

Low Carbon Pulse - Edition 33

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to **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 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** (covering the 12 month period from October 6, 2020 to October 5, 2021, including the **First 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 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 25 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; and 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 **LDC5** 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, Adaption 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.

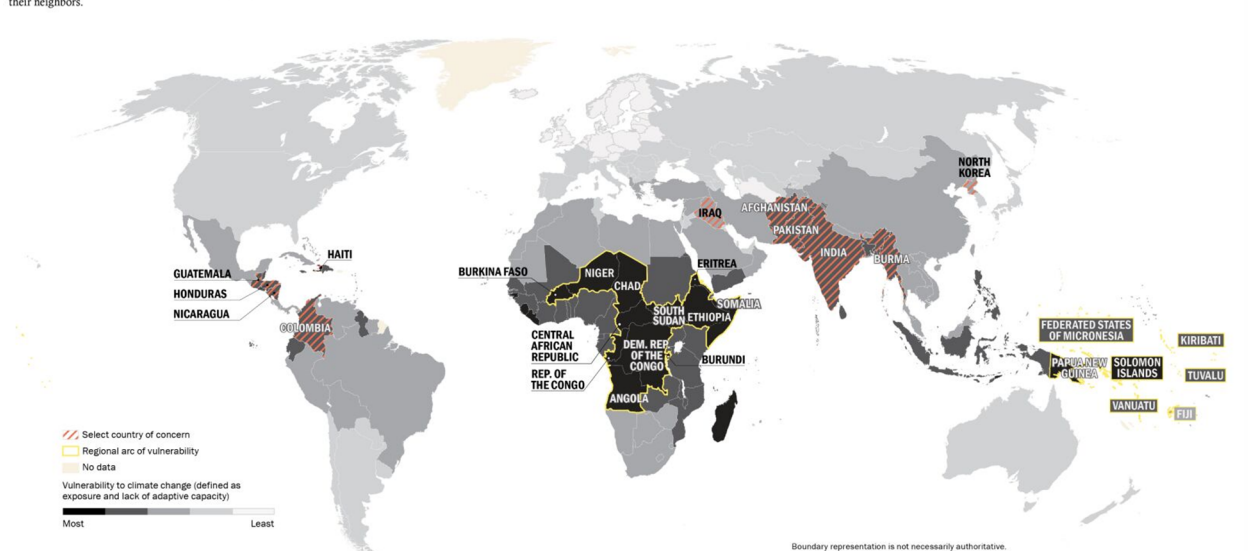
At **APAC** the role for, and the importance of, protected areas will be discussed, in particular the role in conserving nature, delivering services to vital life-supporting ecosystems, safeguarding Africa's wildlife, and promoting sustainable development while conserving the cultural heritage and traditions 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](https://ec.europa.eu/economy_finance) 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](https://www.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 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 contained in the Appendix to **Edition 34** 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 contained in the Appendix to **Edition 36** of Low Carbon Pulse.

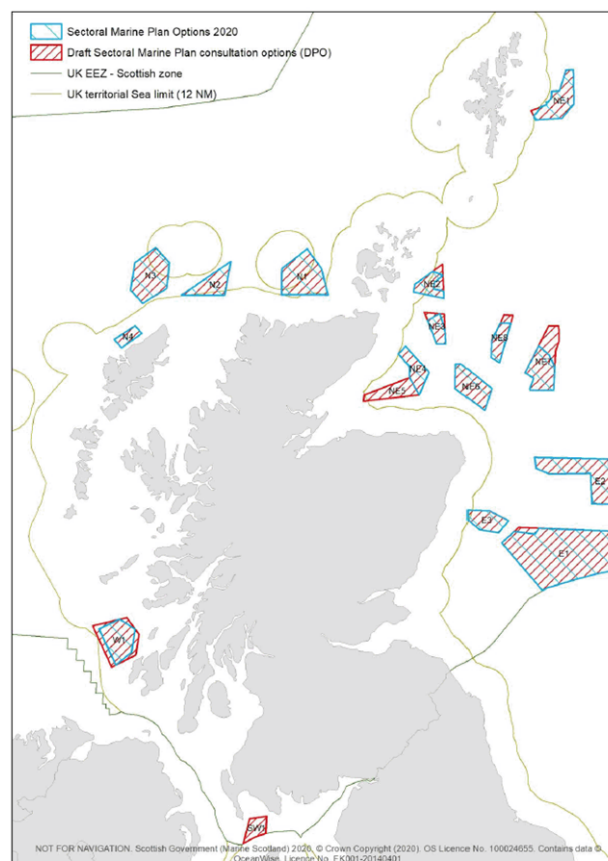
A Big Week For Wind:

- **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 are detailed in the map below.

