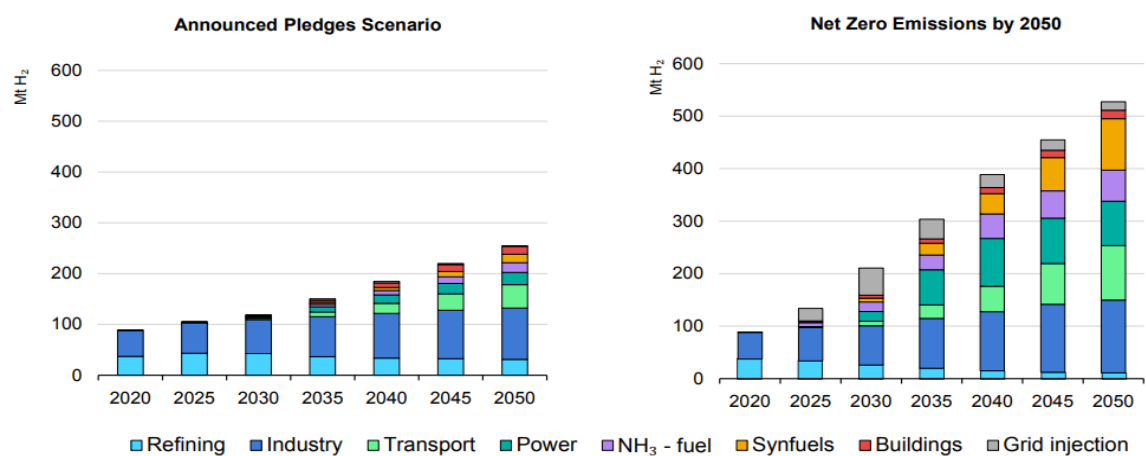
- **Demand side** (taken first because dealt with first in the **GH₂ Review**): The **GH₂ Review** reviews demand across the refining industry, industry (which includes Chemicals and Iron and Steel), Transport, Buildings and Electricity Generation; and
- **Supply side**: The **GH₂ Review** reviews the use of electrolysis, fossil fuels with carbon capture, hydrogen based fuels, and emerging technologies.

For anyone looking to get up the curve on hydrogen, pages 41 to 175 of the **GH₂ Review** provides a great overview on demand and supply side development

- **Demand side**: The demand side section of the **GH₂ Review** is well-worth a read, but it is best read with the **IEA Report** in mind. High level demand side overviews are included below, but these do not do justice to this section of the **GH₂ Review**, but which illustrate the need for policy settings to promote the use of hydrogen.

Government pledges suggest greater hydrogen use, but not nearly enough to the level needed to achieve net zero energy system emissions by 2050

Hydrogen demand by sector in the Announced Pledges and Net zero Emissions scenarios, 2020-2050



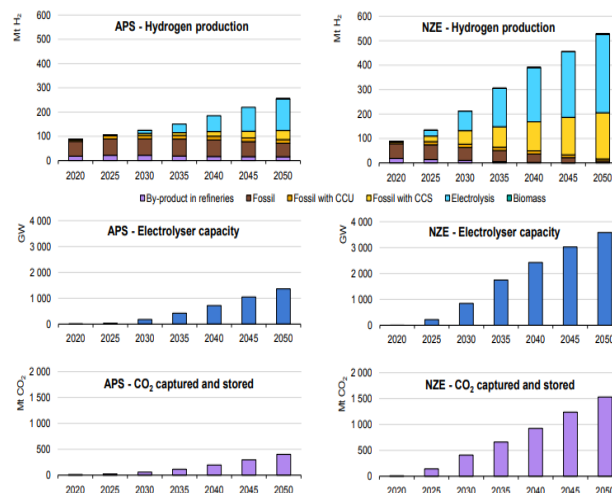
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Notes: "NH₃ - fuel" refers to the use of hydrogen to produce ammonia for its use as a fuel. The use of hydrogen to produce ammonia as a feedstock in the chemical subsector is included within industry demand.

- **Supply side**: As with the demand side section of the **GH₂ Review**, the supply side section is well-worth a read, again with the **IEA Report** in mind. High level supply side overseas are included below.

Decarbonising hydrogen production will require rapid electrolysis and CCUS roll-out

Global hydrogen production, installed electrolyser capacity and CO₂ captured and stored in the Announced Pledges and Net zero Emissions scenarios



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Notes: APS = Announced Pledges Scenario. NZE = Net zero Emissions Scenario. CCS = carbon capture and storage; CCU = carbon capture and use. Hydrogen production from fossil fuels with CCU refers to ammonia production in which captured CO₂ is used to produce urea fertiliser. When urea fertiliser is applied to soil, it breaks down again into ammonia and CO₂, with the latter released into the atmosphere.

- **WEO:**
 - **Purpose:** The purpose of the **WEO** is to provide a guidebook to those attending **COP-26**, and the agenda of the guidebook is to ensure that it was understood that the pathway chosen must be to limit the increase in average global temperatures to **1.5°C** above pre-industrial times.
It is clear that this purpose was achieved – there was a clear understanding at **COP-26** of the need to stay tethered to **1.5°C**, but that the agenda needs to continue to be worked on, with the issue at large being that more **GHG** emissions need to be reduced in greater mass and at a higher rate.
 - **Sibling publication:** The **WEO** recognises that the analysis in the **WEO** relies on the **IEA Roadmap**. In short the **WEO** is all about keeping the door open to limiting the increase in average global temperature to **1.5°C** above pre-industrial times.

IRENA Reports:

The Intentional Renewable Energy Agency (**IRENA**) is an intergovernmental organisation supporting countries in the transition to renewable / sustainable energy, and is reported to be actively engaged with more than 180 countries in this endeavour.

- **IRENA Reports during September and October, 2021)**

- [Renewables Readiness Assessment Paraguay \(Paraguay Report\)](#).; and
- [A Pathway to Decarbonising the Shipping Sector by 2030 \(DSS by 2050\)](#)

For the purposes of this September and October 2021 Report on Reports, the [DSS by 2050](#) report is covered in more detail.

- **Provenance of the DSS by 2050 report:** In 2019 **IRENA** contributed to the Global Maritime Summit in Singapore, with **IRENA** joining the Getting to Zero Coalition (**GtZ Coalition**) in January 2020. The ambition of the **GtZ Coalition** is to develop and to deploy vessels, that are viable commercially, operating as zero-emission vessels by 2030 along deep sea trade routes. Since 2018, **IRENA** has been participating in Mission Innovation initiatives, including in the launch in June 2021 (see **Edition 19** of Low Carbon Pulse) of the Zero-Emission Shipping Mission (see **Edition 30** of Low Carbon Pulse). In addition, **IRENA** is working closely with the International Chamber of Shipping.

Renewable electrical energy is the focus of **IRENA**. Renewable electrical energy is required to produce e-fuels and e-feedstocks. In this context, in particular on the production of Green Hydrogen, from which e-fuels and e-feedstocks can be produced, renewable electrical energy needs to be developed and deployed, lots of it. This is the subject of **IRENA's World Energy Transition Outlook: 1.5°C Pathway (WETO)** (see **Editions 21** and **23** of Low Carbon Pulse).

The **DSS by 2050** report is tied to the **WETO** and it build on, and relies on, and reiterates points, made in the **WETO Roadmap**.

- **Purpose of the DSS by 2050 report:** The starting premise of the **DSS by 2050** report is that urgent action is necessary to accelerate the pace of global energy transition and decarbonisation of the global economy at a rate with will result in holding the average increase in temperature globally to **1.5°C** compared to pre-industrial times. As such, the purpose of the **DSS by 2050** report is to provide a pathway, and a tool kit, to achieving this outcome.

As such, the ways and means described in the **DSS by 2050** are intended to achieve this outcome consistent with the broader thinking in the **WETO**: "*this [DSS by 2050] report explores the options and actions needed to progress towards a decarbonised maritime shipping sector by 2050 and seeks to identify a realistic mitigation pathway consistent with a wider societal goal of limiting global temperature rise to 1.5°C ... and brining CO₂ emissions closer to net zero by mid-century*".

- **Form of the DSS by 2050 report:** The **DSS by 2050** report covers the following:

1. Market dynamics and trends, trade volumes, associated energy demand, and **CO₂** emissions;
2. Technology readiness and cost of relevant renewable energy fuels;
3. The long-term decarbonisation pathway by 2050 and its implications; and
4. Enabling actions to raise decarbonisation ambition.

- **Key findings:** Space does not permit detail consideration of each element of the **DSS by 2050** report, but the **DSS by 2050** report contains some compelling and defining findings that are consistent with other publications on the decarbonisation of the shipping sector, and that are consistent with trends in the shipping sector. Those key findings are as follows:

1. renewable e-fuels, ammonia and methanol are the most promising fuels to decarbonise the shipping sector with renewable e-ammonia looking set to be the backbone of the decarbonisation of the shipping sector in the medium to long-term;

2. if renewable e-ammonia is the backbone, Green Hydrogen and Green Hydrogen-based fuels will be the foundation of the shipping sector in the medium to long-term with around 46 million metric tonnes of Green Hydrogen required by 2050, with 73% of the Green Hydrogen required to combine with nitrogen to produce Green Ammonia (implying as much as 184 million metric tonnes of Green Ammonia), 17% for e-methanol and 10% to be used directly is liquid hydrogen using fuel cell technology (mostly on short voyage / domestic shipping trades) and using internal combustion engines developed to be fuelled by hydrogen.

There may be near-term roles for use of fuels derived from biomass (so called advanced biofuels, such as FOGS, FAME and HVOs), but in the medium to long term Green Hydrogen based fuels are regarded as the means of decarbonising the shipping sector; and

3. The **IRENA 1.5°C Scenario** (see **WETO**) cannot be achieved by technology alone. For e-fuels to become the principal choice for powering and propelling the shipping sector, lower renewable electrical energy costs are required to allow increase production in Green Hydrogen.

Critically in this regard, the **DSS by 2050** report states that:

" .. sectoral decarbonisation can be accelerated and ambition can be raised beyond the climate goals by fostering investment in the production of renewable fuels. For this purpose, adopting relevant and timely co-ordinated international policy measures is greatly needed."

As will be apparent to the reader, two concepts are emphasised, **acceleration** and **ambition**. Since the start of Q2 of 2021, these concepts have become ubiquitous among those focusing on what is required to achieve increased levels of progress in **GHG** reductions. The next summaries continue the theme.

NSW Report – Development of a hydrogen industry in New South Wales:

- **Provenance:** The Legislative Council, Standing Committee on State Development developed and published the publication entitled – **Development of a hydrogen industry in New South Wales Report (H₂ NSW Report)**.
- **Purpose of the H₂ NSW Report:** The terms of reference of the **H₂ NSW Report** were to inquire into and to report on the current state of, and opportunities for, development of a hydrogen industry in the State of New South Wales (**NSW**), Australia's most populous State.

The terms of reference provide for the following specificity:

1. The size of the economic and employment opportunity created by the development of a hydrogen industry in **NSW**;
 2. The existing hydrogen capabilities of the State;
 3. The capacity of **NSW** to become, and the barriers to **NSW** becoming, a major production, storage and export hub for hydrogen;
 4. The economics of hydrogen use in different sectors, including use of hydrogen in industrial processes and as a feedstock for industrial processes;
 5. The infrastructure and technology, and the skills and workforce, required to realise the economic and employment opportunities;
 6. The action required by the public and private sector to support the development of the hydrogen industry in **NSW**, and to realise the associated economic benefits;
 7. Potential for employment, direct and indirect, in the hydrogen industry; and
 8. And any other pertinent matters.
- **Background:** The NSW Energy and Environment Minister, The Honourable Mr Matt Kean MP, referred the terms of reference to the Standing Committee on November 19, 2020, and they were adopted by the Standing Committee on December 8, 2020.

In November 2020, (see **Edition 4** of Low Carbon Pulse), the NSW Government announced plans to support the development of 12 GW. This thinking has since expanded.

Since the publication of the **H₂ NSW Report**, NSW has published a hydrogen strategy – **NSW Hydrogen Strategy – Making NSW a global hydrogen superpower** – consistent with Recommendation 1 (below).

In many ways, the **NSW Hydrogen Strategy** takes forward key findings of the **H₂ NSW Report**. It is easy to be conclude that policy settings are catching up with developments to which the private sector is already progress. This is affirmatory both of policy settings and progress of the private sector.

While **NSW** may be a little late to the establishment policy settings to develop a hydrogen economy, it is now very much progressing, and is as well-equipped as any State or Territory to make progress. The one factor that all Australian States and Territories have grasped is the need for Government to be involved, and the role of Government will accelerate progress and define ambition.

• **Key Recommendations and Findings:**

– **Recommendations:** The **H₂ NSW Report** has seven recommendations as follows:

1. NSW Government to finalise and publish a hydrogen strategy, addressing funding, policy and regulation;
2. NSW Government to establishes a cross-sector taskforce;
3. NSW Government to commission a study on large-scale hydrogen storage;
4. NSW Government to continue to support the development of the Hunter and Illawarra regions;
5. NSW Government to invest in demonstration / pilot projects, prioritising those to displace diesel use;
6. NSW Government to create local demand for hydrogen, including gas blending and fuel cell use for public transport;
7. NSW Government to prepare for the transition of the workforce, including to conduct a study assess current skills, gaps in skills, and how to close those gaps.

– **Key Findings:** The key findings of the **H₂ NSW Report** may be regarded as being contained in Chapter 3 of the Report, **The way forward**. The key finding are as follows:

- The development of a hydrogen industry provides an opportunity to transition to clean renewable energy sources;
- The role of Government is critical to realise the opportunity, including:
 1. to develop and to implement a State Strategy (focused on funding and policy);

2. to focus on research and development;
 3. to create local (i.e., domestic) demand for hydrogen; and
 4. to invest in regional hydrogen hubs, particularly in the Newcastle and Woollongong regions;
 5. To provide support for workforce transition and training.
- **Form of the [H₂ NSW Report](#):** The report has three Chapters, and three Appendices. **Chapter 1** provides Background on hydrogen and its uses, its production, and its storage and transportation, and outlines demand and opportunities and the policy and funding framework in Australia; **Chapter 2** provides an assessment of the potential for the hydrogen industry in NSW; and **Chapter 3** provides an assessment of the way forward.

Shell Report:

- **Provenance:** The team at Royal Dutch Shell prepared a publication entitled [Decarbonising Aviation: Cleared for Take-off – Industry Perspectives \(CFTO Report\)](#). The [CFTO Report](#) states that it "reflects the perspectives of over 100 executives and experts representing 68 organisations across almost all segments of the aviation sector, complemented with input from 6,000 travellers worldwide, both leisure and corporate".

The [CFTO Report](#) follows on from the equally good [Decarbonising road freight: Getting into gear: An industry perspective](#) published in February 2021 and covered in **Edition 8** of Low Carbon Pulse.

- **Purpose of the [CFTO Report](#):** The purpose of the [CFTO Report](#) is stated to be:

1. To take a comprehensive view of the decarbonisation of the aviation sector;
2. To reflect the voice of the aviation sector; and
3. To accelerate the pathway to net-zero.

For these purposes, the [CFTO Report](#) states that it broke down its focus into "manageable components".

This was done by "focusing on three core questions: Why should the sector change? Can the sector change? How fast can the sector change?"

