

Low Carbon Pulse - Edition 37

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to the **Long Form Version of Edition 37** of Low Carbon Pulse – sharing significant news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from **Monday March 7, 2022 to Thursday March 31, 2022**.

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1 to 28**, covering the period from October 6, 2020 to October 5, 2021) and click [here](#) for the **Second Compendium of Low Carbon Pulse** (containing **Editions 29 to 36**, covering October 7, 2021 to March 6, 2022, and containing the **January and February 2022 Report on Reports**).

Headlines:

Ill wind:

The impact of the conflict in Ukraine has resonated globally. In the energy sector, the resonance has been foundation shaking. As a result, energy security and energy transition have aligned, with a clear sighted view on natural gas (in the form of liquified natural gas (**LNG**)) as an energy transition fuel, and the need to accelerate development of renewable energy capacity and hydrogen and hydrogen-based fuel production capacity (the "two legs" of decarbonisation).

An element of this alignment has been the commitment between the European Union (**EU**) and the US on the supply and purchase of **LNG** (agreed on March 25, 2022) to the end of 2022. At a country level, the speed at which Germany has moved to procure floating storage and regasification units (**FSRUs**) to receive **LNG** has been telling, which when combined with the accelerated commitment to achieve decarbonisation of the electrical energy industry by 2035, and the commitment to develop a Green Hydrogen pipeline system across Germany, provides a clear strategy.

Burning platform recognised:

- On **March 24, 2022**, the International Energy Agency (**IEA**) released a [press release](#) outlining outcomes from the **IEA Ministerial Meeting** (a special event dedicated to how to adapt better policy, legal and regulatory frameworks to accelerate deployment of clean energy and low emission technologies);
- On **March 29, 2022**, the International Renewable Energy Agency (**IRENA**) published **World Energy Transitions Outlook (WETO) 2022**, "updating" the **IRENA WETO 2021** (see **Editions 21, 23, and 29** of Low Carbon Pulse), and outlining what needs to be done by 2030 to achieve **NZE** by 2050; and
- On **April 4, 2022**, the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report was published.

A standalone **Edition 38** of Low Carbon Pulse will cover the key findings of **WETO 2022** and the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report – effectively, what needs to be done, and by when.

From a thorough read of **WETO 2022** and an early morning read of the **Summary for Policymakers** contained in the 17 Volume **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, these reports are complementary and their findings should be read together. Together they describe what needs to be done, and quickly.

Vale those lost:

Finally, condolences for those lost in the conflict in Ukraine, and safe-haven to those displaced.

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Timeline for March, April and May 2022:

- **IPCC WGIII conference and publication:**

- **Climate Change 2022: Mitigation** arrived on **April 4, 2022:**

- **On February 28, 2022** the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report was published. The key findings of the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report were covered in **Edition 36** of Low Carbon Pulse.

- **From March 21 to April 1, 2022**, meeting virtually, the **IPCC** considered the **IPCC WGIII** contribution to the Sixth Assessment Report (**AR6**). The meeting was the 14th session of **IPCC WGIII** (and the 56th session of the **IPCC**). As with the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report, the **IPCC** considered, line-by-line, the **Summary of Policy Makers** of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report.

On approval of the **Summary of Policy Makers**, the **IPCC** formally accepted the entirety of the **IPCC WGIII** report.

The contribution of the **IPCC WGIII** is to climate change mitigation, assessing methods for the reduction of **GHG** emissions, and removing **GHG** from the atmosphere. As reported in various editions of Low Carbon Pulse (and sibling publications), **GHG** emissions arise from many human activities and sectors, including agriculture and forestry and other land use (**AFOLU**), buildings and the built environment, energy, industry (including cement, chemical and iron and steel production), and waste and waste management.

To the author, the **IPCC WGIII** is the most important of the reports produced by the three **IPCC Working Groups** because it provides the "how" to the description of the "what" arising from the **IPCC WGI** (August 2021) and **IPCC WGII** (February 2022) reports (which cover the extent of climate change and its impacts).

- **On April 4, 2022** the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report was published. As noted above, a standalone **Edition 38** of Low Carbon Pulse cover its key findings.

- **Facts and stats:** As with the lead up to the publication of the **IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability** report, during the lead up to the publication of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, there was a narrative from the **IPCC** around the numbers of comments received, document reviewed, and experts involved in the drafting and review of the **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report, including a total of 59,000 review comments received (including 21,500 comments on the first draft, and 32,500 comments on the second draft), 271 scientists from 65 countries involved in writing the report, and 18,000 publications assessed.

- **IPCC reports – next steps:**

- The **IPCC WGIII Climate Change 2022: Mitigation of Climate Change** report is the third of three Assessment reports from each **IPCC Working Group** forming part of **AR6**.

- In **September 2022**, the **IPCC** will publish the **Synthesis Report** for the purposes of **AR6**.

The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each **IPCC Working Group**, and in three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**).

Following the tried and tested format, the **Synthesis Report** will be in two parts, the **Summary of Policymakers (SPM)** and the **Longer Report**.

- Just as the **IPCC Working Group I Climate Change 2021: The Physical Science Basis** report (in particular the Summary of Policy Makers contained in it) informed discussions at and outcomes from **COP-26** held in Glasgow, Scotland (in October and November 2021), the **SPM** and the **Longer Report** contained in the **Syntheses Report** for the purposes of **AR6** will inform **COP-27** to be held in Sharm el-Sheikh, South Sinai, Egypt from November 7 to November 18, 2022.

- **By the end of May 2022:**

- **Carbon Credits, Article 6 and the Paris Rulebook:**

The demand for carbon credits is increasing at pace in the **Voluntary Carbon Market / Voluntary Carbon Credit Market**. In the **Voluntary Carbon Market / Voluntary Carbon Credit Market**, carbon credits have value to corporations that have committed to achieving **GHG** emission reductions and, in the longer term, **NZE**, on the basis of carbon neutrality.

In a stand-alone article, the author of Low Carbon Pulse will outline Carbon Credits, Article 6 and the Paris Rulebook, and the near, medium and long term role of carbon credits, including as deforestation is curtailed and ceases, and afforestation and reforestation continues, and possible regulation of the **Voluntary Carbon Markets / Voluntary Carbon Credit Markets**.

- **E-Fuels / Future Fuels, including derived from biomass and bioenergy:**

The focus on fuels that are not derived or produced from fossil fuels is increasing. Low Carbon Pulse covers E-Fuels / Future Fuels and bio-energy. In addition to the focus on hydrogen and hydrogen based fuels (including ammonia and methanol), including hydrogen derived from biomass, there is a focus on the derivation and production of Renewable Natural Gas (**RNG**), derived from biomass, including biogas / biomethane, both for use as pipeline gas and for use as bio-compressed natural gas (**Bio-CNG**) and bio-liquified natural gas (**Bio-LNG**).

In a stand-alone article, Michael Harrison and Richard Guit will outline the sources of fossil fuels and non-biomass fuels (including crop fuels), and the feedstocks and technologies used to produce each E-Fuel / Future Fuel, and each form of bio-energy, and of course the **GHG** arising from their derivation and production, and use.

Legal, Policy Setting and Regulatory highlights:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.*

- **IEA support for Clean Energy Start-ups:** On **March 14, 2022**, the International Energy Agency (**IEA**) published [How Governments Support Clean Energy Start Ups – Insights from selected approaches around the world](#). The publication is excellent, providing both a summary and a guide.

- **IRENA:**

It has been a busy March 2022 for **IRENA**:

- **Coalition for Action:** On **March 11, 2022**, **IRENA** published [Decarbonising end-use sectors Green Hydrogen Certification](#).

- **Green Hydrogen:** On **March 20, 2022**, **IRENA** published [Green Hydrogen For Industry – A Guide to Policy Making](#) (considered in detail below under **A Guide to Policy Making**);

- **Collaborative Framework:** On **March 24, 2022**, launched the new [Collaborative Framework on Critical Materials For The Energy Transition](#), focusing on the need for cobalt, copper, lithium, nickel and rare earth elements (**REEs**), with the associated publication of [Collaborative Framework on Critical Materials For The Energy Transition](#). The [Collaborative Framework on Critical Materials For The Energy Transition](#), follows like-frameworks from **IRENA** on Hydropower, Ocean Energy / Offshore Renewable Energy, Green Hydrogen, Geopolitics of Energy Transformation, Just and Inclusive Energy Transition and Enhancing Dialogues of High Shares of Renewables in Energy Systems. The [Collaborative Framework on Critical Materials For The Energy Transition](#) will be considered in the **March and April Report on Report**;

- **IRENA Africa Report:** In **March, 2022**, the [Renewable Energy Market Analysis: Africa and its Regions](#) report was published; and

- **WETO 2022:** On **March 29, 2022**, **IRENA** published [World Energy Transitions Outlook: 1.5°C Pathway](#).

- **Australian Federal Court on duty of care:** **Edition 18** of Low Carbon Pulse reported that the Australian Federal Environment Minister had a duty to take account of the interests of younger generations in considering applications for and grants of approvals for new coal mine projects. **Edition 18** of Low Carbon Pulse reported as follows:

"In Australia, the Federal Court found that the Federal Environment Minister has a legal duty not to cause harm to the young people of Australia [i.e., Australians under the age of 18 years] by exacerbating climate change in the context of approving new or expanded coal mine projects. On the day of judgment, the concept of a legal duty of care was not determinative, but the concept may play a role in future decisions".

On **March 15, 2022** (on appeal from the Minister) the Federal Court of Appeal found that a duty of care was **not** owed (here is a [link](#) to the case). The three judges in the Federal Court of Appeal had differing reasons, but all reached the same conclusion, no duty of care was owed, two judges on the basis that a duty of care did not arise (and in concluding this, applying well-established principles of law). Chief Justice Alsup found that a duty did not arise on three main bases, the first of which was that the content and scope of any duty of care would require the court to evaluate, change or maintain matters of policy, an assessment for which courts are not suited.

Whatever the merits of those bringing the action (and the principles of inter-generational equity are sound), it is for the Australian Federal Government, rather than the courts, to develop policy settings and laws and regulations consistent with achieving **NZE**, including to have regard to matters of inter-generational equity.

Preem CCS project report: During **March 2022** the author came across the Project [report](#) (entitled **Legal and regulatory framework Swedish / Norwegian CCS cooperation**). The report is excellent, both as to the specific plans of Preem AB (the largest fuel corporation in Sweden) and general considerations that arise in respect of the capture, transportation and storage of **CO₂**.

Preem wants to capture **CO₂** from its refineries in Sweden, and ship **CO₂** to Norway for storage in the Northern Lights project (part of the Longship Project), off the west coast of Norway.

In this context, the report addresses the legal and regulatory barriers and solutions, including for **BECCS** (bioenergy carbon capture and storage of Bio-CCS) and for the shipping of **CO₂** across borders.

- **Carbon Border Adjustment Mechanism (CBAM) progresses:** On **March 15, 2022**, the European Council of the European Union reached agreement on the Carbon Border Adjustment Mechanism and issued the draft [Carbon Border Adjustment Mechanism regulation \(CBAM Regulation\)](#) As noted in **Edition 22** of Low Carbon Pulse, **CBAM** is a key element of the **Fit for 55** policy settings announced by the European Commission (**EC**) in July 2021.

While the principles underpinning **CBAM** are outlined in **Edition 22** of Low Carbon Pulse, by way of reminder: the key objective of **CBAM** is to avoid carbon leakage, described in the box below.

CARBON LEAKAGE

Carbon leakage is a phrase that is used to describe a situation in which a carbon price in one country may result in a shift in production of goods to another country (with a lower or no carbon price) with the result that there is an increase in total **GHG** emissions in respect of the production of goods.

The risk of carbon leakage is higher in industries and sectors that are fossil fuel (and feedstock) intensive and other carbon intensive fuel (and feedstock) industries and sectors.

Under **CBAM**, prescribed products (see Annex I of the draft **CBAM Regulation**) from the following industry sectors will be regulated: aluminium, cement, electrical energy, fertiliser, iron and steel. Each of these industry sectors may be regarded as carbon intensive, with products produced across these industry sectors within the **EU** being subject to the policy settings, critically the **EU** Emissions Trading Scheme (**EU ETS**).

The **CBAM** is designed to ensure that prescribed products imported into the **EU** (and as such are not subject to the **EU ETS**) have equivalent carbon pricing principles applied to them consistent with the **EU ETS**.

- **Shell directors focus of Companies Act action:** On **March 15, 2022**, it was [reported](#) widely that thirteen directors of Shell plc are being sued by a shareholder, ClientEarth, on the basis that the directors have not discharged their duty to ensure that the business of Shell is undertaken in a way that promotes the success of the company, and to exercise reasonable care, diligence and skill of this purpose. (The reported basis of the claim suggests that this is an action under ss. 172 and 174 of the UK Companies Act.)

By way of reminder: **Edition 18** of Low Carbon Pulse reported on the outcome of an action brought in the District Court in The Hague against Royal Dutch Shell plc as follows:

"On May 26, 2021, the District Court in The Hague, in the Netherlands, delivered its judgment in a case brought against Royal Dutch Shell plc (**RDS**) by Mileudefensie (et al). This judgment required **RDS** to reduce the net **CO₂** emissions of the **RDS** group by at least 45% by 2030, compared to 2019. The required reduction is across Scope 1, 2 and 3 emissions, not in respect of each Scope. The judgment is founded on **RDS** owing a duty of care to all Dutch citizens. It is expected that **RDS** will appeal the judgment."

RDS appealed this decision of the District Court (**Edition 18** of Low Carbon Pulse suggest that it would, and the [Realizing Reserves and Realising Capital](#) article from Ashurst confirmed that **RDS** had appealed).

The author of Low Carbon Pulse noted at the time, and has noted since (including above), that policy settings going to the achievement of **NZE** and progress towards it, are matters for governments, not courts. Once again, Shell finds itself targeted by an action, which if successful, will impose a duty on the directors of Shell, not on all directors of all corporations. This is neither appropriate, nor helpful.

- **Disclosure requirements:** On **March 21, 2022**, the US Securities and Exchange Commission (**SEC**) released proposed climate change disclosure requirements, including required disclosure of climate risks (identification and mitigation) and emissions data. In broad terms, at a principled level, the proposed disclosure requirements are consistent with the **GHG Protocol** (see the [Realizing Reserves and Realising Capital](#) article) and **TCFD** (see **Edition 24** of Low Carbon Pulse). The **SEC** Fact Sheet, [Enhancement and Standardization of Climate-Related Disclosures](#) an excellent overview of the proposed disclosure requirements over three, punchy, pages.

On **March 24, 2022**, the standards boards of IFRS Foundation and Global Reporting Initiative agreed to coordinate their work around reporting on sustainability.

On **March 31, 2022**, the International Sustainability Standards Board (see **Edition 30** of Low Carbon Pulse, under **ISSB in Frankfurt am Main**) published its [proposals](#) for disclosure.

A future stand-alone issue of Low Carbon Pulse will bring together the tenets of the principles of disclosure.

- **Standalone article about EU Green Taxonomy:**

The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**. In anticipation of the expiry of the four month scrutiny and objection period (which started at the end of January 2022) expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article hopefully hby the end of June 2022.

Climate change reported and explained:

*This section considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.*

- **Preservation and conversation a pressing issue:**

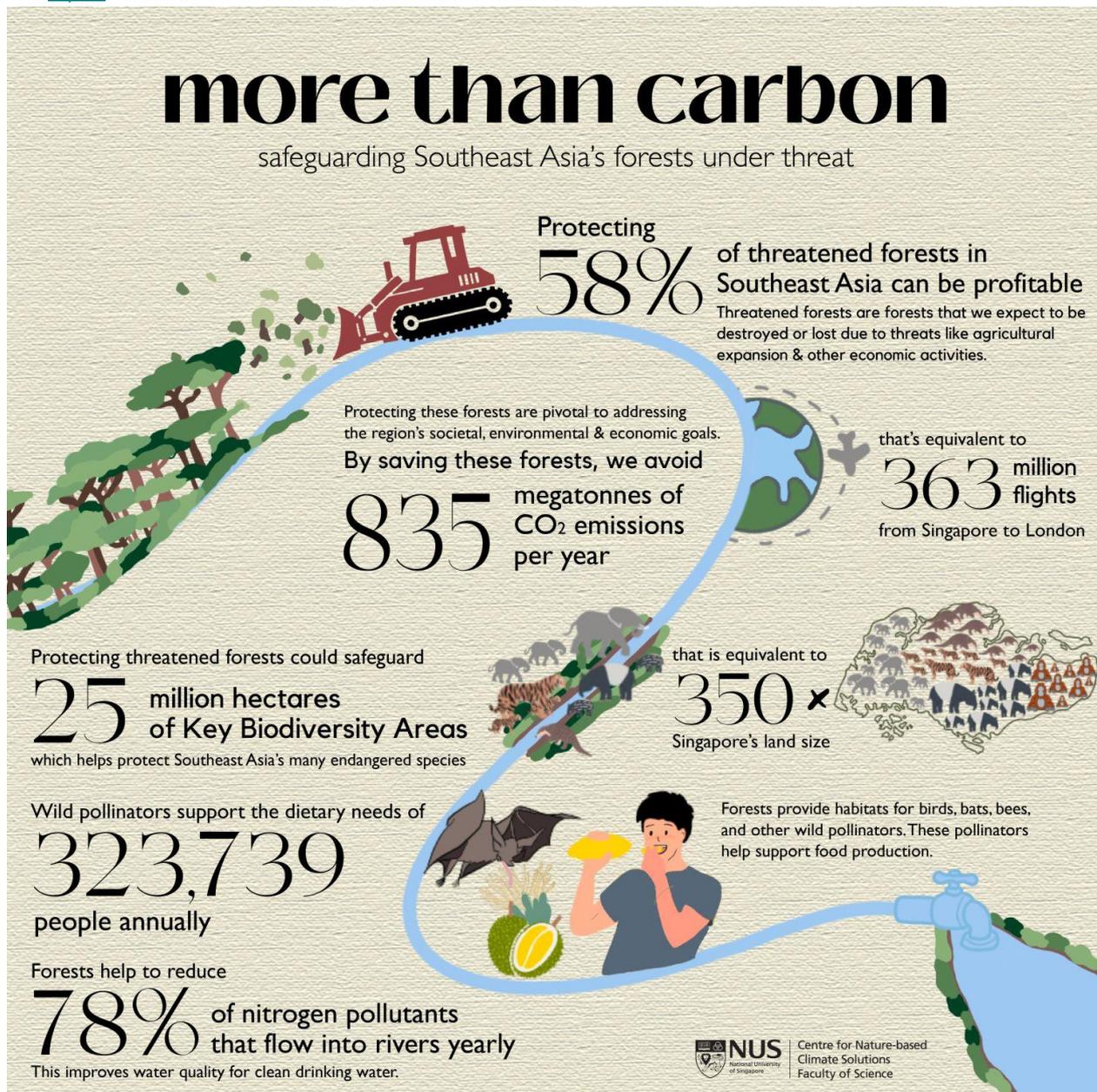
- **Edition 36** of Low Carbon Pulse noted the report published by [nature](#) report (entitled [Observed poleward freshwater transport since 1970](#)), the headline from which is that the global water cycle is 7.4% (having been estimated to be between 2% and 4% previously). Increased global temperatures are accelerating or intensifying (depending on how one views the water cycle). In summary, the result of this acceleration / intensification is that

freshwater moves to wet regions, with the result that, as a general statement, and overtime, drier regions, critically, sub-tropical regions become drier. The implications of this are many and varied.

- On **March 7, 2022**, it was reported widely that one of the implications is that untouched forest loses its stability as a result of drier conditions, and its ability to grow back after drought and wildfire is reduced, and as a result takes longer. The loss of stability is most marked closer to farms, roads and urban areas, and regions that are becoming drier – resulting in dieback. In the Amazon, where all contributing factors are present, the risk of dieback is heightened. In a [study](#) published around **March 7, 2022** (entitled [Pronounced loss of Amazon rainforest resilience since the early 2000s](#)), Mr Tim Lenton, of the University of Exeter studied satellite data, considering the implications of that data after drought and fire.

In an article in the [New Scientist](#) (under [Amazon rainforest nears tipping point that may see it become savannah](#)) it is noted that, "More than three-quarters of the world's largest rainforest has become less resilient to drought since the early 2000s, with areas near humans and with lower rainfall being the worst hit".

- More than carbon:** On **March 7, 2022**, the **NUS Centre for Nature-based Climate Solutions** published a helpful graphic in the context of the preservation and conservation of land mass in Southeast Asia: the graphic is taken from a report produced by the **NUS Centre**, led by Tasya Vadya Sarira, and Centre Members Yiwen Zeng and Lian Pin Koh. The [report](#) considers on all of the matters touched on above.



- More carbon in 2021 than ever before:** On **March 8, 2022**, the **IEA** released [Global Energy Review: CO₂ Emissions in 2021](#) (the **CO₂ 2021 Report**). The headlines arising from the **CO₂ 2021 Report** are that 15.3 billion metric tonnes of **CO₂** emissions arose from the use of coal and over 7.5 billion tonnes arose from the use of natural gas. While some of the increase in **CO₂** emissions can be explained by the unusual circumstances in Europe and the US, necessitating increased use of fossil fuels, the overall growth in **CO₂** emissions is a function of the continued economic development of a limited number of countries, including India and the **PRC**.

As regular readers of Low Carbon Pulse will know, both India and the **PRC** are making progress in the development and deployment of renewable electrical energy and clean-to-low carbon energy carrier production, but it takes time to displace existing capacity. As such any adverse headlines emerging from the **CO₂ 2021 Report** directed at either India or the **PRC** need to be viewed in this context.

- **Energy Transitions Commission conclusions:** On **March 9, 2022**, the Energy Transitions Commission (**ETC**) published **Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive** (**ETC Report**).

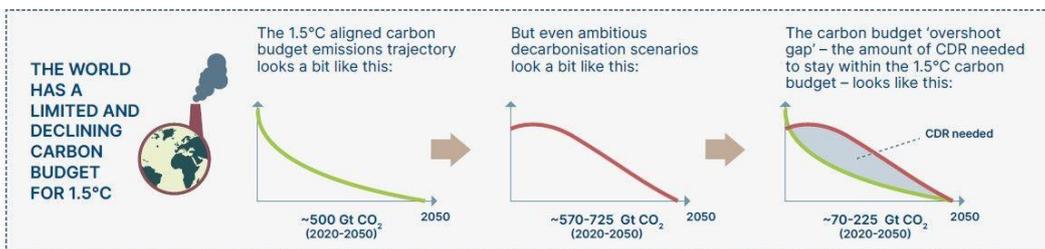
The headline arising from the **ETC Report** is that to ensure that the average increase in global temperatures does not exceed **1.5°C** above pre-industrial times, **165 giga-tonnes** of **CO₂** will have to be removed from the atmosphere by 2050, and as a consequence of this finding, much deeper thinking is required around carbon credits and carbon off-sets and trading. This is a long-standing theme of Low Carbon Pulse, critically the need to move to negative **GHG** emission initiatives sooner rather than later. The following infographic conveys the key finding of the **ETC Report**:



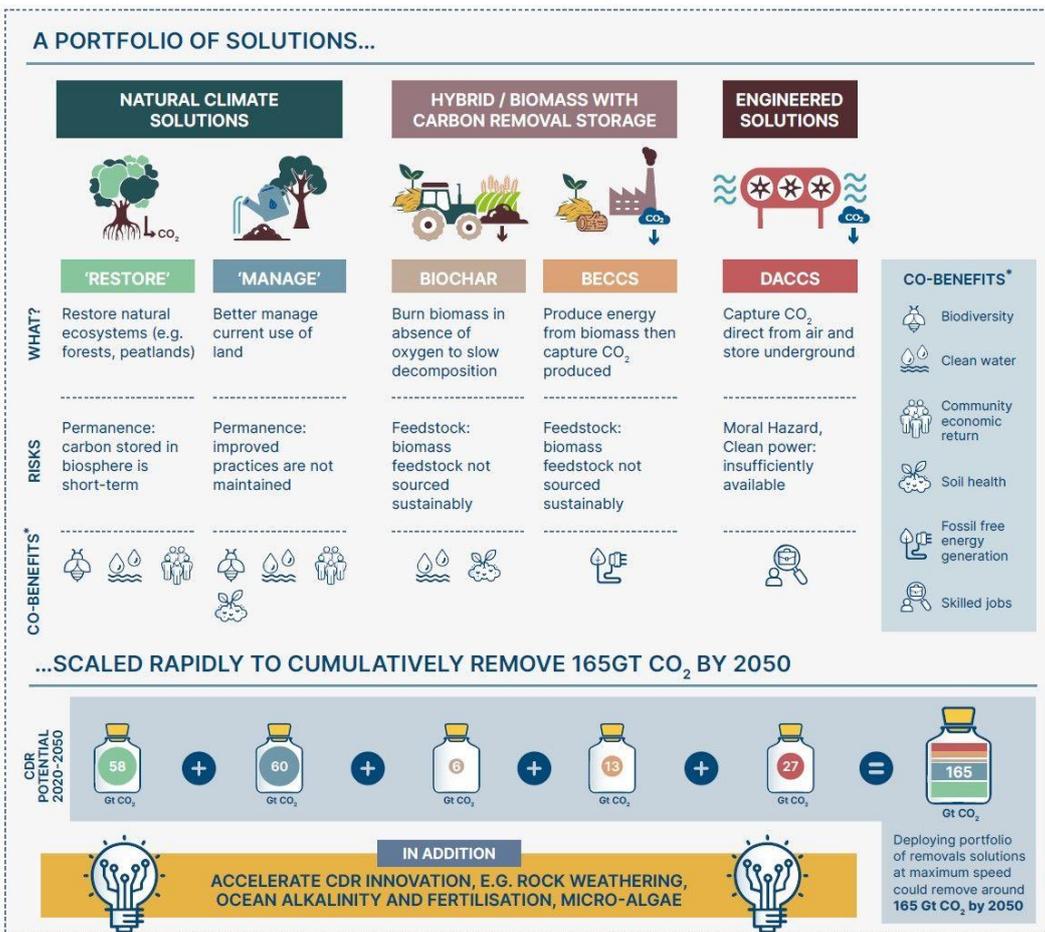
MIND THE GAP: CARBON DIOXIDE REMOVAL (CDR)



CDR is needed in addition to deep and rapid decarbonisation



What will it take to scale CDR to keep 1.5°C alive?



Energy Transitions Commission - March 2022

- **A gathering of world days:**

- **World Water Day: March 22, 2022**, was **World Water Day**. As with International Day of Forests on March 21, 2022, (see below at **International Day of Forests / International Forest Day**) there was considerable coverage of environmental and sustainability issues as they relate to water. There was however a particular focus in the coverage of groundwater, its importance (accounting for 99% of the freshwater globally) and that its importance was not understood, and as a result over-exploited and mismanaged.

UN Water and UNESCO (World Water Assessment Program) published a [report](#) (entitled **United Nations World Water Development Report 2022: Groundwater: making the invisible visible**).

The headline from the report is that water use is to grow by 1%, year on year, for the next 30 years. In this context, water sourced from ground water supplies over 50% (by volume) of current water used for domestic and drinking water. The question posed by the report is how to satisfy the projected growth in the use of water, with sustainable practices, critically avoiding over exploitation and mismanagement.

The **March and April Report on Reports** will cover the report in detail.

- **World Meteorological Day: March 23, 2022**, was **World Meteorological Day**. The World Meteorological Organisation (**WMO**) provided a number of publications and posts to mark the Day.

As might be expected, the focus of the narrative from the **WMO** was climate change. In an article, [Early Warning, Early Action](#), key issues were summarised, and the need for impact-based forecasting practices.

Middle East including GCC Countries:

*This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.*

- **Electric Corp and Energroup align:** On **March 6, 2022**, Energroup (**UAE** sustainable investment corporation) and Israel Electric Corporation (state-owned electrical energy corporation) [announced](#) that they had entered into a preliminary agreement intended to develop Blue and Green Hydrogen projects.

- **Roll-out new H2 trucks:** On **March 7, 2022**, [hydrogenfuelnews.com](#) reported that Colmobil (Israeli vehicle dealer) is to import hydrogen fuelled, fuel cell electric vehicles (**FCEVs**), manufactured by Hyundai, collaborating with Bazan (Israeli petrochemical giant), to produce and to supply the hydrogen, and Sonol (Israel's third largest gas station chain), to develop and to deploy hydrogen refuelling infrastructure.