- **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:

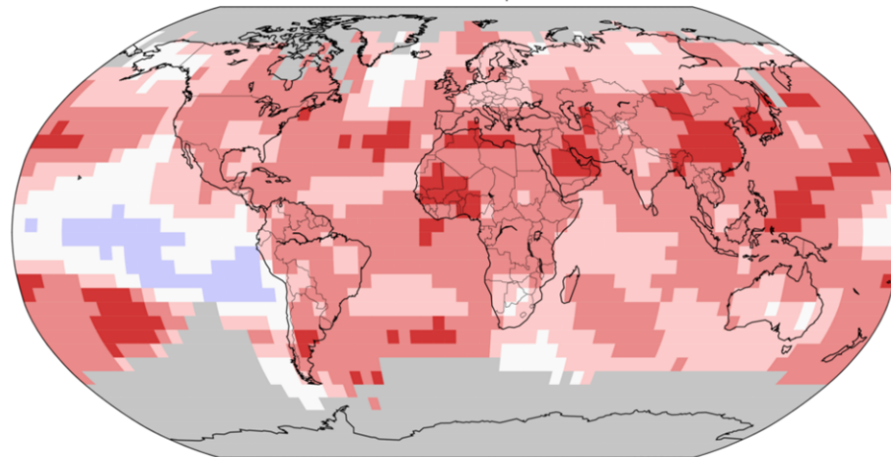
"[2021] was the year of Texas' deep freeze in February, Canada's highest temperatures in recorded history in June, and Germany and Belgium's lethal flash flooding in July".

- 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



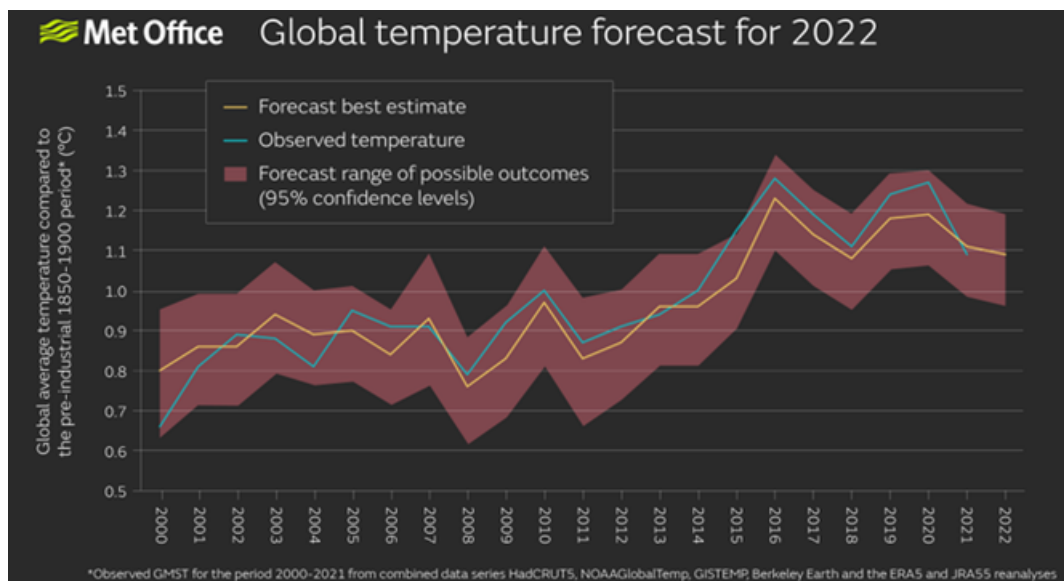
- On January 13, 2022 the [National Oceanic and Atmospheric Administration \(NOAA\)](#) published its [analysis](#) (under **2021 was the world's 6th-warmest year on record**).

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**.