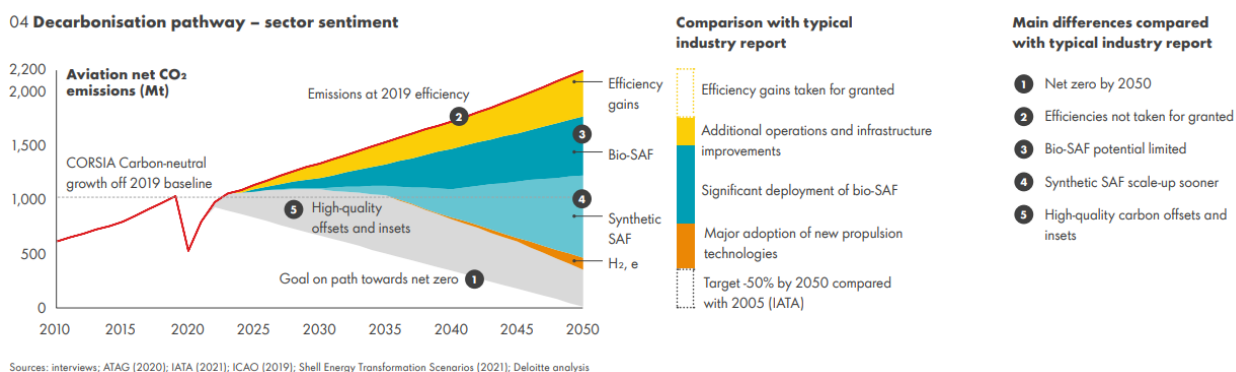
The answer to these questions produced nine highlights:

02 Research highlights		
Why should the sector change?	1. Aviation has often been considered a sector that will decarbonise later than others because of the complexity involved and the view that aviation accounts for just 3% of global emissions . But there is a need to act now .	3. Long-term customer demand , enabled by recognition mechanisms and differentiated propositions , will play a fundamental role in providing the funding and incentives for airlines to invest in lowering their emissions.
		4. Country- and region-based policy incentives relating to supply and demand will accelerate the adoption of SAF and regulation at regional and global level.
Can the sector change?		5. Offsets can play an essential role in funding the early stages of decarbonisation. But for this to happen, they must be made more transparent and verifiable . They need to be more emotionally appealing to passengers, and their impact should be clearer.
	2. The sector is facing several barriers to decarbonisation , mainly: <ul style="list-style-type: none"> • targets are insufficiently ambitious, unsupported by local regulation, and constrained by the perceived need for international alignment; • cost of Sustainable Aviation Fuel (SAF) is prohibitively high, with many in the sector expressing uncertainty about how to reduce it and concerns about the availability of feedstock; • leisure passengers are reluctant to absorb the cost of lower emission solutions; and • concerns about offsets relating to quality, transparency and communications lead to limited uptake. 	6. Choosing SAF as the primary means of decarbonisation will have a disproportionate impact on lowering emissions, because there is no need to redesign aircraft. As a result, investments and R&D efforts can focus mainly on scaling production and lowering cost.
How fast can the sector change?		7. Collaboration with other sectors is essential to the successful deployment of SAF. It can drive down the cost of required technologies , such as hydrogen production, direct air capture and biomass conversion, and ensure effective use of scarce resources .
		8. The pathway to decarbonisation needs to be more ambitious and investments need to start sooner to address societal expectations, reach sufficient SAF volumes and bring down cost to the levels required for large-scale adoption within 15 years.
		9. Individual initiatives should be integrated into comprehensive plans representing all points along the value chain – from energy producers to end-customers. These plans should be systematically deployed in areas with favourable policies, market conditions, and access to SAF.

The executive summary of the [CFTO Report](#) deals with each of these nine highlights – these are summarised below.

- **Background:** The aviation sector is recognised as being difficult to decarbonise, and likely to be one of the later, if not the last, sector to be decarbonised. The [CFTO Report](#) states that the aviation sector is "a source of around 3% of global carbon dioxide ... emissions, and as the global economy continues to develop in the coming years ... aviation volumes will grow." As is the case with the road freight industry, the it is projected that **CO₂** emissions from the aviation sector will double by 2050 if no action is taken.
- **Substance of the [CFTO Report](#):** The substance of the findings of the [CFTO Report](#) is to be found in the nine highlights arising from the three questions asked:
 1. Aviation is often considered a sector that will decarbonise later than others, but there is a need to act now;

2. Barriers to entry exist, including targets are insufficiently ambitious, the cost of sustainable / synthetic aviation fuel (**SAF**) is high, prohibitively so, and leisure travellers are reluctant to absorb the cost of achieving lower **GHG** emission outcomes.
 3. Long term customer demand will provide the basis for a range of funding and incentives to allow investment in lowering GHG emissions;
 4. Country and regional-based policy incentives to accelerate supply of, and demand for, **SAF** are required;
 5. Offsets can play an essential role in funding the early stages of decarbonisation;
 6. Choosing **SAF** as the primary means will have as disproportionate (beneficial) impact on lowering emissions [**Note: not** removing emissions] because there is no need to redesign aircraft;
 7. Collaboration with other sectors is critical to the supply of **SAF**;
 8. The pathway to decarbonisation needs to be more ambitious; and
 9. Individual initiatives should be integrated into comprehensive plans along all points of the value chain.
- The following graphic provides a perspective on the decarbonisation of the aviation sector:



- **Form of the CFTO Report:** In addition to the Executive Summary, the **CFTO Report** comprises the following sections:
 - **Where we are today;**
 - **The Deadlock: Barriers to Decarbonisation;**
 - **Decarbonising Aviation: a New Approach;** and
 - **The Flight Plan: Accelerating Decarbonisation.**
 The entire **CFTO Report** is well-worth reading (and re-reading).

ALL PAPERS, REPORTS AND STUDIES COVERED IN LOW CARBON PULSE DURING SEPTEMBER & OCTOBER 2021	
Organisation	Title / subject Matter
Airbus	Hydrogen: An energy carrier to fuel the climate-neutral aviation of tomorrow
Australian Energy Market Operator	Electricity Statement of Opportunities Report (ESOO Report)
Australian Hydrogen Council	Unlocking Australia's hydrogen opportunity
BloombergNEF	New Energy Outlook
BloombergNEF and wbcSD	Hot Spots for Renewable Heat: Decarbonising Low-to-Medium Temperature Industrial Heat Across the G-20
Climate Action Tracker	Climate target updates slow as science ramps up need for action
DNV	Energy Transition Norway 2020 (DNV Report)
E3G	No New Coal by 2021: The Collapse of the Global Coal Pipeline
Euromia Research & Consulting	CCUS Development Pathway for the EfW Sector

Gas Infrastructure Europe (GIE)	<i><u>Picturing the value of underground gas storage to the European hydrogen system / Guidehouse study</u></i>
Global Wind Energy Council	<i><u>Global Offshore Wind Report 2021</u></i>
H2Accelerate	<i><u>Expectations for the fuel truck market</u></i>
H2 Cluster Finland	<i><u>A systemic view on the Finnish hydrogen economy today and in 2030 – Our common playbook for the way forward</u></i>
Intergovernmental Panel on Climate Change	<i><u>Sixth Assessment Report – Climate Change 2021, The Physical Science Basis</u></i>
IEA	<i><u>Hydrogen in Latin America</u></i>
IEA	<i><u>Global Hydrogen Review 2021</u></i>
IEA	<i><u>Curtailing Methane Emissions from Fossil Fuel Operations</u></i>
IEA	<i><u>World Energy Outlook 2021</u></i>
IEA	<i><u>Net Zero by 2050 – A Roadmap for Global Energy Sector</u></i>
IEA	<i><u>Achieving Net-Zero Electricity Sectors in G7 Members</u></i>
IEA	<i><u>Phasing Out Unabated Coal – Current status and three case studies</u></i>
IMF	<i><u>World Economic Outlook</u></i>
IRENA	<i><u>Renewables Readiness Assessment Paraguay</u></i>
IRENA	<i><u>A Pathway to Decarbonize the Shipping Sector by 2050</u></i>
IRENA	<i><u>World Energy Transitions Outlook</u></i>
James Cook University	<i><u>The global value of coastal wetlands for storm protection</u></i>
Lancaster University	<i><u>The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations</u></i>
The Met Office (Royal Meteorological Society)	<i><u>State of the UK Climate in 2020 (2020 Report)</u></i>
National Centers for Environmental Information	<i><u>Global Climate Report – August 2021</u></i>
Nature	<i><u>The contribution of insects to global forest deadwood decomposition</u></i>
New South Wales Legislative Council	<i><u>Development of a hydrogen industry in New South Wales</u></i>
Office of Energy Efficiency & Renewable Energy	<i><u>Off-shore Wind Market Report (US OWF Report)</u></i>
Oxford Institute for Energy Studies	<i><u>Why Are Gas Prices So High</u></i>
Oxford Institute for Energy Studies	<i><u>Carbon Capture and Storage: The Perspective of Oil and Gas Producing Countries</u></i>
Shell	<i><u>Exploring the Future of the Voluntary Carbon Market</u></i>
Shell and Deloitte	<i><u>Decarbonising Aviation: Cleared for Take-off, Industry Perspectives</u></i>
S&P Global Platts	<i><u>Platts Global Integrated Energy Model – Strategic Planning for a world in transition.</u></i>
United Nations	<i><u>UNFCCC NDC Synthesis Report</u></i>
United Nations	<i><u>2021 Production Gap Report</u></i>
US EIA	<i><u>International Energy Outlook</u></i>

World Bank	<u>Groundswell Part 2: Acting on Internal Climate Migration</u>
World Bank	<u>Key Factors For Successful Development of Offshore Wind in Emerging Markets</u>
World Meteorological Organization	<u>Climate Indicator and Sustainable Development: Demonstrating the Interconnections</u>
Wood Mackenzie	<u>How to scale up carbon capture and storage</u>
Wood Mackenzie	<u>Global Energy Storage Outlook</u>

The author of the September and October Report on Reports is Michael Harrison.

Appendix

EDITION 4 – NOVEMBER AND DECEMBER 2021, REPORT ON REPORTS



Welcome to **Edition 4 of Report on Reports** – sharing summaries of papers, reports and studies published (publications) in respect of net-zero emissions (**NZE**), and related matters.

Editions 1 and 2 of Reports on Reports are to be found in **Edition 23** (July 2021 Report on Reports) and **Edition 27** (August Report on Reports), both of which are in the [First Compendium of Low Carbon Pulse](#). **Edition 3** of the Report on Reports is set out above.

This edition covers papers, reports and studies published during November and December 2021. As noted in various editions of Low Carbon Pulse, each Report on Reports is intended to provide a summary of key findings of publications that appear to the author of Low Carbon Pulse to be both of interest and of significance.

All papers, reports, studies in this **Edition 4 of Report on Reports**, were referred to in **Editions 29, 30, 31 and 32** published during November and December 2021. Each of these Editions is included in this **Second Compendium of Low Carbon Pulse**.

The following table details each paper, report and study covered in this November and December Report on Reports, and has a link to it:

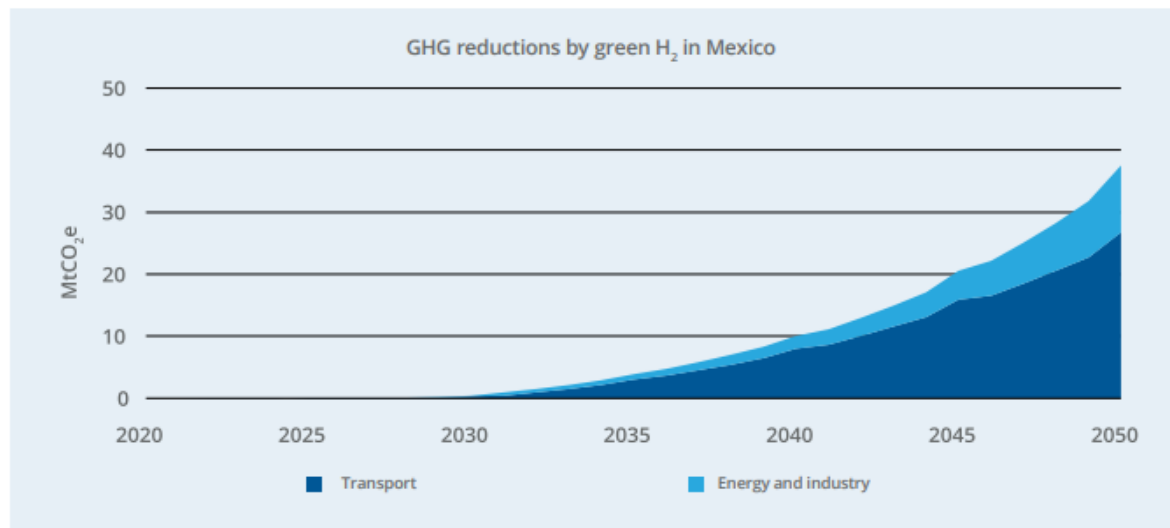
PUBLICATIONS DETAILED IN NOVEMBER AND DECEMBER REPORT ON REPORTS			
ORGANIZATION / AUTHOR	LINK	ORGANIZATION / AUTHOR	LINK
<i>Alianza Energetica Energiepartnerschaft</i>	Green Hydrogen in Mexico: towards a decarbonization of the economy	<i>International Energy Agency (IEA)</i>	Greenhouse Gas Emissions from Energy
<i>Australia United Arab Emirates Business Council</i>	Strengthening Alternative and Renewable Energy Pathways: Investment and Collaboration Opportunities Between Australia and UAE		Renewables 2021
<i>AUS: Department of Industry, Science, Energy and Resources</i>	State of Hydrogen 2021 Report	<i>IRENA</i>	Reforming Korea's Electricity Market for Net Zero
<i>UK: Department for Business, Energy & Industrial Strategy</i>	Biomass Policy Statement	<i>LDES and McKinsey & Company</i>	France 2021
<i>ENEA Consulting / Deloitte</i>	Australia's Bioenergy Roadmap	<i>Summaries: Hydrogen Strategies</i>	Renewables Readiness Assessment Paraguay
<i>Hydrogen Council / McKinsey & Company</i>	Hydrogen for Net Zero - A critical cost competitive energy vector		A Pathway to Decarbonising the Shipping Sector by 2030
			Net-zero power – Long duration energy storage for a renewable grid
			Geothermal: The Solution underneath
			Hydrogen and PTX – Opportunities in Denmark

Alianza Energetica Energiepartnerschaft:

- **Title, and provenance, of report:** [Green Hydrogen in Mexico: towards a decarbonization of the economy \(GH2 Mexico\)](#): The **GH2 Mexico** report is the work of the German-Mexican Energy Partnership and the Energy Transition Support Program in Mexico (TrEM). The **GH2 Mexico** report is mammoth work of the highest quality. For the purposes of this **November and December 2021 Report on Report** the executive summary is the focus, but the content of the **GH2 Mexico** report is described, and the content of particular interest highlighted.
- **Background and Purpose:** The **GH2 Mexico** report is intended to provide an overview of hydrogen globally, the uses of Green Hydrogen, and the role of Mexico in the production of Green Hydrogen.
- **Summary:** The uses of Green Hydrogen are identified as Renewable Energy Storage, Electric Mobility, Green Chemicals, Natural Gas Decarbonization, Liquid Synthetic Fuels, Buildings and Industrial heat and power. This is nothing new, but the executive summary in the **GH2 Mexico** report provides granularity not seen in other reports, including from **IEA** and **IRENA**.
- **Volumes of the GH2 Mexico report:**
 - **Volume I:** National and international context of green hydrogen provides an overview of hydrogen as an energy vector (technologies and applications); international background of hydrogen as a decarbonization vehicle; current hydrogen situation in Mexico, and conclusions and recommendations.