A trend identified in previous editions of Low Carbon Pulse is that those involved in the hydrogen value chain will support the development of the hydrogen value chain by committing to use **FCEVs** themselves.

- **BEEAH Energy and Chinook Sciences busy:** On **March 7, 2022**, [fuelcellworks.com](#) reported that BEEAH Group (leading sustainability corporation) and Chinook Sciences (UK based technology corporation) had signed an agreement to produce "clean to green" hydrogen to provide hydrogen to power and to propel over 300 trucks and buses a day.

The hydrogen is to be produced from waste at a waste-to-hydrogen facility, producing high-quality activated carbon as well as "clean to green" hydrogen. BEEAH Group will supply the non-recyclable waste streams (predominantly plastics and wood), and will process those waste streams using Chinook Sciences' gasification technology.

It is understood that the waste-to-hydrogen facility will be able to process up to 18 metric tonnes (or 18,000 kilograms) of waste streams a day. As reported, the cost of production of clean hydrogen will be less than the cost of the diesel fuel that the clean hydrogen will displace.

- **Busy day in paradise:** On **March 7, 2022**, it was reported widely that Acme Group (Indian renewable energy company) and Scatec (Norway based renewable power producer) are to develop a Green Ammonia production facility in Oman. The Green Ammonia production facility is world scale, with nameplate Green Ammonia production capacity of 1.2 million metric tonnes a year on completion of planned development and deployment.

It is understood that the Green Ammonia production capacity is to be developed on a phased basis, with the first phase the development and deployment of 500 MW of photovoltaic solar capacity to power 300 MW of electrolyser capacity, to produce Green Hydrogen which in turn will be used as feedstock to produce Green Ammonia.

By way of reminder – something of a feature on Oman:

- **Oman goes Green by Blue: Edition 18** of Low Carbon Pulse reported that: "On May 22, 2021, plans to develop a USD 30 billion, 25 GW, Oman Green Energy Hub (**OGEH**) were announced. The **OGEH** is to be located close to the Arabian Sea. The development of the **OGEH** is to be spear-headed by InterContinental Energy, in partnership with OQ (state owned Omani oil and gas company) and EnerTech (Kuwaiti based investor). The renewable electrical energy produced from on-shore photovoltaic solar and wind farms, will allow the production of 1.8 million metric tonnes per annum of Green Hydrogen and, as reported, 10 mpta of Green Ammonia.

Construction of **OGEH** is to be undertaken in phases, and is scheduled to commence in 2028, with completion of the final phase scheduled for 2038. On full development, the **OGEH** is to be powered by 25 GW of photovoltaic solar and wind.

InterContinental Energy is a name that will be familiar to those following the **Asian Renewable Energy Hub** being developed in the Pilbara Region of Western Australia (see [Edition 2](#) of Low Carbon Pulse) and the **Western Green Energy Hub** in Western Australia (see [Edition 22](#) of Low Carbon Pulse).

- **Oman's aim is true: Edition 20** of Low Carbon Pulse reported that: "On June 16, 2021, the scale of the plans for Oman became clearer, in light of an interview given to S&P Global Platts, by CEO of OQ (a state owned oil and gas company), Mr Salim al-Huthaili.

Mr Salim al-Huthaili brought together the economics of using electrical energy from solar sources (the cheapest electrical energy in history in the **GCC** countries) rather than using natural gas molecules to produce electrical

energy: "We are looking at solar projects and combined solar and wind on our plants ... That will free up gas molecules that we are burning to employ into much more valuable processes rather than burning ...".

This is at the heart of the electrons versus molecules debate broadly. (Leaving to one side any discussion around energy security, if one turns around the thinking, this informs the efficiency debate around the use of hydrogen (in particular Green Hydrogen) as a fuel to generate base-load dispatchable energy.)

The clarity of thinking and the policy setting of moving to use renewable electrical energy to preserve molecules to produce hydrogen and hydrogen-based energy carriers is compelling.

Mr Salim al-Huthaili went on to state that OQ is developing projects to produce: "... both Blue Ammonia and Blue Hydrogen .. The Blue Ammonia project can be accelerated ... it is a matter of capturing the CO₂ and obtaining certification that it qualifies [as Blue Hydrogen and as such] as Blue Ammonia and can be sold to the market as Blue Ammonia".

In addition to Blue Hydrogen and Blue Ammonia, OQ is considering the development of Green Hydrogen, Green Ammonia, Green Methanol and Green Steel projects. It is anticipated that these projects will be developed with international partners, as is the case with the **Oman Green Energy Hub**."

- **Common sense from Fitch: Edition 21** of Low Carbon Pulse reported that: "On June 28, 2021, Fitch Solutions Country Risk & Industry Research published some themes that have emerged or are emerging.
The [publication](#) covers 4.5 pages or so, but packs a fair punch, providing cogent perspectives and clarity around emerging themes. Building on one of the themes noted in recent editions of Low Carbon Pulse is viewing **CO₂** as a resource, and in this context looking to accelerate CCS / CCUS technology as having long term benefits.
The publication provides real clarity in noting that in the context of the use of CCS:
 - for **FOR** (and **EGR**): "On a net basis, the overall CO₂ released both from production and consumption) is less, assuming the additional oil recovered would have been recovered and consumed regardless of the injection of CO₂"; and
 - has one key challenge, and that is the need for favourable local geology, and that in this context emphasising the development of CCUS technology was critical so as to make use of **CO₂** as a resource, and have the means of doing so." [Note: Oman has favourable geology]
- **Self-fulfilling dynamics in Oman: Edition 22** of Low Carbon Pulse reported that: "On July 19, 2021, it was reported that Uniper (leading international energy company) has signed a cooperation agreement with the shareholders in **Hyport DUQM** to develop the business case for the off-take of Green Hydrogen through the negotiation of an exclusive off-take agreement for Green Ammonia and to provide related engineering services.
As noted in previous editions of Low Carbon Pulse, there is palpable progress across the **Gulf Cooperation Council (GCC)** countries towards the development of Green Hydrogen and Green Ammonia (and Blue Hydrogen and Ammonia). **Edition 20** of Low Carbon Pulse included a narrative around the highly prospective, world-class resources that exist in the **GCC** countries."
- **Oman building on progress: Edition 25** of Low Carbon Pulse reported that: "Uniper (leading international energy company) had signed a cooperation agreement with the shareholders in **Hyport DUQM** to develop the business case for the off-take of Green Hydrogen through the negotiation of an exclusive off-take agreement for Green Ammonia and to provide related engineering services.
On August 13, 2021, it was announced that the Oman Ministry of Energy had established an alliance (**Hy-Fly**) of thirteen public and private sector organisations (including Oman LNG, OQ, BP, Shell and TotalEnergies) to work together to develop initiatives for the purposes of the production, transportation, use and export of clean hydrogen, and clean hydrogen-based fuels.
- **OQ signs JDA: Edition 29** of Low Carbon Pulse reported that: "On October 17, 2021, OQ (the Omani state-owned energy company) had signed a Joint Development Agreement with Dutco, Linde and Marubeni to undertake feasibility studies to assess the development of a 400 MW Green Hydrogen and Green Ammonia production facility (**SalalahH2 Project**) in Oman's Salalah Free Zone. The **SalalahH2 Project** will make use of OQ's existing ammonia production plant at Salalah".
- **Oman and Siemens mapping a way forward: Edition 30** of Low Carbon Pulse reported that: "On November 11, 2021, the Oman Hydrogen Centre (**OHC**) signed a memorandum of understanding (**MOU**) with Siemens Energy Oman to collaborate on the development and deployment of hydrogen energy projects and on hydrogen initiatives in the Sultanate of Oman".
- **Oman and BP committed to multiple GWs: Edition 33** of Low Carbon Pulse reported that: "On January 17, 2022, the Oman Ministry of Energy and Minerals had signed an agreement with BP (leading international energy corporation) to progress with the development of a combined renewable electrical energy and Green Hydrogen production project by 2030. In the near term, BP will assess the solar and wind resources in a 8,000 km² area of land that would be used to locate photovoltaic solar and wind generation capacity to provide renewable electrical energy for the production of Green Hydrogen".
- **Consolidation of ownership to expand capacity**; On **March 9, 2022**, [gulfnews.com](#) (under **EGA, TAQA, Dubal Holding and EWEC to expand clean energy generation**) reported on the plans of the Abu Dhabi National Energy Company (**TAQA**), Dubal Holding, Emirates Global Aluminium (**EGA**) and Emirates Water and Electricity Company (**EWEC**) to enhance generation optimisation, and in this context, to decarbonise the production of aluminium by **EGA**.
- **KSA signals 15 GW push**: On **March 8, 2022**, [pv.magazine.com](#) reported (under **Saudi minister appears to signal 15 GW, two year clean energy push**) that Crown Prince Abdulaziz bin Salman bin Abdulaziz Al Saud had indicated that the Kingdom of Saudi Arabia (**KSA**) was planning a massive renewable energy drive by the end of 2023.
In the context of the execution of the power supply agreement for the 700 MW Al-Rass photovoltaic solar project (see **Edition 29** of Low Carbon Pulse) by ACWA Power (a corporation based in Saudi Arabia), ACWA Power released the following announcement:

"During the signing ceremony, the Minister of Energy announced that the energy sector aims to launch several renewable energy projects to produce approximately 15,000 MW of clean energy between the years 2022 and 2023, with the aim of diversifying the energy mix and achieving its designated targets".

- **UAE and Austria align:** On **March 11, 2022**, it was reported widely that the **UAE** and Austria had signed an agreement to provide a framework to provide for collaboration across hydrogen technology. This agreement is reported to build on the agreement signed by **UAE** and Austria in 2021 (see **Edition 23** of Low Carbon Pulse). Sulatan al-Jaber, Minister of Industry and Advanced Technology and the managing director of ADNOC stated that the agreement aims to "**establish a comprehensive collaboration in hydrogen technology, which will build on the strengths of each [country] and contribute to the UAE's position as a leading global energy producer**".
- **DEWA Aquifer Storage and Recovery:** On **March 14, 2022**, Dubai Electricity and Water Authority (**DEWA**) announced that it had completed construction of the first stage of its Aquifer Storage and Recovery (**ASR**) project. While the thinking behind the **DEWA ASR** project focuses on it as a strategic reserve of water, it appears possible that **ASR** technology will be applied to store water as feedstock for Green Hydrogen production in due course.
- **UAE and Germany:**
 - **Working Group:** On **March 15, 2022**, it was reported widely that the **UAE** and Germany Working Group met in Dubai, **UAE**, to discuss future cooperation. (See **Edition 30** of Low Carbon Pulse in respect of the establishment of the Working Group.)
It is understood that the first meeting of the Working Group focused on the development of hydrogen business opportunities and hydrogen technology.
 - **UAE and Germany working all week:** The week-beginning **March 21, 2022**, saw considerable activity between the **UAE** and Germany, including on **March 22, 2022**, the [announcement](#) from ADNOC that it had signed a memorandum of understanding with the German Federal Minister for Economic Affairs and Climate Action, Dr Robert Habeck, with ADNOC and Germany to undertake studies jointly to strengthen the collaboration to develop clean hydrogen capacity, including work around hydrogen logistics and pilot cargoes, in addition to studies to be undertaken jointly on difficult to decarbonise sectors, including considering new uses of clean hydrogen.
It is reported that Uniper and JERA Americas, working with Hydrogenious LOHC Technologies, will be working on the use of LOHC technology to transport hydrogen and hydrogen-based fuels.
- **NEOM progress continues:**
 - **Helios Green Light:** On **March 17, 2022**, it was reported widely that the USD 5 billion Helios Green Hydrogen production project (part of the development of the Neom project) is to commence construction. The Helios project is to be powered by 4 GW of renewable electrical energy. It is expected that the Helios project will be producing Green Hydrogen by 2026. The Helios project is to deploy 120 electrolyzers supplied by thyssenkrupp AG. The commencement of construction is a landmark.
 - **ENOWA Green Utility:** On **March 21, 2022**, NEOM [announced](#) the launch of **ENOWA** which will lead the development and deployment of NEOM's world class sustainable energy and water systems, including [The Line](#), [OXAGON](#) (see **Editions 31** and **35** of Low Carbon Pulse) and [Trojena](#), and of course as a shareholder in the joint venture with Air Products to develop the Helios Green Hydrogen production project.
- **Masdar releases Sustainability Report:** On **March 22, 2022**, Masdar (the Abu Dhabi Future Energy Company) released its [ninth sustainability report](#). The Masdar Sustainability Report has become a reference work.
The key headline from the Masdar Sustainability Report is that Masdar intends to accelerate 100 GW of installed renewable energy capacity, and then double that capacity again, to 200 GW.
- **UAE and the Netherlands sign MOU:** On **March 22, 2022**, [hydrogen-central.com](#) (under **UAE Could Be One Of The Biggest Suppliers of Hydrogen to Europe**) reported that the **UAE** and the Netherlands had signed a memorandum of understanding to work together to develop export-import corridors for clean hydrogen, between the **UAE** and the Netherlands as the gateway to Europe.
- **ACWA Power suspends investments in fossil fuels:** On **March 24, 2022**, [arab-news.com](#) reported that ACWA Power (owned by PIF) "is steady working toward achieving the Kingdom's mission of reaching net zero carbons by 2060, as the company has decided not to invest in oil- or coal-fired power plants going forward".

Africa:

*This section considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to Africa. Africa remains the continent with the most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.*

- **Alignment in Egypt:**
 - On **March 10, 2022**, it was reported widely that Scatec (leading Norwegian renewable electrical energy corporation) had signed a memorandum of understanding (**MOU**) with the Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority. It is understood that the **MOU** provides for the development jointly a 1 million metric tonnes per annum Green Ammonia production facility (with potential to expand to 3 million metric tonnes annually).
The Green Hydrogen and Green Ammonia production facility is to be located in the Ain Sokhna Industrial Zone within the Suez Canal Economic Zone. The New and Renewable Energy Authority will allocate land proximate to the production facility on which renewable electrical energy capacity will be installed to power the production facility.
 - On **March 28, 2022**, it was reported widely that A.P. Moller – Maersk had entered into a memorandum of understanding (**MOU**) signed by the Prime Minister of Egypt, [Mr. Mostafa Madbouly](#), under which A.P. Moller will work with Suez Canal Economic Zone, The Sovereign Fund of Egypt, the Egyptian Electricity Transmission Company, and the New and Renewable Energy Authority to develop green energy and green fuel production capacity.

- **Use of PPP delivery in forestry:** On **March 17, 2022**, blogs.worldbank.org (the World Bank Blog) reported on the use of a public private partnership (**PPP**) in Ghana for the purposes of AFOLU (i.e., Agriculture, Forestry and Other Land Use) projects. The Ghana Forestry Commission (**GFC**) contracted with the private sector to develop and to operate AFOLU projects located on land managed by the **GFC** on a sustainable basis, using private sector capital and expertise, while at the same time involving local communities and the resources of the **GFC**.
- **Nigeria launches updated energy and emissions model:** On **March 21, 2022**, mottmac.com reported (under **Nigeria becomes the first African country to launch an updated 2050 Calculator to support low-carbon development**) that the Energy Commission of Nigeria (**ECN**), the Federal Ministry of Environment and the British Embassy in Abuja had launched jointly an updated version of the Nigeria Energy Calculator 2050 (**NECAL 2050**). The updated version includes updates across industry sectors as follows: bio-energy and waste, buildings, **CO₂** removal, electricity, industry, land and transport. Dr Abdulwaheed Ahmed of **ECN** noted that "... **NECAL 2050** will support Nigeria's reporting to UNFCCC, the National Biennial Update Report, the National Inventory Report in addition to [achieving] alignment with the NDCs and the Nigeria Energy Transitional Plan ...".
- **Eni water PPPs:** On **March 23, 2022**, eni.com announced that its subsidiary corporations, Nigerian Agip Exploration and Agip Energy and Natural Resources, and the Food and Agriculture Organisation of the UN (FAO) had commissioned 11 water schemes in Borno and Yobe States, North East Nigeria. Each water scheme is integrated: comprising sourcing raw water from boreholes, use of electrical energy sourced from photovoltaic solar panels to pump water and to power water treatment facilities, providing water for domestic use and drinking, and for micro-irrigation purposes.
- **Renewable Energy Market Analysis:** As noted above, in March, 2022, the **IRENA Africa Report** was published. In addition to the **IRENA Africa Report**, at woodmac.com, Wood Mackenzie released a paper, **Utility 3.0: How Africa is remaking the grid**. This will be considered in detail along with the **IRENA Africa Report** in the **March and April Report on Reports**, to be contained in the Appendix to the Second Compendium of Low Carbon Pulse.

India and Indonesia:

*This section considers news items within the news cycle of **Edition 37** of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most **GHG** emissions.*

- **Feasibility Study to decarbonise maritime industry:** On **March 10, 2022**, h2-view.com reported (under **Indonesian maritime industry to be decarbonised with hydrogen**) that the Asian Development Bank (**ADB**) supported by Longitude Engineering, is to undertake a feasibility study, jointly, with PT Pertamina. The purpose of undertaking the feasibility study is stated to be to develop a road map for the integration of low carbon fuels into the domestic shipping industry, with hydrogen (and hydrogen-based fuels), being key for these purposes.
- **India 50 GW of solar:** On **March 15, 2022**, pv-magazine-australia.com reported that to December 31, 2021, India had installed 50 GW of photovoltaic electrical energy capacity (40.4 GW utility scale, and 8.57 GW roof-top), having added 3.17 GW of installed capacity during Q4 of 2021, of which 2.5 GW was utility-scale and 520 MW roof-top.
- **ArcelorMittal and Greenko co-develop 975 MW:** On **March 22, 2022**, the economic-times.com reported (under **ArcelorMittal joins hands with Greenko for renewable energy projects**) that ArcelorMittal and Greenko had agreed to co-develop 975 MW of photovoltaic solar and wind renewable energy capacity as part of the progress being made by ArcelorMittal to decarbonise the production of iron and steel. The co-development will be located in Andhra Pradesh and will provide "round-the-clock" renewable electrical energy, and is to be funded by ArcelorMittal and designed, constructed, operated and maintained by Greenko.
- **KPMG takes the pulse:** On **March 25, 2022**, KPMG India launched its **India Decarbonisation Hub**. To accompany the launch of the Indian Decarbonisation Hub, KPMG published **India's green hydrogen ambition - setting the wheels in motion**, which provides a helpful overview of the current state of play, and the road ahead.
- **USD 1.2 billion Green Hydrogen Project in Indonesia:** On **March 25, 2022**, it was reported widely that Hyundai and Samsung are to join with Global Green Growth Institute (**GGGI**) to develop a Green Hydrogen Project in Indonesia. It is understood that the intention is to derive renewable electrical energy from geothermal energy sources, with the Green Hydrogen to be supplied to the Sei Mangkei Industrial Zone, Sumatra, with the Green Hydrogen to be used to decarbonise industrial activities, including the difficult to decarbonise cement and iron and steel industry sectors. Further, it is understood that the Green Hydrogen Project will use Green Hydrogen to produce Green Ammonia, with the Green Ammonia to be exported, including to **ROK**, with Hyundai to provide the shipping for export, and KOGAS to import the Green Ammonia. Samsung Engineering will undertake the design and viability study for the project.
- **India SAF:** On **March 26, 2022**, Axens [announced](https://axens.com) that Axens, Airbus, GMR Airports (an airport operator), Groupe ADP (also and airport operator) and Safran had signed a memorandum of understanding to collaborate in making Indian aviation future ready by undertaking a study in respect of sustainable aviation fuel (**SAF**) to assess the potential of **SAF** in India.
- **PT Pertamina investments plans:** On **March 25, 2022**, energyvoice.com reported that PT Pertamina plans to invest up to USD 11 billion on renewable energy projects over the period 2022 to 2026 so as to continue progress in energy transition.
- **OIES updates Report:** Towards the end of March 2022, the Oxford Institute for Energy Studies updated its [publication](https://oies.org) **India's Progress on its Climate Action Plan – An Update in Early 2022**. The publication is well-worth a read.
- **India Hydrogen Alliance – March 2022:** Attached is the link to the March edition of **India H2 Monitor - March 2022**. As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the content of the **India H2 Monitor**.

Japan and Republic of Korea (ROK):

*This section considers news items within the news cycle of this **Edition 37** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

- **Japan's 11th solar auction:** On **March 9, 2022**, the **Green Investment Promotion Organisation** in Japan released the [results](#) (please see the original results in Japanese [here](#)) of the 11th solar auction for projects with an electrical energy dispatch rating of greater than 250KW.
As reported, 273 photovoltaic solar projects had bids accepted, with bids accepted in respect of 268.7 MW of installed capacity. The outcome of the 11th solar auction is significant because the average bid was below ¥10 per kW/h for the first time, and as such the lowest in any preceding auction.
The 11th solar auction is the last that will be undertaken using fixed tariffs. The next auction will award bids on the basis of a feed-in premium tariff.
- **Japan to accelerate off-shore wind field development:** On **March 18, 2022**, it was reported widely that the Minister of Economy, Trade and Industry of Japan, Mr Kōichi Hagiuda, had announced that Japan will accelerate the development of off-shore wind field capacity.
- **POSCO in South America:** On **March 21, 2022**, [mining.com](#) reported that POSCO (leading iron and steel producer head-quartered in **ROK**) is to invest USD 4 billion in a new lithium mining project in Argentina. The mining project is understood to be located on a salt flat, Salar del Hombre Muerto, which is located on the border between provinces of Catamarca and northern Salta. It is understood that production of 100,000 tonnes a year of lithium hydroxide is expected on completion of the development of the mine.
Argentina, Bolivia and Chile form the "lithium triangle", each home to large reserves of lithium. On **March 29, 2022**, Rio Tinto announced plans to acquire the Rincon lithium mine project within the lithium triangle (in Argentina).

PRC and Russia:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the **PRC** and **Russia**, being countries that give rise to the most and the fourth most **GHG** emissions.*

- **Sinopec continues progress on hydrogen:** On **March 17, 2022**, it was reported widely that Sinopec (one of the Big Three **PRC** NOCs) is to increase its investment in the development and deployment of Green Hydrogen facilities so as to develop 500,000 metric tonnes of Green Hydrogen annual production capacity by 2025.
As reported previously in Low Carbon Pulse, Sinopec intends to have deployed hydrogen refuelling infrastructure in 1,000 locations by 2025, which will have refuelling capacity of 200,000 metric tonnes a year.
A reminder of Sinopec Plans: To regular readers of Low Carbon Pulse, this news item may jog the memory - **Edition 19** of Low Carbon Pulse reported as follows:
"Sinopec plans to produce 500,000 tonnes of Green Hydrogen by 2025:
 - **From Grey to Green: Edition 5** of Low Carbon Pulse outlined the position of Sinopec as a producer of hydrogen using traditional technologies, producing over 3 million metric tonnes per annum (*mmtpa*) of hydrogen. **Edition 18** of Low Carbon Pulse outlined the development by Sinopec of its first Green Hydrogen facility in Ordos, Inner Mongolia, which is to start producing Green Hydrogen by the end of 2022.
While Sinopec is the world's largest refiner of petroleum products, it has recognised for some time that there is a need to shift to low and no carbon, including to align with achieving peak **GHG** emissions by 2030, and net-zero **GHG** emissions by 2060. Sinopec is not alone among Chinese companies in responding to this imperative.
 - **From production to distribution:** Chinese state owned enterprise, Sinopec, has been focused on its strategic shift to Green Hydrogen, and its wholly-owned subsidiary, Sinopec Star Co., Ltd (*Sinopec Star*), is working towards the achievement of this shift. It is planned that *Sinopec Star* will develop projects to produce 500,000 metric tonnes per annum of Green Hydrogen by the end of 2025.
In the context of developing supply and demand in tandem, at the same time as Sinopec is developing its Green Hydrogen production capacity, through *Sinopec Star*, it is developing hydrogen refuelling infrastructure and stations (*HRI/Ss*). It is reported that Sinopec is working with Air Liquide in the roll-out of *HRI/Ss*.
For completeness, attached are links to each other edition of Low Carbon Pulse in which a news item was included relating to Sinopec: **Editions 5, 9, 13, 18, 21, 26, 32, 33** and **34**. For those with the time, the telling take-away will be the consistency between what was planned, and what has been implemented.
- **PRC continues progress on hydrogen:** On **March 23, 2022**, [h2-view.com](#) reported on the plans of the **PRC** for the development of hydrogen production capacity with the National Development and Reform Commission (**NDRC**) and the National Energy Administration (**NEA**) providing a roadmap to 2025, 2030 and to 2035.
In the near term, the plan is to develop hydrogen production capacity so as to produce 200,000 metric tonnes of clean hydrogen by 2025. This sits well inside the aspirations of Sinopec to have developed 500,000 metric tonnes of Green Hydrogen production capacity by 2025.
In the medium term (by 2030), the plan is to have developed a hydrogen production industry configured to produce clean hydrogen using integrated hydrogen technologies so as to maximise the reduction in **GHG** emissions arising from production, transportation, storage and use of hydrogen. In the near to medium term, the focus appears to be the decarbonisation of the mobility industry.
In the medium to longer term (by 2035), the plan is to have developed hydrogen production capacity so as to support the decarbonisation of the difficult to decarbonise industries.

- **A reminder of PRC plans:**

On **March 5, 2022**: [Reuters](#) reported that the **PRC** had firmed-up plans to develop and to deploy 450 GW of new photovoltaic solar and wind capacity in the Gobi Desert, and other desert regions: Director of **NDRC**, Mr He Lifeng said:

"China is going to build the biggest scale of solar and wind power generation capacity on the Gobi desert in history, at 450 GW".

While the development and deployment of photovoltaic solar and wind power in the Gobi Desert has been flagged (for example, see **Edition 21** of Low Carbon Pulse) for some time, the confirmation from **NDRC** at the National People's Congress can be viewed as a firm policy setting. It is understood that the construction of 100 GW of photovoltaic solar capacity is already underway in the Gobi Desert. As noted in previous editions of Low Carbon Pulse, the renewable electrical energy generated in the Gobi Desert, and other desert regions, will be transmitted to the load for that electrical energy using ultra-high voltage direct current transmission systems.

During the week beginning February 28, 2022: it was reported widely that the **PRC** plans to develop and to deploy hydrogen refuelling infrastructure at 2,000 sites across China, and for 1 million FCEV in China, by 2035.

Europe and UK:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to countries within the European Union (EU) and the EU itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards NZE. In combination, countries comprising the EU give rise to the most GHG emissions after the Peoples Republic of China (PRC) and the US. The UK is a top-twenty GHG emitter, but has been a front-runner in progress towards NZE.*

- **Clearing Round in ScotWind:** On **March 7, 2022**, Crown Estate Scotland (**CES**) [indicated](#) that it will undertake a **Clearing Round** under which further lease areas will be auctioned, specifically lease area NE1 east off Shetland.

It is understood that bidders in the **ScotWind Leasing Scheme** (see **Edition 33** of Low Carbon Pulse) process that were not successful (but scored highly applying assessment criteria) will be eligible to bid in the **Clearing Round**.

It is understood that **CES** will outline its plans for a **Clearing Round** during **April 2022** (which will be covered in **Edition 39** of Low Carbon Pulse). This may be regarded as timely in the context of plans across Europe and the UK to accelerate the development of hydrogen production capacity in the context of an accelerated move towards renewable electrical energy development and the attendant ability to produce Green Hydrogen as a result.

By way of reminder: Edition 33 of Low Carbon Pulse reported on the outcome of the **ScotWind Leasing Scheme**, and **Edition 22** of Low Carbon Pulse reported on the process.

- **EU to accelerate decarbonisation initiatives:**

- **Edition 36** of Low Carbon Pulse reported:

"During the week commencing February 28, 2022, it became apparent that the **EU** intends to seek to reduce exposure to volatile hydrocarbon prices (coal and natural gas) by accelerating progress to increased renewable electrical energy and the production and use of Green Hydrogen (**Hydrogen Accelerator**), and in the near to medium term, to access more varied sources of natural gas supply, principally in the form of LNG.

During the next two quarters of 2022, the expectation is that there will be a focus on maximising gas in storage, to at least 80% by September 30, 2022. At the same time, it is understood that the **Hydrogen Accelerator** policy setting will be implemented.

By way of rare editorial comment, the **EU** needs to be clear to the market, committing to the market to ensure that term contracts are concluded for LNG to allow the development of further LNG supply sources globally by underpinning the economics of those developments. Germany is doing this already."

