

# Low Carbon Pulse - Edition 36

## GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS



Welcome to **Edition 36** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (**GHG**) emissions (**NZE**) for the period from Monday February 21, 2022 to Sunday March 6, 2022 (inclusive of each day).

Please click [here](#) for the **First Compendium of Low Carbon Pulse** (containing **Editions 1** to **28**, covering October 6, 2020 to October 5, 2021) and [here](#) for the **Second Compendium of Low Carbon Pulse** containing Editions 29 to 35, covering October 7, 2021 to February 20, 2022). Click [here](#) and [here](#) for the sibling publications of Low Carbon Pulse, the **Shift to Hydrogen (S2H2): Elemental Change** series and [here](#) for the first feature in the **Hydrogen for Industry (H24I)** features.

Having received feedback, **Low Carbon Pulse** will move to a monthly news cycle (to be published during the first week of each calendar month) with Edition 37 to be published April 5, 2022. As news items arise throughout each month, **Low Carbon Pulse Bulletins**, will be published. The move to a longer news cycle allows the author to complete articles in the **S2H2: Elemental Change** series and further **H24I** features, and other articles.

### Headlines:

#### **US Federal waters off-shore bonanza:**

As foreshadowed in [Edition 33](#) of Low Carbon Pulse, the US Federal government held its first auction process for the award of off-shore wind fields in US Federal waters field in the final week of February 2022. On Friday 24, 2022 the hammer fell on the auction process, with heightened expectations matched – see [page 22](#) below.

#### **Burning platform risk:**

The International Panel on Climate Change (**IPCC**) **Working Group II** (on Impacts, Adaption and Vulnerability) (**WGII**) finalised its findings as part of the Sixth Assessment Report (**AR6**), which were published on February 28, 2022 (see [page 2](#) below), with the headline being that: "**The extent and magnitude of climate change impacts are larger than estimated in previous assessments**".

#### **Burning issue of plastics gets a platform:**

At the meeting of the UN Environment Assembly (**UNEA**) in Nairobi, Kenya, 175 UN Member States agreed to address plastic at large in the environment (see [page 4](#) below). An article on plastics is close to being finalised.

#### **Vale SK Warne:**

Each Saturday (and Sunday) morning, at around 4 am, the author sits down to write Low Carbon Pulse. On the morning of Saturday March 5, 2022, the author's routine was upset by news of the passing of Mr SK Warne, or **Warnie** to millions around the world. One of the author's favourite sporting memories arises from a One Day International day night match at the Sydney Cricket Ground (Steve Waugh was injured), Warnie was captain. At slip, in ringing bowling changes and field settings Warnie was as masterful as he was at leg-spin bowling. Vale, Warnie.

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### Timeline for February and March 2022:

- Key conferences and publications:

- **Climate Change 2022: Impacts, Adaptation and Vulnerability** report:
  - **IPCC WGI**: From February 14, 2022 to publication on February 28, 2022, the **IPCC WGI** met to finalise its findings ahead of the release of the **IPCC WGI** report - The **Climate Change 2022: Impacts, Adaptation and Vulnerability** report which was published on February 28, 2022

The meeting was the 12th session of **IPCC WGI** (and the 55th of the **IPCC**). The **IPCC WGI** considered the **Summary for Policymakers**, and approved it. On approval, the **IPCC** formally accepted the entirety of the **IPCC WGI** report.

- **Coverage ahead of publication**: On February 22, 2022, the [BBC News, Science](#) (under **IPCC: Climate change report to sound warning on impacts**) flagged that the the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report would outline key "tipping points" that are likely to be passed as the impacts of climate change eventuate, including some tipping points that will not be capable of being reversed. The [BBC News](#) item stated that "**the impact of climate change will likely be the most worrying assessment yet of how rising temperature affects every living thing**". While this statement has the sharp edge of the by-line writer, the statement is entirely valid – the impact of climate change needs to be understood to impart the sense of urgency required to avoid the worst impacts of climate change and, if not possible to avoid, to manage the mitigation of the impacts effectively.

It is clear that the world is not well equipped to avoid or to mitigate the impact of climate change. It is hoped that the findings of the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report will focus the minds of governments globally.