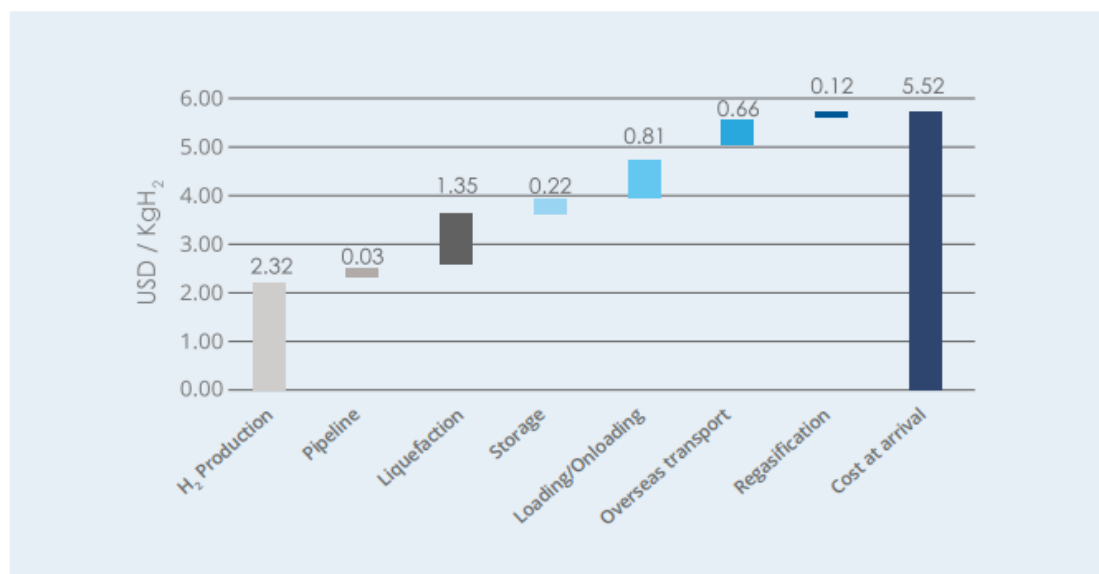
Volume 1 is well-worth a read providing a helpful overview, and some helpful diagrams and infographics:

Figure 2-1. GHG emissions reductions from introducing green hydrogen in Mexico.



- **Volume II:** Green Hydrogen integration into the grid providing an overview of renewable energy and green hydrogen potential in Mexico, energy storage technologies, and hydrogen integration potential in the National and Melege energy systems, and conclusions and recommendations.

Figure 7-1. Hydrogen export breakdown by cost components from Mexico to the EU in 2030.



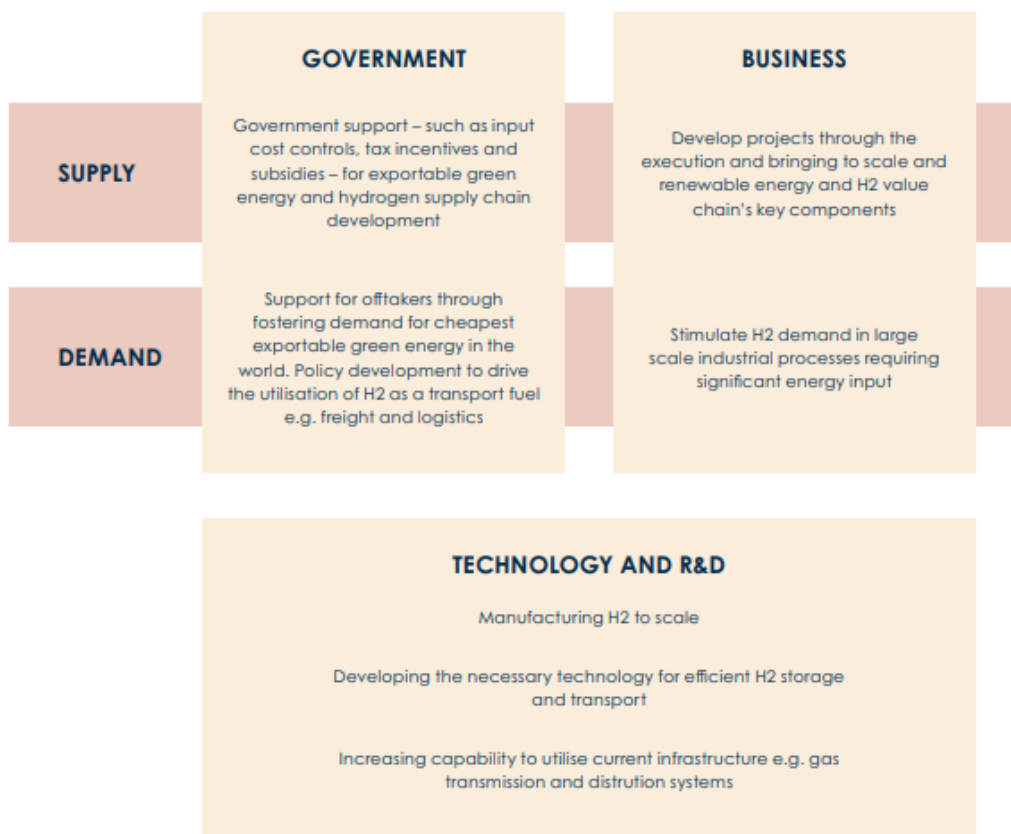
- **Volume III:** Opportunities for the State Productive Enterprises PEMEX and CFE providing hydrogen demand scenarios, projections of LCOH for green hydrogen, opportunities for hydrogen in refineries, opportunities for green hydrogen in ammonia production, opportunities for green hydrogen for synthetic fuels, opportunities for green hydrogen in gas infrastructure and opportunities for green hydrogen in thermal power plants.

While the entire **GH2 Mexico** report is excellent, **Volume III** is exceptionally helpful, in particular for those keen to gain a clear understanding of the Levelized Cost of Hydrogen (**LCOH**).

There are other Volumes but these are key.

Australia United Arab Emirates Business Council:

- Title, and provenance, of report:** [Strengthening Alternative and Renewable Energy Pathways: Investment and Collaboration Opportunities Between Australia and UAE \(AUS / UEA Energy Pathways\)](#): The Australia UAE Business Council allows access to senior decision makers in business and government with the aim of deepening bilateral trade and investment.
 The **AUS / UEA Energy Pathways** report is the final report of the Renewable and Alternative Energies Working Group. The Renewable and Alternative Energies Working Group was co-chaired by Mr Sam Pearce (QIC) and Mr Przemak Lupa (Masdar), both of whom are highly experienced and very well-regarded energy professionals.
- Background and Purpose:** The **AUS / UEA Energy Pathways** final report is intended to highlight and to showcase investment opportunities between Australia and the **UAE**.
- An identified core:** The **AUS / UEA Energy Pathways** final report identifies the core of the basis for progress to realise all opportunities in the following diagram:
 As noted in many editions of Low Carbon Pulse, all strategies and opportunities need to be viewed through the lens of supply and demand development, and the means to that development.
- An identified reader:** The **AUS / UEA Energy Pathways** final report notes it is intended to provide guidance to each of Australia's and **UAE's** respective investors.



- An identified subject matter:** The **AUS / UEA Energy Pathways** final report looks at a spectrum of renewable and alternative energies as follows:
 - Green Hydrogen and fuels;
 - Utility-scale renewable energy and battery storage; and
 - Australian waste to energy segment.
- The AUS / UEA Energy Pathways** final report comprises key sections as follows:
 - Sections 3 and 4: Forward and Introduction** the subject matter of which is covered above;
 - Section 5: Australian Opportunities for UAE Investors**, providing helpful summaries of **Australia's Green Hydrogen Investment Landscape, Australia's Renewables and Battery Storage Landscape**, and **Australia's Waste to Energy Opportunities**, with helpful descriptions of policy setting frameworks, key stakeholders and providing a balanced perspective on the roadblocks and challenges.
 - Section 6: UAE Opportunities for Australian Investors**, providing helpful summaries of **UAE's Green Hydrogen Investment Landscape** and **UAE Renewables and Battery Storage Net Zero and international competitiveness**, again with helpful descriptions of policy setting frameworks, key stakeholders and providing a balanced perspective on the roadblocks and challenges, and possible entry strategies.

Australian Government – Department of Industry, Science, Energy and Resources:

- **Title, and provenance, of report:** [State of Hydrogen 2021 \(State of H2\)](#): The Department of Industry, Science, Energy and Resources (**DISER**) published the **State of H2** report in December 2021.
- **Background and Purpose:** The **State of H2** report is intended to track progress in Australia in comparison to global progress, measuring progress of hydrogen industry and providing a snap shot of its progress.

For purposes of framing progress, the team at **DISER** outline the scope for the use of hydrogen in the Australian context, and notes that Australia has "**all the ingredients to be a major hydrogen producer and exporter, including abundant and cheap renewable resources, geological storage resources and a proven track record as an energy exporter**".

- **An identified core:** The **State of H2** report hones in on the core of the role of Governments: "**Governments will continue to work with industry to overcome any barriers to development. This work focuses on 3 areas: building demand, achieving low-cost hydrogen production at scale [and] reducing hydrogen delivery costs**".

In addition to this high level summary, the team at **DISER** provide a summary of government actions (at all levels of government) to overcome any barriers to development. Also the role of government in the development of hydrogen hubs is outlined, as is the need to continue to develop international partnerships.

- **A set of identified outcomes and progress against them:** In a really helpful table, that brings together the industry development signals, pace points in 2025 and 2030, and current status, the **State of H2** report outlines progress.

Table 1: Overview of Australia's progress across the industry development signals

INDUSTRY DEVELOPMENT SIGNAL	2025 PACE	2030 PACE	CURRENT STATUS
Investment	Advancing quickly	Advancing	<ul style="list-style-type: none"> • Private sector investment is growing with committed investment exceeding A\$1.6 billion. • Public sector investment reached \$1.27 billion in June 2021.
Project scale	Advancing quickly	Advancing quickly	<ul style="list-style-type: none"> • Project announcements indicate scale could reach over 100 MW by 2025. • Gigawatt-scale projects have been announced and are expected to start operating in the second half of the decade. However, a final investment decision on these projects has not been made.
Cost-competitiveness	Advancing quickly	Advancing	<ul style="list-style-type: none"> • Clean hydrogen costs are expected to decline to between A\$2 and A\$4 by 2030.¹
Australia's exports	Advancing	Advancing	<ul style="list-style-type: none"> • Investment is being directed to hydrogen supply chains. Front end engineering and design studies are underway. • Supply chains still require development for Australia to be a major global supplier. • To support supply chain development, supply chain studies are underway with international partners like HySupply. • The government has supported hydrogen hubs to stimulate demand and produce clean hydrogen for domestic and export markets.
Chemical feedstock	Advancing quickly	Advancing quickly	<ul style="list-style-type: none"> • Projects to use clean hydrogen in existing facilities have been announced. • Current announcements account for 20% of total electrolyser capacity.
Steel making	Advancing slowly	Advancing slowly	<ul style="list-style-type: none"> • Limited activity in this area. However, several announcements from steel producers indicate an intent in this sector. • Clean steel is a priority technology under Australia's Technology Investment Roadmap.
Electricity grid support	Advancing slowly	Advancing slowly	<ul style="list-style-type: none"> • Limited trials are underway to test whether hydrogen can provide frequency control ancillary services (FCAS).
Mining and off-grid	Advancing	Advancing slowly	<ul style="list-style-type: none"> • A few projects are exploring hydrogen for microgrid applications. However, there are no plans for either small-scale or wide-scale rollout at this stage. Fortescue and ATCO are exploring hydrogen mobility at a mine site. • \$103.6 million in government funding has supported microgrid pilots and deployment.
Power generation*	Advancing quickly	Advancing	<ul style="list-style-type: none"> • Two new hydrogen-ready gas generators reached final investment decision in New South Wales: Snowy Hydro's 660 MW Kurri Kurri gas generator and Energy Australia's 316 MW Tallawarra B gas generator. Additional projects are also in the pipeline, specifically AIP's Port Kembla gas generator.
Light transport	Advancing slowly	Advancing slowly	<ul style="list-style-type: none"> • Limited deployments or infrastructure to support hydrogen use in light transport. • Four refuelling stations and approximately 30 vehicles are in operation. Some additional projects are targeting operations in 2025. • The Australian Government has launched its Future Fuels Fund to take advantage of opportunities offered by electric, hydrogen and bio-fuelled vehicles. This includes support for electric vehicle refuelling infrastructure, including hydrogen fuel cell vehicles.
Heavy transport	Advancing slowly	Advancing slowly	<ul style="list-style-type: none"> • Hyzon Motors and Fortescue Metals are collaborating on hydrogen-powered buses for mining applications. • The Australian Government's Future Fuels Fund and Freight Productivity Program will support further heavy transport uptake.
Gas networks	Advancing	Advancing	<ul style="list-style-type: none"> • Activity is underway to trial hydrogen blending. Nine projects are expected to be operational by 2025. • Gas networks are targeting 100% hydrogen in regions of the network by 2030. • Australian Governments have agreed to national gas regulatory framework amendments to bring hydrogen, bio-methane and other renewable gas blends within its scope. Reforms are expected to initially focus on gases and blends that can be used in existing natural gas appliances.
Industrial heat	Advancing	Advancing	<ul style="list-style-type: none"> • Limited activity. However, Grange Resources (Tasmania) Pty Ltd is undertaking a feasibility study looking at hydrogen for industrial heat.

Note: *Power generation refers to global progress as the indicator explicitly relates to international electricity demand
Source: Adapted from KPMG analysis, June 2021.

- The **State of H2** report comprises four chapters as follows.
 - Chapter 1: Australia's Pathway For A Clean Hydrogen Future;**
 - Chapter 2: Hydrogen Industry Development;**
 - Chapter 3: Government Actions To Advance The Industry;**
 - Chapter 4: Next Steps.**
- **Key issues arising from each Chapter:**
 - **Chapter 1:** The key theme to emerge from **Chapter 1** is that the [National Hydrogen Strategy](#) in Australia takes an adaptive approach, involving and requiring the ongoing assessment of the development of the industry. In the context of pace points (2025 and 2030) described above, the adaptive approach has two phases: first, involving foundation and demonstration (2020 to 2025), focusing on creating, demonstrating and testing supply chains, and building capacity (**first phase**); and secondly, large-scale market activation (2025 to 2030), building on the **first phase**, and focusing on scaling you supply to respond to developing markets that will underpin that supply (**second phase**).
 - **Chapter 2:** As will be apparent from the table above, the **State of H2** report is intended to monitor progress of the development of the hydrogen industry to stated signals. As might be expected, given the **second phase** described above, the **State of H2** report focuses on the development of supply-side and the demand-side. This approach is consistent with the best practice globally. For these purposes, **Chapter 2** considers Investment and Supply and Demand, critically, by sector of users of hydrogen.
 - **Chapter 3:** Governments in Australia are undertaking activities and developing policy settings that are aligned with the National Hydrogen Strategy. Consistent with the **first phase**, the activities and policy settings described in **Chapter 3** are focused on the development of technology and capacity. While some commentators suggested greater levels of financial support, and for larger-scale projects, as a general statement, it is necessary to prove up technology and capacity ahead of larger-scale support. This said, there is a clear understanding that government can get ahead of barriers to development by looking at hydrogen hubs and the development of common / share infrastructure.
 - **Chapter 4:** Consistent with thinking around international partnerships, **Chapter 4** notes that international engagement needs to continue. As a stepping stone to scale, the development of domestic demand for hydrogen is noted as matter requiring continued work. In terms of future areas of work, **Chapter 4** notes the in the medium term, energy market reform is required, including to achieve the targeted production cost of below AUS 2 per kilogram of hydrogen. In this context, it is important to ensure continued energy security and to continue to get ahead of the need of infrastructure development.
- **Summary:** The **State of H2 Report** is a great summary of the state of play in the development of the hydrogen industry in Australia at the end of 2021. Given the nature of the **State of H2 Report**, there are no surprises in the Report, but a key take away from the Report is the coherence and responsiveness of Australian Governments (Federal and State and Territory) to the ever changing and accelerating development of the hydrogen economy.

Australian National University:

- **Title, and provenance, of report:** ['Clean' hydrogen? Comparing the emission and cost of fossil fuels versus renewable electricity based hydrogen Statement \(Clean Hydrogen Paper\)](#): The authors from the Crawford School of Public Policy, School of Engineering, and Zero-Carbon Energy for Asia Pacific Grand Challenge from the Australian National University (ANU) published the **Clean Hydrogen Paper** in November 2021.
- **Background and Purpose:** The **Clean Hydrogen Paper** is intended to assess and to report on the **GHG's** arising from the use of fossil fuel feedstocks to produce hydrogen, with and without CCS.
- **Key finding / findings:**

The key finding are as follows:

" ... emissions from gas or coal based production systems could be substantial even with CCS, and the cost of CCS is higher than often assumed ... Carbon prices of [AUS]\$22-46 per metric tonne of CO₂-e would be required to make hydrogen from fossil fuels [using] CCS competitive with hydrogen production from fossil fuels without CCS. At the same time there are indications that electrolysis with renewable energy could become cheaper than fossil fuel with CCS options, possibly in the near-term future. Establishing hydrogen supply chains on the basis of fossil fuels, and many national strategies foresee, may be incompatible with decarbonisation objectives and raise the risk of stranded assets".