- **EC plans clear and hard:** On **March 8, 2022**, the European Commission (**EC**) outlined its plans to accelerate the development of renewable electrical energy capacity across the **EU**, and to increase fourfold the Green Hydrogen production capacity by 2030 (**RePowerEU**, including a **Hydrogen Accelerator**).

EC Vice-President, Mr Frans Timmermans said (in echoes of a by-gone age, of the dash for gas):

"Let's dash into renewables at lightning speed. Renewables are cheap, clean, and potentially an endless course of energy instead of funding the fossil fuel industry elsewhere, they create jobs here ... It's hard, bloody hard. But it's possible".

In short, there are two legs to **RePowerEU**, first, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and, second, the dash to accelerate renewable electrical energy deployment.

Notably, Mr Timmermans included nuclear reactor electrical energy power generation in the thinking. This is consistent with the **Green Taxonomy** and the positions of both France and the Netherlands since the start of 2022. The attached [link](#) links to the detail of **RePowerEU**.

The **RePowerEU**, is consistent with (some may say follows) the progress that has been made in recent times in **EU** countries, in particular in northern Europe.

On **March 3, 2022**, the **IEA** published [A 10 Point Plan to Reduce EU Reliance on Russian Natural Gas](#). The first five points in the plan (dealing with macro issues) are entirely consistent with **RePowerEU**.

On **March 11, 2022**, The Oxford Institute For Energy Studies published [Potential development of renewable hydrogen imports to European markets until 2030](#). The OIES publication is both timely and thought provoking, and, as ever with publication from **OIES**, well-worth a read.

- **Energy Transition in action:**

As noted in recent editions of Low Carbon Pulse (and above) the German Federal Government is progressing a multi-stream strategy to accelerate to 100% renewable electrical energy by 2035 while at the same time diversifying the sources of natural gas (critically, the importation of LNG from diverse sources). The Dutch

Government has a €35 billion transition fund, including €15 billion for "advanced renewable energy carriers", with a working assumption that the Dutch Government will earmark around €5 billion of the €15 billion for Green Hydrogen production. Germany and the Netherlands continue to lead the European hydrogen race.

• **LNG receiving terminals as part of energy transition:**

- **Edition 36** of Low Carbon Pulse reported on the re-enlivening plans in Germany (under **LNG Terminals progressing**) to develop two LNG receiving terminals at Wilhelmshaven (Uniper) and at Brunsbüttel (Gasunie and Kreditanstalt für Wiederaufbau (**KfW**)) so as to ensure diversified sources of natural gas imported as **LNG**. On **March 8, 2022**, it was reported widely that Enel, giant Italian utility, is to revisit plans to develop **LNG** receiving terminal south of Rome, to allow it to source natural gas from diversified sources.

As noted above, the development and deployment of LNG receiving terminals offers a medium term means of energy transition, and energy security. As noted in various editions of Low Carbon Pulse, energy transition, and progress to **NZE**, requires natural gas, and policy settings that recognise this will allow the development of sufficient natural gas resources, and as such mitigate against energy cost / price variability that has become the norm absent policy settings of this kind.

• **Continued progress in the development of LNG receiving terminals:**

- On **March 23, 2022**, Germany agreed a long-term contract with Qatar to take **LNG**.
- On **March 23, 2022**, **German LNG Terminal announced** that it had signed a memorandum of understanding under which it will contract long-term for capacity in the Brunsbüttel LNG receiving terminal project, having 165,000 m³ of storage capacity and two berths capable of accommodating Q-Max (266,000 m³) **LNG** carriers.
- On **March 25, 2022**, the German Federal Minister for Economic Affairs and Climate Action, Mr Robert Habeck announced that the German Federal Government had promoted securing three floating storage and regasification units (**FSRUs**) for use by RWE and Uniper (each corporation contracting under time-charterparties for the **FSRUs**).

The speed with which the German Federal Government has continued to act to secure alternative supplies of LNG has been exemplary.

- **Policy settings proceeding at the same rate as the practical:** On **March 25, 2022**, the German Federal Government issued a report entitled **Energy Security Progress**. In the report, the German Federal Minister for Economic Affairs and Climate Action states:

"The Federal Government has opted for three floating LNG terminals ... via the companies RWE and Uniper in order to increase [further] security of supply in Germany. The companies are currently in contract negotiations for the leasing of these floating LNG terminals. These negotiations are in the home stretch".

In summary, since the end of February 2022: Gasunie and **KfW** (acting on behalf of the German Federal Government) have agreed in principle to develop an LNG receiving terminal at Brunsbüttel; Uniper is developing an LNG receiving terminal at Wilhelmshaven; and RWE has announced that it will develop an ammonia import facility at Brunsbüttel.

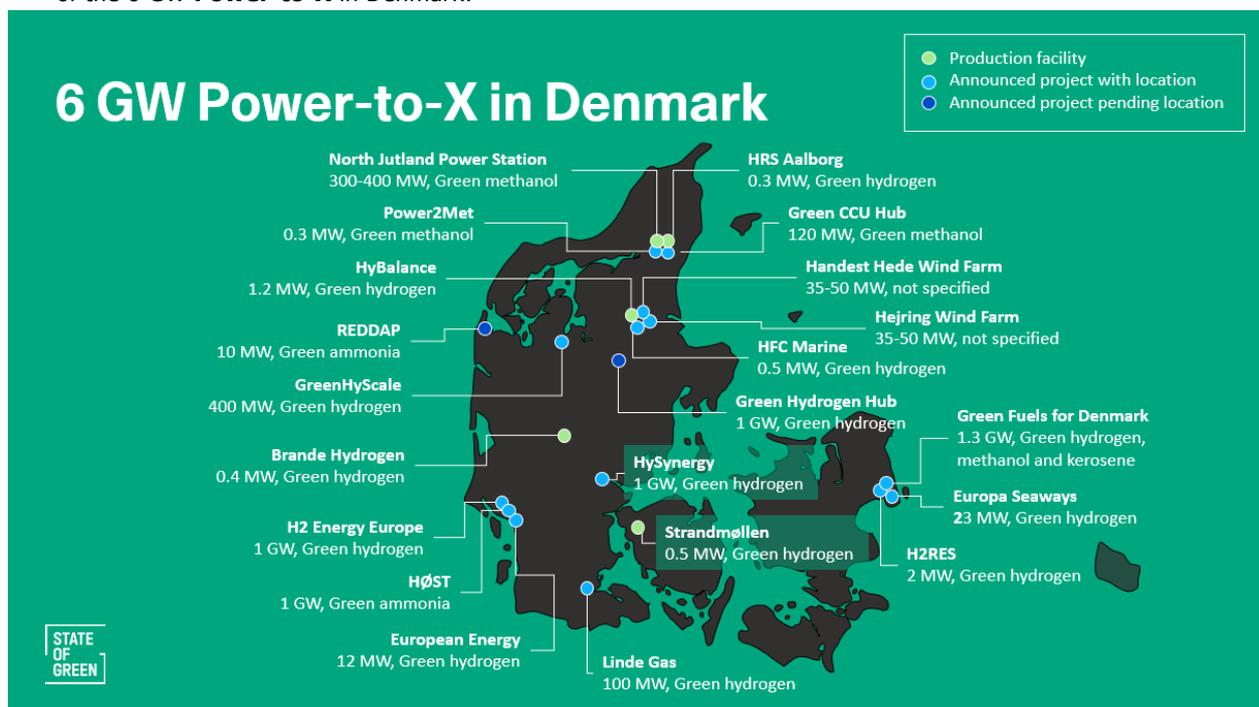
- **Cluster sequencing Phase 2:** On **March 22, 2022**, the UK Department for Business, Energy & Industrial Sector issued a **notice** (entitled **Cluster sequencing Phase-2: eligible projects (power CCUS, hydrogen and ICC)** detailing the projects that had satisfied the eligibility criteria (outlined in **Phase-2 guidance**) for **Phase-2** progress. As outlined in previous editions of Low Carbon Pulse, on May 7, 2021, the UK Government launched its carbon capture, usage and storage (CCUS) cluster sequencing process to identify and to sequence CCUS clusters suitable for deployment in the mid-2020s. The East Coast Cluster and HyNet Northwest were selected and sequenced into Track-1 clusters. The Scottish Cluster was announced as the Reserve Cluster. See **Edition 29** of Low Carbon Pulse for summary. **Edition 30** of Low Carbon Pulse reported that: "On November 8, 2021, the UK Government called for submissions from organisations wanting to take part in **Phase 2 of the CCUS Cluster Sequencing Process**. Phase-2 is stated to be "open to Power, Industrial Carbon Capture and Hydrogen production projects which meet the technology specific eligibility criteria."

Edition 33 of Low Carbon Pulse reported on the process for, and progress of, submissions to apply for Power Carbon Capture (CC), Hydrogen and Industrial Carbon Capture (ICC), to connect either to Track-1 cluster or to the Reserve Cluster or as part of the Phase-2 cluster sequencing process. **Edition 33** also noted that as the Phase-2 cluster sequencing process progressed, Low Carbon Pulse would report on that progress.

The following table identifies the projects that have satisfied the eligibility criteria for **Phase-2**:

CO2 CLUSTER	POWER CCS	HYDROGEN	INDUSTRIAL CARBON CAPTURE
East Coast Cluster:	VPI Humber Zero; Whitetail Clean Energy; Net Zero Teesside Power; Alfanar CCGT Teesside; Keadby 3 CC Power Station and C.Gen Killingholme	N2NorthEast; Uniper Humber Hub Blue Project; bpH2 Teesside and Hydrogen to Humber (H2H) Saltend	STV 1,2 and 3 Energy from Waste CC projects; Tees Valley Energy Recovery Facility Project; Altalto Immingham waste to jet fuel project; Lighthouse Green Fuels; Redcar Energy Centre; Humber Zero Refinery; Prax Lindsey Refinery; ZerCal250; Teesside Hydrogen CC; Saint-Gobain Glass CC; Norsesea CC; CF Fertilisers Billingham Ammonia CCS; Teesside Green Energy Park, and North Lincolnshire Green Energy Park
HyNet Northwest	Making Net Zero Possible – Grain	Project Cavendish & HyNet Hydrogen Production Project	Viridor Runcorn Industrial CCS; Protos Biofuels and Energy Recovery; Hanson Padeswood Cement CCS; CF Fertilisers Ince CC Plant; Buxton Lime Net Zero; EssarOil UK CCU; and Emerge CCS
Scottish Cluster	Peterhead Carbon Capture Power Station	Acorn Hydrogen & Fife Hydrogen Hub	CO2 Extraction form St Fergus Gas and SAGE Terminal and Acorn Capture

- **UK ETS Development Review:** On a busy week for the UK Department for Business, Energy & Industrial Sector, on **March 25, 2022**, it announced an [Open consultation - Developing the UK Emissions Trading Scheme \(UK ETS\)](#), with the link taking the reader to the document outlining the matters under consideration. As the title suggests, the consultation is open to all, with the UK Government announcing that the consultation will be of particular interest to corporations in the agricultural, aviation, maritime, power, and waste sectors, and those involved in **GHG** abatement and removal. The open consultation process closes at 11.45 pm on June 17, 2022.
- **All is well in the Kingdom of Denmark:**
 - **Denmark Power-to-X:** In Denmark, the concept of **Power-to-X** is well-established, and becoming part of the framework for progress towards the achievement of **NZE**. In December 2021, the Danish Government launched a strategy to develop **Power-to-X** (see **December and January Report on Reports** in the [Second Compendium of Low Carbon Pulse](#)).
 - In this context, the Danish Government has earmarked funding support for the development of **Power-to-X** capacity development, critically the development of electrolyser capacity, with the policy setting target being the development and deployment of between 4 GW and 6 GW of production capacity.
 - **Principal objectives:** There are four objectives to the promotion and development of **Power-to-X** capacity in Denmark, as follows: **1. Power-to-X** must contribute to achieving the objectives in the Danish Climate Act; **2.** It is necessary to develop the framework and infrastructure for the **Power-to-X** sector to develop; **3.** It is necessary to improve the interface between the current energy system and the **Power-to-X** sector; and **4.** Denmark must be able to export **Power-to-X** products and technologies. The following map provides an overview of the 6 GW **Power-to-X** in Denmark.



Americas:

This section considers news items that have arisen within the news cycle of this **Edition 37** of *Low Carbon Pulse* relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.

- **Stitching together renewable energy seams:** On **March 8, 2022**, [cleantechnica.com](#) published an article authored by Ms Tina Casey. The article is well-worth a read, both for the outline of plans and for the optimism that the plans engender. The article notes that the US' massive off-shore wind resources are "finally in the pipeline" (see **Editions 2, 7, 8, 20, 21, 26**, and **30** of *Low Carbon Pulse*) and the "land-based renewable energy profile is about to get a shot of adrenaline".
- The "shot of adrenaline" is sourced from plans of two leading transmission system operators (the **Midcontinent Independent Power System Operator** or **MISO** and the **South West Power Pool** or **SPP**) "to stitch together" their systems, and in doing so "opening a bottleneck that has held back wind and solar developers for years".
- The thinking (which is continuing to develop) is based on the [Interconnections Seam Study](#), with the core idea being the efficiency benefits of uniting the Eastern and Western US transmission systems. After further work by **MISO** and **SPP**, seven projects have been identified (having a combined cost of USD 1.65 billion) in a **Joint Interconnection Queue Study (JIQS)** that contemplates the stitching together of both systems.
- The headline from the **JIQS** is that between 28 and 53 GW of "interregional generation enablement" will arise, and will likely encourage further renewable electrical energy installation.
- In a letter penned by the CEO of **MISO**, Mr John Bear, and the President of **SPP**, Ms Barbara Sugg, it is emphasized that: "**consumer preferences and public policy goals have increased the demand for renewable energy, and, increasingly, our member utilities are moving the progress of those needs**".

- **Louisiana Energy Law:** On **March 9, 2022**, it was reported widely that the Louisiana State Legislature was considering the basis to increase the scale and size of off-shore wind field leases, including how to collect royalties on power generation.
- **Massachusetts Energy Law:** On **March 9, 2022**, it was reported widely that the Massachusetts House of Representatives had passed [Bill H415 \(An Act Advancing Offshore Wind and Clean Energy\)](#) that requires State utilities to enter into long-term contracts for electrical energy generated by off-shore wind fields in an amount "**equal to ... 5,600 megawatts of aggregate nameplate capacity not later than June 30, 2027**".

Having passed through the House of Representatives, the Bill needs to be signed by the Governor of Massachusetts before becoming law.

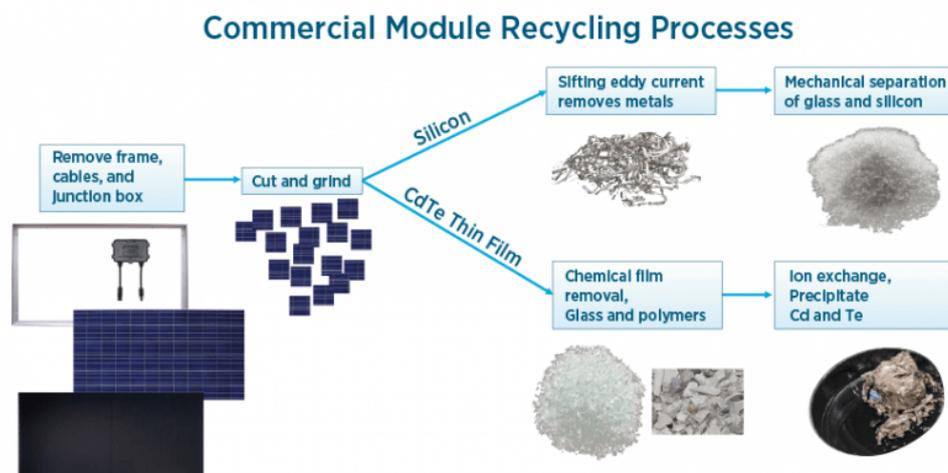
As might be expected, the Bill establishes an **Off-shore Wind Transmission Working Group** that will allow the augmentation and expansion of the transmission grid to realise the benefits of this initiative. As noted in previous editions of Low Carbon Pulse, transmission systems need to be augmented and expanded well-ahead of the generation of renewable electrical energy coming on-line.

- **Hubbub among the States:**

- **Edition 35** of Low Carbon Pulse reported that the US **DOE** had "gone-live" on the implementation of the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**. Going live involves rolling-out the initiatives in the **IIAJA**. The largest hydrogen program in the **IIAJA** provides the US **DOE** with USD 8 billion to provide support for **at least four hydrogen hubs** that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO₂** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.
- **Edition 36** of Low Carbon Pulse reported (under **Mountain States Hub**) that **Colorado, New Mexico, Utah** and **Wyoming** had signed a memorandum of understanding to develop a regional clean Hydrogen Hub, and in so doing, position more effectively to seek funding from the **Infrastructure Investment and Jobs Act (IIAJA)**.
- **Mississippi States Hub:** **Arkansas, Louisiana and Oklahoma** are reported to be progressing with a like initiative to create a bipartisan three-state bloc to develop a **regional clean Hydrogen Hub**.
- **West Virginia gets in first:** On **March 22, 2022**, it was reported widely that the State of West Virginia, through the **West Virginia Hydrogen Hub Coalition** had submitted a proposal to the US **DOE** seeking funding to develop a hydrogen hub in the State.
- **Northeast Hydrogen Hub:** On **March 24, 2022**, the Governor of New York State, Ms Kathy Hochul indicated that New York, together with Connecticut, Massachusetts and New Jersey, and 40 hydrogen ecosystem partners, were combining for the purposes of seeking to become one of at least four regional clean hydrogen energy hubs.

For the **Mountain States Hub, Mississippi States Hub, West Virginia Hydrogen Hub** and **Northeast States Hub**, the development of a Hydrogen Hub represents an opportunity to take advantage of their natural advantages.

- **Peru H2:** On **March 11, 2022**, **H2 Peru** (the **Hydrogen Industry Association in Peru**) presented its hydrogen strategy roadmap entitled [Bases and Recommendations for the elaboration of the green hydrogen strategy for Peru \(HSR\)](#) (the roadmap report is in Spanish). The **HSR** provides a roadmap for Peru to become a global scale producer of hydrogen.
- **US DOE five-year plan for NZE Waste from PV:** On **March 18, 2022**, the US **DOE** had released an [action plan](#) for the safe and responsible handling of photovoltaic solar panel end-of-life (**EOL**) materials. While the design-life of photovoltaic panel **EOL** materials is 30 years, photovoltaic solar panels have been installed for some time, and getting ahead with a plan for their **EOL** is well-timed.



Photovoltaic solar panels comprise cadmium telluride and silicon. Around 95% of each solar panel is recyclable, with the cost between 9 and 15 times the cost of disposing to landfill.

- **Canada Climate Change Report:** On **March 23, 2022**, Canada's [Changing Climate Report in Light of Latest Global Science Assessment \(Climate Change Report or CCR\)](#) was published. The **CCR** is a supplement to Canada's 2019 Changing Climate Report, updating the earlier report to take into account the findings of the [IPCC Working Group I Climate Change 2021: The Physical Science Basis](#).

- **Alberta picks six:** On **March 31, 2022**, it was reported widely that the province of Alberta, Canada, had selected six proposals to progress in the process to develop the first carbon storage hubs in Canada. It is understood that proposals from the follow are to progress: Bison Low Carbon Ventures, Enbridge Inc., (see **Editions 23** and **34** of Low Carbon Pulse), Enhance Energy, Pembina Pipeline Corporation and TC Energy (in joint venture), Shell and Wolf Carbons Solutions.

France and Germany:

*This section considers news items within the news cycle of this **Edition 37** of Low Carbon Pulse relating to France and Germany. Within the news-cycle for this **Edition 37**, the news-items have come thick and fast.*

- **Germany earmarks €200 billion by 2026:** On **March 7, 2022**, the German Finance Minister, Mr Christian Linder, [announced](#) plans to provide funding to enable German industry to accelerate progress towards **NZE**, including funding to accelerate the development of hydrogen technology and to allow the build-out of battery electric vehicle (**BEV**) recharging infrastructure.

By way of reminder: **Edition 36** of Low Carbon Pulse reported as follows:

"The German Federal Government wants to progress to 100% renewable electrical energy by 2035. The accelerated target contrasts with the previous target of moving away from fossil fuels "well before 2040".

To achieve this goal the German Federal Government is understood to be progressing amendments to the Renewable Energy Sources Act (**EEG**). It is understood that the **EEG** is ready, and that it will contemplate (and provide a path to) the achievement of photovoltaic solar and wind power reaching 80% of electrical energy used by 2030.

By 2030, it is expected that Germany's on-shore wind farm capacity will have doubled to 110 GW of installed capacity, with off-shore wind field capacity to reach at least 30 GW of installed capacity (equivalent to the output of 10 nuclear energy power stations). Photovoltaic solar installed capacity is planned to reach 200 GW by 2030."

- **Germany and Australia open incubator:** On **March 8, 2022**, Germany and Australia progressed their combined policy settings and as a result opened the [Innovation and Technology Incubator \(HyGate\)](#). It is hoped that **HyGate** will promote Australian and German participants to work together to develop new, and to improve existing, technologies, with the ultimate purpose of reducing the cost of production of hydrogen.

By way of reminder: **Edition 20** of Low Carbon Pulse reported on the bi-lateral alliance agreement signed by Germany and Australia relating to hydrogen production, trade in hydrogen, and the facilitation of a renewable energy-based hydrogen supply chain between the two countries. **Edition 31** of Low Carbon Pulse discussed the formation of **HyGATE**; **HyGATE** being one of three initiatives contemplated in the [Australia-Germany Hydrogen Accord](#) that signed in June 2021.

- **French State Support for Normand'Hy:**

- **Funding support on time:**

On **March 8, 2022**, it was reported widely (and announced by Air Liquide) that it had received funding support from the French Government.

The **CEO and Chair of Air Liquide, Mr Benoît Potier** said:

"Air Liquide Normand'Hy is at the heart of a vast ecosystem whose ambition is to decarbonise the Normandy industrial basin, notably by giving access to a low-carbon hydrogen network to major industrial companies such as TotalEnergies, but also contributing to the development of low-carbon heavy duty mobility on the Axe Seine".

As noted below (under **France promotes 15 major H2 projects**), Normand'Hy is one of 15 projects in respect of which [Important Project of Common European Interest](#) is sought.

- **Edition 29** of Low Carbon Pulse reported as follows (under **The road to Normand'Hy**):

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

The Green Hydrogen production facility is located within the Normandy carbon cluster / industrial basin, with Air Liquide intending to supply Green Hydrogen to industrial customers and to the mobility / transport sector.

The Green Hydrogen production facility will connect to Air Liquide's existing hydrogen pipeline network in Normandy."

It will be noted that a final investment decision of Air Liquide was dependent on the provision of funding support.

- **France promotes 15 major H2 projects:**

- On **March 9, 2022**, the French Government announced a list of 15 major hydrogen projects to submit to the **EC** each to be designated as an [Important Project of Common European Interest \(IPCEI\)](#).

The map below provides detail of the location of each of the 15 projects. The 15 projects will require €7 billion in investment in the medium term, including €2 billion in funding support.

- The **15 projects** may be **grouped into three categories:**

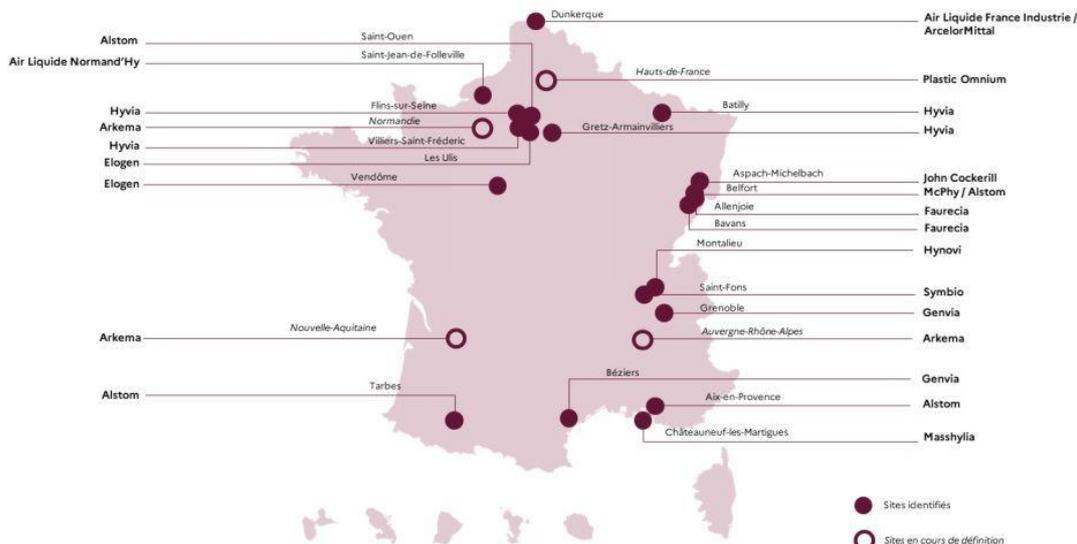
- **Giga-factory developments for electrolysers:** Elogen (see below under **Elogen to establish giga-factory**), Genvia, John Cockerill and McPhy;

- **Manufacture for mobility:** fuel cells (Alstom, HYVIA and Symbio), tanks (Faurecia and Plastic Omnium) and key components (Arkema); and

- **Hydrogen production capacity:** Air Liquide's Normand'Hy project (see above) and the Dunkirk iron and steel project (see **Edition 34** of Low Carbon Pulse), Hynovi (Hynamics and VICAT) and Masshylia (Engie and TotalEnergies).

Les 15 grands projets hydrogène que la France soumet à la Commission européenne dans le cadre du PIIEC

(en jeu, un total de près de 7 milliards d'euros d'investissements,
dont près de 2 Md€ de subventions publiques)



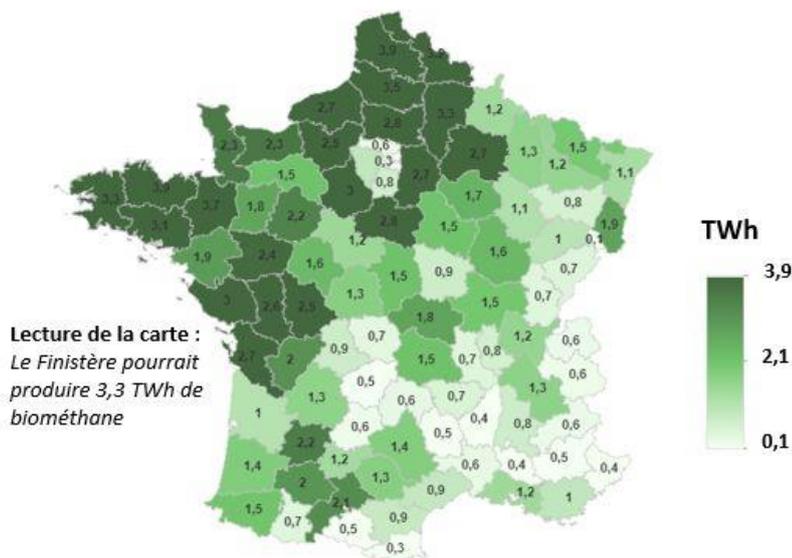
- France's role in bio-gas and bio-methane production:** As noted above, there are two legs to **RePowerEU**, near to medium term energy security (through diverse sources of natural gas supply, delivered into the **EU** as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and the dash into renewables. As regular readers of Low Carbon Pulse will have noted, biogas and biomethane production has received increasing coverage.

On **March 10, 2022**, the author came across a map of France providing an indication of the potential for France to produce biogas and bio-methane. The headline notes that France could derive up to 320 TWh of electrical energy a year from the use of various technologies to derive and to produce biogas and biomethane as follows: Methanization – 130 TWh; Pyro-gasification – 90 TWh; Hydrothermal gasification – 50 TWh; and Methanation 50 TWh. It is understood that current natural gas energy use equates to 475 TWh a year.

The sources of feedstock for the derivation and production of bigas / biomethane are organic, including from municipal solid waste, crop residues, livestock manure, agri-food industry waste, biowaste, and sludge from waste water.

Potentiel de gaz pouvant provenir de méthanisation en France

Potentiel réaliste de biométhane (en TWh) pouvant être produit par département (hors culture énergétique). Le cumul est égal à 130 TWh.