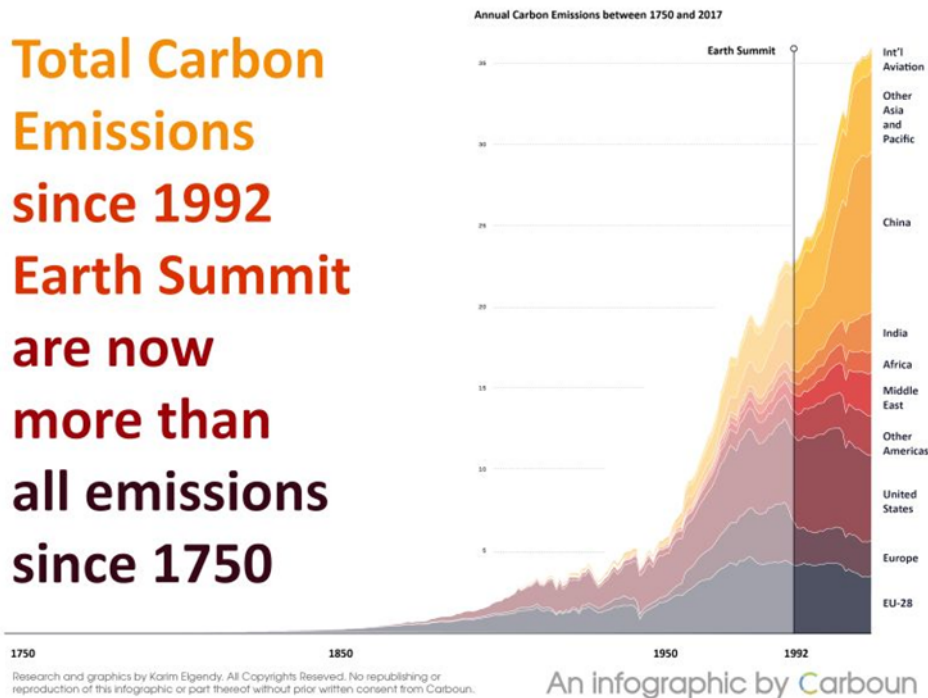
- 2022 in numbers:** On December 29, 2021, the UK Met Office released its [forecast](#) for average global temperatures during 2022:

"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://omanobserver.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 Riyad 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.

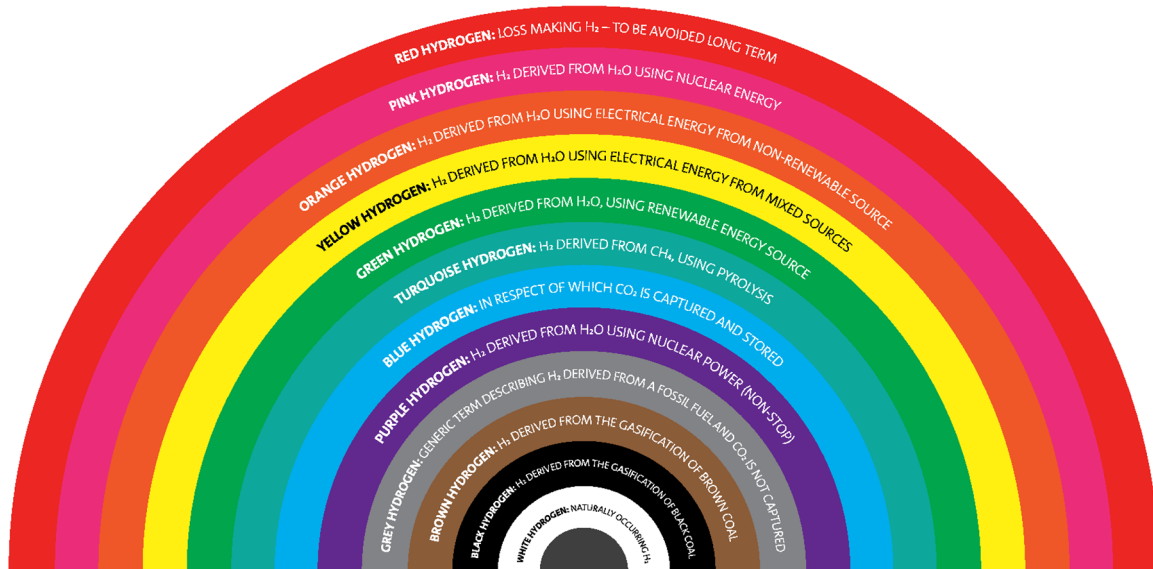
See: Aramco [website](https://aramco.com).

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 Fertiglobe 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 Fertiglobe (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**

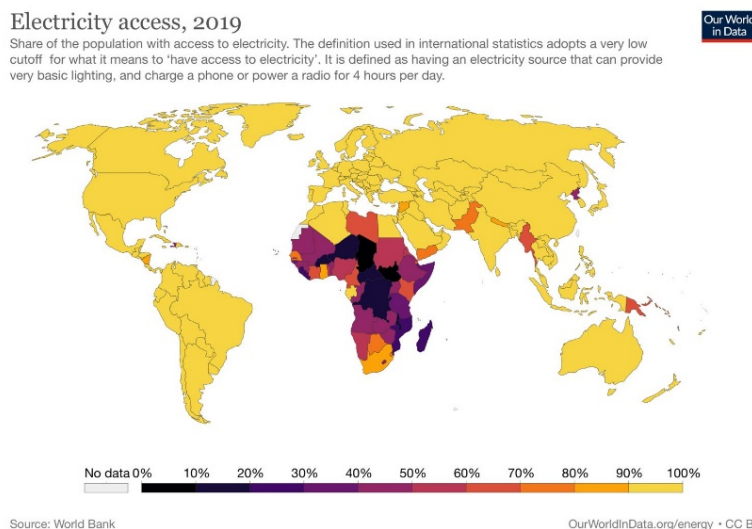
Rehabilitation Project) announced the success of the second phase of the Blue Carbon Environmental and Social Responsibility project.