The **Clean Hydrogen Paper** provides compelling evidence for the purpose of these findings. There are a number of counterfactuals to these findings, but it is most important to note that to progress to **NZE** it may be that natural gas and hydrogen derived from natural gas (not coal without close to 95% effective CCS) may be a means to develop the supply and demand side of the hydrogen market in the near term, to be displaced by green hydrogen in due course. There are policy settings globally designed entirely for this purpose.

Department for Business, Energy & Industrial Strategy:

- **Title, and provenance, of report:** [Biomass Policy Statement \(UK BPS\)](#): The UK Department of Business, Energy & Industrial Strategy (**DBEIS**) published the **UK BPS** report in November 2021.
- **Background and Purpose:** The **UK BPS** is intended to provide a strategic view of the role of biomass across the [UK] economy in the medium (by 2035) to long term (by 2050) in the context of the UK [Net Zero Strategy](#), with the UK BPS stating that: "**Biomass has a role to play ... and is a vital source of the key green technologies and energy carriers highlighted as necessary for net zero: low carbon electricity, hydrogen, carbon capture, and bioenergy**".

In this context, the **UK BPS** is intended to outline how biomass can best support decarbonisation across the UK, and in doing so, create new jobs, tackle climate change, and improve air quality and the environment.

For these purposes, the **UK BPS** considers:

- how use of biomass can achieve **GHG** emission reductions and **GHG** removal in the following sectors: power, heat and buildings, industry, transport, agriculture and land use, land use change and forestry (**LULUCF**) and bioeconomy;
- the biomass feedstocks that may be used, including domestic and imported biomass feedstocks (for example, food and feed crops, perennial energy crops (Miscanthus and short rotation coppice (**SRC**)), short rotation forestry (SRF), and wastes, agricultural, forestry and processing residues (**In Scope Biomass**); and
- the use of biogas derived from biomass feedstocks for power and heat generation, and lower to low carbon fuel production, including hydrogen from biogas, and in this context the use of BECCS.

For the purpose of the **UK BPS**, biomass is stated to cover "**a broad and varied range of materials, and current biomass resource supply is diverse**", with biomass defined as "**any material of biological origin (including biodegradable fraction of products, wastes and residues from a biological origin)**". Sustainable biomass is stated to be "**a low carbon alternative to fossil fuels for energy (heat, power and transport fuels), including as an energy source for industrial processes or as a raw material used to make products (such as bio-based plastics and materials from foundational industries)**".

The biomass feedstocks defined above as **In Scope Biomass** are stated to be types of biomass that are acceptable for the purposes of the **UK BPS**. This is not to exclude other types of biomass, but the **In Scope Biomass** may be regarded as prequalifying.

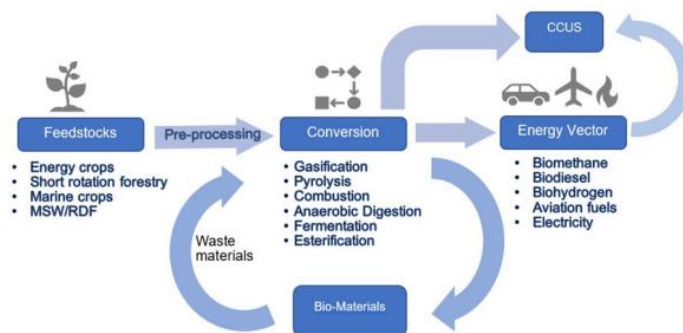


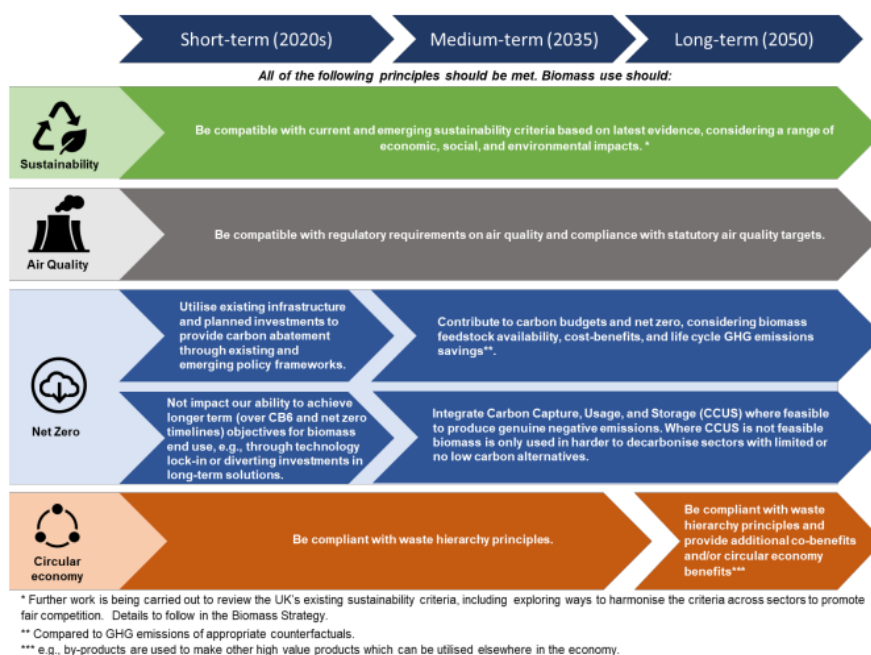
Figure 1: Schematic diagram representing potential routes for biomass processing and use across the economy.

- **An identified set of principles:** The **UK BPS** sets out three key principles to be applied over the short (2020s) and medium and long term: **1.** Compliance with sustainability criteria and waste hierarchy principles; **2.** Contribution to carbon budgets and net-zero considering feedstock availability, life-cycle **GHG** emissions and cost benefits; and **3.** Biomass to be used with carbon capture utilisation and storage where feasible, otherwise used only in hard-to-decarbonise sectors with limited or no low carbon alternatives.
In passing it is noted that these key principles appear to the author to be balanced.
- **An identified expectation:** The position of the **DBEIS** could not be clearer:

"We expect biomass use to be prioritised according to these principles, in areas, such as sustainable aviation fuel and hydrogen production helping to decarbonise greenhouse gas (GHG) intensive sectors such as aviation and industry, and as a fossil fuel replacement to make valuable products from materials further down the waste hierarchy and provide a circular economy benefit. Over time, as technology develops, we expect biomass use [also to be focused] in applications that can deliver negative emissions through Bioenergy with Carbon Capture and Storage (BECCS), while also supporting energy security".
- **The UK BPS** comprises three chapters as follows:
 - Chapter 1: Biomass Feedstock;**
 - Chapter 2: Biomass use in a low carbon economy;**
 - Chapter 3: Research and Innovation.**
- **Key issues arising from each Chapter:**
 - **Chapter 1:** A reasonably full range of biomass feedstocks are considered in **Chapter 1**, with the core biomass feedstocks identified in the following schematic diagram:
Given the three key principles, **Chapter 1** considers sustainable biomass, understanding what sustainable biomass supply comprises, and then considers a number of sources of biomass feedstock supply by reference to clear principles.

- **Chapter 2:** The uses of biomass in a low carbon economy is considered in detail. **Chapter 2** is the guts of the **UK BPS** and is well-worth a read, in fact it is a helpful summary in the context of countries with more developed waste collection systems, and an ability to extend and the vary those systems while holding true to the three key principles.

Figure 2: Overarching priority use principles for biomass use over three timescales: 2020's, up to 2035, and to 2050.



Chapter 2 identifies, at a high level, some of the legal and regulatory matters that will need to be addressing for biomass (and biogas and biomethane derived from biomass) to supply bioenergy to satisfy bioenergy demand.

- **Chapter 3:** The need for research and innovation are considered in **Chapter 3**. As with the **State of H2** report on the context of the development of supply of hydrogen in Australia, the **UK BPS** identifies the need for the development of technology to create sustainable biomass supply and effective BECCS.

EIC Insight Report – Global Offshore Wind:

- **Title, and provenance, of report:** **Energy Industries Council Report – Global Offshore Wind, November 2021 (EIC GOW)**, published by the Energy Industries Council (**EIC**). The **EIC** is a not-for-profit organisation, established in 1943, wholly owned by the members of it, of which there are currently around 700, most with UK operations.
- **Background and Purpose:** The **EIC GOW** is intended to provide input as to how best to realise the potential of off-shore wind development. While the **EIC GOW** is based on 2020, the trends identified continue: 2020 was a record year for the installation of off-shore wind field capacity, and 2021 has out-stripped 2020 by some distance, the PRC and the UK are now leading the way, but the growth of the development of off-shore wind capacity is not limited to any market:

"Off-shore wind's potential does not however stem from the significant growth in one market, but the fact that it is not represented on almost every continent [only Antarctic is missing]. Striking within the just under 404 GW of capacity additions by 2035 that the EIC is tracking, is the significant role played by emerging markets and the leading industry players pushing them into the offshore wind scene. Examples include Brazil with over 47 GW in the pipeline, Ireland with just under 23 GW and Poland with roughly 9 GW of project activity".

Marking the pace of development the pipelines for Brazil and Poland would seem likely to become multiples of these reported numbers.

The **EIC GOW** is intend to showcase the state of the market globally, and it does this effectively, very effectively with case studies on the UK Offshore Wind Market, the European Offshore Wind Market, the Americas, Asia Pacific, the Middle East and the Floating Offshore Wind Market. Issues arise from each geographical area / market covered.

It will not come as a surprise that the requiring issues that arise are the need to address the time taken to get consented and the financing of the projects, critically, what is required to mobilise project finance to allow timely development of the require GW of off-shore wind field capacity to develop sufficient renewable energy, as one leg of energy transition, allow the production of hydrogen and hydrogen-based fuels, as the second leg of energy transition.

ENEA Consulting and Deloitte for ARENA:

- **Title, and provenance, of report:** **Australia's Bioenergy Roadmap (AUS BR)**: The Australian Government, Australian Renewable Energy Agency (**ARENA**), commissioned ENEA Consulting and Deloitte Financial Advisory to prepare the **AUS BR**. The **AUS BR** was published in November 2021.

- **Background and Purpose:** The **AUS BR** is intended to provide a basis for the enhancement of the bioenergy sector in Australia, and in so doing to identify the role of bioenergy as part of the future energy needs of Australia. For these purposes, the **AUR BR** states that it presents a framework from November 2021 to 2030 outline: **1.** where bioenergy has a comparative advantage and complements other lower to low emissions alternative technologies; **2.** current barriers to the development of the bioenergy sector; **3.** findings for government and industry to drive commercial outcomes; and **4.** how to inform the broader community.

For the purpose of the **AUS BR**, **bioenergy** is defined as "**a form of renewable energy generated from the conversion of biomass into heat, electricity, biogas and liquid fuels**", and **biomass** is defined "**organic matter derived from forestry, agriculture or waste streams available on a renewable basis**", and may include combustible components of municipal solid waste. In broad terms this is aligned with the **UK BPS** definitions, but for the time being is less granular and as such less directional.

- **Summary of the AUS BR:**

– **Key Themes:**

Theme 1: The **AUS BR** provides direction in respect of three hard-to-abate opportunities for bioenergy: **1.** Renewable Heat Generation (using both gaseous and solid biomass as feedstock); **2.** Aviation (using sustainable / synthetic liquid fuels); and **3.** Gas Grid Injection (using biomethane derived from biogas). Focusing on these three opportunities is described as Targeted Deployment.

Targeted Deployment is a great idea, and is consistent with the technology available for the purposes of that Targeted Deployment.

Time frame 2021-24 2025-30	Possible action options for industry, state and Commonwealth governments	
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THEME 1: ENABLING MARKET OPPORTUNITIES IN HARD-TO-ABATE SECTORS

	<p>Industrial renewable heat</p> <ul style="list-style-type: none"> • Raise the profile of bioenergy solutions and successful project case studies • Educate industrial heat consumers about bioenergy solutions and benefits • Provide financial support for feasibility studies to encourage uptake and scale-up • Explore ways to overcome short project payback expectations 	<ul style="list-style-type: none"> • Review market developments periodically to ascertain future priorities and efforts
	<p>Sustainable aviation fuels</p> <ul style="list-style-type: none"> • Communicate the role and benefits of biojet fuels to the community • Coordinate public-private partnerships across all stakeholder groups to develop the market • Assess opportunities in foundation sub-markets such as the Royal Australian Air Force or regional routes • Encourage research, pilots and trials focusing on the demonstration of advanced biojet fuels from non-food resources at commercial scale 	<ul style="list-style-type: none"> • Assess ways to bridge the economic viability gap such as lowering production costs for biojet fuel production in the long term
	<p>Renewable gas grid injection</p> <ul style="list-style-type: none"> • Develop a certificate of origin scheme to complement the work underway on hydrogen • Clean Energy Regulator to finalise Emissions Reduction Fund methodologies underway recognising biomethane injection into gas networks • Pursue a uniform regulatory approach for digestate specifications and use • Continue to assess the appropriateness of the natural gas specifications for biomethane grid injection and implement amendments to the National Gas Law so it extends to renewable gas blending to provide more legal certainty for industry⁶ 	<ul style="list-style-type: none"> • Assess ways to bridge the economic viability gap such as lowering production costs for biomethane production from anaerobic digestion • Promote the ongoing development of case studies focusing on biomethane production from anaerobic digestion


Theme 2: The *AUS BR* identifies market opportunities where bioenergy use will complement low emission alternatives, electricity and road transport markets.

Time frame



2021-24

2025-30

Possible action options for industry, state and Commonwealth governments



THEME 2: ENABLING MARKET OPPORTUNITIES WHERE BIOENERGY CAN COMPLEMENT OTHER LOW EMISSIONS ALTERNATIVES

	<p>Road transport</p> <ul style="list-style-type: none"> • Educate the community about biofuels and their future potential • Consider broader ways to harmonise the treatment of biofuels with conventional fuels where appropriate • Encourage research, pilots and trials focusing on the demonstration of advanced biofuels from non-food resources at commercial scale, in combination with biojet fuels • Consider the role of biofuels in aligning Australia's fuel quality standards to address aromatics levels⁹ • Review market developments periodically to ascertain future priorities and efforts 	<ul style="list-style-type: none"> • Review market developments periodically to ascertain future priorities and efforts
	<p>Dispatchable renewable electricity</p> <ul style="list-style-type: none"> • Promote successful business cases optimising diverse revenue streams • Increase visibility of bioenergy in schemes promoting dispatchable electricity generation 	

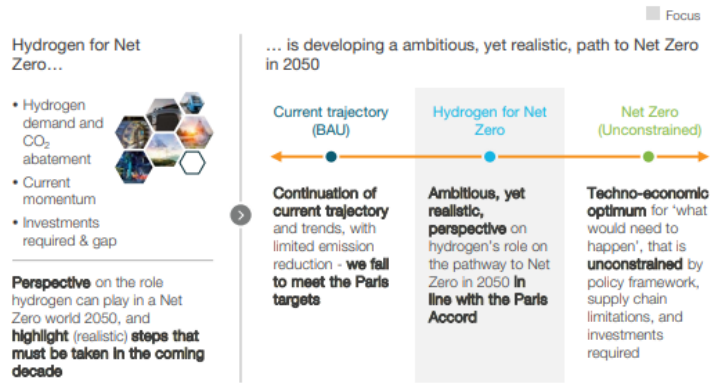
In addition, there are **Themes 3** and **4**. **Theme 3** goes to realising sources of biomass for bioenergy. The focus of the work in this area bring, expand and settle on an assessment of sources of biomass for bioenergy, noting the importance of "making the most of waste and residue resources", and in this context developing a sustainable sources of biomass for bioenergy, and developing hubs to consolidate sources so as to avoid duplication. **Theme 4** goes to developing an ecosystem to support participants in the development of the growth of the bioenergy market.