SOURCE : OPEN DATA RESEAU ENERGIE, 2022

[**Note:** For further information and background, please connect to the [Ashurst Waste Compendium](#)]

- **Germany and Norway aligned:**

- On **March 17, 2022**, it was reported widely that Germany and Norway had discussed the feasibility of the transportation of hydrogen produced in Norway, via pipeline, for delivery to Germany. It is understood that the use of Blue Hydrogen (near to medium term) and Green Hydrogen (medium to long term) is being considered.
- On **March 16, 2022**, a Joint Statement was released as follows:

"Norway wants to [contribute actively] to the rapid development of the hydrogen market in Germany and the EU. To this end, it has been agreed that a joint review will be conducted with a view to make large-scale transport, including via pipeline, of hydrogen from Norway to Germany possible.

We plan to [commission rapidly] a joint feasibility study on this. Germany would like to see Norway become a future partner for the production and supply of hydrogen. In order to realise the fastest possible high-volume imports of hydrogen and ensure rapid availability thereof, [also jointly] we will plan the use of Blue Hydrogen for a transition period.

In this context, we will ensure environmental and climate integrity by establishing for example the highest possible standards of Carbon Capture and Storage".

For the author, this is an early contender for a definitive statement for the theme and trends of 2022 – acceleration and pragmatism.

- **ICE on ice:** On **March 15, 2022**, it was reported widely that Germany had agreed to align with the **EU** to cease the sale of internal combustion engine (**ICE**) vehicles (cars and vans) fuelled by motor spirit (gasoline / petrol) and diesel by 2035, and like e-Fuels.

The following [link](#) provides the **EU** policy setting on the cessation of the sale of **ICEs**.

- **RWE and OGE plan hydrogen backbone:** On **March 24, 2022**, it was reported widely that RWE (the German renewables electrical energy giant) and OGE (a German TSO) had outlined their plans to roll-out hydrogen infrastructure to produce and transport hydrogen, including a 1 GW electrolyser and a 1,500 kilometre, hydrogen pipeline system (the **H₂ercules Project**).

It is reported the **H₂ercules Project** will cost around €3.5 billion.



Source: [Hydrogen fast track: OGE and RWE present national infrastructure concept "H₂ercules"](#)

The **H₂ercules Project** will import Green Hydrogen from Belgium, the Netherlands and Norway. With the developments during March 2022, it is estimated that by 2030, Germany may have 30 GW of Green Hydrogen capacity, around three times as that contemplated in July 2020 by the German Federal Government.

- **French Government back development LNG terminal at Le Havre:** On **March 26, 2022**, it was reported by Les Echos that the French Government is considering, with TotalEnergies, the development of facilities at Le Havre, a northern sea port in France, using an **FSRU**.
- **Italy 2, Poland 1:**
 - On **March 28, 2022**, it was reported widely that Italy is considering the deployment of two **FSRUs**.
 - On **March 31, 2022**, it was reported widely that PGNiG (leading natural gas corporation in Poland) had placed an order for an **FSRU** for deployment in Gdansk Bay, Gdansk, Poland.

It is to be expected that the move to LNG and **FSRUs** will continue, and more likely than not, gather pace.

- **Eni SpA CEO on the mark:** Edition [28](#) of Low Carbon Pulse reported that Eni SpA Chief Executive, Mr Claudio Descalzi, was promoting the need for energy security policy. On **March 29, 2022**, Mr Descalzi revisited the issue, saying that Europe is "an empty box", saying that it has never had a well thought-out energy strategy.
- **Germany and the Netherlands aligned:** The Federal Government of Germany, North Rhine-Westphalia and the Federal Ministry for Economic Affairs and Climate Action for the Netherlands commissioned the **Hy3 Project (Decarbonising the Dutch and German Industry through Hydrogen)** involving consideration of what a transnational hydrogen economy may look like in 2050. On **March 31, 2022**, it was reported that the **Hy3 Project** study had been published jointly by Forschungszentrum Julich, Dena, and TNO. As might be expected, the key finding of the **Hy3 Project** study is that cooperation between Germany and the Netherlands, in developing a common hydrogen market and common infrastructure, will boost opportunities to realise a decarbonised regional economy. The **March and April Report on Reports** will consider the **Hy3 Project** study.

Australia:

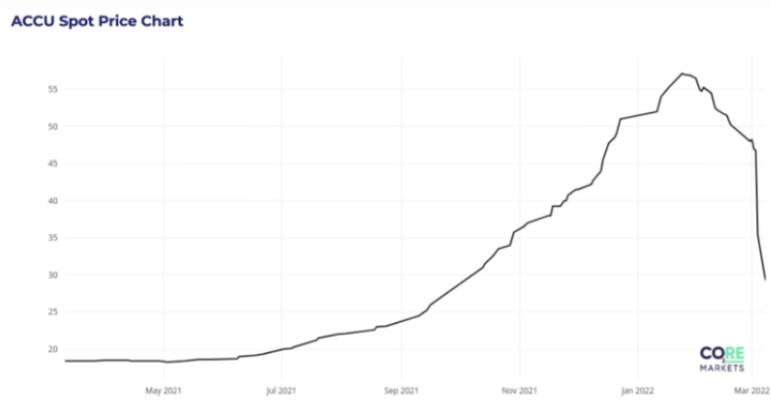
*This section considers news items that have arisen within the news cycle of this **Edition 37** Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita.*

*Australia is however progressing to **NZE** at a faster rate than many other developed countries, and, along with the GCC Countries, is one of four countries rich in solar resources (and wind resources) that appear likely to lead in the development of the hydrogen economy over the next five years (and beyond): Australia, Chile, the **PRC** and Spain.*

- **ACCUs and Emission Reduction Fund:** On **March 4, 2022**, Australian Federal Minister for Industry, Energy and Emissions Reduction, Mr Angus Taylor, announced that Australian Carbon Capture Units (**ACCUs**) could be sold to buyers of carbon credits seeking to deliver on voluntarily assumed commitments to achieve carbon neutrality (the **proposed change**). (The centre piece of the Australian Federal Government's policy settings to achieve **GHG** emission reductions is the [Emission Reduction Fund](#)).

During the week beginning **March 7, 2022**, the implications of the decision of the Australian Federal Energy Minister, Mr Angus Taylor became apparent, and for the balance of the month there was (and no doubt for some time to come, there will be) an increasing focus on the decision of Mr Taylor, and the legislative basis for the grant of **ACCUs**.

The impact on the price of **ACCUs** is illustrated in the following graph (source: [Australia's carbon market in disrepute, attacked from within and without – pv magazine Australia \(pv-magazine-australia.com\)](#))



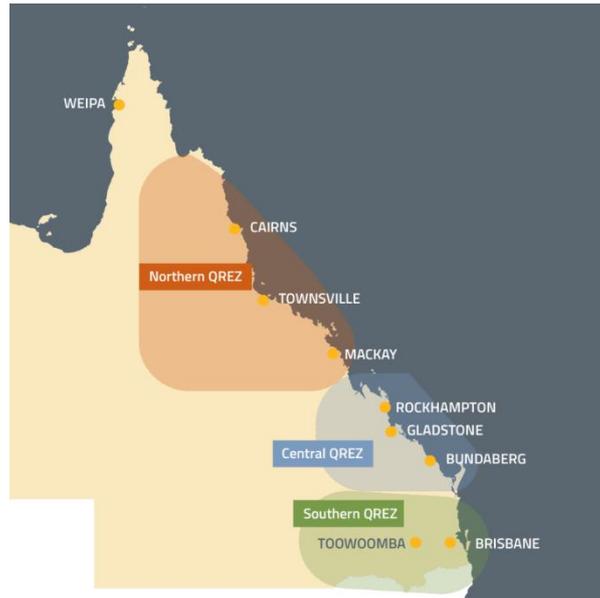
The impact on the price of **ACCUs** may be regarded as unsurprising given the announcement made by Minister Taylor. What has been surprising is the accompanying narrative, in particular from Professor Andrew Macintosh (chair of the Integrity Committee of the Emissions Reduction Fund for six years):

"The available data suggests that 70 to 80% of the ACCUs issued to these projects [i.e., under the Emissions Reduction Fund] are devoid of integrity – they do not represent real and additional abatement".

As might be expected, a number of industry participants and experts have suggested that the Federal Australian Government reconsiders the **proposed change**, including as part of a wider review.

- **Western Australia Legislation:** On **March 9, 2022**, the Western Australian Government [announced](#) that it is drafting the Greenhouse Gas Storage and Transport Bill to help Western Australian to transition to **NZE** by 2050.
- **Port Bonython Hydrogen Hub:** On **March 11, 2022**, the South Australian Government [announced](#) partners for the development of the Port Bonython Hydrogen Hub.
- **Queensland Government confirms thinking on Queensland Renewable Energy Zones:**
 - **Edition 31** of Low Carbon Pulse reported as follows:
 - **"Queensland continuing to deliver:** In November 2021, the Queensland Government released [Consultation on the model for QREZ design and access – Delivering Queensland Renewable Energy Zones](#). The consultation is being undertaken to develop the models for the delivery of the three Queensland Renewable Energy Zones (**QREZs**), Northern, Central and Southern, with the delivery of the **QREZs** being aligned with the achievement of Queensland's commitment to reduce **GHG** emissions by 50% by 2030.
 - There has been a good deal of comment about the consultation paper, with an apparent consensus that more than 3.3 GW of renewable electrical energy contemplated will be required."
 - The **November and December Report on Reports** considered the consultation paper in more detail.

- On **March 14, 2022**, the Queensland Government confirmed the **Central QREZ**, **Northern QREZ** and the Southern **QREZ** as follows:



- NSW Ahead of the curve:** On **March 24, 2022**, it was reported widely that the Government of New South Wales (NSW) has announced an expression of interest process under which interested private sector parties could register interest to develop a standby 700 MW / 1,400 MWh Waratah Super Battery (a **Very Big BESS**).

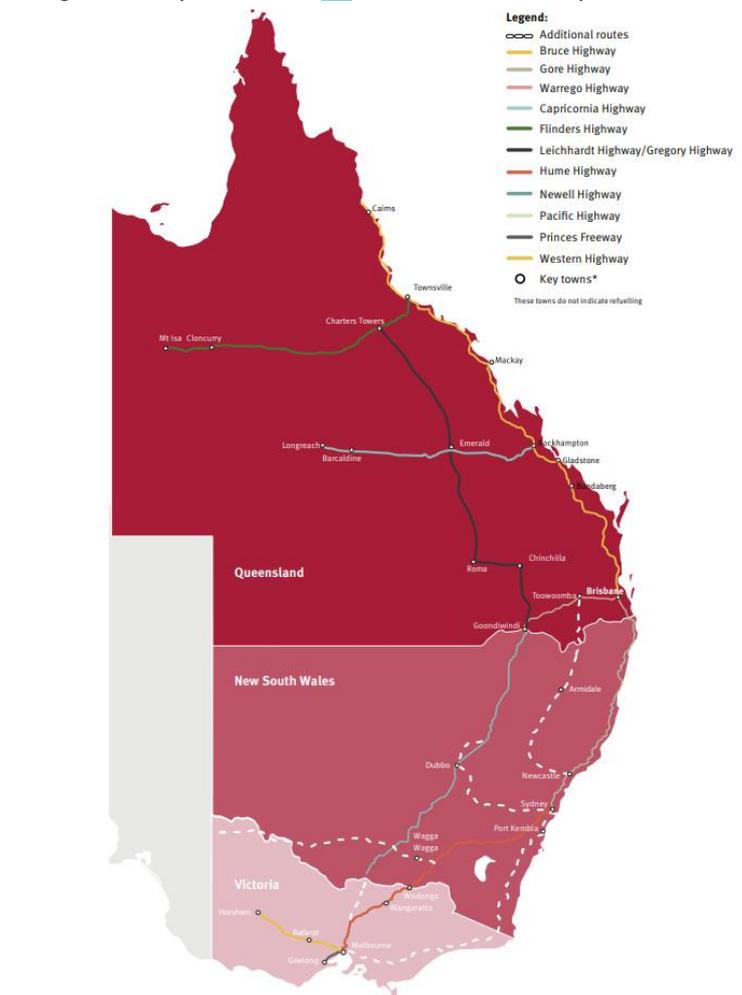
The **Very Big BESS** is to be located on the Central Coast region of NSW and is critical to the maintenance of integrity and stability of electrical energy supply in response to the announcement by Origin Energy of its intention to shutter the 2,880 MW Eraring Coal-fired Power Station in August 2025 (see **Edition 35** of Low Carbon Pulse).

- Eastern Sea-board States – Nation Building (again):** On **March 25, 2025**, it was reported widely that the Governments of the Australian States of New South Wales, Queensland and Victoria are to develop the **East Coast Hydrogen Refuelling Network**.

The timing and the thinking behind the **East Coast Hydrogen Refuelling Network** is clear for all to see, but it is not often that Governments take a lead that works at so many levels, critically to allow the development of supply to satisfy domestic demand that will be encouraged by the development of the Network.

Australia has world class renewable energy resources, and as such the ability to produce hydrogen, but scale is needed, and in the first instance this scale will be achieved through domestic demand.

(Source: [East Coast Renewable Hydrogen Refuelling Network \(hpw.qld.gov.au\)](https://www.hpw.qld.gov.au))



Blue and Green Carbon Initiatives and Biodiversity:

This section considers news items that have arisen within the news cycle of this **Edition 37** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.

- **Blue Carbon report:** On **March 9, 2022**, the [Blue Marine Foundation](#), working with the University of Exeter and support of DP World (global leading cargo logistics, port terminal operations and maritime and landside services) published a report entitled [Blue Carbon In the United Kingdom](#). The report is well-worth a read.
- **Blue Carbon, Sindh Province, Pakistan:** On **March 10, 2022**, Respira International [announced](#) that it had purchased some of the first tranche of carbon credits (Delta Blue Carbon Project (DBC-1)), together with Carbon Growth Partners and Trafigura. The source of the carbon credits are the world's largest mangrove swamp restoration project, and as such a leading Blue Carbon project: it is understood that the Delta Blue Carbon Project is restoring more than 73,000 hectares of degraded mangrove swamps and tidal wetlands.

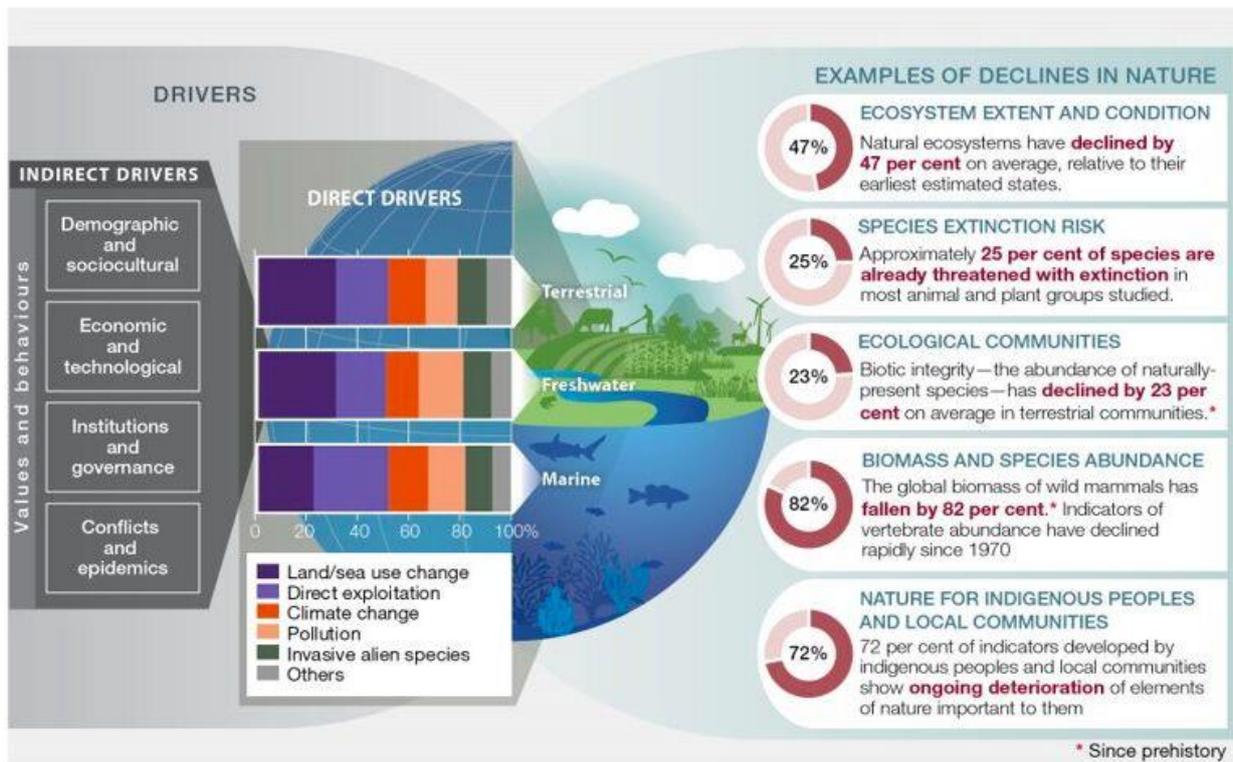
The Delta Blue Carbon Project has been developed by [Delta Capital](#), the Government of Sindh and [Pollination Group](#).

Soil loss: In a [study](#) (from the University of Massachusetts Amherst) published in the [Earth's Future](#) journal, it is stated that since the mid-1900s in the mid-west US, on average, two millimetres of soil has been lost each year (the **Soil Loss Study**). Stated by mass, this is 56 billion tonnes of soil in total.

While some of the findings in the study continue to be tested, it seems that the cause of soil loss is clear, the use of ploughing technology has contributed materially and significantly.

If one sits the findings of the **Soil Loss Study** alongside the finding from a study from [Nature.com](#) (entitled **Relocation croplands could drastically reduce the environmental impacts of global food production**) it is possible to discern patterns, and to develop thinking around longer-term planning.

- **Bioplastic whitepaper:** On **March 15, 2022**, Carbion and TotalEnergies published [Sustainable sourcing of feedstocks for bioplastics](#) – Clarifying sustainability aspects around feedstock use for the production of bioplastics. For those interested in plastics generally, and bioplastics in particular, the publication is excellent.
- **Biodiversity paper:** On **March 15, 2022**, **UNEP-WCMC** published the following infographic. The infographic provides a helpful snap-shot summary of the factors that impact biodiversity, directly and indirectly.

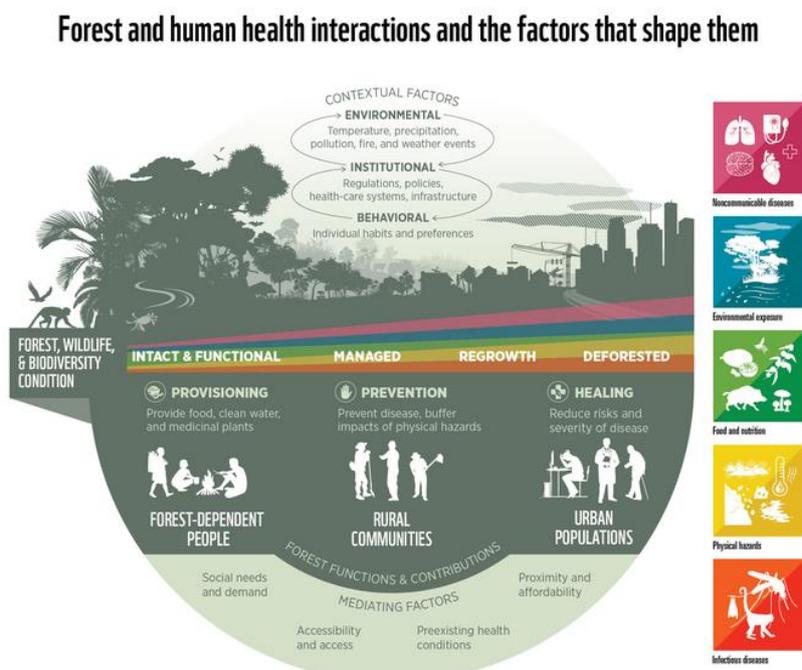


Examples of global declines in nature, emphasizing declines in biodiversity, that have been and are being caused by direct and indirect drivers of change (IPBES, 2019)

- **Blue Carbon in Indonesia:** On **March 16, 2022**, [EcoShape](#) published [Building with Nature in Indonesia: Restoring an eroding coastline and inspiring action at scale \(2015-2021\)](#). The publication outlines the action taken to restore coastline in Central Java that has been eroded. The action taken allows the stabilization of coastline so as to allow mangroves to seed and to grow, and, overtime, to develop (to some, to restore) aquaculture options. The publication is well-worth a read, in particular for countries in South East Asia and across the Pacific.
- **30% of land preservation:** In recent months, there has been a growing acceptance of the need to preserve at least 30% of land mass of each country to its natural or wild condition, or to restore land mass so as to achieve this goal. The thinking on this policy setting is not new, but it appears to have become a plank of policy setting. The thinking on this policy setting, and the 30% goal, will allow conservation of biodiversity and contribute to the capture of **CO₂**, and in so doing mitigate the effect of climate change. The preservation of at least 30% of land mass will safeguard the **CO₂** stored in the biosphere and over time increase the **CO₂** stored (see the United Nations Environment Programme World Conservation Monitoring Centre (**UNEP-WCMC**) report entitled [Strengthening](#)

[Synergies: How action to achieve post-2020 global biodiversity conservation targets can contribute to mitigating climate change](#)).

- **International Day of Forests (or International Forest Day): March 21, 2022**, was International Day of Forests. As noted in **Edition 33** of Low Carbon Pulse, life on earth is a result of forests, and as such the preservation of forests, stopping deforestation, and progressing afforestation and reforestation are existential. As might be expected, an array of publications arose to mark the day, including UN Climate Change publication, [Why Forests are our biggest ally in tackling the climate crisis – And why we should begin to treat them like one](#), and the [Respira International](#) publication, [Why invest in forest conservation first](#). The following graphic provides a helpful reminder:



(Source: World Wildlife Fund, [How Forests Provide, Prevent and Heal | Blog Posts](#))

By way of background, attached is a [link](#) to the **Global Biodiversity Outlook 5** (the flagship publication of the Global Biodiversity Outlook) that summarises data on biodiversity, noting that forests provide one of frameworks for biodiversity – Land and Forests.

- **Blueprint For Nature:** From **March 14 to March 29, 2022**, the **Open-ended Working Group on the Post-2020 Global Biodiversity Framework** met in Geneva, Switzerland. The purpose of the meeting was to advance work on the development of the **Global Diversity Framework**, with the purposes of the **Global Diversity Framework** to address the loss of habitat and resulting loss of biodiversity.

As noted in **Editions 33** and **34** of Low Carbon Pulse, later in 2022, the second part of **COP 15** will take place in the **PRC**. During the first part of **COP-15** the [Kunming Declaration](#) was adopted, addressing bio-diversity loss.

As might be expected, the **Open-ended Working Group** was accompanied by multiple narratives – for example, Wetland International continued to emphasise the importance of wetlands (covering 7% of land mass, and home to 40% of the world's diversity). On **March 23, 2022**, Wetland International published an [article](#) on the key issues for wetlands in the context of the development of the **Global Diversity Framework**.

On **March 29, 2022**, a [press release](#) was published, noting progress around targets and supporting mechanisms. It is clear however that a good deal of work needs to be done ahead of, and at, the second part of **COP 15**.

Bioenergy and heat-recovery:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass. **Bioenergy** includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form. In addition, recovered heat and waste heat (derived from any source, including waste water) has been added to this section.

From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67% of energy arising is wasted. The increased awareness of sourcing heat reflects increased awareness of the energy used to heat buildings, and its source: heating buildings results in around 25% of total final energy demand, with around 75% of the feedstock used to satisfy that energy demand derived from fossil fuels.

- **Biogas and Biomethane:** As noted above, there are two legs to the **RePowerEU** policy settings, near to medium term energy security (through diverse sources of natural gas supply, delivered into the EU as liquified natural gas (**LNG**) and increased production of bio-gas and bio-methane within the **EU**) and the dash into renewables.

The role that biogas and biomethane has to play is likely to increase, and to do so dramatically in the near to medium term as renewable sources of feedstock are sought and used to derive or to produce biogas / biomethane as part of the means of assuring near to medium term energy security in the **EU**. By some estimates, by 2030 up to 35 billion m³ of biogas / biomethane may be derived or produced, and by 2050 up to 100 billion m³.

Continuing the theme of clear policy settings, it would make sense for the Renewable Energy Directive to contemplate the role of biogas / biomethane specifically.

- **Fortum and Microsoft – world first:** On **March 17, 2022**, Fortum [announced](#) that it had entered into a unique project with Microsoft, with Fortum (Finnish state-owned utility company) to capture excess heat generated by a new data centre region to be built by Microsoft in Helsinki, Finland.

The data centres will use electrical energy from renewable sources, and the clean heat arising from the data centres will be used to heat premises that are connected to the Fortum district heating system. The location for the data centres was chosen to allow the capture of clean heat, and its use in the district heating system.

As President and CEO of Fortum, Mr Markus Rauramo said:

"Sometimes the most sustainable solutions are the simple ones: by tapping into waste heat from data centres, we can provide clean heat for homes, businesses and public buildings in Espoo's and the neighbouring communities district heating network in Finland, and reduce about 400,000 tonnes of CO₂ emissions annually".

- **Repeat of TotalEnergies' infographic:** It would not be an edition of Low Carbon Pulse without an excellent infographic from the good folk at TotalEnergies.

Edition 34 included an infographic entitled [TotalEnergies' Aerobic Digestion Ecosystem infographic](#). **Edition 35** of Low Carbon Pulse included an infographic entitled [Hydrogen Production Ecosystem](#).

As a sibling to the **TotalEnergies' Aerobic Digestion Ecosystem infographic**, the infographic below provides an excellent overview of a biogas plant using anaerobic digestion technology to derive biogas from organic biomass (feedstock). Given the increased focus of bioenergy (including biogas and biomethane, we have repeated it.

The biogas produced from the plant is itself feedstock for the production of biomethane (in the US referred to as **Renewable Natural Gas** or **RNG**), which can be compressed to produce compressed natural gas or **Bio-CNG** or liquified to produce **Bio-LNG**.



Attached is a [link](#) to the Ashurst Waste to Wealth Compendium including articles on waste, waste technologies, and anaerobic digestion.

BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "**BESS** storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events". The **November and December Report on Report** provides a summary of the LDES Council and McKinsey report from November 2021 (see [Second Compendium of Low Carbon Pulse](#))

- **RWE develops HESS:** On **March 7, 2022**, it was reported widely that RWE (the German electrical energy giant), through RWE Gas Storage West, plans to develop a **HESS** at Kottiger Hook in Gronau, Germany by 2027. The **HESS** will use an underground salt cavern, with connection to above ground dispatch storage.

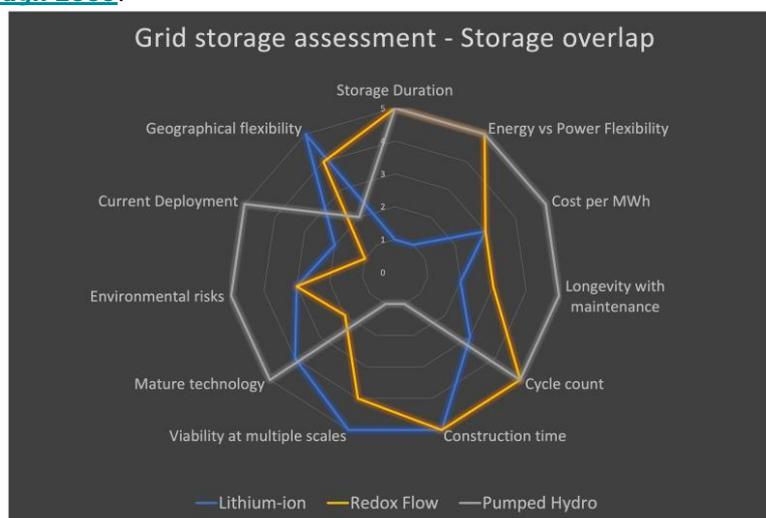
As noted in previous editions of Low Carbon Pulse, the development of **HESS** is key to the development of the hydrogen ecosystem. By way of background, the following link is to a [British Geological Survey](#) article (entitled **Safe storage of hydrogen in porous rocks: the challenges and the knowledge gaps**), which is an excellent primer.