The 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 **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 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, 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 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 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 Shangdong 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 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 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](https://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 comprise the Appendix to **Edition 36** 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 and scale-up of **LH2** carriers is key to the development of the hydrogen export industry.

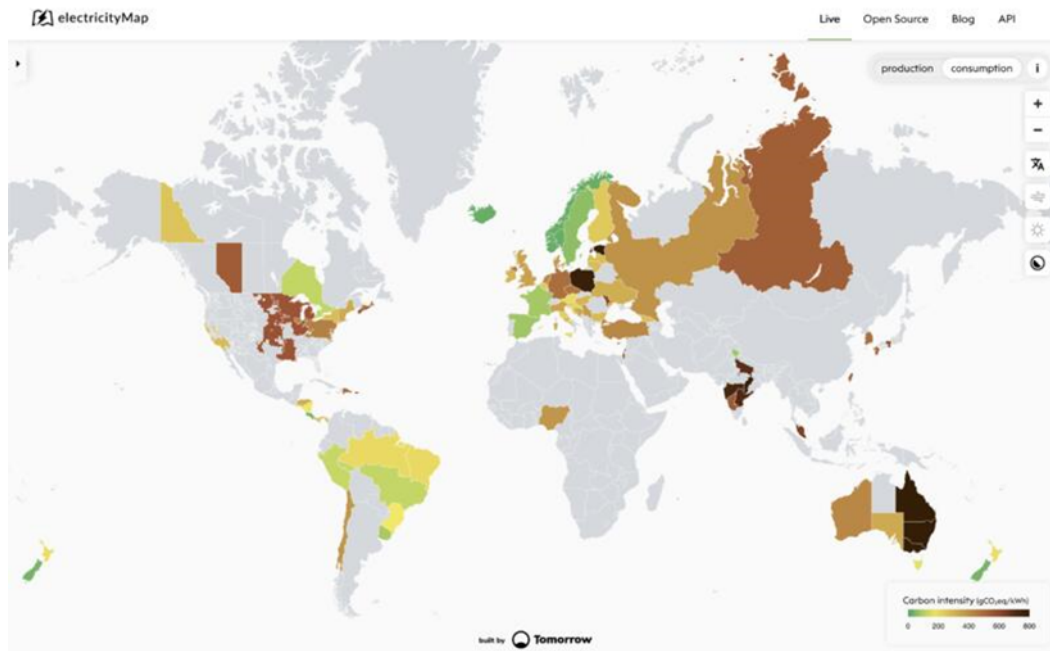
On December 24, 2021, the **Suiso Frontier** left Japan, docking at the Port of Hastings, Victoria, Australia, on January 20, 2022. The arrival of the **Suiso Frontier** was marked by an arrival ceremony.

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".

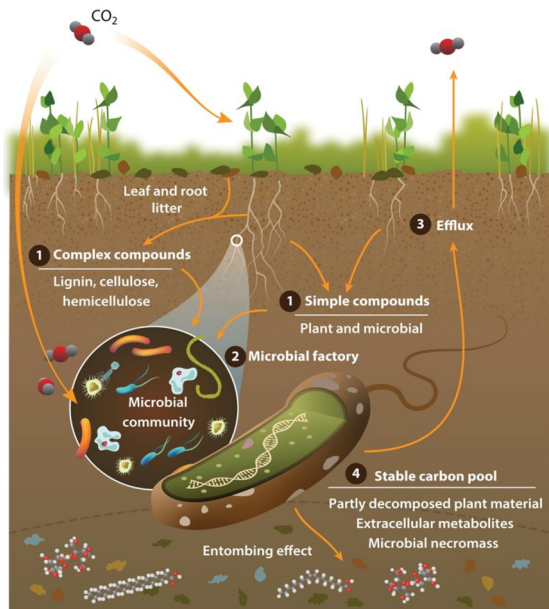
The study does not allow us to conclude that there is or is not a point at which flora will cease to increase the rate of photosynthesis, but the study does underline the importance of ceasing deforestation, and accelerating reforestation and the increased use of afforestation.

- **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.