- **Key Insights:** The Key Insights section of the *AUS BR* provides further detail to support Targeted Deployment. The analysis is worth a read, but is unlikely to surprise any person working actively in the bioenergy and waste sector.

Hydrogen Council and McKinsey & Co:

- **Title, and provenance, of report:** *Hydrogen for Net-Zero – November 2021 (H2NZE)*: The Hydrogen Council (peak industry association) and McKinsey & Co (leading consulting firm), published their third progress report during 2021, with January and July. The *H2NZE* report was published in November 2021.
- **Background and Purpose:** As with the first two progress reports, the purpose of the *H2NZE* report is to report on development of hydrogen supply and demand given the central role that hydrogen has to play in achieving progress towards *NZE*.
- **Key messages:** As with the first two progress reports, the third progress report provides a helpful executive summary that pulls out the key messages:
 - Limiting the increase in global average temperatures to a 1.5°C above pre-industrial times is now the orthodoxy;
 - Biofuels, energy efficiency and clean hydrogen offer the only long term, scalable cost-effective options;
 - Hydrogen is critical for decarbonising industry, longer range ground mobility, international travel, and heating applications, and some power generation;
 - Scaling through 2030 is critical for meetings long term targets, and unlocking cost efficient decarbonisation opportunities;
 - There is strong momentum but a USD 540 million gap in capital investment existing through 2030.
- **The H2NZE** report is structured as follows:

Introduction: Framing perspectives and outlining common themes that run through the balance of the publication. The framing is helpful and includes the following schematic:



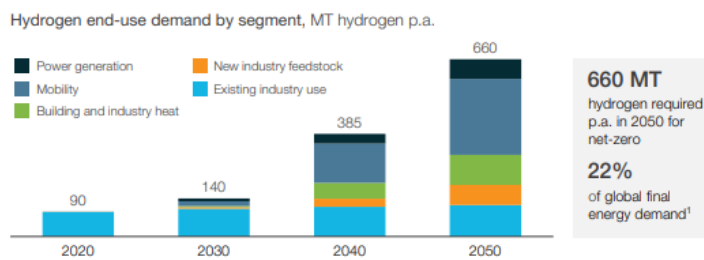
- Chapter 1: Demand for hydrogen and its cost and carbon cutting role;**
- Chapter 2: Scaling until 2030 is critical for meeting long-term targets;**
- Chapter 3: Hydrogen momentum and required investments;**
- Chapter 4: Action is required.**

• **Key issues arising from each Chapter:**

– **Chapter 1 – Demand for hydrogen and its cost and carbon cutting role:** While the first two progress reports outlined the development of supply and demand, the **H2NZE** provides a deeper dive into demand development.

Working from the assumption that clean hydrogen capacity needs to be developed to achieve **NZE**, the **H2NZE** report outlines thinking around global demand, by sector, to 2050 as follows:

Exhibit 3 – Global hydrogen demand by segment until 2050

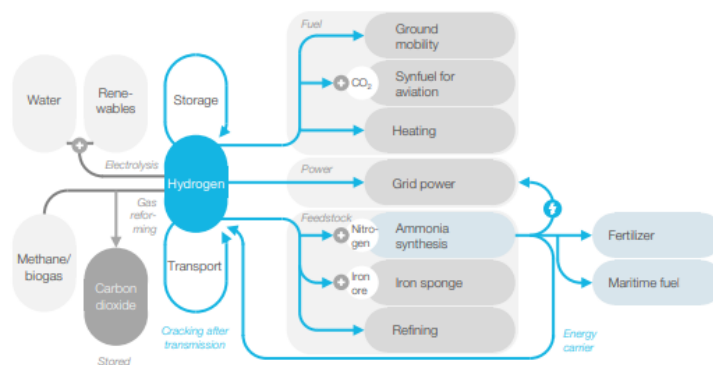


1. IEA net-zero scenario with 340 EJ final energy demand in 2050. H+V assumed. Excluding power.

The use of hydrogen by each sector is considered in detail (pages 16 and 17).

A light is shone on the role of hydrogen in the energy system – storage, system integrity and stability, transmission, and unlocking untapped stranded renewables. This perspective is presented in a schematic:

Exhibit 4 – Hydrogen pathways in the energy system



Clean hydrogen produced from "stranded" renewables used as reductant in steel production - or to fuel ships and trucks
Chemicals and energy sectors are coupled - chemicals become energy carriers or fuels

Note: Selected examples – not exhaustive

A perspective is provided on the geographical markets from which demand will come to 2050.

- **Chapter 2 – Scaling until 2030 is critical to meeting long term targets:** The headline targets are that by 2030, 75 million metric tonnes of clean hydrogen must be produced annually, and there must be a 30% reduction in the production of grey hydrogen.

Further, 690 million metric tonnes of low carbon and renewable hydrogen supply is required to meet hydrogen demand of 660 million metric tonnes by 2050 (allowing for losses in the supply chain), 140 to 180 million metric tonnes per year of low-carbon hydrogen, and 400 to 550 million metric tonnes per year of renewable hydrogen.

For these purposes, **low-carbon hydrogen** referring to hydrogen produced from energy sources of non-renewable origin with a carbon footprint below a specified threshold, and **renewable hydrogen** referring to hydrogen produced from energy sources of a renewable origin. With **clean hydrogen** being low-carbon or renewable hydrogen.

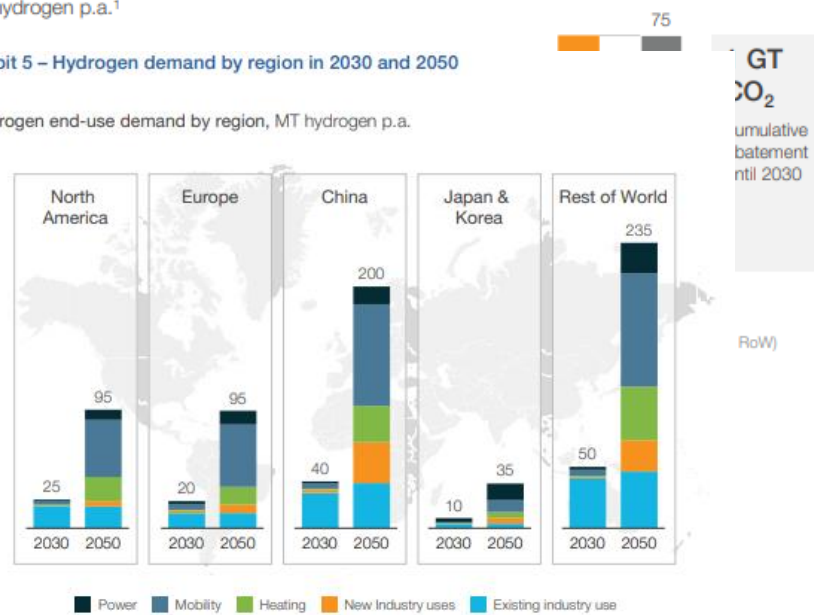
In this context, the **H2NZE** report provides a helpful schematic demonstrating the clean hydrogen deployment required to achieve the 2030 target:

Exhibit 9 – Clean hydrogen deployment by sector in 2030

Clean hydrogen end use demand in 2030, MT hydrogen p.a.¹

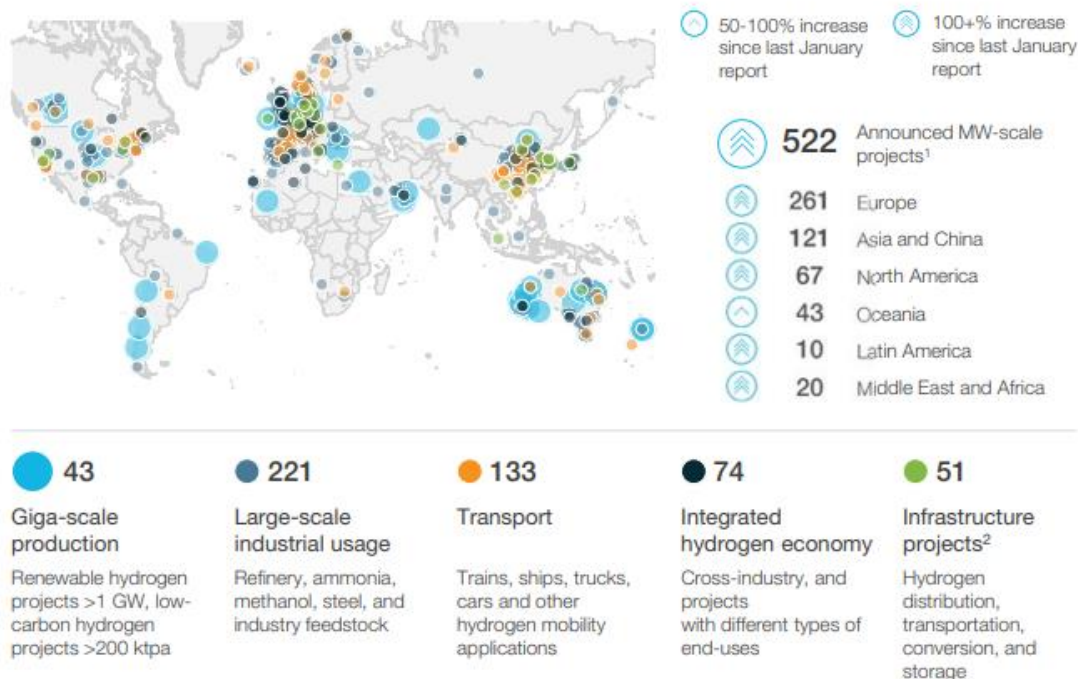
Exhibit 5 – Hydrogen demand by region in 2030 and 2050

Hydrogen end-use demand by region, MT hydrogen p.a.



- **Chapter 3 - Hydrogen momentum and required investments:** The most used map in the hydrogen industry is included at page 36 of the **H2NZE** report, providing an update on the maps from the first and second progress reports:

Exhibit 11 - Hydrogen project announcements



The map marks further momentum, but the by-line is that the level of momentum is not enough for the purposes of achieving the headline target of 75 million metric tonnes of clean hydrogen by 2030. The by-line is consistent with messaging before, during and after **COP-26**.

- **Chapter 4 – Call to action:** Consistent with messaging before, during and after COP 26, the message is made cogently in the **H2NZE** report as follows:

"Momentum is strong; industrial players across the value chain are willing and eager to invest and scale hydrogen, while governments across continents increasingly recognise hydrogen's critical contribution to decarbonisation. Nevertheless, **translating momentum and intentions into real developments is becoming increasingly urgent**. If we are to decarbonise economies and limit global warming to 1.50C-1.80C [reflecting the conclusions from **COP-26** – see **Edition 29** of Low Carbon Pulse] actions must take place in the coming decade – the 2050 ambition of 80 GT **CO₂** abated cannot be realized unless the foundation is laid today".

IEA Reports:

The International Energy Agency (**IEA**) was established in 1974 as a response to the oil price crises during that year. The **IEA** now comprises 30 member countries, and 8 association countries.

The **IEA** has become one of the leading energy data collection and analysis organisations, and from this, key to information provision and to research globally.

- **IEA Reports during November and December 2021:**

- [Greenhouse Gas Emissions from Energy](#)
- [Renewables 2021](#)
- [Reforming Korea's Electricity Market for Net Zero](#)
- [France 2021](#)

It is important to note that all of the **IEA** publications tie back to the **IEA's Net Zero by 2050 – A Roadmap for Global Energy Sector (IEA Roadmap)**, reported on in **Editions 17, 18, 20, 21, and 22** of Low Carbon Pulse (all of which are contained in the [First Compendium of Low Carbon Pulse](#)).

For the purposes of this **November and December 2021 Report on Reports**, the **Renewables 2021** report and the **France 2021** report are reported upon in more detail, with headlines for each of them included here for those who simply want to understand what each covers and its context:

- **Renewables 2021 report:**

- **Purpose:** The **Renewable 2021** report is something of a stock-take in light of increased nationally determined contributions (**NDCs**) in the lead up to, and at **COP-26**, and something of a call to renewed efforts to "propel renewable electricity growth to new heights."
- **Findings and key outcomes:** The **Renewable 2021** report highlights the following in the Executive Summary: In the context of increased NDCs and increased progress:
 - **Additions of renewable power capacity were on track to set another annual record in 2021, driven by photovoltaic solar;**

- **The growth in renewable capacity is forecast to accelerate in the next five years, accounting for almost 95% of the increase in global power capacity through 2026;**
- **The PRC and EU are set to overshoot their current targets, setting the state for a more ambitious growth trajectory for renewable electrical energy;**

In the context of increased costs, photovoltaic solar will set new records and wind capacity will increase over the coming five years:

- **Even with surging commodity prices and increased manufacturing costs for photovoltaic solar, capacity is increasing;**
- **On-shore wind additions through 2026 will increase at a rate that is 25% higher on average than during the 2015-2020 period;**
- **Total off-shore wind capacity is forecast to increase so as to triple by 2026;**

In the context of the ever increasing capacity, Asia will overtake the EU, with India and Indonesia leading the way in the increased demand for biofuels.

In the context of increased momentum, renewable heat and steam will increase, but not significantly.

In the context of high commodity and energy prices, there are uncertainties.

In the context of the right policy settings, there is the prospect of "a huge wave of private capital" investment on renewables, including electrical energy, heat and steam energy, and biofuels and biogas.

In the context of increased investment in renewables, persistent challenges need to be addressed, in particular governments need to address barriers to entry.

In the context of increased use of renewables in the difficult to decarbonise industries, policy settings need to encourage the development of supply and demand in tandem.

Finally, looking to the **IEA Roadmap**, for all the progress made and predicted to be made, that rate of the roll out of renewables needs to increase if **NZE** is to be achieved by 2050.

- **France 2021 Energy Policy Review:**

- **Purpose:** The forward to the **France 2021 Energy Policy Review** provides context to the review, placing the report in the context of France's commitment to achieving **NZE** by 2050:

"France's nuclear fleet is ageing and maintaining its low-carbon power generation will require timely decisions about future electricity mix along with an acceleration of clean energy investments ...

France has considerable work ahead on the road to net-zero. It needs to focus on implementation, reviewing progress to date, and increasing co-ordination across government ... I strongly believe that this report can help France advance its energy and climate goals while ensuring fairness, energy security and economic growth."

- **Time waits for no one:** Since the publication of the **France 2021 Energy Policy Review**, President Macron has announced (see **Edition 35** of Low Carbon Pulse in this Second Compendium):

Clear on nuclear: In a busy week for President Macron, on February 10, 2022, President Macron announced that the nuclear industry in France was to undergo a rebirth. The announcement by President Macron has been signalled for a while (see **Editions 29** and **31** of Low Carbon Pulse), and aligns with the **EU Green Taxonomy**.

President Macron announced that six new nuclear reactors would be developed (with options to develop a further eight to make 14) so as to remove the reliance of France on fossil fuels, and to allow France to achieve carbon neutrality by 2050. As noted in previous Ashurst publications, around 70% of the electrical energy generated in France is derived from use of nuclear reactors.

In context, it is important to understand that the rebirth is a matter of renewal – a firm proportion of France's existing nuclear reactor power stations will come to the end of their life-cycle by 2035. It is understood that the six new nuclear reactors will be 1,650 MW EPR2 – being third generation pressurized water reactors.

Clear line of sight on renewables: At the same time as the development of new nuclear reactors was announced, President Macron announced that the development and deployment of photovoltaic solar and off-shore wind field capacity would be accelerated. In this context, President Macron announced that France will have developed 40 GW of off-shore wind field capacity by 2050, on a rough and ready basis, equating to 50 off-shore wind field projects. Currently France has 2 GW of off-shore wind field capacity, and it has plans to procure a further 8.75 GW of off-shore wind field capacity by 2028 (see **Editions 16** and **32** of Low Carbon Pulse).