- **AGL Energy gets green light for green project:** On **March 8, 2022**, it was reported widely that AGL Energy (one of the three large integrated energy corporations in Australia), had been given approval to develop and to deploy a 500 MW / 2000 MWh **BESS** at the site of the Liddell coal-fired power station in the Hunter Valley, New South Wales (the Liddell coal-fired power station to be shuttered completely by 2023, with shut-down of units having commenced).
- **Quidnet Energy:** On **March 9, 2022**, [cleantechnica.com](#) reported (under [High Pressure Water Energy Storage Coming to San Antonio](#)) that it intends to develop a Geothermal Pumped Storage (**GPS**) facility in San Antonio, Texas, having signed a 15 year agreement with **CPS Energy** (the municipal electric utility serving the city of San Antonio).

GPS uses Quidnet Energy technology (based on technology developed by the oil and gas industry), with water pumped underground, for these purposes using excess renewable electrical energy, which water is stored under pressure, with the water then released from storage to drive hydroelectric turbines to generate renewable electrical energy. (Quidnet Energy has backing from [Breakthrough Energy](#).)

- **Grid Storage Assessment:** On **March 15, 2022**, the author came across the following graphic providing a basis for the assessment of storage means and solutions across a grid.

The graphic is taken from an excellent article by Michael Bernard entitled [Longer term grid storage is a massive growth market through 2060](#).



Source: [illumine.com](#)

- **CIP and Alcemi make gold:** On **March 15, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) and Alcemi had combined to develop 4 GW of **BESS** across the UK. It has been reported that **CIP** will lead procurement and development activities, with the first **BESS** to be energised in 2023.
- **EDF Pivot Power BESS:** On **March 22, 2022**, it was reported widely that Pivot Power (a subsidiary of EDF) has been granted approval to develop and to deploy two **BESSs** (each of 50 MW / 100 MWh) in the UK – one at Sundon, Luton (to go live in 2023), and the other at Indian Queens, Cornwall (to go live in 2024).

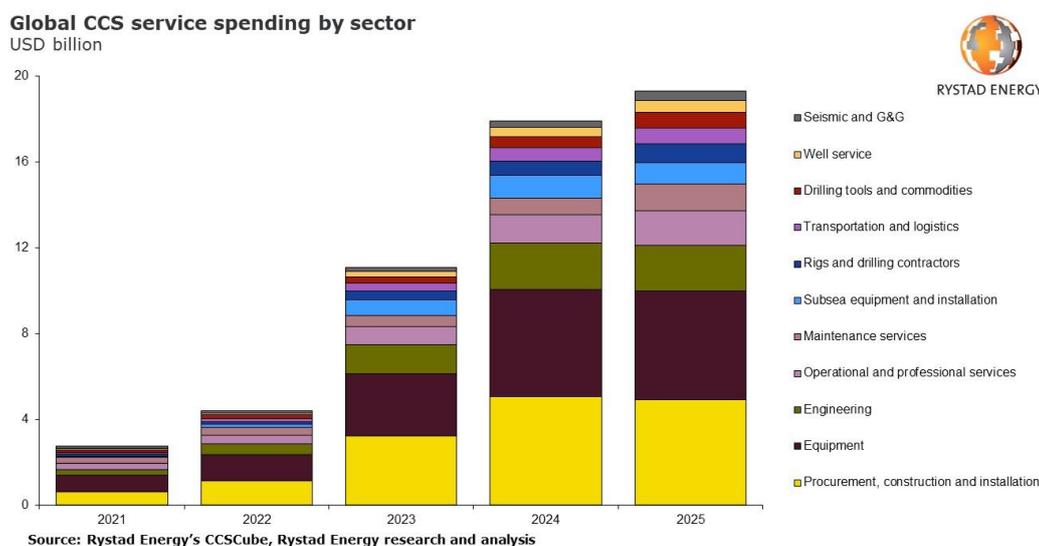
The two **BESSs** are part of the Pivot Power Energy Superhub project to roll-out up to 2 GW of **BESS** capacity across the UK: to date Pivot Power has gone live with **BESSs** in West Midlands (two 50 MW / 100 MWh) and Oxford.

Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

This section considers news items that have arisen within the news cycle of this **Edition 37** of *Low Carbon Pulse* relating to carbon accounting and carbon dioxide removal (CDR), including bioenergy carbon capture (BECCS), bioenergy carbon capture use and storage (BECCUS), carbon capture and storage (CCS), carbon capture use and storage (CCUS) and direct air capture (DACs). Effective accounting for carbon arising and CDR go hand-in-hand. By way of background CDR is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (BECCS), wet land restoration, ocean fertilisation, ocean alkalisation, enhanced terrestrial weathering and direct air capture and storage (DACs) are all means of CO₂ removal. The IEA pathway to NZE estimates that in order to achieve NZE it will be necessary to capture and to remove up to 7.6 giga-tonnes of CO₂ each year through CCS, CCUS and CDR. CCS and CCUS (and BECCS and BECCUS) involve the capture at the source of CO₂, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.

- **Talos Energy Good to Go:** On **March 16, 2022**, it was reported widely that Talos Energy had executed lease documentation with the Texas General Lease Office in respect of the previously announced carbon capture and sequestration site located off-shore Jefferson County, Texas. (**Edition 35** of *Low Carbon Pulse* has earlier coverage.)
- **Rystad Energy presses CCS:** On **March 17, 2022**, the good folk at Rystad Energy made a press release in respect of their findings about the increased use of CCS.

The Rystad Energy analysis in the near term is detailed in the following bar chart:



• CCS Databases:

- During the **week beginning March 14, 2022**, the author of *Low Carbon Pulse* came across the US **DOE** National Renewable Energy Laboratory (**NREL**) **Carbon Capture and Storage Database**, which includes information on active, proposed and discontinued CCS projects around the world.

The **NREL Carbon Capture and Storage Database** has been developed from publicly available information globally, and includes details of the evaluation of sites for CO₂ storage, estimated project development and operation costs, mass of CO₂ captured / stored and the technologies deployed.

For those active in CCS, the **NREL Carbon Capture and Storage Database** is both a helpful summary and tool.

- On **March 24, 2022**, **CO₂ Value** launched a **New CCU Project Database**. The New CCU Project Database is available publicly (hence the link), and provides a reference for CCS / CCUS projects across Europe.
- On **March 24, 2022**, the **Clean Air Task Force** launched its **Carbon Management Tracker**, mapping carbon capture projects in the Middle East and North Africa.

The accompanying narrative from the Clean Air Task Force notes that the number of projects (ten in total, five of which are already in operation) is relatively small compared to the US and Europe, and very small given the estimated capacity of the Middle East and North Africa to store CO₂ (estimated to be at least 492 billion tonnes (or 492 giga-tonnes) of CO₂, or around 10 times the aggregate mass of CO₂-e emissions arising globally each year.

By way of a reminder, under **Mapping CO₂ storage in the US**, **Edition 34** of *Low Carbon Pulse* reported on the **Atlas of Carbon and Hydrogen Hubs from the Great Plains Institute** and the US DOE **Carbon Storage Atlas**.

- **First BECCS:** On **March 22, 2022**, **Bellona.org** reported (under **Oslo leading by example: world's first CO₂ capture and storage on waste incinerator to become reality in 2026**) that the Klemetsrud CO₂ capture and storage project will be the world's first waste-to-energy plant with full scale CCS (BECCS depending on one's view). The Bellona Foundation is working with City of Oslo and Fortum Oslo Varme for seven years to realise this outcome.
- **Pulling up DACs to capture CO₂:** On **March 23, 2022**, Occidental Petroleum Corp announced that it intends to develop and to deploy up to 70 carbon capture facilities globally by 2035, with each CC facility to capture as much as 1 million metric tonnes of CO₂ directly from the atmosphere (and otherwise from the climate system).

The construction of the first CC DAC plant (located in the Permian Basin, West Texas) is expected to start during the second half of 2022, with operational completion scheduled for Q4 of 2024.

Carbon Credits and Hydrogen Markets and Trading:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development of hydrogen markets and trading (bilateral and likely wholesale).

• Climate Impact X:

- **CIX partners with Carbonplace:** On **March 25, 2022**, The [Business Times.com](https://www.businesstimes.com) reported that CIX had partnered with Carbonplace (a carbon credit settlement platform, developed by seven banks - BNP Paribas, CIBC, Itau Unibanco, National Australia Bank, NatWest Group, Standard Chartered and UBS).

The purpose of the partnership is to lower the cost of entry to corporations seeking to acquire high-quality carbon credits in the voluntary carbon market which CIX is to facilitate.

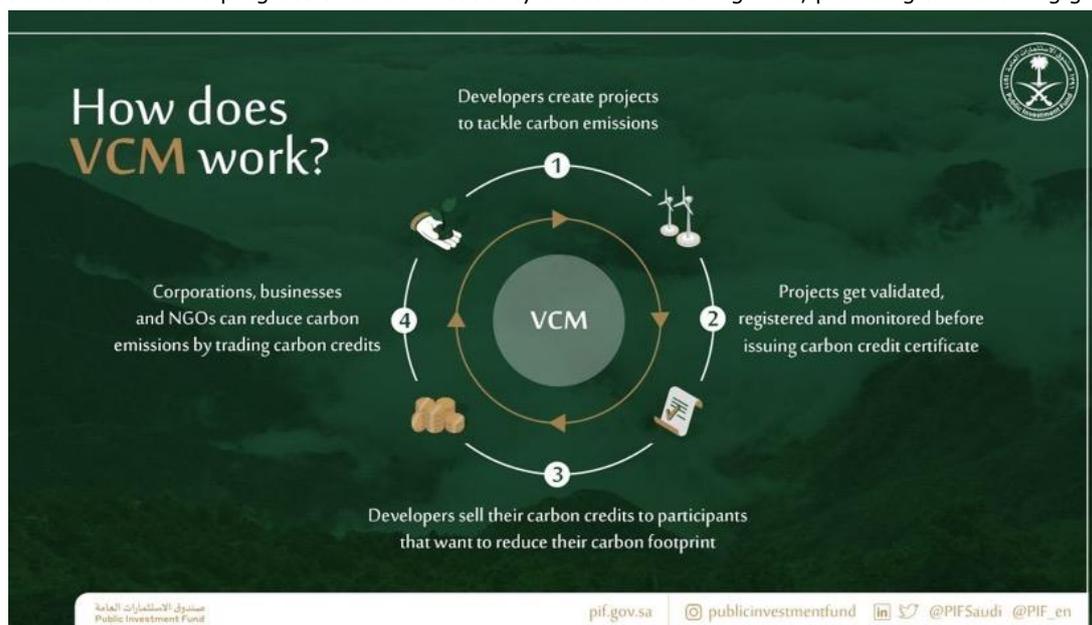
- **By way of reminder:** As reported in **Edition 18** of Low Carbon Pulse, "On May 20, 2021, plans for a new global carbon exchange were announced. The global carbon exchange is to be located in Singapore. DBS Bank, Singapore Exchange, Standard Chartered Bank and Temasek have established a joint venture, **Climate Impact X (CIX)**, for this purpose". The stated intention of the **CIX** is to provide "high-quality carbon credits to address hard-to-abate emissions".

Managing Director of the Monetary Authority of Singapore, Mr Ravi Menon, noted that the **CIX** represented the adoption of a "twin strategy" of the reduction of **GHG** emissions and the off-set of **GHG** emissions, which provides a "practical and effective" way to achieve the Paris Agreement Goals.

On **March 3, 2022**, it was reported widely that DBS Bank, Standard Chartered Bank, and Temasek are continuing to put in place the arrangements to allow the development of **CIX**. It has become increasingly clear that **CIX** will provide a trading platform for high quality carbon credits / carbon offsets. The standalone article entitled **Carbon Credits, Article 6 and the Paris Rulebook** will provide a detailed perspective on the importance of effective trading platforms.

• MENA Voluntary Carbon Markets:

- On **March 25, 2022**, Ms Riham ElGizy reported (on LinkedIn) that it had been a Big Day for the MENA regional Voluntary Carbon Market (**VCM**), with the announcement of the first five potential partners in the market, Aramco, Saudi Airlines, ACWA Power, Maaden and ENOWA. Low Carbon Pulse will follow the development of the market.
- On **March 24, 2022**, the PIF announced that the **VCM** will provide the means to connect corporations and institutions (and investors) with a supply of quality carbon credits, so as to allow those corporations and institutions to achieve progress to carbon neutrality ahead of achieving **NZE**, providing the following graphic.



(Source: [Public Investment Fund \(PIF\) | LinkedIn](https://www.linkedin.com/company/public-investment-fund))

- On **March 29, 2022**, the Abu Dhabi Global Market (the UAE's financial free zone) [announced](#) that it was partnering with AirCarbon Exchange to create the "world's first fully integrated" carbon trading exchange and clearing house.
- **Mandatory Markets as a contrast:** On **March 30, 2022**, the **ICAP Status Report 2022** was [published](#), with the headlines being that there 25 emissions trading schemes globally, covering 17% of global GHG emissions (9 Gt of **CO₂-e**).

The **ICAP Status Report** is well-worth a read, and provides a helpful contrast the developing momentum in respect of the Voluntary Carbon Markets, and the development of trading platforms to market carbon credits.

E-fuels & feedstocks / Future Fuels & Feedstocks / Now Fuels & Feedstocks:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and **Future Fuels** (energy carriers derived and produced that are characterised as clean carbon or low carbon fuels). **E-fuels** include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.*

- **EDF Renewables and Hynamics Tees Green Hydrogen:** On **March 9, 2022**, it was reported widely that EDF Renewables (a subsidiary of Electricite de France) and Hynamics (Electricite de France's hydrogen subsidiary) are to develop a new photovoltaic solar farm (EDF Renewables) that will supply renewable electrical energy to produce Green Hydrogen using an electrolyser (from Hynamics), the sizing of which is 50 MW, but with expansion to 500 MW over time to allow supply to develop in line with demand. The renewable electrical energy to power the electrolyser will be sourced from the photovoltaic solar farm, and from the off-shore wind field that EDF Renewables is developing. The Green Hydrogen produced by the [Tees Green Hydrogen](#) project will assist in the decarbonisation of industrial activities on Teesside, including the production of iron and steel by British Steel.
- **AP Moller – Maersk and Ørsted aligned:**
 - **Edition 26** of Low Carbon Pulse reported on the decision of A.P. Moller - Maersk to order eight dual fuel container vessels (with an option for a further four), capable of being powered and propelled by methanol. In reporting on this decision it was noted that A.P. Moller – Maersk was aware of the need to continue to procure supplies of methanol. As noted in editions of Low Carbon Pulse then and since, one of the key risks for A.P. Moller - Maersk in procuring dual fuel container ships was the supply of sufficient clean or low carbon methanol.
 - **Methanol supply:**
 - On **March 10, 2022**, Ørsted announced that it had signed a letter of intent with A.P. Moller - Maersk to develop a Power-to-X-facility on the US Gulf Coast to produce e-methanol to fuel A.P. Moller -Maersk's dual fuel container vessels.
The Power-to-X-facility contemplated will be world scale – a 675 MW Power-to-X-facility able to produce 300,000 metric tonnes of e-methanol a year. The Power-to-X-facility will be powered by 1.2 GW of renewable electrical energy from off-shore wind fields and photovoltaic solar farms to be developed by Ørsted.
 - On **March 10, 2022**, Proman [announced](#) that it had signed a cooperation agreement under which, among other things, Proman will aim to supply A.P. Moller - Maersk with between 150,000 to 200,000 metric tonnes of bio-methanol from its 200,000 metric tonne a year facility. The feedstock for the production of the bio-methanol is stated to be otherwise non-recyclable forest residues and municipal solid waste. (Proman has an existing methanol facility in Pampa, Texas.)
 - On **March 10, 2022**, A.P. Moller - Maersk [announced](#) (by way of something of a summary) that it had entered into six strategic partnerships globally to scale Green Methanol production by 2025, with partners CIMIC, ENRIC, European Energy (see below), Green Technology Bank, Ørsted (see above), Proman (see above) and WasteFuel (see **Edition 32** of Low Carbon Pulse).
CEO of Fleet & Strategic Brands, A.P. Moller – Maersk, Ms Henriette Hallberg Thygesen said: *"To transition towards decarbonisation, we need a significant and timely acceleration in the production of green fuels. Green Methanol is the only market-ready and scalable available solution today for shipping. Production must be increased through collaboration across the eco-system around the world. That is why these partnerships mark an important milestone to get the transition to green energy underway"*.
 - **Business to Business:** While clear policy settings are needed from governments globally to provide assurance or at least guide rails in the development of supply and demand in making progress towards the achievement of **NZE**, it is clear that major corporations are able to develop supply on the basis of a clear line of sight to demand. A.P. Moller – Maersk continues in the vanguard of leading corporations making decisions that will reduce **GHG** emissions arising from shipping.
One of the privileges of writing Low Carbon Pulse is following the progress that is made by leading corporations in progress to achieving **NZE**, as the following **By way of reminder** illustrates.
- **By way of reminder:**
 - **Edition 26** of Low Carbon Pulse covered in detail the decision by A.P. Moller – Maersk to accelerate "the rate of its fleet decarbonisation with an order for eight container vessels capable of being powered and propelled using carbon neutral methanol. With each container vessel costing USD 175 million, this is a USD 1.4 billion commitment. The eight container vessels are to be built by Hyundai Heavy Industries (**HHI**) and delivered in 2024. The multi-vessel shipbuilding contract with **HHI** gives Maersk an option for four additional container vessels. As would be expected, the engines will be dual fuel, to allow the use of both low carbon methanol and low sulphur heavy fuel oil. As noted in previous editions of Low Carbon Pulse, **HHI** has been working on the dual fuel technology for some time with MAN ES and Alfa Laval (see **Edition 21** of Low Carbon Pulse)".
 - **Edition 26** of Low Carbon Pulse noted that: "Possibly the most stated and restated theme in Low Carbon Pulse (and sibling publications relating to hydrogen and hydrogen-based fuels) is the need for supply and demand for hydrogen and hydrogen based energy carriers to develop in tandem.
In the announcement of the order for the eight container vessels, Mr Soren Skou noted that: " .. *this is a firm signal to fuel producers that sizeable market demand for the green fuels of the future is emerging at speed*". It is understood that Maersk will use **carbon neutral e-methanol or sustainable bio-methanol** as soon as possible. Also it is understood that in the near to medium term, the supply of low carbon methanol is likely to be challenging. To address this challenge, it should be expected that A.P. Moller – Maersk will increase demand from corporations with which it has existing supply arrangements, and contract with other corporations for supply".

- **Petronas and ENEOS making progress:** On **March 11, 2022**, it was reported widely that Petronas (the national oil company of Malaysia) and ENEOS (leading hydrocarbon importer into, and refiner in, Japan) are undertaking a feasibility study jointly to assess hydrogen production and a conversion project to use hydrogen as a feedstock to produce a clean / low carbon energy carrier / vector. Also it is understood that the feasibility study will consider the production of Green Hydrogen.

By way of reminder: Edition [27](#) of Low Carbon Pulse reported that **ENEOS** and **Petronas** (the national oil company of Malaysia) signed a memorandum of understanding for the development, jointly, of a clean hydrogen supply chain between Malaysia and Japan.

- **A Guide to Policy Making:**

- On **March 20, 2022**, **IRENA** published [Green Hydrogen For Industry – A Guide to Policy Making](#). The publication is both a summary and reference guide, and is well-worth a read.

There is nothing new in **Green Hydrogen For Industry – A Guide to Policy Making**, but there are helpful points of reference; touchstones for those developing and implementing policy settings as follows:

- **Policy makers have a number of solutions to effect energy transition** "with Green Hydrogen being one of them alongside electrification, energy efficiency, greater material efficiency, a circular economy approach, higher energy efficiency and carbon capture measures. These solutions are not in competition with each other. Instead, they can complement each other when proactive policy making is in place".
- **Policy setting for Green Hydrogen strategy relies on the assessment of different factors**, critically "technological readiness of the decarbonisation solutions and the potential size of the local hydrogen demand";
- **Policy makers can devise policy settings to support Green Hydrogen and the energy transition** in the difficult to decarbonise industry sectors and can do so "through a careful assessment of the experiences in the renewable energy sector as well as by considering the distinctive nature of the [applicable] industrial sector".

As noted, this is nothing new in this, rather it is a synthesis of good sense, a guide to thinking, not a tool-kit.

- **By way of reminder:** In 2020, **IRENA** published an initial report considering Green Hydrogen policy settings: [Green Hydrogen: A Guide to policy setting](#), followed by [Green Hydrogen Supply: A guide to policy making](#) in 2021. In addition, **IRENA** has published the following on Green Hydrogen since 2018: [Hydrogen from renewable power: Technology outlook for the energy transition](#) (2018), [Hydrogen: A renewable energy perspective](#) (2019), [Reaching zero with renewables](#) (2020), [Green Hydrogen Cost reduction: Scaling up electrolyzers to meet the 1.5°C climate goal](#) (2020), [Renewable energy policies in a time of transition: Heating and Cooling](#) (2020), [Enabling Measures Roadmap for Green Hydrogen](#) (2021) (with the World Economic Forum), and [Geopolitics of the Energy Transformation: The Hydrogen Factor](#) (2022).
- **bp Energy Outlook out:** On **March 14, 2022**, bp released its [Energy Outlook 2022](#).

The key takeaways for the author from the **bp Energy Outlook 2022** edition are as follows (tying to the three current scenarios described):

- **Accelerated:** There has been an increase in the ambition and acceleration of policy settings among some countries, but more ambition and acceleration is required;
- **Net Zero:** There has been an acceleration in the level of installation of photovoltaic solar and wind capacity, increased sales of EVs and the rate of progress of CCS / CCUS projects contemplated has increased markedly;
- **New Momentum:** There has been new momentum broadly across progress to addressing climate change, including decarbonisation and as such **NZE**.

The key takeaways need to be considered against the realities of increasing mass of **GHG** emissions year-on-year (with the exception of 2020), and as such the increased rate of consumption of the finite carbon budget.

- **Hyzon and Raven SR progressing:** Edition [16](#) of Low Carbon Pulse and [Hydrogen for Industry – Hydrogen from Waste](#) reported on the joint venture between Hyzon and Raven SR to derive and to produce hydrogen from waste. From the level of reporting, it would have been apparent to the reader that the writer of Low Carbon Pulse considered the development as both material and significant.

On **March 15, 2022**, it was reported widely that Samsung Ventures had joined Chevron Corporation, Itochu Corporation and Ascent H2 Fund in backing Raven SR in respect of its first waste to hydrogen plant in northern California. Under the deal between Samsung Ventures and Raven SR, Raven SR is to work with Samsung C&T (as sibling corporation of Samsung Ventures) to "advance the scalability" of the Raven SR technology to develop and to deploy it in the Asian market.

On **March 30, 2022**, it was reported widely that Raven SR was to develop a hydrogen from waste facility in Aragon, Spain. As reported, the facility will treat 75 metric tonnes of organic waste a day to produce 1,600 metric tonnes of hydrogen a year.

- **CH4, H2 and NH3 Terminal News:**

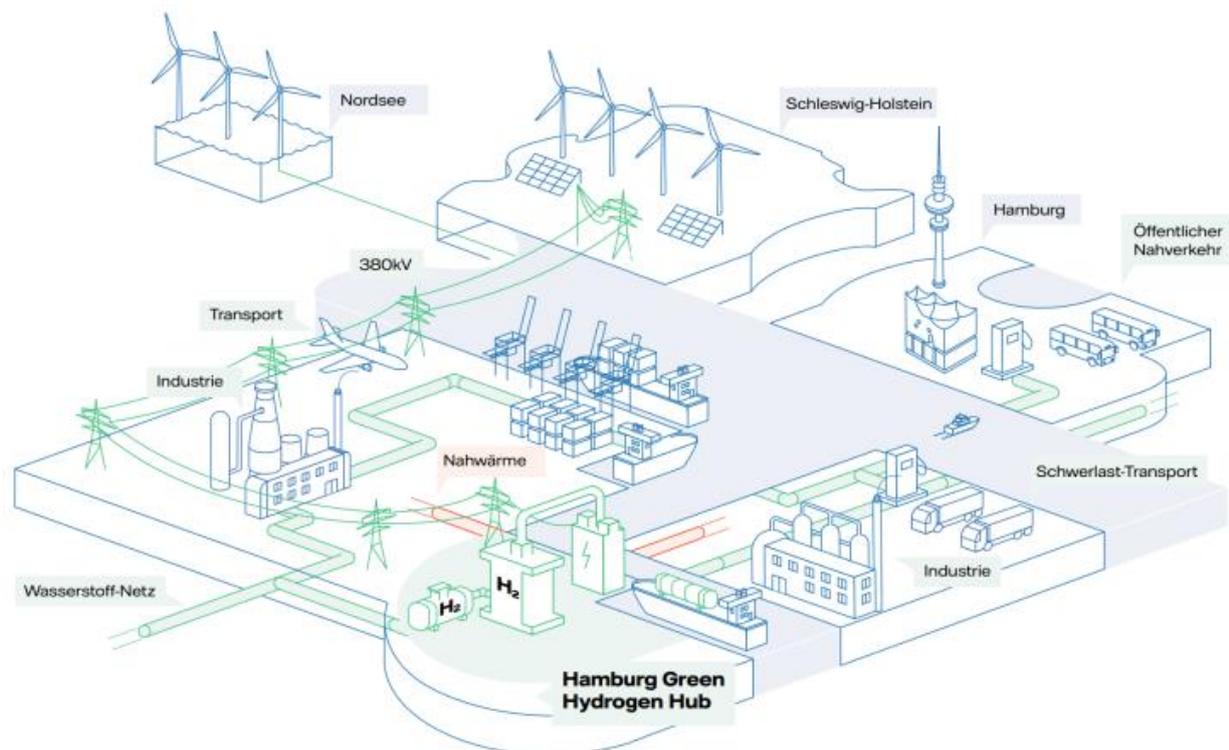
- **LNG Terminals progressing:** Edition [36](#) of Low Carbon Pulse reported that "the German Federal Government had asked Uniper to resume its plans to develop an LNG receiving terminal in Wilhelmshaven as the Federal German Government develops its thinking around energy security. As originally planned, Uniper intended to develop a 7.3 million metric tonnes per annum floating storage receiving terminal (**FSRU**).

In addition to an **FSRU** at Wilhelmshaven, the Federal German Government wants to develop and deploy an LNG receiving terminal at the North Sea Port town of Brunsbüttel. The LNG receiving terminal at Brunsbüttel had been planned for a while by joint venturers Gasunie (a Dutch natural gas infrastructure and transportation company) and Oiltanking (a logistics service provider of tank terminals for petroleum products, chemicals, and gases), a subsidiary of Marquard & Bahls AG), with Vopak reported as passive in the joint venture."

Edition [36](#) of Low Carbon Pulse reported that it was "understood that RWE expressed interest in use of the LNG receiving terminal at Brunsbüttel to re-gasify LNG imported from Australia".