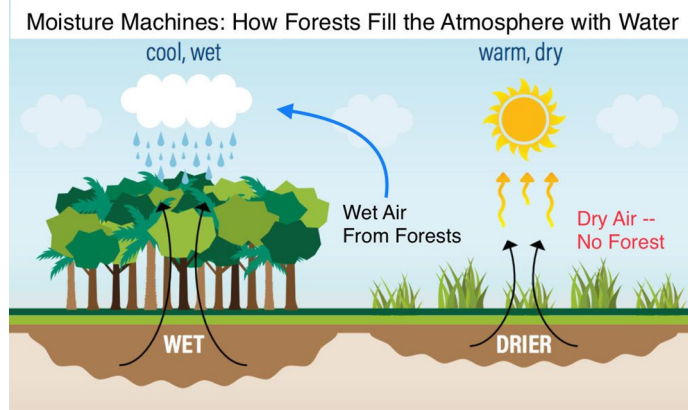
- **Soil microorganisms and carbon capture:** **Edition 32** of Low Carbon Pulse included two diagrams providing a diagrammatic representation of the [function of soil](#) and [the role of healthy soils](#) in the context of Sustainable Development Goals.

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 ...

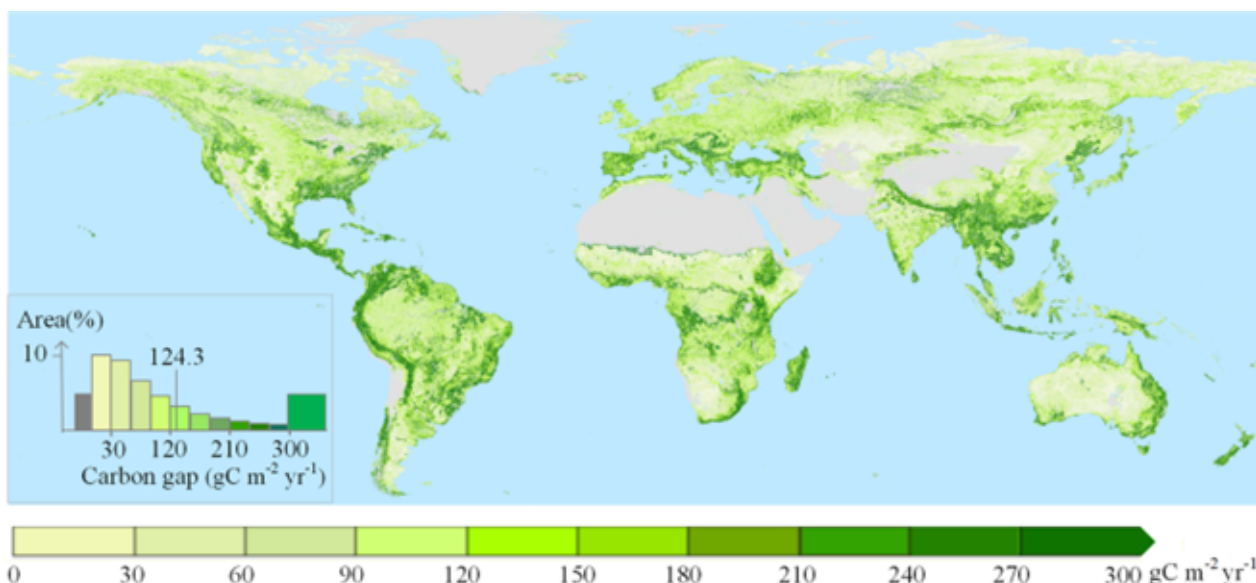
The planet's three trillion trees release an estimated 60,000 cubic kilometres of water a year [Note: This is at the lower end of estimates with others as high as 73,000 km³]. Forming clouds as moisture blows downwind, this moisture is responsible for at least half of all the rain and snow that falls 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:

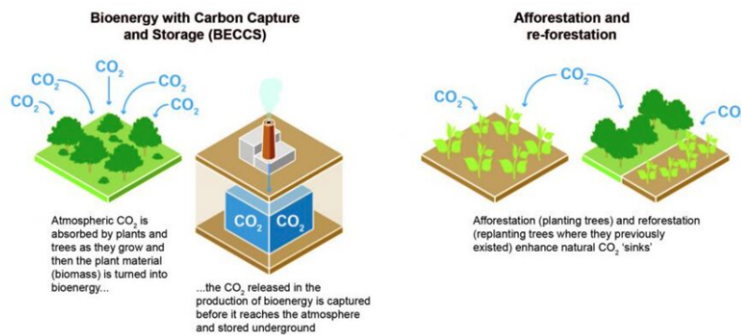
This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including to bioenergy carbon capture (**BECCs**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture 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.