In addition, President Macron said that €1 billion in funding support would be provided to allow the development and deployment of emerging and new technologies, including the development and deployment of floating off-shore wind field capacity. "

[**Note:** The impending announcement from President Macron was awaited before the author completed this section of the **November and December Report on Reports**]

France an early thought leader of the global energy transition. France benefits from decarbonised electricity and the lowest per capita emissions of advanced economies thanks to the role of nuclear energy, which accounted for 71% of its power generation mix in 2019, and the role of hydroelectric generation capacity, accounting for 10% of its power generation mix.

France has long had a plan: France has a decarbonisation framework, anchored by the Energy Transition Law of 2015, building on the National Low-Carbon Strategy for 2050, with targets for the reduction of fossil fuel

use and emissions by sectors under three five-year carbon budgets to 2034. This said, France is behind its targets for energy efficiency, renewable electrical energy and **GHG** emission reductions.

- **Findings:** The **France 2021 Energy Policy Review** includes the following findings (summarised for the purpose of this narrative):
 - **Since 2015, France has taken significant action to promote progress towards NZE;**
 - **Despite significant action to develop policy settings, France is lagging on implementation;**
 - **There is no framework to assess or to guide achievement of domestic targets;**
 - **France has the opportunity to align with the EU target of 55% reduction by 2030, and Fit-for-55;**
 - **Policy settings are required to enable the development of renewable electrical energy capacity;**
 - **Policy settings are required to enable competitive in the retail electricity market.**
- **Recommendations:** The **France 2021 Energy Policy Review** makes the following recommendations:
 - Increase implementation focus and policy certainty to accelerate private investment;
 - Ensure consistency of 2030 targets with the updated National Low-Carbon Strategy and multi-year plan;
 - Align national and regional policies, regulations and targets, and reduce administrative burden;
 - Scaling and normalising the climate objectives into government and fiscal policy settings and spending;
 - Introduce an energy-system approach across key energy carriers and networks.

In addition, the recommendations included: "Clarify the ambitions of the closure and long-term operation of existing and the construction of new nuclear reactors in France, including financing mechanisms to mitigate uncertainties on the path towards net zero to support an affordable, sustainable and secure energy mix". The announcement by President Macron means that this recommendation has been acted upon.

IRENA Reports:

The International Renewable Energy Agency (**IRENA**) is an intergovernmental organisation supporting countries in the transition to renewable / sustainable energy, and is reported to be actively engaged with more than 180 countries in this endeavour.

- **IRENA Reports during November and December:**

- [Renewables Readiness Assessment Paraguay \(Paraguay Report\)](#).; and
- [A Pathway to Decarbonising the Shipping Sector by 2030 \(DSS by 2050\)](#).

For the purposes of this **November and December Report on Reports**, the **Community Energy Toolkit** is outlined [[DSS by 2050](#) report is covered in more detail].

- **Provenance and purpose of the Community Energy Toolkit:** The **Community Energy Toolkit** has been prepared by **IRENA** under the auspices of the **IRENA Coalition for Action**. The **Community Energy Toolkit** is intended to provide a toolkit to accelerate the transition to renewables and ensure it is just and fair, providing new approaches to involve a wider variety of actors.

The context is the recognition that the pace of renewable electrical energy development and deployment needs to accelerate, and quickly, to ensure that the average in global temperatures does not exceed **1.5°C**. As such the why is known; it is the how that is the focus of the **Community Energy Toolkit**.

The **Community Energy Toolkit** is well-worth reading for the case studies.

The **Community Energy Toolkit** provides what it describes as some key takeaways as follows:

- Communities should identify opportunities to make productive use of renewable energy;
- Communities should nurture dialogue among community members to foster a shared purpose and leverage knowledge and experience from the group to take their initiatives forward;
- Communities should invest time in building capacity through technical training in renewable, developing an understanding of regulatory requirements and government policies, and acquiring the necessary financial know-how to develop business plans for their community energy initiatives;
- Community energy can be a vehicle for gender and youth equity next to inclusiveness;
- Many successful community energy initiatives are the product of partnerships;
- When working with partner organisations, communities should help their partners develop an understanding of local contexts and their values and needs;
- Communities can turn to other communities for inspiration and guidance.

It is important to understand that the **Community Energy Toolkit** is seeking to promote incremental acceleration as one of the means to acceleration of the roll out of the development of renewable electrical energy, not the only means of doing so. What might be the next step is for the **IRENA Coalition for Action** to provide action packs that allow communities to realise the key takeaways in each of their local and national jurisdictions.

- **Provenance of the DSS by 2050 report:** In 2019 **IRENA** contributed to the Global Maritime Summit in Singapore, with **IRENA** joining the Getting to Zero Coalition (**GtZ Coalition**) in January 2020. The ambition of the **GtZ Coalition** is to develop and to deploy vessels, that are viable commercially, operating as zero-emission vessels by 2030 along deep sea trade routes. Since 2018, **IRENA** has been participating in Mission Innovation initiatives, including in the launch in June 2021 (see **Edition 19** of Low Carbon Pulse) of the Zero-Emission Shipping Mission (see **Edition 30** of Low Carbon Pulse). In addition, **IRENA** is working closely with the International Chamber of Shipping.

Renewable electrical energy is the focus of **IRENA**. Renewable electrical energy is required to produce e-fuels and e-feedstocks. In this context, in particular on the production of Green Hydrogen, from which e-fuels and e-

feedstocks can be produced, renewable electrical energy needs to be developed and deployed, lots of it. This is the subject of **IRENAS [World Energy Transition Outlook: 1.5°C Pathway \(WETO\)](#)** (see **Editions 21** and **23** of Low Carbon Pulse).

The **DSS by 2050** report is tied to the **WETO** and it builds on, and relies on, and reiterates points, made in the **WETO Roadmap**.

- **Purpose of the DSS by 2050 report:** The starting premise of the **DSS by 2050** report is that urgent action is necessary to accelerate the pace of global energy transition and decarbonisation of the global economy at a rate which will result in holding the average increase in temperature globally to **1.5°C** compared to pre-industrial times. As such, the purpose of the **DSS by 2050** report is to provide a pathway, and a tool kit, to achieving this outcome. As such, the ways and means described in the **DSS by 2050** are intended to achieve this outcome consistent with the broader thinking in the **WETO**: "*this [DSS by 2050] report explores the options and actions needed to progress towards a decarbonised maritime shipping sector by 2050 and seeks to identify a realistic mitigation pathway consistent with a wider societal goal of limiting global temperature rise to 1.5°C ... and bringing CO₂ emissions closer to net zero by mid-century*".
- **Form of the DSS by 2050 report:** The **DSS by 2050** report covers the following:
 1. Market dynamics and trends, trade volumes, associated energy demand, and **CO₂** emissions;
 2. Technology readiness and cost of relevant renewable energy fuels;
 3. The long-term decarbonisation pathway by 2050 and its implications; and
 4. Enabling actions to raise decarbonisation ambition.
- **Key findings:** Space does not permit detail consideration of each element of the **DSS by 2050** report, but the **DSS by 2050** report contains some compelling and defining findings that are consistent with other publications on the decarbonisation of the shipping sector, and that are consistent with trends in the shipping sector. Those key findings are as follows:
 1. renewable e-fuels, ammonia and methanol are the most promising fuels to decarbonise the shipping sector with renewable e-ammonia looking set to be the backbone of the decarbonisation of the shipping sector in the medium to long-term;
 2. if renewable e-ammonia is the backbone, Green Hydrogen and Green Hydrogen-based fuels will be the foundation of the shipping sector in the medium to long-term with around 46 million metric tonnes of Green Hydrogen required by 2050, with 73% of the Green Hydrogen required to combine with nitrogen to produce Green Ammonia (implying as much as 184 million metric tonnes of Green Ammonia), 17% for e-methanol and 10% to be used directly is liquid hydrogen using fuel cell technology (mostly on short voyage / domestic shipping trades) and using internal combustion engines developed to be fuelled by hydrogen.
There may be near-term roles for use of fuels derived from biomass (so called advanced biofuels, such as FOGS, FAME and HVOs), but in the medium to long term Green Hydrogen based fuels are regarded as the means of decarbonising the shipping sector; and
 3. The **IRENA 1.5°C Scenario** (see **WETO**) cannot be achieved by technology alone. For e-fuels to become the principal choice for powering and propelling the shipping sector, lower renewable electrical energy costs are required to allow increase production in Green Hydrogen.

Critically in this regard, the **DSS by 2050** report states that:

" .. sectoral decarbonisation can be accelerated and ambition can be raised beyond the climate goals by fostering investment in the production of renewable fuels. For this purpose, adopting relevant and timely co-ordinated international policy measures is greatly needed."

As will be apparent to the reader, two concepts are emphasised, **acceleration** and **ambition**. Since the start of Q2 of 2021, these concepts have become ubiquitous among those focusing on what is required to achieve increased levels of progress in **GHG** reductions. The next summaries continue the theme.

LDDES and McKinsey & Company:

- **Title, and provenance, of report:** **[Net-zero power – Long duration energy storage for a renewable grid \(LDDES – R#\)](#)**: The Long Duration Energy Storage Council (peak industry association for the energy storage industry) and McKinsey & Co (leading consulting firm) have prepared **LDDES – R#** report. The **LDDES – R#** was published in November 2021.
The Long Duration Energy Storage (**LDDES**) Council (**LDDESC**) was established at **COP 26** on November 4, 2021 (see **Edition 30** of Low Carbon Pulse). The **LDDESC** was established to provide guidance to Governments to the transmission grid operators on the objective of working towards global deployment of 85 – 140 TWh of long duration energy storage by 2040. The founding members of the **LDDESCs** (in alphabetical order) were: Alfa Laval, Ambri, Azelio, Baker Hughes, Breakthrough Energy, BP, CellCube, Ceres, Echogen Power Systems, EnergyDome, Enlighten, EOS, ESS, Inc., Ezinc, Form Energy, Greenko, Highview Power, Malta, Neom, Quidnet Energy, Redflow, Rio Tinto, Siemens Energy, and Stiesdal. These founding members have been joined by further members (see **Edition 34** of Low Carbon Pulse).
The **LDDESC** is stated to be "*a global, CEO-led organisation that strives to accelerate of the energy system at the lowest costs to society by driving for innovation and deployment of long duration energy storage*".
- **Background and Purpose:** The **LDDES – R#** report is intended to provide an introduction to LDDES and its role in progress towards the decarbonisation of the energy system. As such, **LDDES – R#** report frames the issue attendant with decarbonisation of the energy system, and the central role that **LDDES** will play.

The issue is framed by: "**What is the issue?** To avoid catastrophic climate change, we need [rapidly] to build a net-zero power sector predominantly powered by renewable energy. As the proportion of renewables grows, we are presented with 3 challenges: balancing electricity supply and demand; a change in transmission flow patterns; and a decrease in system stability" (the **Three Challenges**).

The means of addressing the issue is then addressed in the **LDES – R#** report: the use of **LDES** and unlocking the value of **LDES**.

• **Summary of the LDES – R# report**

The use of **LDES**, and the scale of the task, is addressed head on in the Executive Summary of the **LDES – R#** report – **LDES** is all about technology, and the Executive Summary provides an overview of each technology.

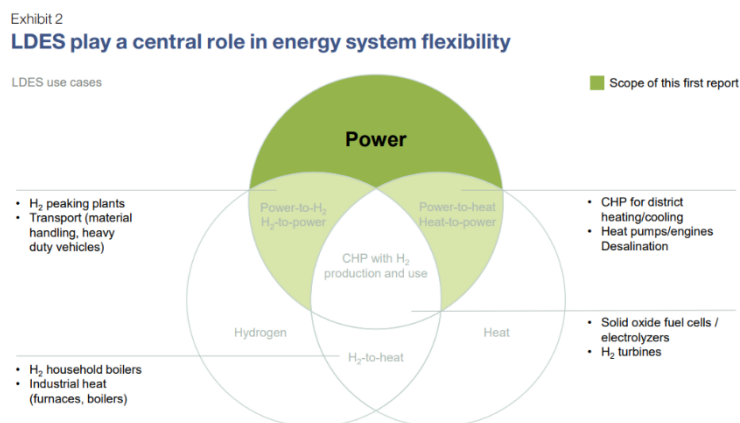
The balance of the **LDES – R#** report is devoted to the ways and means of accelerating the deployment of **LDES** at the same time as accelerating the development and deployment of renewable electrical energy capacity. The two need to develop in tandem, like the development of the supply and demand for hydrogen.

• **After the Executive Summary the LDES – R# report is structured as follows:**

- **1. Introduction:** Frames the role of **LDES** in the decarbonisation of power systems by 2040, increasingly regarded as essential to keeping the increase in global average temperatures to **1.5°C** above pre-industrial times, and achieving **NZE** by 2050. The decarbonise the power system the **Three Challenges** need to be overcome.

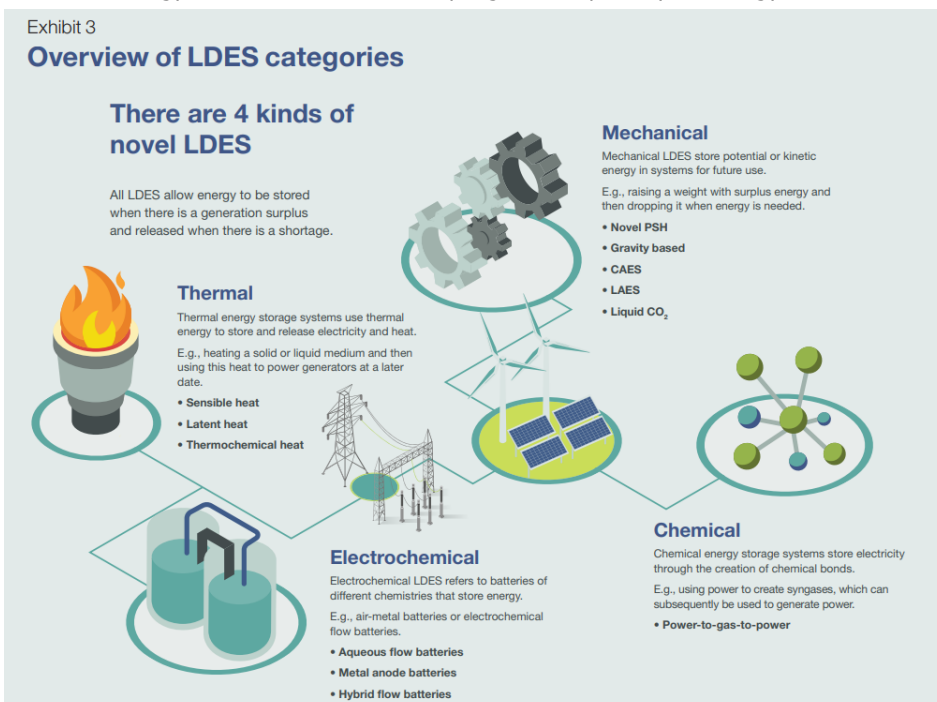
The **Three Challenges** can be overcome by introducing flexibility across power systems across different time spans as follows: intraday flexibility (<12 continuous hours), multiday and multiweek flexibility (12 hours within day and across weeks), seasonal flexibility, and flexibility to respond to extreme weather events.

- **2. LDES technologies characterisation and current status;** Frames the **LDES** technologies, and how **LDES**



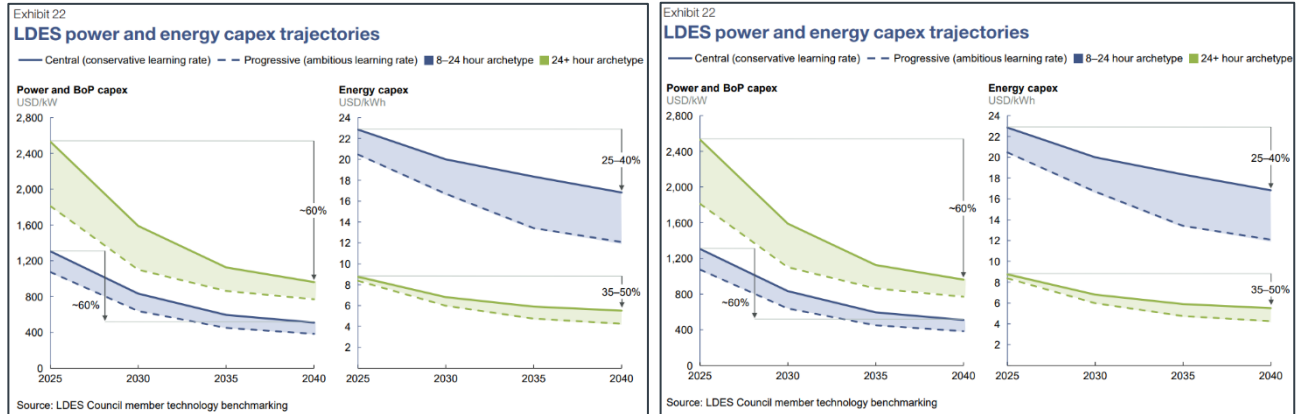
allows energy to be stored at times when energy supply exceeds demand and released at times when energy demand exceeds supply.