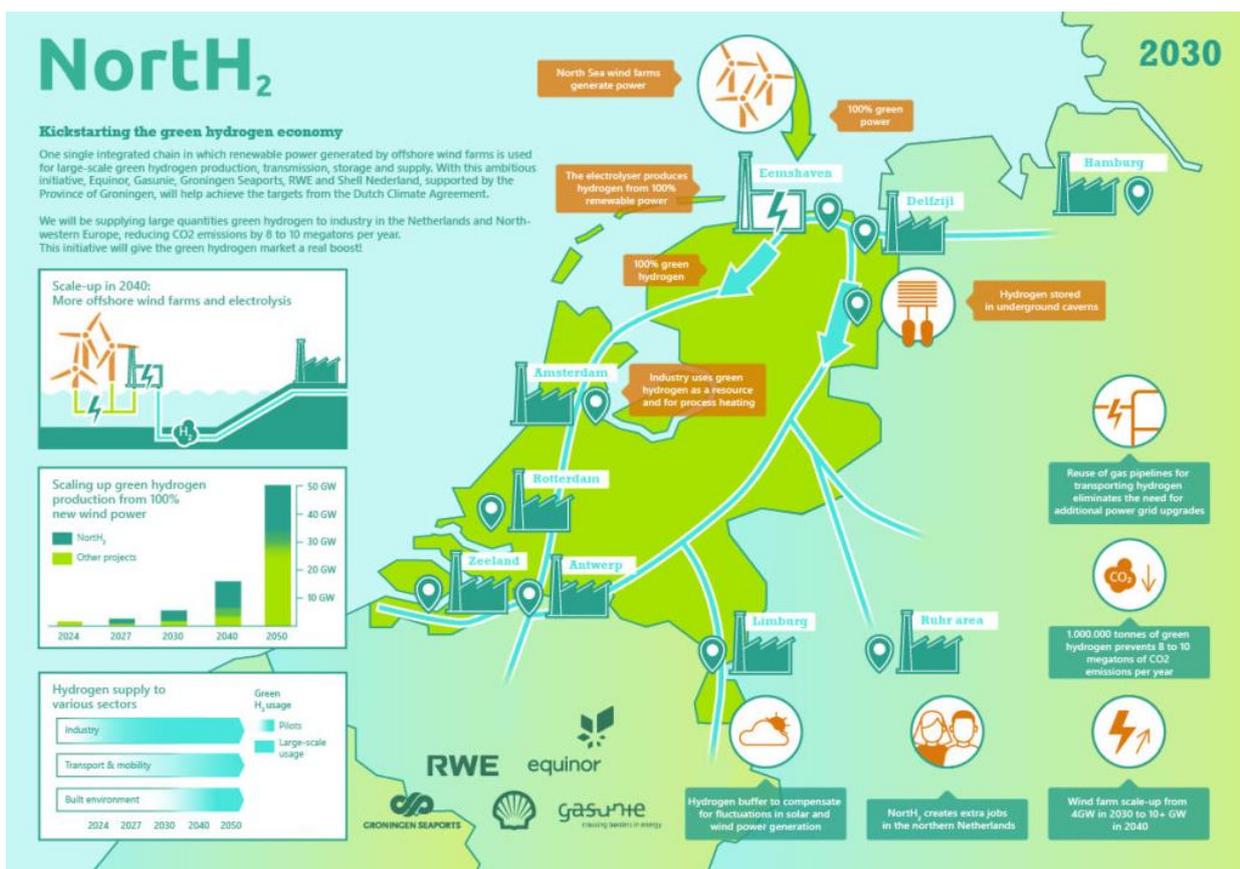
- On **March 18, 2022**, RWE [announced](#) that it will develop an ammonia terminal, capable of taking delivery of up to 300,000 metric tonnes of ammonia by 2026. It is expected that RWE will work with the shareholders of German LNG Terminal GmbH, Gasunie, Kreditanstalt für Wiederaufbau (**KfW**), and RWE, with RWE to be a key user of the LNG regasification terminal, importing LNG from around the world. The LNG and ammonia terminal projects are both supported by Brunsbüttel Ports GmbH.
- On **March 30, 2022**, it was reported widely that E.ON and Tree Free Solutions (**TES**) had partnered to investigate how they will work together to import liquified e-methane (combining Green Hydrogen with captured **CO₂** using renewable electrical energy (hence the "e")) from the Middle East to Germany (**TES's broader plans** and AiP were also reported on in **Edition 36** of Low Carbon Pulse.) The thinking involves the likely development of a green gas terminal in Wilhelmshaven, which would accept **LNG** in the first instance and progress to e-methane over time.
- **Motive clear:** On **March 23, 2022**, ITM Power (leading electrolyser technology corporation) [announced](#) that it had concluded a strategic partnership agreement with Vitol Holding SARL under which ITM Motive Limited (trading as Motive) could become a 50/50 joint venture of ITM Power and Vitol. Under arrangements for the joint venture, Motive has contracted with ITM Power (as preferred supplier) for up to 240 MW of electrolyser capacity to produce Green Hydrogen at the location of hydrogen refuelling infrastructure.
- **Moorburg, Hamburg:** On **March 23, 2022**, [hydrogen-central.com](#) reported (under **Former Coal Plant Site Moorburg in Hamburg Could Produce Green Hydrogen by 2026**) that a feasibility study had concluded that the Moorburg site would be used to house a 500 MW electrolyser to produce Green Hydrogen. The Moorburg site will require funding support, ideally with the project designated as an Infrastructure Project of Common European Interest.

Hamburg Green Hydrogen Hub



- **CS Energy, Kogan Creek:** On **March 24, 2022**, it was reported widely that CS Energy is to develop and to deploy a 50 metric tonne a year hydrogen production demonstration facility near Chinchilla, Queensland, Australia (the **Kogan Renewable Hydrogen Demonstration Plant** or **KRHDP**). The **KRHDP** is to be constructed by IHI Engineering Australia (a subsidiary of IHI Corporation). On **March 30, 2022**, it was reported widely that a 100 MW / 200 MWh BESS (using Tesla Megapack Technology) would be co-located at Kogan.
- **Sunfire GmbH scaling production:**
 - On **March 23, 2022**, it was reported widely that Sunfire GmbH (Dresden head-quartered electrolysis technology corporation) had contracted with P2X Solutions Oy (Finnish head-quartered circular economy solutions corporation – see **Edition 25** of Low Carbon Pulse) to supply a 20 MW alkaline electrolyser to allow P2X Solutions to produce Green Hydrogen. Previous editions of Low Carbon Pulse have covered both Sunfire GmbH and P2X Solutions.
 - On **March 24, 2022**, it was reported widely that Sunfire GmbH had partnered with Blue Earth Capital AG and Copenhagen Infrastructure Partners (**CIP**), raising €195 million to allow it to scale up the production of its alkaline electrolysers, with a clear line of sight to supply up to 640 MW of electrolysers to **CIP**.

- On **March 28, 2022**, Sunfire GmbH [announced](#) that it had commissioned successfully an alkaline electrolyser in Völs, Austria.
- Considerable industry interest in Carbon Clusters and Hydrogen Hubs: Editions 32 and 36** of Low Carbon Pulse reported on the plans to develop Carbon Clusters and Hydrogen Hubs in the Hunter Valley and the Illawarra regions of New South Wales, Australia. On **March 28, 2022**, it was reported widely that expressions of interest (**EOIs**) had been received, providing for investment of up to AUD 4 billion, reflecting considerable interest of the private sector into the development of each Cluster and Hub, with the **EOIs** reported to include proposals to develop 5.9 GW of renewable electrical energy capacity (more than eight times the target), and 268,000 metric tonnes of Green Hydrogen (enough to fuel 26,000 heavy goods vehicles / trucks).
- Global Energy Ventures Tiwi Islands project progresses: Edition 33** of Low Carbon Pulse reported on the planned development of a Green Hydrogen production facility on Grootte Eylandt (Tiwi Islands) off the Northern Territory, Australia. On **March 28, 2022**, [pv-magazine](#) reported that traditional landowners had granted permission to conduct onsite environmental and engineering studies.
- EON and FFI ink in green:** On **March 29, 2022**, it was reported widely that E.ON SE and Fortescue Future Industries (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO) had signed a supply and distribution agreement, with the two leading corporations combining to deliver 5 million metric tonnes a year of Green Hydrogen into the European market by 2030.
It is understood that that EON and FFI will work with the German and Australian Federal Governments to ensure that Green Hydrogen is delivered as contemplated. A "shout out" again to Dr Forrest, and his team. As ever, Dr Forrest sets what may appear to be stretch targets, and then bends them to his considerable will.
- Oracle Green Hydrogen Project Advance: On March 30, 2022**, it was reported widely that Pakistan's Green Hydrogen Project (see **Editions 29 and 35** of Low Carbon Pulse) has advanced with the conclusion of a joint venture agreement with Kaheel Energy (100% owned by His Highness Shaikh Ahmed Dalmook Al Maktoum).
- Eneco and OCI join North2:** A number of editions of Low Carbon Pulse have reported on North2 (see **Editions 5, 8, 16, 30 and 31** of Low Carbon Pulse). On **March 31, 2022**, it was reported widely that Eneco (producer and supplier of natural gas, electricity and heat in the Netherlands) and OCI NV (leading producer and supplier of hydrogen-based feedstocks) had joined Equinor, Gasunie, RWE and Shell in North2. It is understood that OCI NV is committed to purchasing up 40% of the Green Hydrogen produced by North2.



(Source: <https://www.offshorewind.biz/2022/03/31/eneco-and-oci-join-north2-offshore-wind-to-hydrogen-consortium/>)

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

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of:

- areas in which: **1.** infrastructure will be developed and deployed to support the development and deployment of hydrogen production capacity and use (**Hydrogen Hubs**), the capture of carbon dioxide, and the consolidation of captured carbon dioxide for storage or use or both (**Carbon Clusters**); and **2.** technologies facilitating energy transition will be concentrated and supported (**Hydrogen Corridors and Valleys**); and
- **giga-factories** that fabricate and manufacture photovoltaic solar panels (and associated equipment), wind-turbine blades and towers (and associated equipment), electrolysers (and associated equipment), electric batteries and hydrogen fuel cells, and transmission cabling (including HVDC transmission cabling).

Also the section considers developments in cities to decarbonise (including using waste heat), and to cool, cities. The development of infrastructure at ports and installation and support vessels for off-shore wind developments are considered in the **Ports Progress and Shipping Forecast** section of each edition.

- **UN Environment Program (UNEP) reports on cities:** On **March 4, 2022**, the **UNEP** published [Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions](#). The report will be considered in the **March and April Report on Reports**.
- **NEL plans expansion of capacity to 2 GW:** On **March 9, 2022**, [fuelcellsworks.com](#) reported that NEL ASA (leading electrolyser technology provider) is planning to increase its electrolyser production capacity. While this increase in capacity is driven by demand it is also informed by the policy settings from the **EU** to accelerate the development of hydrogen production capacity in the **EU**. The current electrolyser production capacity at NEL's Herøya plant is understood to be 500 MW, with the ability to increase production capacity to 2 GW.

As noted above (under **EU to accelerate decarbonisation initiatives**), the **EC** announced **RePowerEU** on March 8, 2022, providing strong policy signals to both supply and demand side to participate in the Green Hydrogen Value Chain. It is to be expected that other electrolyser technology providers will expand their production capacity in the near term. Apart from the significance for NEL and the electrolyser supply chain globally, this announcement illustrates the supply side response to clear policy settings within the **EU**. Clear policy settings remain critical to the development, and now the acceleration, of supply and demand for Green Hydrogen.

- **Elogen to establish giga-factory:** On **March 9, 2022**, [h2-view.com](#) reported that Elogen is to establish an electrolyser stack giga-factory at the Les Ulis site, in Vendôme, France.

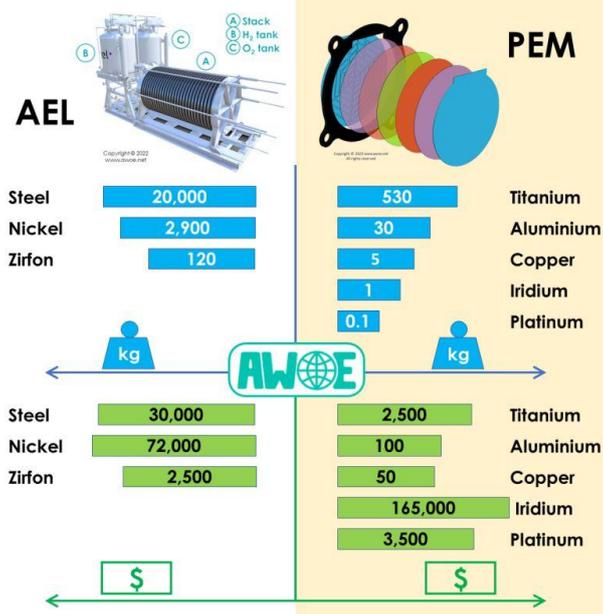
Subject to achieving IPCEI status, the production capacity will reach 1 GW by 2030: IPCEI connotes Important Project of Common European Interest.

- **Background on electrolysers:**

At the moment around 61% of electrolysers use **AE** technology and around 30% use **PEM** technology.

ANATOMY OF AN ELECTROLYSER	
Alkaline electrolysers (AE) produce H ₂ using a liquid electrolyte, using nickel electrodes and stainless steel for the stack.	AEs and PEMs have similar electrical energy efficiency, with the consumption of electrical energy being almost the same. PEM's operate at a higher electrical current, and as such are more productive per unit of stack mass.
Polymer Electrolyte Membrane or Proton-Exchange Membrane (PEM) electrolysers operate in an acidic environment, using iridium coated anodes and platinum coated cathodes, both the anode and cathode are made from titanium.	

The graphic below illustrates the current metal and mineral use of both **AEs** and **PEMs**:



In addition to **AE** and **PEM** electrolyser technologies, there are what may be regarded as emerging technologies of anion exchange membranes (**AEM**) and solid oxide electrolysis cells (**SOEC**). It is fair to say that **SOEC** electrolysers are emerging more quickly, and more developed, than **AEM**.

SOLID OXIDE ELECTROLYSER CELLS (SOECS)

SOECs operate at high temperatures and with high electrical efficiencies of 79-84% (LHV), and require a heat source to produce steam. Therefore if **SOEC** hydrogen were used to produce synthetic hydrocarbons (power to liquid and power to gas) it would be possible to recover waste heat from the synthesis processes to produce steam for further **SOEC** electrolysis. Nuclear power, solar thermal and geothermal heat systems, as well as industrial waste heat, could provide heat sources for **SOECs**.

SOEC electrolysers can be operated in reverse mode as fuel cells, to convert hydrogen back into electrical energy (again, distinct from **AE** and **PEM**.) Combined with hydrogen energy storage systems (**HESS**), **SOECs** can provide balancing services to grids, increasing the overall use of the **SOEC**. **SOEC** can be used for co-electrolysis of steam and **CO₂** so as to create a synthetic gas mix comprising **CO** and **H₂** for conversion into synthetic fuel.

- **Basque Hydrogen Corridor:** The Basque Energy Agency (**EVE**) has developed a **Basque Hydrogen Strategy (BHS)** and key part of the **BHS** is the development of the **Basque Hydrogen Corridor (BHC)**, which comprises 78 corporations and institutions, including CIC energiGUNE.

In an [article](#) published on **March 10, 2022**, CIC energiGUNE outlines the **BHS** and the role of the **BHC**. The article is well-worth a read.

- **Electrolyser technology development:**

- On **March 14, 2022**, it was reported widely that the US **DOE** National Renewable Energy Laboratory (**NREL**) is developing new, and improving existing, electrolyser technologies to improve the efficiency of the electrolysers. The **NREL** is an Energy Efficiency and Renewable Energy part of the US **DOE**. The work of the **NREL** fits within the work streams arising from the Hydrogen at Scale (**H2@Scale**) initiative of the US **DOE**.

By way of background, two key issues going to the unit cost of production of hydrogen using an electrolyser are as follows:

- **the electrical efficiency (EE) of the electrolyser used:** how much renewable electrical energy is required to produce one kg hydrogen, determined by the following calculation energy capable of use / (divided by) energy used to produce that energy x 100%, for example: $33.3 / 50 \times 100\% = 66.6\%$, $33.3 / 40 \times 100\% = 83.25\%$, and theoretically $33.3 / 33.3 \times 100\% = 100\%$; and
- **the utilisation of the electrolyser used:** being the percentage of time that an electrolyser can be used to produce hydrogen. The intermittent / variable nature of renewable electrical energy (**REE**) results in lower levels of utilisation, and higher unit costs of production than would arise if there was 24/7 **REE** supply. This is where use of **BESS** can help or, in time, a 100% renewable grid, or both.

In passing, for the author, all work of the **NREL** has become compulsory reading – keep it simple findings, supported by understandable modelling.

- On **March 15, 2022**, [nature](#) published [A high-performance capillary-fed electrolysis cell promises more cost competitive renewable hydrogen](#).

For those interested in differing electrolyser technologies the article in [nature](#) is clear and informative. On **March 16, 2022**, at [cefc.com](#) (under **CEFC congratulates Hysata on recognition in scientific journal Nature Communications**) Australia's Clean Energy Finance Corporation congratulated Hysata as a recipient of funding from the Clean Energy Innovation Fund of the Clean Energy Finance Corporation (**CEFC**).

The headline from the article is that the alkaline capillary-fed electrolysis cell technology outlined achieves an energy efficiency of 98%, with an energy consumption of 40.4 kWh/kg of hydrogen production.

If this level of energy efficiency is achievable at scale, the key operating cost of the production of Green Hydrogen, renewable electrical energy, will be reduced dramatically on a unit cost of production basis.

Further, given the nature of the alkaline capillary-fed electrolysis cell technology, the cost of the balance of the plant (being those parts of the Green Hydrogen plant other than the electrolyser) will be less than current electrolyser technologies.

A shout out to the CEFC: As at March 2022, the **CEFC** had provided funding support of AUD 10.5 billion, supporting projects with an investment value of AUD 36.6 billion. The **CEFC** is a model funding support agency.

- **Green Hydrogen from Gippsland Clean Energy Park:** On **March 15, 2022**, it was reported widely that the Clean Energy Finance Corporation (**CEFC**), Hostplus and Octopus Australia had combined to develop the Gippsland Clean Energy Park (**GCEP**).

While it is early days for the **GCEP**, the **GCEP** has a 3,000 hectare site (which is located within the Gippsland Renewable Energy Zone), and it is expected that the **GCEP** will be developed on a staged basis. Low Carbon Pulse will report on the development of the **GCEP** as its staged development continues.

- **Northvolt charging ahead:**

- **Edition 36** of Low Carbon Pulse reported that [northvolt](#) (under [Northvolt to transform closed paper mill in Sweden into new Gigafactory](#)) had announced that it plans to develop the Kvarnsveden Mill and the area surrounding it at Borlange, Sweden.

As announced, northvolt is to use the site to manufacture battery cells - up to 100 GWh of cathode material annually.

- On **March 15, 2022**, Northvolt announced plans to construct the Northvolt Drei at Heide, Schleswig-Holstein, Germany, to manufacture battery cells - up to 60 GWh annually: in context, 60 GWh of battery cells is sufficient for 1 million **BEVs**.

In addition to battery cell manufacture, Northvolt intends to construct a battery recycling facility at the site.

• **Tesla:**

- **Opens in Berlin:** On **March 22, 2022**, [dw.com](https://www.dw.com) reported (under **Tesla opens Giga Berlin factory in Germany**) that Mr Elon Musk (Chief Executive of Tesla) delivered Tesla BEVs to customers personally to mark the opening of Tesla's Giga Berlin plant, the largest EV plant in Europe.

On **March 16, 2022**, the opening of the Tesla Giga-Factory in Berlin was flagged by Forbes in the context of reporting on the plans of Volkswagen to develop six new Giga-Factories for the purposes of achieving its target of 240 GWh of production capacity by 2030.

- **Open to FCEV technology?** On **April 1, 2022**, [whichev.net](https://www.whichev.net) reported on a Mr Elon Musk tweet in which Mr Musk had indicated that Tesla was to develop the Model H (a fuel cell electric vehicle), which would use fuel cell technology to power and to propel the Model H.

To the author, there remains the risk that this is an April Fool's joke about fuel cells.

- **HyPoint opens in Sandwich:** On **March 22, 2022**, [hydrogenfuelnews](https://www.hydrogenfuelnews.com) reported (under **Hypoint opens hydrogen fuel cell plant in the United Kingdom**) on the formal opening of the HyPoint new fuel cell plant for R&D and production facility located in Sandwich, Kent.

The facility will undertake R&D and production of fuel cells for aviation, including ZeroAvia and Piasecki.

- **Inauguration of ACC Nersac plant:** On **March 11, 2022**, the [ACC Nersac plant](https://www.acc-nersac.com) was inaugurated in Nersac, France. On March 23, 2023, Mercedes Benz AG joined TotalEnergies and Stellantis in the ACC joint venture.

For the purposes of achieving its target of 120 GWh of production capacity by 2030, ACC plans to develop a third production site at Termoli, Italy.

- **VinFast Vast-Giga-Factory for North Carolina, USA:** On **March 29, 2022**, The White House released a [statement](https://www.whitehouse.gov) (**Statement by President Biden on Electric Vehicle and Battery Manufacturing Investments in North Carolina**) outlining the plans of electric vehicle maker VinFast (Vietnamese headquartered BEV manufacturer) to build a USD 4 billion electric vehicle and battery manufacturing facility in North Carolina.

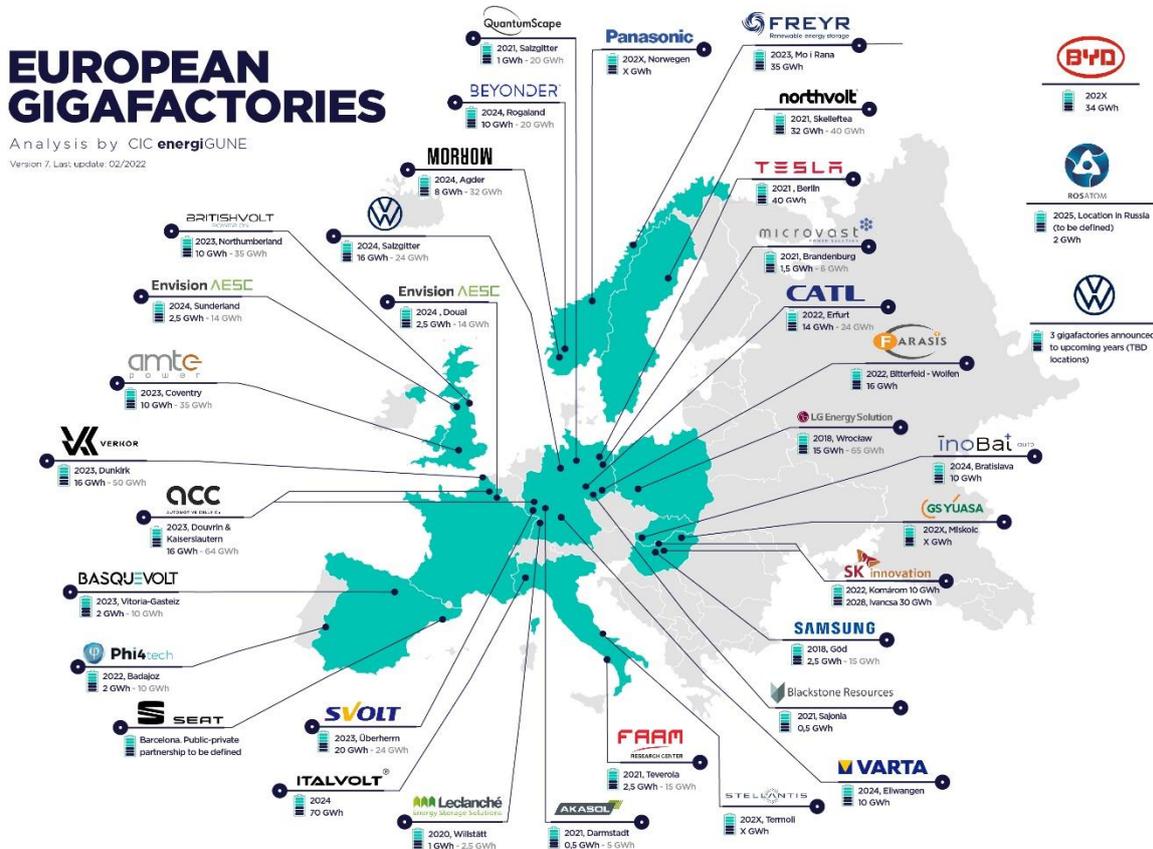
- **Siemens Energy plans to produce electrolyzers on industrial scale:** On **March 31, 2022**, it was reported widely the Siemens Energy (leading global energy transition technology corporation) is to develop an electrolyser manufacturing plant in Berlin, Germany.

It is understood that the plant will be the first giga-watt manufacturing plant for complete electrolyser systems.

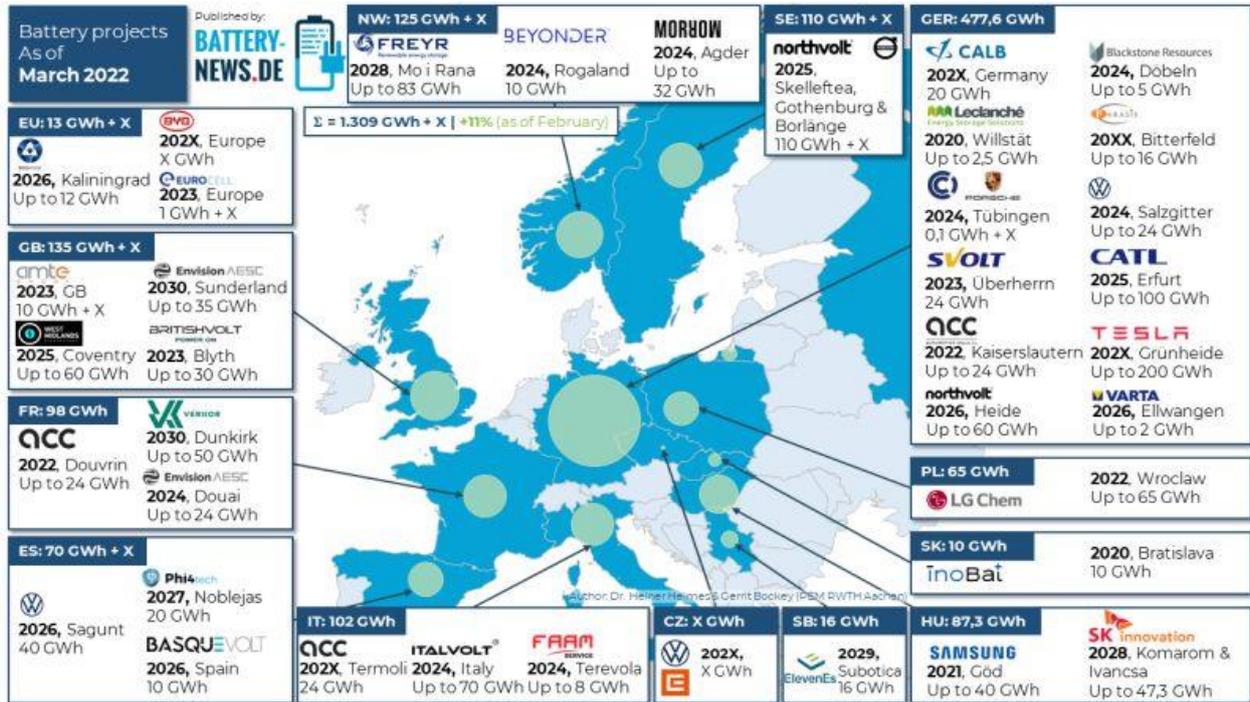
The reporting picks up the need for the cost of electrolyser manufacture to fall so as to contribute to a reduction in the cost of Green Hydrogen production.

- **Updated European Giga-factories map: Edition 33** of Low Carbon Pulse included a map showing the location and size of giga-factories across Europe.

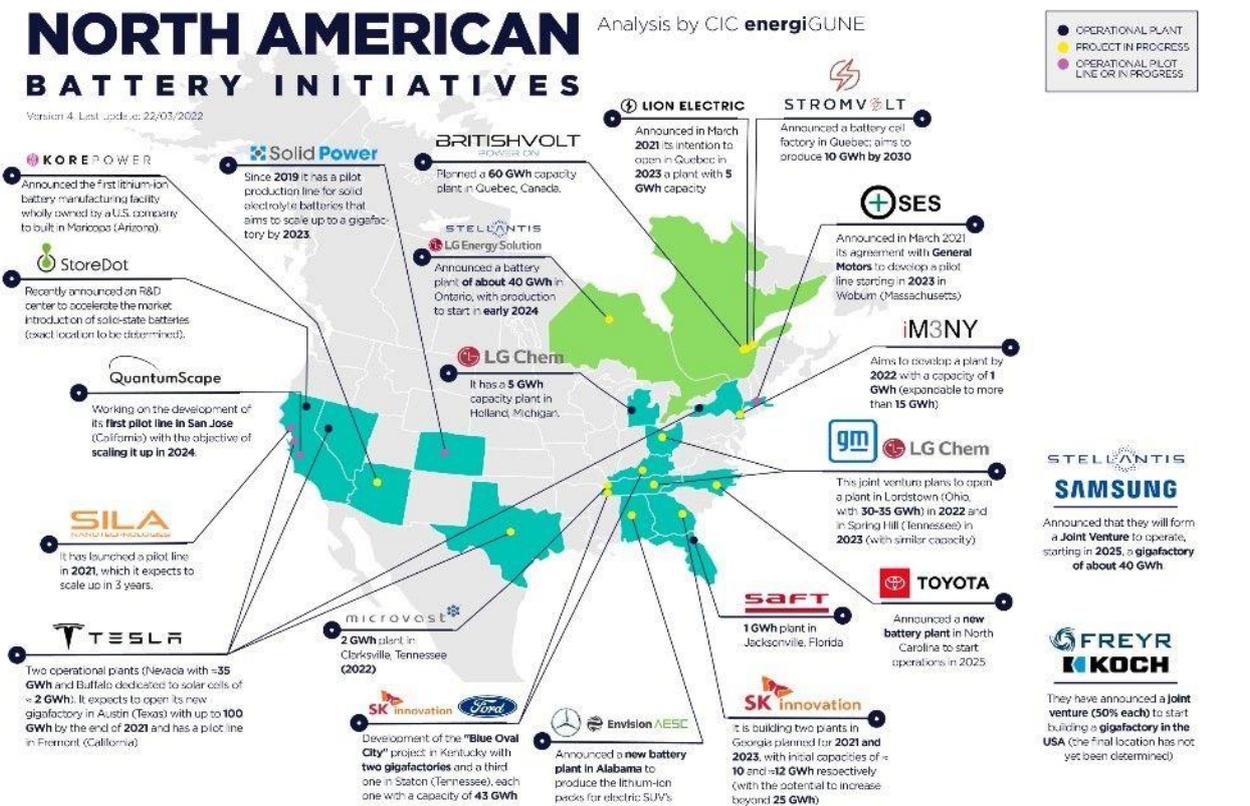
With thanks again to **CIC energiGUNE**, the most recent map is included below:



- **Battery project in Europe as of March 22, 2022:** [Battery-News.de](https://www.battery-news.de) has published the following infographic to detail battery production projects in Europe.