The signals going into and during the 12th session of **IPCC WGI**, and in the report, stress urgency, tempered by "real politics". It is important to understand the continuing political reality: as noted by the chair of **IPCC WGI**, Professor Hans-Otto Pörtner "**One key message has come out of previous reports – political will, in terms of climate action, is the bottleneck for a sustainable future**".

- **Headlines from the Summary of Policy Makers**:

The author is continuing to read the [Climate Change 2022: Impacts, Adaptation and Vulnerability](#) report in full:

The [Summary of Policy Makers](#) presents the key findings of the **IPCC WGI**, and its key contribution to the Sixth Assessment Report (**AR6**) of the **IPCC**.

The key findings are as follows:

1. Human induced climate change has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt;
2. Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change;
3. Global warming, reaching 1.5°C in the near term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans. Near-term actions would reduce substantially projected losses and damages related to climate change in human systems and ecosystems compared to higher-warming levels, but cannot eliminate them all;
4. Beyond 2040 and depending on the level of global warming, climate change will lead to numerous risks to natural and human systems;
5. Climate change impacts and risks are becoming increasingly complex and more difficult to manage;
6. If global warming transiently exceeds 1.5°C in the coming decades or later (overshoot), then many human and natural systems will face additional severe risks;
7. Progress in adaptation has been observed across all sectors and regions, generating multiple benefits;

- 8.** There are feasible and effective adaptation options that can reduce risks to people and nature;
  - 9.** Soft limits to some human adaptation have been reached, but can be overcome by addressing a range of constraints. With increasing global warming, losses and damages will increase and additional human and natural systems will reach adaptation limits;
  - 10.** Maladaptation needs to be avoided – this requires flexible policy settings and implementation;
  - 11.** Political commitment and follow through is required to enable adaptation;
  - 12.** Worldwide climate resilient development action is more urgent than assessed in AR5;
  - 13.** Climate resilient development is enabled by governments, civil society and the private sector, and requires inclusive development choices;
  - 14.** The global trend in urbanisation offers a critical opportunity in the near-term;
  - 15.** Safeguarding biodiversity is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation, pointing to the conservation of approximately 30% to 50% of the Earth's land, freshwater and ocean seas; and
  - 16.** It is unequivocal that climate change has already disrupted human and natural systems.
- **Adaptation from COP-26:** In seeking to frame thinking around the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report, it is helpful to reflect on what was agreed at **COP-26** in respect of Adaptation, and to follow the narrative thread that has emerged.



- **Loss and damage versus Losses and damages – a focus of debate and wording:** It was reported ahead of the **IPCC WGI** meeting that a tussle was likely to emerge to avoid the concept of loss and damage. It will be apparent from the key findings (and the balance of the report) that losses and damages are addressed. This tussle is not new. At the heart of the tussle is the concern of some more developed countries about acknowledging loss and damage as having been caused (and, therefore, how, and by whom), rather the preference of these developed countries is to look forward to recognise what is required to avoid and to mitigate, and, if not possible, to avoid, how best to mitigate.

For ease of reference, set out below are six slides summarising that which was agreed on loss and damage at **COP-26**:





#### **IPCC reports – next steps:**

- In April, the **IPCC WGI** will publish the **Climate Change 2022: Mitigation of Climate Change** report;
- In May, Low Carbon Pulse will bring together the key findings of each **IPCC** Working Group report, updating **Edition 24** of Low Carbon Pulse (which was published in mid-August 2021); and
- In September, the **IPCC** will publish the **Synthesis Report**. The **Synthesis Report** will synthesise and integrate materials contained in the Assessment Reports from each **IPCC** Working Group, and in three Special Reports (**Global Warming of 1.5°C**, **Climate Change and Land** and **The Ocean and Cryosphere in a Changing Climate**).

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

- **During the week commencing February 28, 2022:**

- The **5th UN Environment Assembly (Assembly)** met in Nairobi, Kenya, to discuss the adoption of a global plastic treaty.

On March 2, 2022, the **Assembly** concluded with **14 resolutions** to strengthen actions for nature to achieve Sustainable Development Goals. (The **Assembly** comprises 193 UN Member States, and convenes every two years).

The key headlines from the **Assembly** involve plastics. It was agreed to establish an Intergovernmental Negotiating Committee "to forge an international legally binding agreement to end plastic pollution". To many, including Executive Director of the UN Environment Program, Ms Inger Andersen, the agreement was the most significant environmental multilateral agreement since the Paris Agreement.