These concepts are well-known and understand in the context of pumped storage. The added dimension is long duration. In this context, the advantages of **LDES** technologies are outlined as follows: the marginal cost of storage additional energy is low, there is a decoupling of the quantity of energy that an LDES technology can



store and the rate at which **LDES** can update and release energy, **LDES** technology is modular and widely deployable quickly.

- **3. Modelling the flexibility need for future power systems:** Concludes that the total addressable market (TAM) for **LDES** may reach **1.5 to 2.5 TW** by **2040**. Further, this is considered to be achievable and consistent with decarbonising energy systems by 2040. The issue, as ever, is cost, not value. The value is clear, the need is clear.
- **4. Cost Analysis:** The author is not going to try to summarise the nuance on Cost Analysis, rather the following diagrams summarise matters perfectly:



These graphs convey the costs over time from capex and opex perspectives. The Cost Analysis provides cogent support for the decline in unit costs over time.

- **5. LDES business cases:** The business case of **LDES** is already established, with some installed **LDES** having returns on investment of more than 10%. The enable and ultimately to maximise the deployment of **LDES**, it is necessary for **LDES** technologies to develop further so as to reduce costs and improve performance.
- **6. Road to competitiveness and key market enablers:** Three actions are identified to unlock **LDES** value as follows: **1.** Long term system planning to attract appropriate levels of private investment; **2.** Support for first deployments and scaling-up capabilities to lower investors barrier to entry and risk; and **3.** Create a market to ensure appropriate rates of return.
- **The conclusion:** The **LDES** has significant potential to become the most cost-competitive solution for energy storage beyond a duration of six to eight hours. But the potential will be realised only if action is taken in the short and medium term to provide the an environment that will encourage investment over the short and medium term.

Quick summaries:

The purpose of this section, Quick Summaries, is to provide a snap shot of publications that are worth reviewing, but do not necessitate a deep dive because they do not provide sufficient detail or policy settings are developing:

- **Geothermal: The Solution Underneath – The Value of Geothermal for a Clean Energy Transition** published by IDB, Global Geothermal Alliance and IRENA provide a helpful overview of geothermal as a source of energy, and its main characteristics and benefits;
- **Hydrogen and PTX – Opportunities in Denmark** published by the Ministry of Foreign Affairs of Denmark (Invest in Demark) provides a basis for investors to assess the role of PTX and the scope to develop or to participate in the development of PTX projects in the county;
- **The Polish Hydrogen Strategy** will be considered in another Ashurst publication;
- **QREZ – Consultation on the model for QREZ design and access:** published by the Queensland Government is well-worth a read in the context of understanding the basis for the proposed establishment of three Queensland Renewable Energy Zones (**QREZ**), Northern, Central and Southern. Low Carbon Pulse will cover the development of the **QREZ** as the policy settings scope each **QREZ**.

Appendix

EDITION 5 – JANUARY AND FEBRUARY 2022, REPORT ON REPORTS



Welcome to **Edition 5 of Report on Reports** – sharing summaries of papers, reports and studies published (publications) in respect of net-zero emissions (NZE), and related matters.

Editions 1 and 2 of Reports on Reports are to be found in the [First Compendium of Low Carbon Pulse](#). **Edition 3** (covering **September and October 2021 Report on Reports**) and **Edition 4** (covering **November and December 2021 Report on Reports**) are to be found above in this **Second Compendium of Low Carbon Pulse**. This **Edition 5** covers papers, reports and studies published during January and February 2022.

All papers, reports, studies in this **Edition 5 of Report on Reports**, were referred to in **Editions 33, 34, 35** and **36** published during January and February 2022. Each of these Editions is included in this **Second Compendium of Low Carbon Pulse**.

The following table details each paper, report and study covered in this November and December Report on Reports, and has a link to it:

PUBLICATIONS DETAILED IN JANUARY AND FEBRUARY REPORT ON REPORTS			
ORGANIZATION / AUTHOR	LINK	ORGANIZATION / AUTHOR	LINK
ANZ	ANZ Hydrogen Handbook – 2022 (AH2 H2H 2022)	The International Renewable Energy Agency (IRENA)	Smart Electrification with Renewables: Driving the Transformation of Energy Services
House of Commons – Business, Energy and Industrial Strategy Committee	Decarbonising heat in homes (DHIH Report) – Seventh Report of Session 2021-22	National Renewable Energy Laboratory (NREL)	Storage Futures Study: Grid Operational Impacts of Widespread Storage Deployment (GOI Study)
International Energy Agency (IEA)	Electricity Market Report – January 2022:	International Energy Agency (IEA)	Global Methane Tracker – 2022 update
International Energy Agency (IEA)	Canada 2022 – Energy Policy Review		

ANZ Hydrogen Handbook:

- **Title, and provenance, of report:** The [ANZ Hydrogen Handbook – 2022 \(AH2 H2H 2022\)](#) is the work of the team at Australia and New Zealand Banking Group Limited. The **ANZ H2H 2022** publication is of the highest quality, providing an easy to read, but appropriate detailed, description of the basis for, and the dynamics of, the development hydrogen industry.

For the purposes of this **January and February 2022 Report on Report**, we provide an overview of the content of the **ANZ H2H 2022** publication, which the author expects to become a referenced work.

- **Background and Purpose:** The **ANZ H2H 2022** publication is intended to provide readers up-to-date, insightful and practical information on the emerging hydrogen economy. The **ANZ H2H 2022** publication achieves its intended purpose to perfection.
- **Summary:** The **ANZ H2H 2022** publication is set out in the following sections: Hydrogen – is it a lot of hot air; Colours of Hydrogen; Hydrogen Electrolysers; Transportation and Mobility, Carbon Capture and Storage, and Green Steel. The key points from each section are outlined below.

In addition, the **ANZ H2H 2022** publication provides a Map of Australian Hydrogen Projects, a Glossary and Conversion Factors.

- **Sections of the ANZ H2H 2022 publication:**

- **Hydrogen – is it a lot of hot air:** In this section, there is a Hydrogen 101 covering why the focus on hydrogen (critically the role of hydrogen as an energy carrier that give rise to no **CO₂** on use), how it is produced (covering Blue Hydrogen and Green Hydrogen production), the current economics of hydrogen production and use, transporting and storing hydrogen, and the challenges for the production and use of hydrogen commercially.

Also the **ANZ H2H 2022** publication highlights the opportunities for Australia:



(Source: page 8, The [ANZ Hydrogen Handbook – 2022 \(AH2 H2H 2022\)](#))

- **Colours of hydrogen:** To regular readers of Low Carbon Pulse this is well-trodden territory, but the **ANZ H2H 2022** publication provides a useful summary:

Main types of Hydrogen Energy	
Green	<ul style="list-style-type: none"> • Produced through electrolysis of water using a renewable power source • Zero carbon emissions in production and combustion
Blue	<ul style="list-style-type: none"> • Same production process as brown or grey hydrogen • Carbon emissions are captured
Grey	<ul style="list-style-type: none"> • Produced from methane or natural gas through steam methane reforming • Material carbon emissions released during production
Brown	<ul style="list-style-type: none"> • Produced from coal through gasification • Material carbon emissions released during production

Other types of Hydrogen Energy	
Turquoise	<ul style="list-style-type: none"> • Produced when natural gas is broken down with the help of methane pyrolysis (as opposed to steam methane reforming) into hydrogen and solid carbon. The difference is that the process is driven by heat produced with electricity, rather than through the combustion of fossil fuels. • The output of carbon in solid form (rather than CO₂) means there is no requirement for CCS and the carbon can even be used in other applications, such as a soil improver or the manufacturing of certain goods such as tyres. Where the electricity driving the pyrolysis is renewable, the process is zero-carbon, or even carbon negative if the feedstock is bio-methane rather than fossil methane (natural gas).
Pink/Purple/Red	<ul style="list-style-type: none"> • Produced by electrolysis using nuclear power.
Yellow	<ul style="list-style-type: none"> • Produced by electrolysis using grid electricity.
White	<ul style="list-style-type: none"> • A naturally-occurring geological hydrogen found in underground deposits and created through fracking. • There are no strategies to exploit this hydrogen at present.

(Source: page 10, The [ANZ Hydrogen Handbook – 2022 \(AH2 H2H 2022\)](#))

This section contains final thoughts, identifying key considerations as: **1. Safety**; **2. Sources of Water** (noting the need for desalination, but not the use of waste water); **3. The need for the build out of renewable electrical energy**; **4. The need for CCS for the production of Blue Hydrogen**; and **5. The need for supply and demand to grow in tandem**. For regular readers of Low Carbon Pulse, each of these issues has been canvassed at length.

- **Hydrogen Electrolysers:** This is an excellent section. There is an executive summary that provides an overview of the key points arising from the section as follows: **1.** Electrolysers can be used to produce hydrogen for use, and to produce hydrogen for storage (as Low Carbon Pulse has it, a HESS) to provide energy storage across a grid; **2.** Electrolyser production is increasing, and is likely to increase still further; and **3.** "For Australia to achieve its goal of becoming a global leader in low emissions technology, and for corporations to meet their targets of net zero emissions, hydrogen must be in the nation's energy mix".

The section on hydrogen electrolysers is well-worth a read, touching on each current technology, size, pricing, and the hydrogen supply / value chain, and the major manufacturers of hydrogen electrolysers.

- **Hydrogen Transportation and Mobility:** Another excellent section. Again, there is an executive summary that provides an overview of the key points arising from the section as follows: **1.** Understanding the economic practicalities of hydrogen transportation is important, including the cost of production at the point of use versus the cost of production and transportation to the point of use (a key dynamic now in respect of current use of grey hydrogen), and a key dynamic going forward; **2.** Australia is uniquely positioned to become a global leader in the production and export of clean hydrogen; **3.** While there are established technologies to transport and to store hydrogen, those technologies need to be developed to scale to achieve commercial / economically sustainable outcomes. Again, while there is nothing new in this findings, the findings flow from detailed consideration of the dynamics in an Australian context.

The section on hydrogen transportation and mobility considers compression, liquefaction, chemical compounding with other molecules to form Liquid Organic Hydrogen Carriers (**LOHCs**), with nitrogen to form ammonia (**NH₃**) or with metallic compounds to form hydrides (including methylcyclohexane).

- **Carbon Capture and Storage:** Again, another excellent section split into **Chapter 1: CCS**; and **Chapter 2: Legal & Regulatory**.

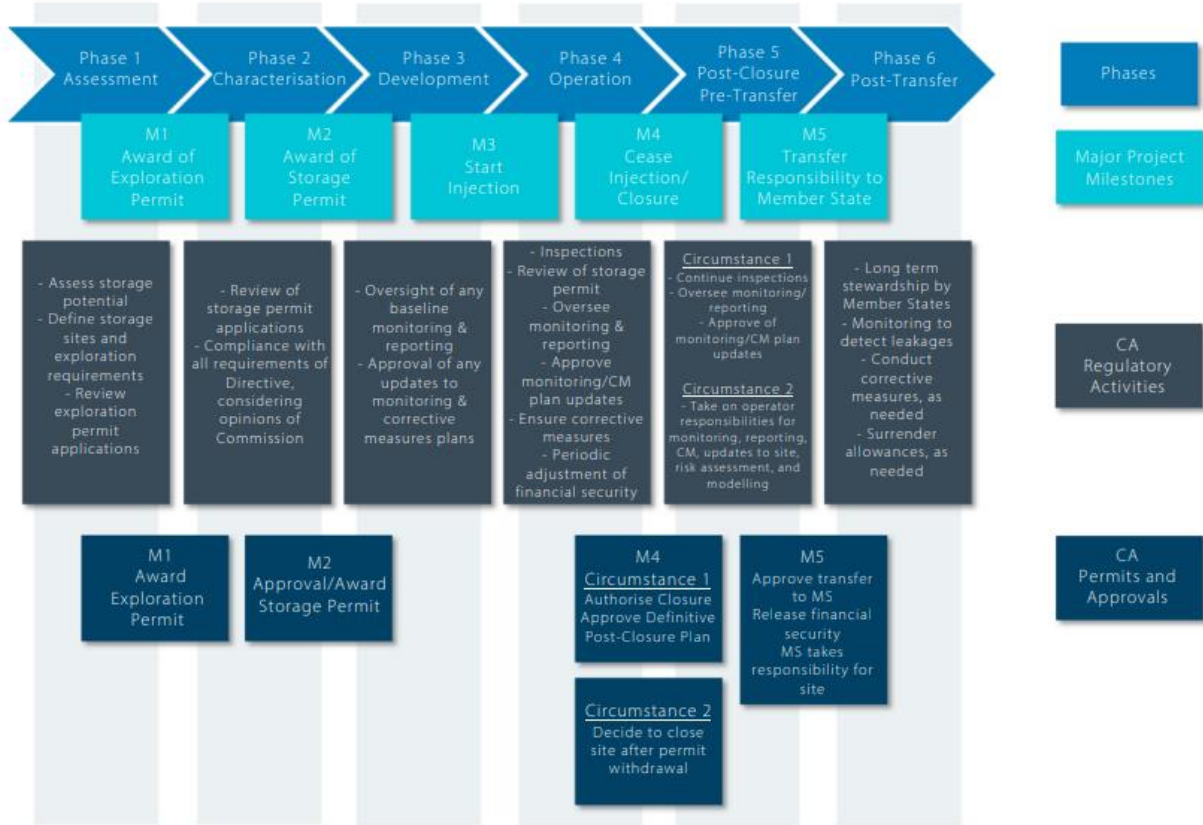
Chapter 1: CCS provides an overview of carbon capture systems (CCS); CCS policy settings globally; CCS: Economics, including Carbon Capture Cost, Carbon Capture Cost Reduction; **CO₂** transportation, by pipeline,

ship and truck; and CO₂ storage. In addition, **Chapter 1** considers Hydrogen Hubs and Carbon Clusters and the outlook for CCS.

Chapter 2: Legal & Regulatory Framework provides an overview of the key requirements for the development of CCS. In addition, Chapter 2 touches on the EU regime for CCS (**CCS Directive**) and the European Union Emissions Trading Scheme (which is relevant to the **CCS Directive**).