- **Updated US Giga-Factories Map: Edition 32** of Low Carbon Pulse included an infographic detailing Giga-Factories across the US. On **March 24, 2022**, CIC energiGUNE published an updated map which is set out below:



Green Metals / Minerals, Mining and Difficult to Decarbonise Industries:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of E-fuels and Future Fuels to process and to treat those metals and minerals. Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.*

- Green Steel Tracker:** On **March 14, 2022**, the **Green Steel Tracker** was released. The **Green Steel Tracker** has been developed by the Stockholm Environment Institute and the Leadit Secretariat. A link to the internet site with the **Green Steel Tracker** is included [here](#) (at the website of Leadit – Leadership Group for Industry Transition). The **Green Steel Tracker** is a helpful tool for those wishing to follow green iron and steel projects globally.
- **Anglo American and EDF plan big:** On **March 18, 2022**, rechargenews.com reported (under **Anglo American and EDF plan 5 GW "renewables ecosystem" for South African mining**) that Anglo American plans to develop a "regional renewable energy ecosystem" (**RREE**). The **RREE** will comprise photovoltaic solar and wind, and storage facilities. It is understood that Anglo American is to work with EDF to install between 3 and 5 GW of renewable electrical energy capacity by 2030.
 - **thyssenkrupp Steel and STEAG partner:** On **March 21, 2022**, it was reported widely that thyssenkrupp Steel and STEAG (to produce and to supply Green Hydrogen) were combining to integrate hydrogen at the large steelmaking facility in Europe. The integrated steelmaking facility is at Duisburg, and will deploy a 520 MW electrolyser to produce Green Hydrogen for use in the high heat temperature processes required for the production of iron and steel.
- By way of reminder:** Editions **5** and **11** of Low Carbon Pulse reported on the early stage thinking to develop a Green Steel facility at Duisburg, reporting as follows:
- **Edition 5** of Low Carbon Pulse reported that: In Duisburg, Germany, it is proposed to use Green Hydrogen to manufacture Green Steel. The proposal is at feasibility study stage at the moment, with an electrolysis plant, with capacity of up to 500 MW, to produce Green Hydrogen and oxygen for use at the thyssenkrupp steel mill. The feasibility study is being undertaken by STEAG (an energy company based in Essen) and thyssenkrupp (technology and iron and steel). For a technology provider and steel producer like thyssenkrupp there is an ability to create supply and demand, and as such not to wait on the development of a hydrogen supply market."
 - **Edition 11** of Low Carbon Pulse reported that: "The proposed thyssenkrupp upgrade to its existing Duisburg steel works by undertaking the HydrOxy Hub Walsum project (reported upon in **Edition 5** of Low Carbon Pulse), continues to be reported upon. On **February 26, 2021**, it was reported that the HydrOxy Hub Walsum project is seeking recognition as an Important Project of European Common Interest (**IPCEI**) for the purposes of obtaining funding. The current contemplated scale of electrolysis plant is 500 MW to produce Green Hydrogen".

Wind round-up, on-shore and off-shore:

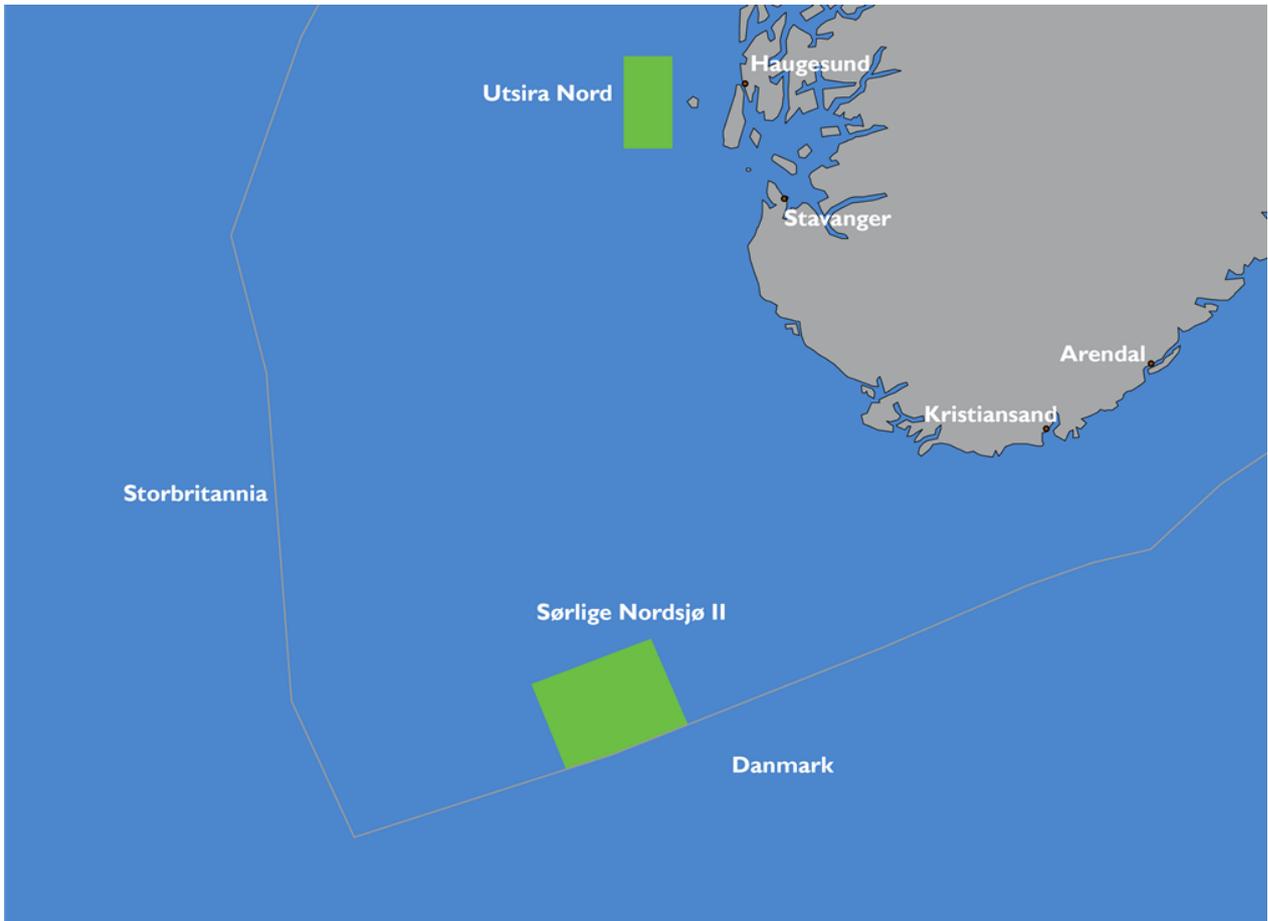
*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).*

- **Danish Downunder:** On **March 7 and 8, 2022**, it was reported widely that Copenhagen Energy A/S, through Leeuwin Offshore Wind Pty Ltd, intends to develop up to 3 GW of off-shore wind field capacity in **Geographe Bay** off of south west, Western Australia. The proposed **Geographe Bay** development is around 130 kms south of Perth, between the towns of Mandurah and Bunbury, within both Commonwealth of Australia and Western Australia waters. As reported, the development will comprise 200 turbines, each having a capacity range of between 15 to 20 MW, and up to six off-shore substations. Construction will start in 2026 and on completion Geographe Bay will produce up to 11 TWh of renewable electrical energy a year.
- **Danish in Columbia:** On **March 8, 2022**, it was reported widely that **Copenhagen Infrastructure Partners** or **CIP** (leading global renewable energy developer and investor) and the Mayor of Barranquilla, Mr Jaime Pumarejo, were to sign an agreement (during CERAWEEK, Houston, Texas) to allow the development of a 350 MW off-shore wind field development off the coast of Columbia.
In a press release from the Columbian Ministry of Mining and Energy, Minister Mr Diego Mesa noted the commitment of the Columbian Government to the development of off-shore wind field capacity and hydrogen production, including, critically, the **Offshore Wind Roadmap** in the process of development with the World Bank Group, and **the Hydrogen Roadmap**. In this context, it is understood that Columbia has off-shore wind resources that will allow the installation of up to 50 GW of off-shore wind field capacity by 2050. The **Hydrogen Roadmap** contemplates the development of between 1 GW and 3 GW of clean / low emission hydrogen production capacity in the medium term.
- **Danish off-shore ROK:** On **March 8, 2022**, it was reported widely that Vestas had signed a memorandum of understanding with Sejin Heavy Industries and Construction, Ulsan City and Ulsan Port Authority to cooperate in the development of the 9 GW off-shore floating wind field complex.
Ulsan City has signed memorandums of understanding with a number of leading off-shore wind field developers, including BayWare (global renewable energy developer), Equinor (international energy company), Green Investment Group (global leading renewable energy group) and RWE (the German renewables electrical energy giant).
- **BlueFloat and Falck Renewables progress:**
 - **Orda Energia Concession Granted:** On **March 8, 2022**, it was reported widely that BlueFloat Energy and Falck Renewables had been granted a 40 year maritime concession to allow the development of the 1.35 GW Orda Energia floating off-shore wind field project (**Orda Energia OWP**). The **Orda Energia OWP** is to comprise 90 turbines located in waters with depths of 100 to 200 metres.
As will be apparent from the below, this is the fifth off-shore wind field development of BlueFloat Energy and Falck Renewables in off-shore Italy.

- **By way of reminder:** Previous editions of Low Carbon Pulse have reported on the plans of BlueFloat (leading renewable energy corporation) and Falck Renewables to develop off-shore wind field capacity off the coast of Italy as follows:
 - **Edition 29** reported that the first project between Falck and BlueFloat was the 1.2 GW OWF project off Brindisi (Kailia Energia Project), with projected annual generation dispatch of up to 3.5 TWh. On October 26, 2021, it was reported widely that the joint venturers are not seeking a permit in respect of a further 1.3 GW of OWF projects off the southern coast of the province of Lecce. For the projects to proceed, authorisations will have to be obtained from the Ministero per la Transizione Ecologica and maritime concessions granted by the Ministero delle Infrastrutture and the Port Authority of the Southern Adriatic Sea.
 - **Edition 28** of Low Carbon Pulse reported that Falck Renewables (leading Italian renewable energy developer) and BlueFloat Energy (leading off-shore wind developer) had announced that they have entered into a 50:50 joint venture for the purposes of developing off-shore wind field (OWF) projects off the coast of Italy.
 - **Current projects progressing:** By the reckoning of the author, the following off-shore wind field progress are progressing: the 675 MW Minervia Energia project in the Gulf of Squillace, 1.4 GW Nora Energia 1 and 2 wind fields in Gulf of Cagliari and 1.2 GW Kailia Energia of Brindisi.
- **The Netherlands progresses to next auction:**
 - **Regulations issued:** On **March 10, 2022**, offshorewind.biz reported that the Ministry of Economic Affairs and Climate Policy had issued regulations detailing rules for the upcoming licensing of Hollandse Kust (west) Wind Farm Zone, which comprises Hollandse Kust (west) VI and Hollandse Kust (west) VII in the Dutch sector of the North Sea. The licence areas are located 53 kms off the west coast of the Netherlands. The auction for the two licenses open on April 12, 2022 and will close on May 12, 2022.
 - **Double Dutch:** On **March 18, 2021**, it was reported widely that the Dutch Government had doubled its forecasts for off-shore wind field capacity: an additional 10.7 GW of off-shore wind field capacity is to be installed, doubling current planned capacity, to 21 GW of installed capacity by 2030. The capacity will be installed in five zones in the Dutch sector of the North Sea. The Dutch Climate and Energy Minister, Mr Rob Jetten, is reported to have said: "*This is an important step in the transition to more sustainable energy ... to produce much more sustainable energy so that it no longer has to import carbon, gas and oil from other countries ...*". **Edition 32** of Low Carbon Pulse (under **Dutch off-shore wind progress**) reported that: "During the second week of December 2021 it was reported that the Dutch Government intends to expand its off-shore wind capacity, possibly through the development of a further 10.7 GW by 2030, from 11.5 GW to 22.2 GW, with newly designated zones in 1, 2 and 5-East (to accommodate an additional 8 GW), the Ijmuiden Ver North (2 GW) and Hollandse Kust (700 MW)".
 - **By way of further reminder:**
 - **Edition 36** of Low Carbon Pulse reported that Rijksdienst voor Ondernemend (**RVO**) Nederland published a [report](#) (entitled the **Netherlands System Integration Offshore Wind 2030-2040**). The **RVO** is proceeding on that basis that by 2040 there will be 38.5 GW of installed off-shore wind field capacity, moving to 72 GW by 2050 (under one scenario – the national scenario) and 31 GW, moving to 38, 42 GW or 43 GW of installed capacity by 2050 (under three other scenarios).
 - **Edition 29** of Low Carbon Pulse noted that on October 6, 2021, it was reported that the **RVO** is procuring the undertaking of met-ocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the Ijmuiden Ver Investigation Area (**IVIA**). The **IVIA** is one of three off-shore areas identified in the Dutch Offshore Wind Energy Roadmap 2030. The **IVIA** is 62 kms off the west coast of the Netherlands, having an area of 400 km². The **IVIA** has four lots in all, with **IVOA** I and II to be tendered in to 2023, and **IVOA** III and IV to be tendered in to 2025.
- **Global Wind Energy Council (GWEC) highlights five countries:** On **March 11, 2022**, the **GWEC** published [Floating Offshore Wind – a Global Opportunity](#) identifying five countries as comprising the chasing pack (in the sense of chasing to catch France, Japan, **ROK** and the UK), Ireland, Italy, Morocco, the Philippines and the US, being five countries that are likely to spearhead the next wave of floating off-shore wind field developments.
- **Swedish Fair Wind :**
 - **Continues for OX2 in the Baltic Sea:** On **March 14, 2022**, offshorewind.biz reported that OX2 had applied for a Natura 2000 permit to develop the 5.5 GW Aurora off-shore wind field, located 20 kilometres south of Gotland and 30 kilometres east of Öland, within the Swedish Baltic Sea Exclusive Economic Zone. The application by OX2 marks its continued progress, with three major off-shore wind field developments at various stages of development / progress.
 - **By way of reminder:**
 - **On December 30, 2021**, offshorewind.biz reported that OX2 had applied for a Natura 2000 permit to develop the 1.8 GW Triton off-shore wind field, located within the economic zone off the coast of Skåne, Sweden.
 - **On January 17, 2021**, offshorewind.biz reported that OX2 had been granted exploration permits for two off-shore wind fields in the Gulf of Bothnia Exclusive Economic Zone (**EEZ**): the permits were granted at a plenary session of the Finnish Government, and are in respect to the Halla project (approximately 35 km off-shore of the city of Raahel) and Laine project (approximately 30 km off-shore of the adjacent cities of Kokkola and Pietarsaari).
 - **On February 22, 2022**, offshorewind.biz reported that OX2 has applied for a permit to construct the 1.8 GW Triton off-shore wind field project. On grant of the permit, the 1.8 GW Triton project will be constructed 30 kilometres south of Ystad, comprising 129 wind turbines, each with a maximum height of 370 metres. As

reported, the 1.8 GW Triton project will be able to generate up to 7.5 TWh of renewable electrical energy a year. This will represent great progress in the context of the plans and policy settings of the Swedish Government outlined below (under **By way of reminder**).

- **Edition 35** of Low Carbon Pulse reported that the Swedish Government is to identify suitable areas to develop off-shore wind fields for the purposes of generating 120 TWh annually from sources of renewable electrical energy (noting that the electrical energy consumption of Sweden is 140 TWh annually). It is understood that the Swedish Energy Agency (**SEA**) has identified, and reported on, three areas – located in the Baltic Sea, the Gulf of Bothnia and the North Sea having wind resources of between 20 to 30 TWh annually. The **SEA** will work with the Swedish Maritime Administration (**SMA**) to identify areas from which 90 TWh annually can be generated. The **SEA** is to report on progress by no later than March 2023, and the **SMA** no later than December 2024.
- **Taiwan reviewing EIAs:** On **March 15, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported that the Environmental Protection Agency in Taiwan was in the process of reviewing Environmental Impact Statements (**EIAs**) in respect of nine off-shore wind field developments, together projected to comprise 9.1 GW of installed capacity. The majority of the developments are proposed by developers head-quartered in Europe.
- **Shell to ROK:**
 - **Floating plans:** On **March 15, 2022**, it was reported widely that Shell Gas & Power Developments B.V. had signed a memorandum of understanding (**MOU**) with Korea Southern Power Co., Ltd (**KOSPO**) for the purposes of exploring opportunities to work together in the context of energy transition (**KOSPO** is one of the six power generation subsidiaries of Korea Electric Power Corp – see **Edition 30** of Low Carbon Pulse). These opportunities may include off-take of renewable electrical energy from the **MunmuBaram Project** (understood to be progressing to a final investment decision) or future floating off-shore wind field developments, or both.
 - **By way of reminder:**
 - **Edition 26** of Low Carbon Pulse reported that Shell Overseas Investment B.V. had announced its joint venture with CoensHexicon Co. Ltd, with Shell an 80% equity participant, CoensHexicon, a 20%, equity participant, to develop and then to operate the 1.4 GW Ulsan **OWF** project (the **MunmuBaram Project**).
 - **Edition 32** of Low Carbon (under **MunmuBaram licensed**), the **MunmuBaram Project** has been granted an Electricity Business Licence (**EBL**), for its floating off-shore wind field project development.
- **Portugal moves to auction:** On **March 16, 2022**, [Reuters](https://www.reuters.com) (under **Portugal to auction 3-4 GW of floating offshore wind farms in summer**) reported that the Energy Transition Minister, Mr João Matos Fernandes, had indicated that 3 to 4 GW of offshore wind field capacity was intended to be installed by 2026.
- **bp and Marubeni joint venture:** On **March 23, 2022**, bp (leading international energy corporation) [announced](https://www.bp.com) that it had agreed to partner with Marubeni Corporation (leading Japanese integrated investment and trading conglomerate) to explore selected off-shore wind field development opportunities off-shore Japan. The Marubeni Corporation [announcement](https://www.marubeni.com) provided further detail, stating that it had signed a Cooperation Agreement and a Participation Agreement with BP Alternative Energy Investments Limited (**BPAEI**, a wholly owned subsidiary of BP plc). The first stage of the strategic partnership involves the establishment of a joint venture (51% Marubeni Corporation, 49% **BPAEI**) for the purposes of pursuing selected off-shore wind field development opportunities. In addition to off-shore wind field development, the strategic partnership may extend to other decarbonisation projects, including hydrogen.
- **By way of reminder: Edition 35** of Low Carbon Pulse (under **Auction Process**) reported that: The Norwegian Government intended to auction the 3 GW **Sørlige Nordsjø II** in two phases. The auction model is under-development, with legislation required to support the off-shore wind development. It was reported widely that the [Norwegian Offshore Wind Cluster](https://www.offshorewind.biz), met to debate the off-shore auction model with the Norwegian Prime Minister, Mr Jonas Gahr Støre. On February 10, 2022, Prime Minister Støre outlined first phase (comprising 1.5 GW) of the **Sørlige Nordsjø II** off-shore wind field development: the first phase was to be completed in the second half of the current decade, providing up to 7 TWh per annum of renewable electrical energy. Prime Minister Støre did not rule out the provision of government funding support (through subsidies of the electrical energy price). In respect of the second phase of the development of **Sørlige Nordsjø II** project the Prime Minister contemplated that 1.5 GW of renewable electrical energy from this off-shore wind field development may find a market in northern Europe, rather than Norway". For news items relating to the Utsira leases see the following editions of Low Carbon Pulse: **Editions 18, 20** and **35**.
- **Carolinas Greenlighted:** On **March 25, 2022**, [offshorewind.biz](https://www.offshorewind.biz) reported (under **US Greenlights Wind Auction Offshore the Carolinas**) that the Bureau of Ocean Energy Management (**BOEM**) had completed its environmental review, and will hold an off-shore wind field energy auction for two lease areas off-shore North Carolina and South Carolina on May 11, 2022. It has been reported that the acreage of the off-shore wind field lease areas will result in the installation of at least 1.3 GW of off-shore wind field capacity.
- **New Zealand off-shore wind – world class fundamentals:** On **March 28, 2022**, it was reported widely that Copenhagen Infrastructure Partners (**CIP**) has joined forces with NZ Super Fund to develop a 1 GW off-shore wind field development off Aotearoa, New Zealand in the South Taranki Bight.
- This is an exciting development, noting that the off-shore wind resources of New Zealand are world class. The issue for off-shore wind field development will be the cost of development, and the load that the renewable electrical energy dispatched matches.
- **Norway moves to qualitative model:** On **March 24, 2022**, it was reported that the Norwegian Government had proposed to use a qualitative procurement model in respect of the Utsira Nord Lease.



Solar and Sustainability (including NZE Waste):

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers news items relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.

- **ZEBRA crossing:** On **March 17, 2022**, offshorewind.biz reported that the Zero waste Blade ReseArch (ZEBRA) consortium had produced the first prototype wind turbine blade that is 100% recyclable. The blade has been manufactured in Spain: the 62 metre blade is made of Arkema Elium® resin, which is a thermoplastic resin, and glass fabrics.
- **A reminder:** On **March 26, 2022**, the author of Low Carbon Pulse came across the following simple reminder of the nomenclature of carbon neutrality and net zero:

Net-zero WHAT?

Net-zero carbon (CO₂)

Net-zero carbon emissions = **only CO₂**
Carbon neutrality Balancing the emissions and removals of CO₂

Net-zero GHG

Net-zero GHG emissions = **all greenhouse gases**
Climate neutrality Balancing the emissions and removals of all GHGs

GHG – greenhouse gas



The simple reminder is taken from an excellent article written by Ms Eve Tamme.

- **Sustainable City: Edition 17** of Low Carbon Pulse reported on the Woven City as follows:

"Woven City – City of the Future: On May 10, 2021, it was announced that Japanese corporations ENEOS and Toyota Motor Company had combined resources to consider how they may work together to help in the development of Susono City, Shizuoka Prefecture, Japan – "the city of the future" or the Woven City. In a statement about the combination of ENEOS and Toyota to develop the Woven City, Toyota indicated that the plan is to test the basis of the development and implementation of a hydrogen-based supply chain, in and around (and, if you will, woven into the fabric of) the Woven City."

On **March 23, 2022**, it was reported that ENEOS and Toyota have agreed to consider production of "**CO₂-free**" hydrogen production and use within the Woven City.

- **Heliogen and Woodside CS demonstration project:** On **March 28, 2022**, it was reported widely the Woodside Energy (USA) Inc., is to deploy Heliogen AI-enabled concentrated solar technology for the purposes of a demonstration project. The CS demonstration project is to be built in the Mojave, California. While the scale of the CS demonstration project is small, it is telling that Woodside Energy is progressing with it.
- **First sovereign sustainability linked bond:** On **March 29, 2022**, the London Stock Exchange [congratulated](#) The Republic of Chile on the issue of the world's first sustainability-linked bond (a USD 2 billion 4.35% note due March 2042) listed on the London Stock Exchange's International Securities Market and Sustainable Bond Market.
- **MENA Climate Week:** From **March 28 to March 31, 2022**, the first-ever Middle East and North Africa Climate Week (**MENACW**) conference took place in Dubai, United Arab Emirates, under the auspices of the UNFCCC.

On **March 31, 2022**, the UN released the following [press release](#) (titled **MENACW Galvanises Regional Momentum for COP-27**). At the half way point between **COP-26** and **COP-27**, **MENACW** is reported to have built on one (held in Glasgow, Scotland), and prepared for the next (to be held in Sharm El Sheikh, South Sanai, Egypt).

In the context of **COP-27**, the Foreign Minister of Egypt, and incoming **COP-27** President, Mr Sameh Shoukry said:

"Holding the Climate Week for the first time in the Arab region has been clear evidence of the priority that the countries in the region give to international climate action and ways to combat the negative effects of a phenomenon that has seen its repercussions and impacts extend to multiple aspects of life in our countries. Egypt seeks to make the twenty-seventh session of the United Nations Framework Convention on Climate Change a milestone in the field of international climate action, in which pledges and promises are transformed into actual implementation on the ground".

The press release provides the facts and stats around the number of participants, meetings and sessions.

Edition 30 of Low Carbon Pulse reported on the **UN High Level Climate Action Champions** initiative, and in Dubai the **COP-26** Champion, Mr Nigel Topping, and the **COP-27** champion, Mr Mahmoud Mohieldin, announced their [vision](#). As the **MENACW 2022** report on outcomes is published, a future edition of Low Carbon Pulse will report on them.

- **Over 10% of electrical load matched by solar and wind, 38% from all clean power sources:** On **March 30, 2022**, the BBC [reported](#) on analysis in the [ember-climate.org report](#) which concluded that in 2021 (for the first time) renewable electrical energy generated by photovoltaic solar and wind sources had been dispatched to match 10% of electrical load, and electrical energy generated by clean power sources dispatched to match 38% of electrical load. The ember report is well-worth a read.
- **Cepsa steps up – "Small enough to move, big enough to lead":** On **March 30, 2021**, it was reported widely that Cepsa (multinational oil and gas corporation) plans to invest between USD 7.8 billion and USD 8.9 billion in the development of 2 GW of Green Hydrogen capacity and 7 GW of renewable electrical energy capacity. In addition, Cepsa is considering investing in the development of 2.5 million metric tonnes of second-generation biofuel production capacity, and 800,000 metric tonnes of **SAF** production capacity.
- **"Its' take to end the model of "take, make, break and throw away' that is so harmful to our planet":** On **March 30, 2022**, the European Commission (**EC**) presented proposals as part of the **European Green Deal** (see [Editions 14, 16, 22, 23 and 32](#) of Low Carbon Pulse) initiatives of the **EU**.

With the presentation of the **Circular Economy Action Plan**, the **EC** is proposing [new regulations and rules](#) in respect of good and products, including to addressing energy efficiency over the life-cycle of those goods and products, and to design their recycling and repurposing at the end of their design life. In addition, the EC presented proposals in respect of textiles, construction materials and products, and to ensure that customers are informed fully as to the sustainability of the goods and products.

- **CleanCo to go:** On **March 31, 2022**, it was reported widely that CleanCo (the Queensland government-owned clean energy generator) was to supply 100% of the load to retail giants Bunnings, Kmart, Officeworks and Target across Queensland Australia.

Land Mobility / Transport:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.*

- **Buses and coaches:**

- **Air Products to develop mobility facility:** On March 9, 2022, it was reported widely that Air Products (one of the Big Three Industrial Gas producers globally, with Air Liquide and Linde) is to develop a 10 metric tonne a day liquid hydrogen (**LH₂**) production facility in Casa Grande, Arizona, with the **LH₂** to be used in the California mobility market. The **LH₂** production facility will comprise two thyssenkrupp nucera electrolyzers to produce gaseous hydrogen and Air Products technology to liquify to produce **LH₂**.
- **Houston, Texas, Bussing:** On **March 14, 2022**, [houston.culturemap.com](#) reported that the Metropolitan Transit Authority of Harris County had awarded a contract for 20 battery electric buses for Nova Bus (Canadian

headquartered technology corporation, Saint-Eustache), with an option for a further battery electric buses. The first buses are expected to be in operation by late 2022, early 2023.