While not grabbing headlines in the same way as the initiative on plastic pollution, another resolution of the **Assembly** is significant, supporting the establishment of a comprehensive science policy panel to consider the sound management of chemicals and waste generally, and preventing pollution.

To many, plastics is, or has become, a second or third order issue when viewed in the context of climate change. This may be true, but it is an easier issue to address than climate change. Depending on the source from which facts and stats are drawn, between 375 and 400 million metric tonnes of plastic produced each year, with the feedstock almost entirely sourced from petroleum products. The following table illustrates this:

PLASTICS			
Petroleum Source	Monomer & Description of Production	Polymers	SPI Code (Resin Code)
Ethane (C <sub>2</sub> H <sub>6</sub> )	Ethylene (C <sub>2</sub> H <sub>4</sub> , an olefin), produced by cracking ethane, used to produce polyethylene ( <b>PE</b> )	PE is a thermoplastic (aka as polythene), the most commonly used polymer	2 (SPI Code 1) HD 4 (SPI Code 4) LD
	Ethylene (C <sub>2</sub> H <sub>4</sub> , an olefin), produced at very high temperatures in tubular reactor	Polyethylene terephthalate ( <b>PET/PETE</b> ) is a thermoplastic (aka as polyester)	1 (SPI Code 1)
	Ethylene (C <sub>2</sub> H <sub>4</sub> , an olefin) Tetra-fluoro-ethylene	Poly-tetra-fluoro-ethylene ( <b>PTFE</b> ), is a thermoplastic	7 (SPI Code 7)
	Ethyl-urea (C <sub>3</sub> H <sub>8</sub> N <sub>2</sub> O)	Polyurethane ( <b>PUR / PU / PUT</b> ), is a thermo-set, but can be thermoplastic	7 (SPI Code 7)

Propane ( $C_3H_8$ )	Propylene ( $C_3H_6$ , an olefin), produced by liquid catalytic cracking, used to produce polypropylene ( <b>PP</b> )	PP is a thermoplastic (aka: polypropene), second most commonly used polymer	5 (SPI Code 5)
Ethane ( $C_2H_6$ )	Vinyl Chloride ( $C_2H_3Cl$ ): derived from ethylene and chloride (a VCM)	Polyvinylchloride ( <b>PVC</b> ), is a thermoplastic	3 (SPI Code 3)
Tri-chloro-ethane	Vinylidene Chloride ( $C_2H_2Cl_2$ )	Poly-vinylidene chloride ( <b>PVDC</b> ), is a thermoplastic	7 (SPI Code 7)
Ethane ( $C_2H_6$ )	Vinyl Acetate ( $C_4H_6O_2$ ) (a VAM)	Poly-vinyl acetate ( <b>PVAc</b> ), is a thermoplastic	7 (SPI Code 7)
Ethane ( $C_2H_6$ ) Benzene ( $C_6H_6$ )	Styrene ( $C_8H_8$ ): derived from Benzene and Ethylene, ethyl-benzene	Polystyrene ( <b>PS</b> ), is a thermoplastic	6 (SPI Code 6)
Propane ( $C_3H_8$ )	Acrylonitrile ( $C_3H_3N$ ): derived from Propylene ( $C_3H_6$ ), catalysed with ammonia	Poly-acrylonitrile ( <b>PAN</b> ), is a thermoplastic	7 (SPI Code 7)
	Acrylonitrile can produce co-polymers acrylonitrile butadiene styrene ( <b>ABS</b> ) and styrene- acrylonitrile ( <b>SAN</b> ), both are thermoplastics		7 (SPI Code 7)
Ethane ( $C_2H_6$ )	Methyl methacrylate ( $C_5H_8O_2$ ): ethylene ( $C_2H_6$ ) source	Poly-methyl methacrylate ( <b>PMMA</b> )	7 (SPI Code 7)
Natural polymer	Isoprene	cis-Polyisoprene (Natural Rubber)	Not applicable because natural
Butane ( $C_4H_{10}$ )	Chloroprene ( <b>CD</b> ): derived from Butadiene ( $C_4H_6$ , an olefin), then chlorinated	Poly- chloroprene (Synthetic Rubber, including Neoprene)	7 (SPI Code 7)
Methane ( $CH_4$ )	Formaldehyde is catalysed (anionic), to produce homo-polymer Formaldehyde is catalysed (acid), to produce co-polymer	Poly-oxy-methylene ( <b>POM</b> ) is a bio-inert thermoplastic (Also known poly-formaldehyde)	7 (SPI Code 7)
Not applicable	Caprolactam ( <b>Nylon 6</b> ) and adipoyl chloride and hexa-methylene diamine ( <b>Nylon 66</b> )	Nylon	7 (SPI Code 7)
Natural polymer	Lactic acid ( $C_3H_6O_3$ ) derived by the fermentation of carbohydrates or chemical synthesis, with lactic acid being polymerized using ring-opening polymerization	Polylactic ( $C_3H_4O_2$ ) or polylactide ( <b>PLA</b> ) is a thermoplastic aliphatic polyester, sometimes called a bio-plastic	Not applicable because natural