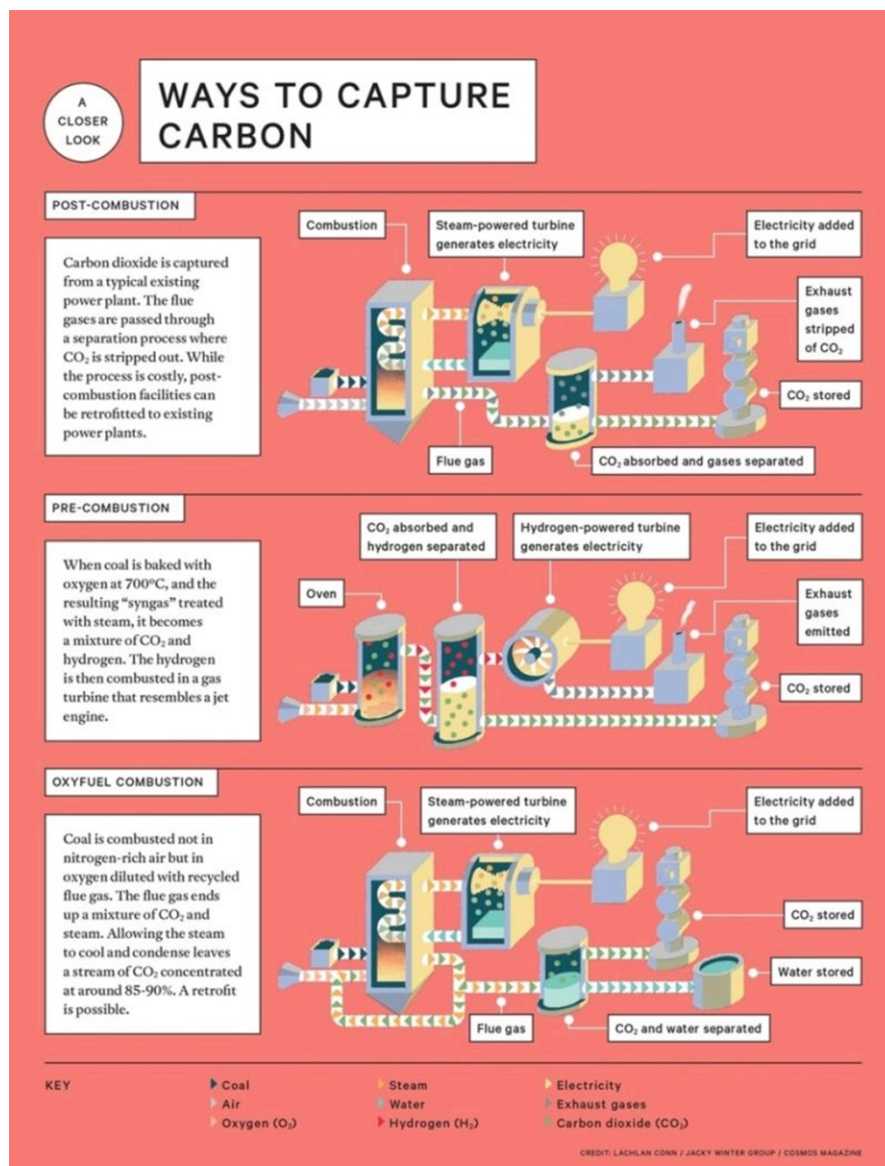
On December 28, 2021, the **IPCC** provided a simple graphic to provide its perspective on **CDR** and negative emissions.

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 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.

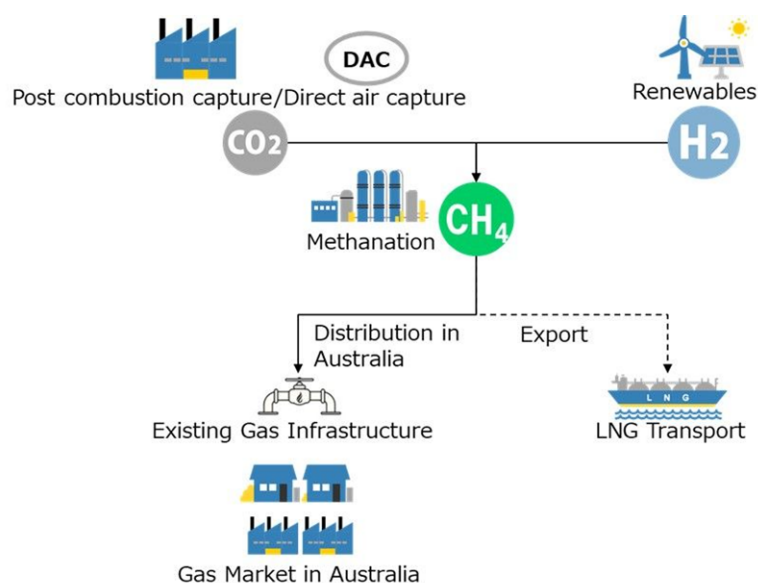
- **Herøya Plant Fertile Plans:** On December 17, 2021, Yara (leading global fertiliser corporation) announced that Green Hydrogen would be produced to provide feedstock to allow production of Green Ammonia at Herøya, Norway. The use of Green Hydrogen will displace the use of hydrogen derived from natural 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. The **HyEnergy** facility will have capacity to produce 60,000 tpa of Green Hydrogen or 300,000 tpa 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 Valparaíso. 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 Ökowerk (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 electrolyzers 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](https://www.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-electrocatalysis 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 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:

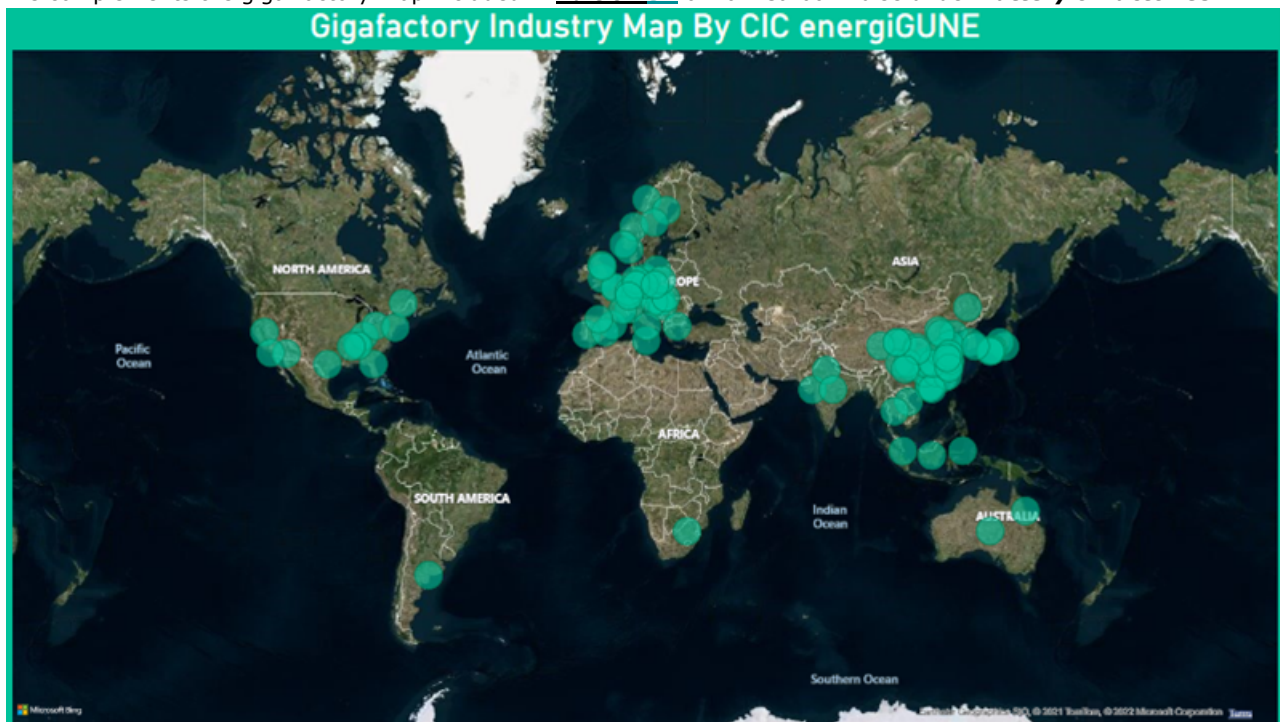
This section considers news items that have arisen within the news cycle of this **Edition 33** of Low Carbon Pulse relating to the development of:

- 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), electrolyzers (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://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** electrolyzers 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 electrolyzers 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](https://www.cummins.com) and [Sinopec](https://www.sinopec.com) 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.

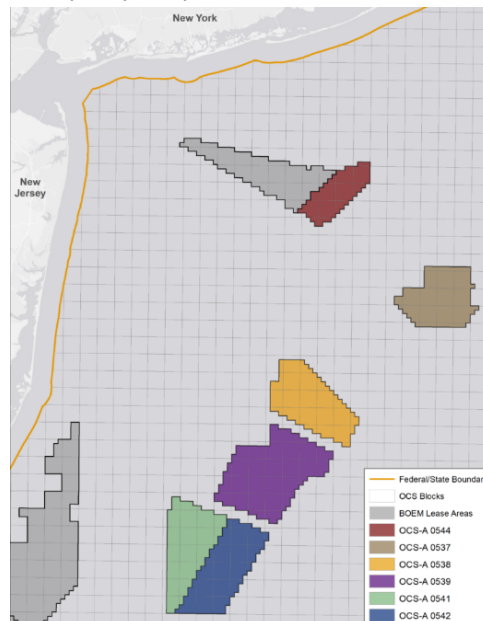
On January 18, 2022, Tennet TSO GmbH [announced](https://www.tennet-tso.com/en/press-releases/2022/01/18-tennet-tso-gmbh-announced) that it had signed a cooperation agreement with **50Hertz** to develop a hub area in Heide, Germany and a HVDC link. This development may be regarded as a forerunner of 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 do 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 Midsjöbanken 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.