For these purposes, the **ANZ H2H 2022** publication outlines the CCS Directive, and included the following:

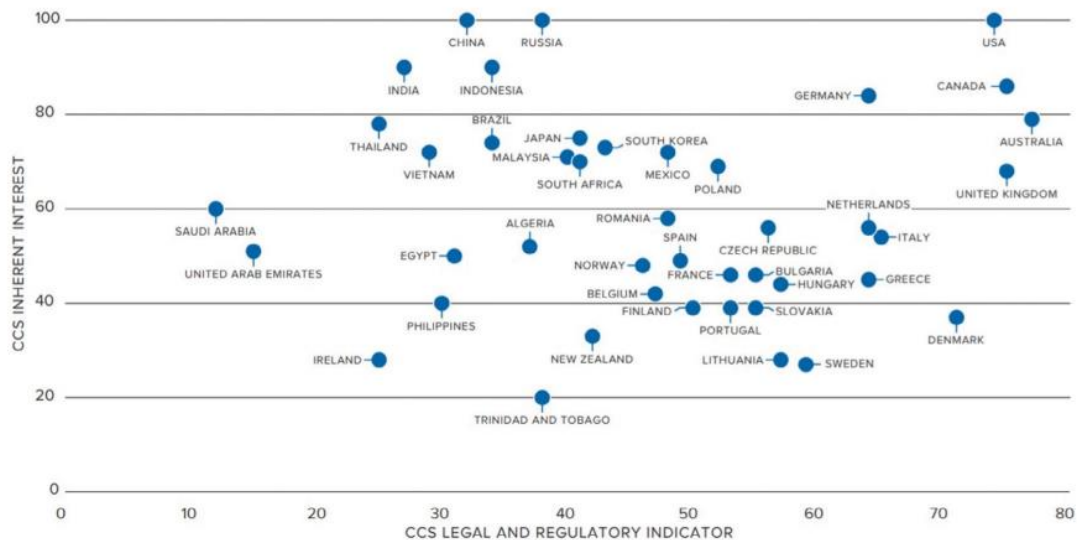
SUMMARY OF CO₂ STORAGE LIFE CYCLE PHASES AND MILESTONES



CO₂ life cycle phases (researchgate.net)

(Source: page 51, *The ANZ Hydrogen Handbook – 2022 (AH2 H2H 2022)*)

Also a CCS Legal and Regulatory Indicator (CCS-LRI) is included, indicating that in 2018 (of the countries reviewed), Australia was reasonably well-placed to address all stages of the life-cycle of a CCS project).



CCS chart – legal and regulatory indicator (globalccsinstitute.com)

- **Green Steel:** While each section is excellent, the section on Green Steel edges out the other sections for excellence. As with the sections on Hydrogen Electrolysers and Hydrogen Transportation and Mobility, the section on Green Steel has an executive summary. The executive summary provides an outline of the key issues as follows: **1.** Hydrogen based iron and steel making is an alternative to traditional coal fired blast furnace / basic oxygen furnace (with resulting **CO₂**): hydrogen displaces metallurgical coal used for the high heat processes, and renewable electrical energy displaces thermal coal used for the generation of electrical energy; **2.** Carbon free iron and steel making illustrates the need to transition to both new technologies and new energy carriers.

House of Commons – Business, Energy and Industrial Strategy Committee:

- **Title, and provenance, of report:** The **Decarbonising heat in homes (DHIH Report)– Seventh Report of Session 2021-22** is the work of the Business, Energy and Industrial Strategy Committee comprising 11 members of the UK Parliament from the Conservative and Labour Parties, and the Scottish National Party. The Committee is appointed by the members of the UK House of Commons (the UK's lower house) to examine the administration, expenditure and policy settings of the Department for Business, Energy and Industrial Strategy (**BEIS Committee**).
- **Background and Purpose:** The **DHIH Report** recognises that the UK will not achieve its' net-zero by 2050 target unless domestic / residential heat is decarbonised. The **DHIH Report** arose from an inquiry of the **BEIS Committee** into the decarbonisation of domestic / residential heating. The **BEIS Committee**, noting that the complexity and scale, and as a consequence the cost, of decarbonisation is a difficult task, given that there are 29 million existing homes that need to be upgraded with low to no carbon heating systems by 2050.
The purpose of the **DHIH Report** is to provide guidance as to how to progress the task of decarbonisation, given the estimated cost of GBP 250 billion by 2050 or around GBP 9 billion a year from the late 2020's to 2050. The estimated cost per household is GBP 10,000.
- **Summary:** The **BEIS Committee** suggests that:
 1. the Government should work with industry and workers to produce an effective road map detailing how the transition to low to no carbon heating will be achieved, and what the transition will mean for different households in different parts of the UK. The **BEIS Committee** recommends that this is done at a local level with local governments across the UK;
 2. the Government should introduce a heat decarbonisation sector deal to sufficiently scale up the heat pump market to ensure there are sufficient heat pumps at the right time;
 3. the Government should create a low to no carbon heating apprenticeship program to develop the skills of younger members of the population who are competent and ready for the development of the sector; and
 4. the Government should create a public awareness campaign, working with energy corporations, to inform consumers / householders of what is required.

IEA Reports:

The International Energy Agency (**IEA**) was established in 1974 as a response to the oil price crises during that year. The **IEA** now comprises 30 member countries, and 8 association countries.

The **IEA** has become one of the leading energy data collection and analysis organisations, and from this, key to information provision and to research globally.

- **IEA Reports mentioned during January and February 2022:**
 - [Electricity Market Report – January 2022;](#)
 - [Canada 2022: Energy Policy Review;](#)
 - [Global Methane Tracker – 2022 update;](#)
 - [Net-zero by 2050: A Roadmap for the Global Energy Sector](#)
 - [Electric cars fend off supply challenges to more than double global sales](#)

It is important to note that all of the **IEA** publications tie back to the **IEA's Net Zero by 2050 – A Roadmap for Global Energy Sector (IEA Roadmap)**, reported on in Editions **17, 18, 20, 21**, and **22** of Low Carbon Pulse (all of which are contained in the **First Compendium of Low Carbon Pulse**).

For the purposes of this **January and February 2022 Report on Reports**, the [Electricity Market Report – January 2022](#), the [Canada 2022 – Energy Policy Review](#) and the [Global Methane Tracker – 2022 update](#) are reported upon in more detail, with headlines for each of them included here for those who simply want to understand what each covers and its context:

- [Electricity Market Report – January 2022:](#)
 - **Purpose:** The **Electricity Market Report – January 2022** report continues the on-going stock-take of progress towards the achievement of **NZE**.
 - **Findings and key outcomes:** The **Electricity Market Report – January 2022** report highlights the following in the Executive Summary:
 - **After a small drop in 2020 global electricity demand grew by 6% in 2021;**
 - **Coal met more than half of the increase in global electricity demand;**
 - **The increased demand for fossil fuel were unmatched by supply, resulting in higher average wholesale electricity prices, in Q4 more than four times as high as the 2015-2020 average;**
 - **During 2022-2024, the IEA expects increased development and deployment of renewable electrical energy to increase supply and move towards matching increased demand;**

- **Fossil fuel generation is to stagnate during 2022- 2024.** In this regard it is to be noted that this finding arose by reference to the factual matrix before the conflict in Ukraine;
- **Today's policy settings are insufficient to reduce GHG emissions for the purposes of the IEA's Net Zero Emissions by 2050 Scenario.**

As a continuing theme, and looking to the **IEA Roadmap**, the renewable electrical energy development and deployment needs to increase, and the rate of increase needs to increase, if **NZE** is to be achieved by 2050.

- **Canada 2022 – Energy Policy Review:**

- **Purpose:** The purpose of the **Canada 2022 – Energy Policy Review** is update to the in-depth review that took place in 2015.
- **Executive Summary:** The Executive Summary provides a description of:
 - the nature of the energy policy settings as they stand at the moment (including the nationally determined contribution of Canada, 40 to 45 reduction of 2005 levels by 2030); and
 - carbon pricing (including progress to CAD 170 **CO₂-e** by 2030), and the key dynamics of the energy industry (including that Canada has one of the cleanest electrical energy systems in the world, with over 85% of electrical energy generated from non-emitting sources, increasing to 90% by 2030, with coal to be phased out by 2030).

This description helps frame the need to decarbonise upstream oil and gas production. This is without doubt where most progress needs to be made in the medium term. In addition, the need for energy efficiency and the development of clean fuel production capacity is noted (currently less than 6% of the total energy supply). As might be expected, there is emphasis on the innovation to develop technology and a people-centred approach to energy transition, critically to achieve just transition.

- **Recommendations of IEA:**

The **Canada 2022 – Energy Policy Review** makes the following recommendations:

1. Model pathways to net zero by 2050 for the energy system, develop national emissions reduction strategies in consultation with the provinces and territories of Canada (and other stakeholders), critically, focussing on buildings, industry and transport, and taking the oil and gas industry along on the journey;
2. Explore how to enhance the role of the federal government in strengthening inter-provincial connectivity, critically, the expanded use of interconnectors and accelerating the necessary augmentation and updating of the electricity transmission grid;
3. Develop (as a matter of priority) energy efficient policy settings, and an energy efficiency strategy, again with the provinces and the territories, and again focused on buildings, industry and transport;
4. Increase federal funding support to accelerate R&D and innovation with a focus on clean energy technology development and innovation.

- **Global Methane Tracker – 2022 update:**

- **Purpose:** The purpose of the **Global Methane Tracker – 2022 update** is to update reporting and awareness of methane (**CH₄**) emissions. As noted in various editions of Low Carbon Pulse, **CH₄** emissions are increasingly seen as unquantified **GHG** emissions, which if reduced (and reduced quickly), will reduce the rate of climate change.

As the **Global Methane Tracker – 2022 update** states: "Tackling methane emissions from the energy sector represents one of the best near-term opportunities for limiting global warming because the pathways for reducing them are well-known and often cost effective".

Also as noted in various editions of Low Carbon Pulse, reductions in **CH₄** emissions, tonne for tonne, are more effective than reductions in **CO₂** because **CH₄** emissions dissipate over a shorter time frame than **CO₂**, and the global warming potential of **CH₄** is greater than that of **CO₂**.

- **Key findings:**

- **CH₄** emissions are 70% greater than national governments have reported;
- **CH₄** emissions are responsible for 30% of the rise in average global temperatures since 1850; and
- the energy sector accounts for around 40% of **CH₄** emissions.

Figure 4.3 Large-scale coal-related methane leaks detected by satellite from 2019-2021



Note: Shows large methane emissions sources detected in areas of coal operations between 2019 and 2021.
Source: Kayros analysis based on modified Copernicus data.

(Source: page 50, [Curtailling Methane Emissions from Fossil Fuel Operations \(windows.net\)](#))

IRENA Reports:

The International Renewable Energy Agency (**IRENA**) is an intergovernmental organisation supporting countries in the transition to renewable / sustainable energy, and is reported to be actively engaged with more than 180 countries in this endeavour.

- **IRENA Reports during January and February 2022:**

- [Smart Electrification with Renewables: Driving the Transformation of Energy Services](#)
- [IRENA H2 Report](#)

For the purposes of this **January and February 2022 Report on Reports**, the [Smart Electrification with Renewables: Driving the Transformation of Energy Services](#) report is outlined.

A summary of the **Smart Electrification With Renewables – Driving the transformation of energy services**, entitled [Electrification with renewables: Driving the transformation of energy services](#) is also available.

- **Provenance of the Smart Electrification With Renewables – Driving the transformation of energy services:** The **Smart Electrification With Renewables – Driving the transformation of energy services** report has been prepared by **IRENA** and State Grid Corporation of China, and is intended to provide policy makers with a conceptual overview of the global transition to electrification with renewable electrical energy. In so doing, the **Smart Electrification With Renewables – Driving the transformation of energy services** report presents recent trends in innovation and technology, outlines possible long-term progress to achieving electrification using renewable electrical energy, and identifies action that may be regarded as priority to achieve that electrification.

The **Smart Electrification With Renewables – Driving the transformation of energy services** report notes the benefit of having developed the report with the China State Grid Energy Research Institute (**SGERI**). **IRENA** states that the report benefits from the perspective of the largest electricity transmission grid in the world, that is focused strongly on the challenges and opportunities of rapid electrification, and in this context digitalisation and deployment of renewable electrical energy capacity as soon as possible, with many of the critical innovations relating to smart electrification taking place at their fastest in the PRC.

Renewable electrical energy is the focus of **IRENA**. Renewable electrical energy is required to produce e-fuels and e-feedstocks. In this context, in particular on the production of Green Hydrogen, from which e-fuels and e-feedstocks can be produced, renewable electrical energy needs to be developed and deployed, lots of it. This is the subject of **IRENA's World Energy Transition Outlook: 1.5°C Pathway (WETO)** (see **Editions 21** and **23** of Low Carbon Pulse).

The **Smart Electrification With Renewables – Driving the transformation of energy services** report is tied to the **WETO** and it builds on, and relies on, and reiterates points, made in the **WETO Roadmap**.

- **Purpose of the Smart Electrification With Renewables – Driving the transformation of energy services report:** The starting premise of the **Smart Electrification With Renewables – Driving the transformation of energy services** report is that as soon as possible there must be an increase to the development and deployment of renewable electrical energy capacity, with ever greater acceleration needed.

It is stated that throughout the **Smart Electrification With Renewables – Driving the transformation of energy services** report, the focus is how to achieve **smart electrification with renewables**, as opposed to poorly planned electrification. For these purposes, smart electrification with renewables focuses on any synergies between major increases in renewable electrical energy generation, electrification and digitalisation, looking to create the conditions for the co-ordinated deployment and more efficient use across the key end-use sectors – buildings, industry, power and transport.

- **Form of the *Smart Electrification With Renewables – Driving the transformation of energy services* report:** The *Smart Electrification With Renewables – Driving the transformation of energy services* report covers the following:
 1. Electrification in the global energy transition;
 2. Electrification technologies, smart strategies, and systemic trade-offs;
 3. Prospects for electrification with renewables in *IRENA* and China State Grid analysis; and
 4. Future priorities on the pathway to smart electrification with renewables.

- **Key findings:** Space does not permit detail consideration of each element of the *Smart Electrification With Renewables – Driving the transformation of energy services* report, but the *Smart Electrification With Renewables – Driving the transformation of energy services* report fulfils its purpose in canvassing how to achieve smart electrification with renewables.

The most compelling section of the *Smart Electrification With Renewables – Driving the transformation of energy services* is the section dealing with future priorities on the pathway to smart electrification with renewables. The key findings from this sections are as follows:

1. While policy makers have gained experience in developing frameworks for renewable electrical energy, and specific aspects of electrification, **more attention is needed towards the development and implementation of policy settings that create synergies;**
2. **Renewable energy electrification policy settings and strategies must be part of national energy plans.** Within those national energy plans, renewable energy electrification development plans and programs must take account of the load profile, including any bottlenecks across the system, and the impact of increased load;
3. **Renewable energy electrification plans** (as part of national energy plans) **should promote, and prioritise, smart electrification policy settings and strategies,** and involve the private sector and end-users to develop this thinking, and to deploy the results of this thinking, so as to achieve most-cost effective solutions. For these purposes, looking for and stress testing smart electrification solutions from around the world will yield cost effective solutions;
4. **Electrical Energy Markets need to allow** (and to promote?) **the development of renewable energy electrification,** and to the extent that they do not do so, they need to be designed / re-designed to do so. This may be regarded as one of the most pressing areas of policy makers;
5. Renewable electrical energy will be the primary route to the decarbonisation of buildings, industry, and transport, with electric cooling and heating (for buildings), the two legs of renewable electrical energy and hydrogen production (for industry) and electromobility (for transport) being key.

Each of building, industry and transport sectors requires policy settings intended to accelerate the achievement of smart electrification.

National Renewable Energy Laboratory (NREL):

- **Title, and provenance, of report:** The *Storage Futures Study – Grid Operational Impacts of Widespread Storage Deployment (GOI Study)* is the work of the *NREL*, operated by the Alliance for Sustainable Energy, LLC, for the US Department of Energy (*DOE*). The *GOI Study* is one of a series of *NREL* Storage Futures Study publications, being the sixth in the series. .
- **Background and Purpose:** The *GOI Study* models the operational impacts of grid-scale storage deployment and relationships between the deployment and contribution of renewable electrical energy..
- **Summary:** The *NREL* finds that:
 1. storage plays an important role in the operations of power systems between now and 2050, by storing the lowest marginal cost generation and generating electrical energy during the highest net load periods;
 2. storage helps with the integration of variable renewable electrical energy generation; and
 3. the flip side of the same coin as integration, storage provides a means of maintaining the integrity and stability of power system.

There is nothing new in the findings of the *NREL*, but the *GOI Study* provides ample support for the findings.

 The **March and April Report on Reports** will be included in the Appendix to this Second Low Carbon Pulse Compendium at the same time that **Edition 39** of Low Carbon Pulse is published.

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We bring together lawyers of the highest calibre with the technical knowledge, industry experience and regional know-how to provide the incisive advice our clients need.



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