© Michael Harrison (drawn from the author's PhD material)

This does not mean that each year 375 to 400 million metric tonnes of plastics are released into the environment, but the plastics that are not collected and recycled or disposed of in an environmentally safe manner are at large in the environment, critically in waterways and oceans.

Low Carbon Pulse will follow the development of the **international legally binding agreement to end plastic pollution**. Plastics has long been a focus of the author of Low Carbon Pulse, and will become another area covered by Low Carbon Pulse. (The author is working on a PhD on plastics (part-time). The UNEP initiatives have provided renewed impetus for the author to finish it.)

- **Plastics in the air:** On February 21, 2022, Wood Mackenzie published an [opinion piece](#) (entitled [Closing the loop on plastic packaging](#)).

As always, the Wood Mackenzie opinion piece is excellent, and is well-worth a read.

The opinion piece covers a number of points, but it covers a key point (certainly from the perspective of the author), and that is the need for progress in the development of effective chemical recycling technologies to allow increased recycling noting that mechanical and thermal recycling technologies, as currently applied, do not allow recycling of the vast majority (by mass) of plastics.

- **Cooling our heels after IPCC WGI and the 5th UN Environment Assembly**

Two key events were to have straddled **Editions 36** and **37** of Low Carbon Pulse, both have been postponed as follows:

- **Middle East and North Africa Week (MENAW):** As the authors of the **Climate Change 2022: Impacts, Adaptation and Vulnerability** report were being interviewed, the inaugural [Middle East and North Africa](#)

**Week**, organised under the auspices of the United Nations Framework Convention on Climate Change (**UNFCCC**) was to have commenced on **February 28, 2022**, and continue through **March 3, 2022**. The **MENAW** was postponed, amidst continued concerns around Covid-19.

The **MENAW** was eagerly anticipated, providing an opportunity to place the Middle East and North Africa clearly at the centre of production of renewable electrical energy and clean hydrogen. Low Carbon Pulse will cover **MENAW** when it takes place, hopefully in Q3 of 2022.

- **IUCN Africa Protected Areas Congress (APAC)**: **APAC** was to have commenced on **March 7, 2022** in Kigali, Rwanda, and continue to **March 12, 2022**. **APAC** was postponed, amidst continued concerns around Covid-19.

**APAC** will be the first continent-wide meeting of African leaders, interest groups and citizens, convened to focus on action required to establish and to preserve protected areas. Low Carbon Pulse will cover **APAC** when it takes place.

The **MENAW** and **APAC** events will add to the emerging agendas for both **COP-27** and **COP-28**.

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

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

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

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

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

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

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

## Legal and Regulatory highlights:

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse in respect of laws and regulation, and broader policy settings, in each case describing substance, progress and impact.*

To manage the length of this **Edition 36** of Low Carbon Pulse, legal and regulatory news items within the current news cycle will be picked up in **Edition 37** of Low Carbon Pulse.

### Standalone article about EU Green Taxonomy:

The format of Low Carbon Pulse does not allow detailed coverage of the various regulations relevant to progress to **NZE** across the **EU**.

In anticipation of the expiry of the four month scrutiny and objection period (which started at the end of January 2022) expiring without an effective objection to the **Taxonomy Complementary Climate Delegated Act**, the author of Low Carbon Pulse will provide a summary of the key regulations and their effect over coming months in a standalone article by the end of June 2022.