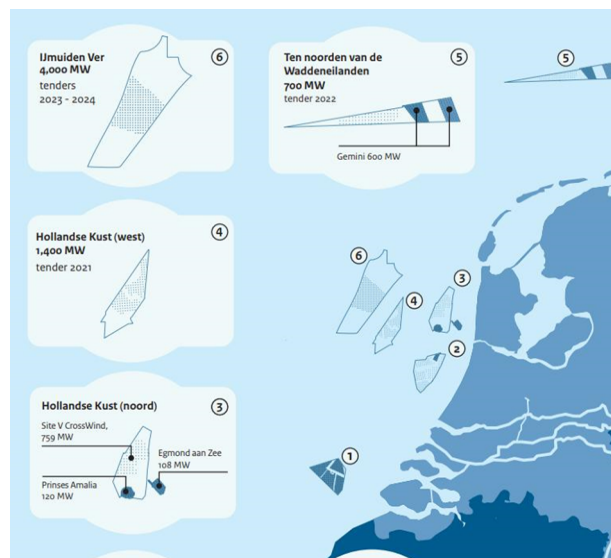
The Victorian project is a 1.3 GW fixed bottom project to be developed off the coast of Gippsland.

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](https://www.mitsubishi.com).)

- **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.

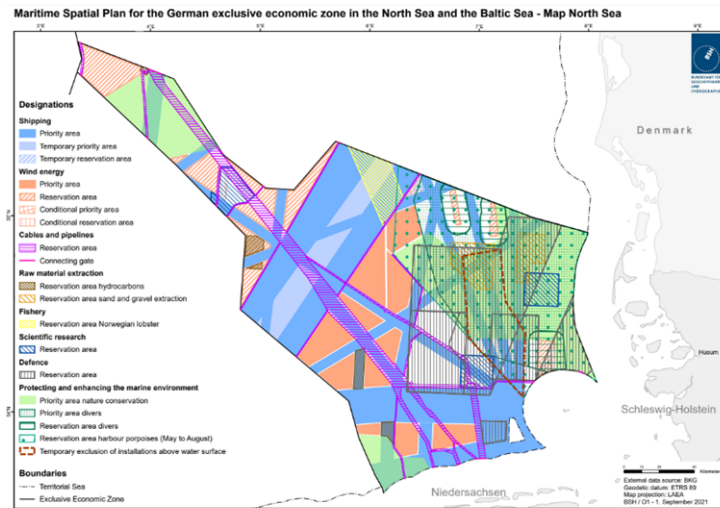


Source: offshoreWIND.biz [LinkedIn](https://www.linkedin.com)

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 Jiangsu Rudong, the 300 MW Jiangsu Dafeng H8-2 and the 1.7 GW Yangjiang Shapa.

- **Boxed in Day:** On December 26, 2021, 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 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 Raahen) 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 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 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, 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 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](#) 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](#) (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.

NZE reports:

At the end of each Low Carbon Pulse, publications reviewed are listed, by organisation, title / subject matter, and link.

| ORGANISATION | TITLE / SUBJECT MATTER |
|---|--|
| World Meteorological Organization (WMO) | <u>State of Global Climate in 2021 – WMO Provisional Report</u> |
| Copernicus Climate Change Service | <u>Annual findings for 2021</u> |
| Government of Denmark | <u>Power-To-X and Hydrogen Opportunities in Denmark</u> |
| 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> |
| UK Department for Business Energy & Industrial Strategy | <u>Transport and storage business model: January 2022 update</u> |
| UK Department for Business Energy & Industrial Strategy | <u>Transport and Storage – heads of terms: January 2022 update</u> |
| IEA | <u>Canada 2022: Energy Policy Review</u> |
| Nature | <u>The global carbon sink potential of terrestrial vegetation can be increased substantially by optimal land management</u> |
| Rethink Research | <u>Hydrogen will shake out industry laggards, warns Rethink</u> |
| Nature | <u>A constraint on historic growth in global photosynthesis due to increasing CO₂</u> |

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