- **Bratislava, Slovakia, Trolley-bussing:** On **March 16, 2022**, Solaris Bus & Coach [announced](#) that its Solaris Trollino 24 trolleybuses would be deployed in Bratislava by mid-2023. Solaris is supplying 16 bi-articulated trolleybuses to operator Dopravný podnik Bratislava.
- **Wroclaw, Poland, electric:** On **March 18, 2022**, Daimler Truck AG [announced](#) that 11 of its eCitaro G electric buses had been ordered by the City of Wroclaw, and would be deployed in the third quarter of 2023.
- **UK on Track to Reach 4000 Zero Emission Bus Pledge:** On **March 28, 2022**, [hydrogen-central.com](#) reported that the UK was on track to deploy 4000 Zero Emission Buses by 2050. This follows a GBP 198 million funding commitment that will provide sufficient funding for the deployment of 943 buses.

The funding is provided in the Zero Emission Buses Regional Area scheme. The funding will support the procurement of both battery electric and hydrogen-powered and propelled buses.

- **Cars (including taxis):**

Other than the commitment of Germany to phase out ICE powered and propelled by fossil fuels by 2035 (see **Energy transition in action** above), there have been no material or significant news items that have come to the attention of the author in the news cycle for this **Edition 37** of Low Carbon Pulse.

- **Fuel Cell and Battery Supply and Technology:**

On **March 22, 2022**, [Wood Mackenzie](#) released its analysis of the supply of batteries. The analysis is excellent, and well worth a read.

- **Industrial Vehicles and Trucks:**

- **Gaussin again:** On **March 17, 2022**, it was reported that Gaussin had revealed the world's automated first hydrogen-powered and propelled fuel cell electric vehicle. The vehicle is to be deployed port side.

- **First hydrogen truck in Australia:** On **March 21, 2022**, it was reported widely that JJ Waste & Recycling had contracted with Pure Hydrogen for a wet-lease of a hydrogen-powered and propelled garbage truck, with Pure Hydrogen providing the truck and the hydrogen for the truck.

- **A.P. Moller – Maersk to deploy 300 electric trucks:** On **March 24, 2024**, A.P. Moller – Maersk [announced](#) that it add 300 electric trucks to its North America network. The electric trucks will be delivered between 2023 and 2025. Einride (a technology corporation that provides freight mobility solutions) will supply the e-trucks, assembled to specification in the US.

- **OCI NV – another first:** On **March 29, 2022**, OCI NV announced that Europe's first Power-to-X truck powered and propelled by green methanol supplied by OCI NV had been driven by the Danish Transport Minister, Trine Bramsen, in Aalborg, Denmark. OCI NV is supplying green methanol to Circle K, to be used in its trucks.

- **Recharging and refuelling infrastructure:**

In addition to the news items covered above in respect of the development of an East Coast of Australia recharging and refuelling network, the following news items are both material and significant:

- **World's largest biomethane refuelling station opens:** On **March 9, 2022**, it was reported that the world's largest biomethane refuelling station had opened at Avonmouth in the UK, capable of refuelling up to 80 heavy goods vehicles / trucks per hour, using 14 high-speed dispensers.

- **Everfuel hydrogen refuelling station opens:** On **March 11, 2022**, [Everfuel](#) announced that the Heinenoord HRS, in the Netherlands, had opened, providing hydrogen refuelling services to Connexion's fuel-cell powered and propelled buses.

The development and deployment of the Heinenoord HRS is the result of the efforts of Province Zuid-Holland, Gemeente Hoeksche Ward, and the European Climate, Infrastructure and Environment Executive Agency (CINEA), the Clean Hydrogen Partnership and the Ministre van Infrastructuur en Waterstaat, and commercial partners Connexion Nel Hydrogen, Rebel and VIRO.

- **KOGAS to roll-out hydrogen refuelling stations:** On **March 24, 2022**, the Korea Gas Corporation (**KOGAS**) stated that by 2030 it planned to establish 152 hydrogen refuelling stations around South Korea, with 90 of the HRS's to be liquid hydrogen.

- **BP to Invest GBP 1 billion:** On **March 25, 2022**, bp [announced](#) that it intended to invest GBP 1 billion over 10 years to expand its EV charging capacity across the UK.

- **Trains:**

- **Wales of a time:** On **March 9, 2022**, it was reported widely that Ballard Motive Solutions is leading a study in respect of the deployment of hydrogen-powered and propelled trains in Wales, in particular the feasibility of their use to displace diesel powered and propelled trains.

- **Scotland on time:** On **March 13, 2022**, [The Scotsman](#) reported on routes within Scotland that were expected to be first to benefit from battery powered and propelled trains, being the Borders Railway between Edinburgh and Tweedbank, and the Fife Circle and Glasgow-East Kilbride. The progress reported in The Scotsman reflects the commitment of the Scottish Government to phase out ScotRail's diesel fleet by 2025.

- **East Japan Railway is testing hydrogen train:** In **March 2022** the testing of the two car hydrogen-powered hybrid (**Hybari**) trainset commenced. The **Hybari** trainset, developed by Hitachi Ltd and Toyota Motor Corporation, is able to travel 140 km at its top speed of 100 km/h between refuelling.

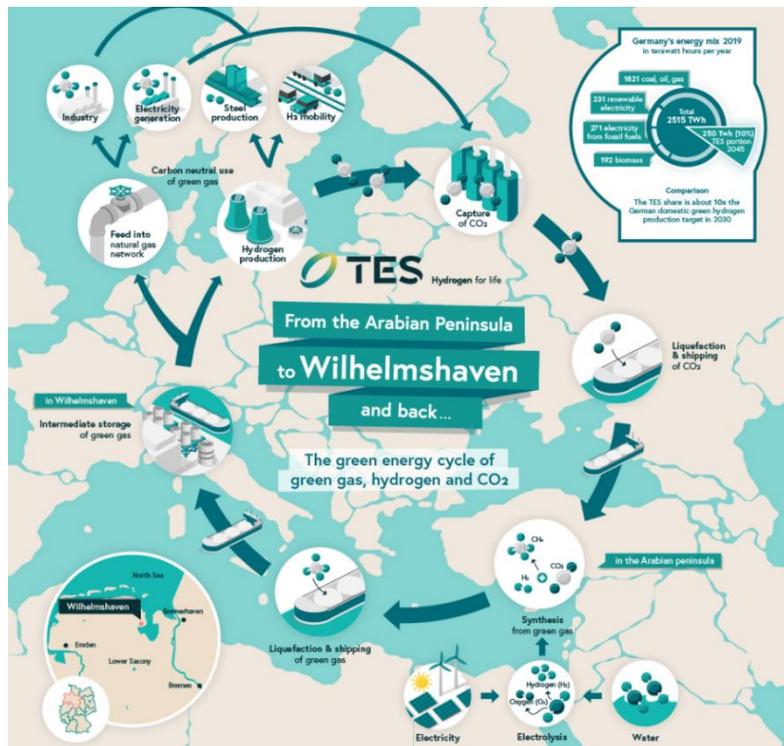
By way of reminder: **Edition 35** of Low Carbon Pulse reported that: "**JR East Hybrid running:** On February 19, 2022, [asia.nikkei.com](#) reported that East Japan Railway (**JR East**) had unveiled Japan's first hydrogen-powered hybrid train (**Hybari**) on February 18, 2022, using technologies developed by Hitachi Corporation and Toyota Motor Corporation – hydrogen fuel cells and electric battery technologies. **JR East** is to commence testing of the **Hybari** in March 2022".

- Bavaria is procuring hydrogen trainset:** On **March 16, 2022**, it was reported widely that the Siemens Mobility and Bayerische Regiobahn had signed a lease of a two car hydrogen-powered Mireo Plus trainset, developed by Siemens Mobility. The Mireo Plus trainset is to be tested on the Augsburg-Füssen route, starting in mid-2023.
By way of reminder: Edition 22 of Low Carbon Pulse reported that: "For some time, Ballard Power Systems (**BPS**) has been making progress across a number of sectors. On July 15, 2021, it was reported widely that **BPS** is to supply 200 kw fuel cell modules under arrangement with Siemens Mobility GmbH to power a two car Mireo Plus H passenger train trials in Bavaria, Germany (one of the hydrogen hot spots in the **EU**). The fuel cell modules are located on the roof of the passenger train, and power and propel the train with electric battery technology located underneath the floor of the train. It is reported that the trials will start in 2022. The Mireo Plus H passenger train is designed for use on non-electrified lines at speeds of up to 160 kph."

Ports Progress and Shipping Forecast:

This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for **E-Fuels / Future Fuels** (including **Hydrogen Hubs**) and to capture and to store or to use carbon, or both (including **Carbon Clusters**), and the connection of port infrastructure to the hinterland. Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.

- Ferries and other craft:**
 - Energy Observer observed in Singapore:** On **March 10, 2022**, it was reported that the Energy Observer (the world's first hydrogen powered and propelled vessel) had arrived in Singapore, moored at ONE⁰15 Marina Sentosa Cove. The Energy Observer is powered and propelled by photovoltaic solar and wind, which produce hydrogen from seawater.
 - Sembcorp Marine completes fabrication:** On **March 16, 2022**, Sembcorp Marine announced that it had completed the fabrication of the first of three zero-emission battery powered Ropax Ferries for Norled AS. The design of each of the Ropax Ferries has been optimised for the requirements of Norled A/S, with each ferry to be powered and propelled by lithium-ion batteries, and having a back-up battery-diesel hybrid mode. Each battery is to be charged / recharged using renewable electrical energy from hydroelectric sources.
 - By way of reminder:** As reported in **Editions 23** and **30**, in late July 2021, Norled As is the owner of the **MF Hydra** (styled as the first liquid hydrogen powered ferry). As reported, the **MF Hydra** is 82.4 metres in length, with capacity for 300 passengers and 80 motor cars. On February 2, 2022, it was reported widely that Ballard Power Systems is to supply two of its 200KW FCwave fuel cell modules to Norled A/S, the owner of the **MF Hydra**. As will be apparent from the previous new items, during 2022 the **MF Hydra** will start to serve the Hjelmeland-Skipavik-Nesvik route in Rogaland.
- Green Ports:** The following map-graphic illustrates the role of ports and shipping in the context of the planned developments at the Port of Wilhelmshaven.



(Source: <https://www.offshore-energy.biz/tes-pushes-wilhelmshaven-green-energy-hub-development/>)

- **Green Shipping:**

In addition to the news items covered above in respect of the ADB and Pertamina and A.P. Moller – Maersk, the following news items are both material and significant:

- **Egil Ulvan Rederi H2 vessel gets AiP:** In early March, and then throughout March, 2022, it was reported that Egil Ulvan Rederi AS has received Approval in Principle (**AiP**) from Lloyds Register for its zero-emission self-discharging hydrogen-fuelled bulk carrier – the **With Orca**. The With Orca is designed by Norwegian Ship Design. It is understood that a long-term transport contract is to be firm up with Felleskjøpet Agri and Heidelberg Cement for the use of the **With Orca**, a 88 metre, 5,500 metric tonne bulk carrier.
As reported the **With Orca** will be powered and propelled by hydrogen, with propulsion and energy capture provided by two rotor sails as well as hydrogen. The hydrogen will be stored in the **With Orca** in compressed form and a hydrogen combustion engine for use in higher load conditions, and a fuel cell electric system for use in lower load conditions. The hydrogen is to be supplied by Statkraft (global leader in hydropower and Europe's largest generator of renewable electrical energy).
- **MAN B&W Engines ordered: Edition 29** of Low Carbon Pulse reported that Dalian Shipbuilding Industry Co. Ltd was to build two 7,500 m³ liquid **CO₂** carriers to transport **CO₂** captured and liquified as part of the Longships project, with the **CO₂** to be stored in the Northern Lights project (part of the Longship Project).
On **March 9, 2022**, MAN Energy Solutions [announced](#) that Dalian Shipping had ordered two MAN B&W 7S5ME-GI dual-fuel engines.
- **Power Transfer Vessel:** On **March 10, 2022**, it was reported widely that **ClassNK** (Japanese classification society) had signed a memorandum of understanding with **PowerX Inc.**, providing for their collaboration in respect of the development of the Power ARK, a power transfer vessel. The concept of the Power ARK is that electrical energy is transferred to it, charging 100 grid batteries on board the Power Ark.

Airports and Aviation:

*This section considers news items that have arisen within the news cycle of this **Edition 37** of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

- **A world of sunlight:** On **March 7 and 8, 2022**, it was reported widely that Lufthansa Group and Swiss International Airlines (**SAL**) and Synhelion had established a strategic collaboration to allow progress to the realisation of "sun-to-liquid fuel (**STF**).
As reported, Synhelion is developing a technology that uses "concentrated solar heat" to derive synthetic gas (syngas, as contrasted with natural gas), which is then synthesised to produce e-kerosene. The production of e-kerosene from the syngas uses long established technology. Synhelion has received funding support from the German Federal Government to enable it to develop its "sun to fuels plant" in North Rhine-Westphalia, Germany. It is understood that by 2023, **SAL** will be using the **STF**.
- **A world of flight:**
 - On **March 7, 2022**, it was reported widely that Airbus Industries and Fortescue Future Industries (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO) had established a basis for the development of a partnership under a memorandum of understanding (**MOU**), with the intention for the corporations to work together to progress development of zero emissions aircraft powered and propelled by hydrogen. A link to the joint announcement is [attached](#).
It is understood that the MOU contemplates that the corporations will identify, and work to remove, any constraints on the use of Green Hydrogen, and the development of Green Hydrogen supply chains. In this context, it is understood that Airbus Industries will assess energy and fuelling needs of the aviation industry, and FFI will develop the hydrogen supply chains.
 - On **March 17, 2022**, it was reported widely that [Airbus Industries](#) and [Delta Airlines](#) had agreed (as part of its aim to Fly to Net Zero) to work together to accelerate the development of hydrogen-powered and propelled aircraft. For these purposes, Delta Airlines will work with Airbus Industries to identify fleet and network expectations and requirements to enable it to progress to the use of commercial aircraft powered and propelled by hydrogen.

By way of reminder:

- **Edition 35** of Low Carbon Pulse, reported that Airbus Industries may manufacture engines powered by hydrogen. On February 23, 2022, it was reported widely that Airbus Industries and CFM International (a 50/50 joint venture between GE Aviation and Safran Aircraft Engines) are working together to test the use of hydrogen to power engines to propel aircraft.
- **Edition 32** of Low Carbon Pulse reported that Airbus Industries intends to develop a zero-emission hydrogen powered and propelled commercial aircraft by 2035.
On February 22 and 23, 2022, it was reported widely that by 2035 Airbus Industries intends to fly a hydrogen-powered and propelled Airbus A380.
The announcement that the Airbus A380 was to be the Airbus Industries aircraft resulted in multiple diagrams, the most helpful of which is as follows:
- **Zero-e since Q3 of 2020:** Airbus Industries announced its thinking around progress to use hydrogen to power and propel aircraft at the end of Q3 of 2020 ("**Zero-e**"). The announced thinking was accompanied by an outline of [three hydrogen powered aircraft concepts](#): Turbofan; Turboprop; and Blended-Wing Body (BWB).
- **FlyZero spot-on:** In **March 2022**, FlyZero, led by the Aerospace Technology Institute published [Hydrogen Infrastructure and Operation, Airports, Airlines and Aerospace](#) (backed by the UK Government). The publication is excellent.

The headline conclusion from the publication is that "green liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft utilising fuel cell gas turbine and hybrid systems". The balance of the publication report is aligned around this conclusion.

While the publication has a UK focus, it has global application, and it points out key (and to many) salutary facts:

- Production of Green Hydrogen requires "unprecedented renewable energy capacity, transporting hydrogen to airports will require gaseous pipelines of liquid tanker deliveries, and the refuelling of aircraft ... will need to take place safely and efficiently alongside conventional aircraft";
- Initially, most airports will be supplied with liquid hydrogen produced and liquified off-site, and transported by tanker;
- As demand increases, particularly at large airports, supplying liquid hydrogen by tanker will cease to be feasible, and hydrogen supply via gaseous pipeline with on-site liquefaction at the airport likely to become the norm;
- While most of the technology required to store liquified hydrogen and to fuel and to refuel aircraft with liquid hydrogen exists, the development of storage and fuelling / refuelling infrastructure at the required scale is likely to prove challenging.
- **Neste's fund continues:** On **March 21, 2022**, [Neste](#) announced that it had contracted with DHL for the supply of 320,000 metric tonnes (or around 400 million litres) of **Neste MY Sustainable Aviation Fuel**. This is the largest **SAF** supply agreement to date for Neste;
- **Rolls Royce Trent 900 engines fuelled by SAF:** On **March 28, 2022**, it was reported widely that an Airbus A380 powered by Rolls Royce Trent 900 engines, had completed its first flight using **SAF**. As noted in previous editions of Low Carbon Pulse, **SAF** is at the early stages of use (effectively an e-kerosene), but with the market for aviation fuel at close to 300 million metric tonnes a year, considerable **SAF** productions capacity needs to be developed to make significant progress to the use of **SAF** as a percentage of aviation fuel.
- **HyPoint – another high point:** On **March 29, 2022**, it was reported widely that HyPoint (technology corporation) had developed a need technology that would allow the carriage of liquid hydrogen (**LH2**) using ultra-light weight fuel tanks.

Quote of the month:

It has been clear since March 7, 2022, the (truth) telling quotes arise reasonably frequently, and stay with the reader. During the news cycle from March 7, 2022, the most telling quote to the author was that Dr Kimberley R. Miner, Climate Scientist at NASA, Professor of Climate Risk:

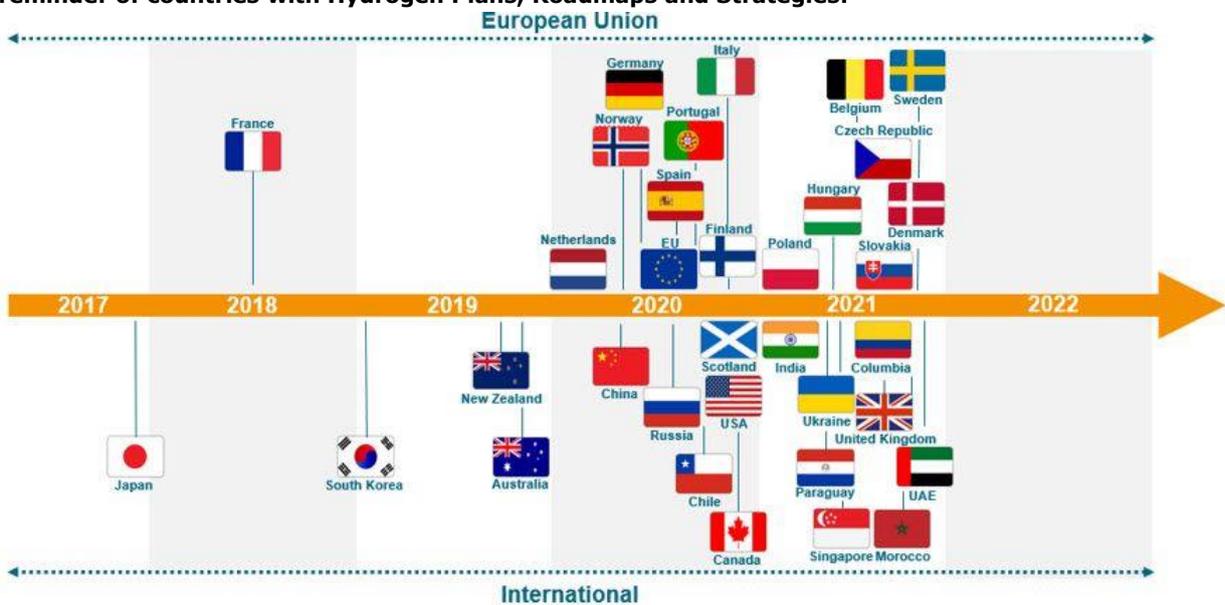
"Despite all of our accomplishments we owe our existence to a six-inch layer of topsoil and that fact that it rains".

This summarises more powerfully and succinctly many publications on the substance of this quote.

Reference Material:

The purposes of this Reference Material section is keep live, reference material that readers may find most useful on an ongoing basis without the need to search for that material:

- **A reminder of countries with Hydrogen Plans, Roadmaps and Strategies:**



- **S&P Global Platts – Atlas of Energy Transition:** On **February 22, 2022**, S&P Global Platts published its [Hydrogen Price Wall](#), mapping hydrogen prices across means of production and regions of use. The [Hydrogen Price Wall](#) is to be found in the updated [Atlas of Energy Transition](#).

While Low Carbon Pulse does not report on the cost or price of hydrogen, the S&P Global Platts [Hydrogen Price Wall](#) (as part of the [Atlas of Energy Transition](#)) provides a helpful point of reference.

Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

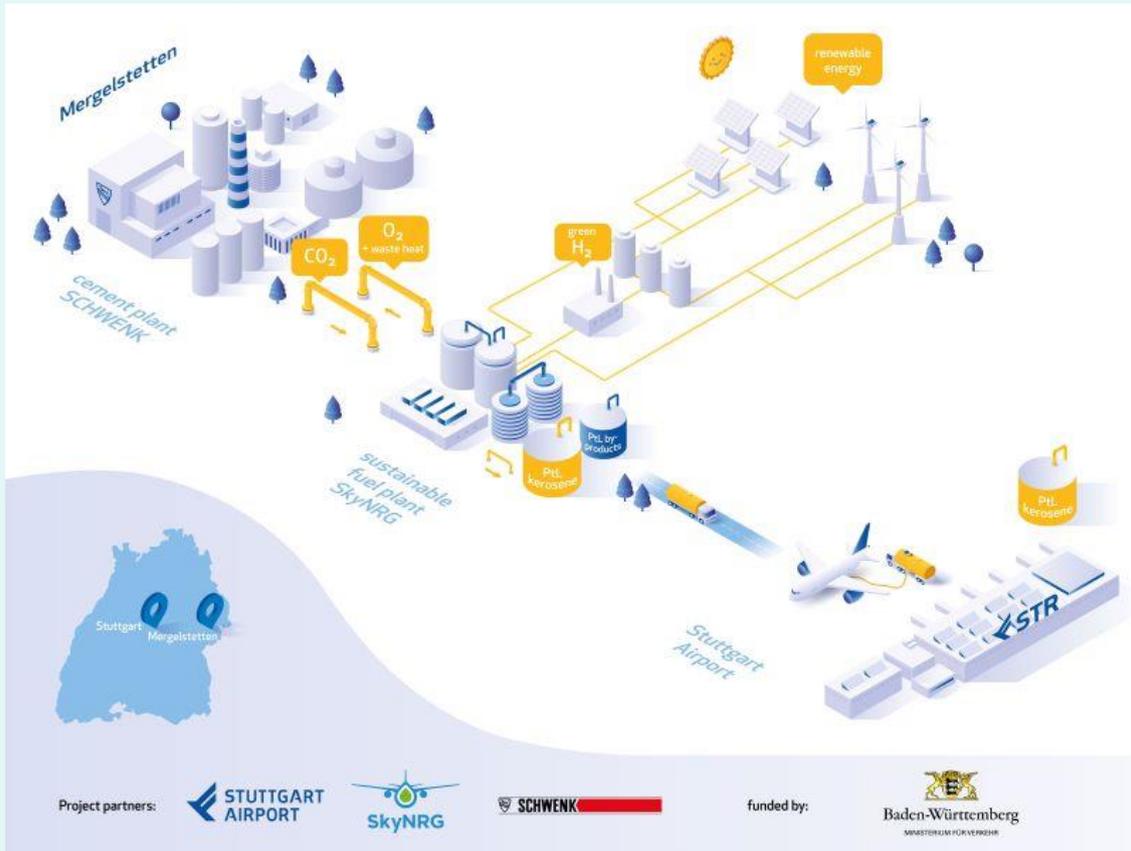
As a reminder, **Edition 35** of Low Carbon Pulse noted in respect of **SAF**:

1. commercial aircraft are not permitted to use **SAF** on its own to propel aircraft (a maximum blend ratio of 50% fossil fuel to 50% **SAF** is permitted);

2. the process to produce **SAF** – there is only one commercially scalable production process – the use of fatty acids and hydrogenated acids as feedstock to produce synthetic paraffinic kerosene. As such, while there are seven approved means of production of **SAF**, only one means is currently commercially scalable; and

3. there is limited available feedstock (i.e. fatty and hydrogenated acids) from which to produce **SAF**. The primary sources of feedstock are animal fats and used cooking oils. As a result, current supply (200,000 metric tonnes of **SAF** annually) is a drop in the ocean of demand for aviation fuel (300 million metric tonnes annually). There is a market for **SAF**, not least because the aviation industry gives rise to around 1 billion metric tonnes of **CO₂-e** each year.

In addition to the reports in **Edition 35** of Low Carbon Pulse on **SAF** on the use of animal fats and used cooking oil, Stuttgart Airport and Schwenk Zement and SkyNRG are progressing with plans to develop synthetic aviation fuel, in the form of synthetic kerosene. The feedstock to produce this **SAF** is **CO₂**, captured from the production of cement, combined with **H₂**. The following infographic provides an overview of the sources of feedstock and the technologies used in the production of synthetic kerosene.



NZE Publications:

At the end of each edition of Low Carbon Pulse, publications mentioned or reviewed in the edition are listed, by organisation, title / subject matter, and link:

ORGANISATION	TITLE / SUBJECT MATTER
Aerospace Technology Institute and FlyZero	<i>Hydrogen Infrastructure and Operation, Airports, Airlines and Aerospace</i>
Blue Marine Foundation	<i>Blue Carbon In the United Kingdom</i>
Carbion and TotalEnergies	<i>Sustainable sourcing of feedstocks for bioplastics</i>
EcoShape	<i>Building with Nature in Indonesia: Restoring an eroding coastline and inspiring action at scale (2015-2021)</i>
Energy Transitions Commission	<i>Mind the Gap: How Carbon Dioxide Removals Must Complement Deep Decarbonisation to Keep 1.5°C Alive</i>
European Investment Bank (EIB)	<i>4th Climate Change Survey.</i>
Global Wind Energy Council (GWEC)	<i>Floating Offshore Wind – a Global Opportunity</i>
Government of Canada (Editors: E Bush and DS Lemmen)	<i>Changing Climate Report in Light of Latest Global Science Assessment</i>
International Carbon Action Partnership (ICAP)	<i>ICAP Status Report 2022</i>
International Energy Agency (IEA)	<i>How Governments Support Clean Energy Start Ups</i>
International Energy Agency (IEA)	<i>A 10 Point Plan to Reduce EU Reliance on Russian Natural Gas</i>
International Renewable Energy Agency (IRENA)	<i>World Energy Transitions Outlook (WETO) 2022</i>
International Renewable Energy Agency (IRENA)	<i>IPCC WGII - Climate Change 2022: Impacts, Adaptation and Vulnerability Report</i>
International Renewable Energy Agency (IRENA)	<i>IPCC WGIII - Climate Change 2022: Mitigation of Climate Change Report</i>
International Renewable Energy Agency (IRENA)	<i>Green Hydrogen For Industry – A Guide to Policy Making</i>
International Renewable Energy Agency (IRENA)	<i>Decarbonising end-use sectors Green Hydrogen Certification.</i>
International Renewable Energy Agency (IRENA)	<i>Collaborative Framework on Critical Materials For The Energy Transition</i>
International Renewable Energy Agency (IRENA)	<i>Collaborative Framework on Critical Materials For The Energy Transition,</i>
International Renewable Energy Agency (IRENA)	<i>Renewable Energy Roadmap for Central America: Towards a Regional Energy Transition</i>
International Renewable Energy Agency (IRENA)	<i>World Energy Transitions Outlook: 1.5°C Pathway.</i>
KPMG	<i>India's green hydrogen ambition - setting the wheels in motion,</i>
Nature	<i>A high-performance capillary-fed electrolysis cell promises more cost competitive renewable hydrogen</i>
Oxford Institute for Energy Studies	<i>Potential development of renewable hydrogen imports to European markets until 2030</i>
United Nations Environment Program	<i>Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions.</i>
University of Exeter (Mr Tim Lenton)	<i>Pronounced loss of Amazon rainforest resilience since the early 2000s</i>
UN Water and UNESCO	<i>United Nations World Water Development Report 2022: Groundwater: making the invisible visible</i>

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