## Climate change reported and explained:

*This section considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to climate change and its impact. The intention is to monitor significant and material data points and information, and to explain them.*

- **CH<sub>4</sub> concentration on the rise:** **Edition 35** of Low Carbon Pulse reported that the International Energy Agency (**IEA**) would release its noted **Global Methane Tracker**, and that the **January and February Report on Reports** would outline its findings.

On February 23, 2022, the **IEA** released its **Global Methane Tracker 2022**. The key finding in the IEA's press release was as follows:

*"Global methane emissions from the energy sector area are about 70% greater than the amount national governments have officially reported ... underlining the urgent need for enhanced monitoring efforts and stronger policy action to drive down emissions of the potent greenhouse gas."*

### By way of reminder:

- **Edition 24** of Low Carbon Pulse noted that the reduction in **CH<sub>4</sub>** emissions is important because the global warming potential of **CH<sub>4</sub>**, as a **GHG**, in terms of potency per tonne, is greater than carbon dioxide (**CO<sub>2</sub>**): a molecule of **CH<sub>4</sub>** has a half-life of 9 years, compared to **CO<sub>2</sub>** with a half-life of 100 years. Over 20 years, **CH<sub>4</sub>** traps up to 84 times as much heat energy as **CO<sub>2</sub>**.
- **Edition 27** of Low Carbon Pulse reported that "Increasing concern about increasing the concentration of **CH<sub>4</sub>** resulted in the announcement on September 17, 2021, by the **EC** and US of the **Global Methane Pledge**, given jointly, to reduce **CH<sub>4</sub>** emissions by nearly a third within the next decade. At that time Low Carbon Pulse expressed:

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

**Edition 34** of Low Carbon Pulse noted that as at February 4, 2022, 103 countries had signed the Global Methane Pledge. **Edition 34** also noted that: "While many countries have signed the Pledge, work needs to be done to implement the Pledge, considerable work". As at March 6, 2022, 111 countries have signed.

- **Edition 29** of Low Carbon Pulse reported on International Energy Agency (**IEA**) [Curtailing Methane Emissions from Fossil Fuel Operations \(CCH4R\)](#). This headline from the **CCH4R** is that the reduction in methane (**CH<sub>4</sub>**) emissions is "among the most impactful ways to combat near-term climate change".

The **CCH4R** notes that:

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

- **Edition 35** of Low Carbon Pulse reported on increasing levels of methane (**CH<sub>4</sub>**) in the climate system (under **Scientists raise alarm over "dangerously fast" growth in atmospheric methane**). **CH<sub>4</sub>** concentration exceeded 1,900 parts per billion during 2021 – see the piece below on the [NOAA 2022 Sea Level Rise Technical Report](#). The nature article notes that the increase in **CH<sub>4</sub>** is caused by both human activities and naturally: 62% of global **CH<sub>4</sub>** emissions from 2007 to 2016 are estimated to have arisen from human activities – see the bar chart at the end of this section.

As is noted (again) in the nature article, tackling methane is probably the best opportunity to buy some time to allow decarbonisation to progress so as to avoid the worst effects of climate change by limiting the increase in average global temperatures to **1.5°C** above pre-industrial times.

- **Climate Change impacting water cycle:** On February 23, 2022, [nature](#) published a report (entitled [Observed poleward freshwater transport since 1970](#)), the headline from which is that the global water cycle is 7.4% (having been estimated to be between 2% and 4% previously). By way of reminder, the water cycle describes the movement of water globally: evaporation, ascension, condensation, and precipitation.

Increased global temperatures are accelerating or intensifying (depending on how one views the water cycle). In summary, the result of this acceleration / intensification is that freshwater moves to wet regions, with the result that, as a general statement, and overtime, drier regions, critically, sub-tropical regions become drier.

(For further detail on changes to the water cycle see the [IPCC WGI Climate Change 2021: The Physical Science Basis](#) Report.)

## GCC Countries:

This section of Low Carbon Pulse considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the Gulf Cooperation Council (**GCC**) Countries, being countries that are leading the way in the development of Blue Hydrogen and Green Hydrogen capacity for own use and for export.

- **EWEC auction:** On February 21, 2022, EWEC (Emirates Water and Electricity Company) [announced](#) that it would conduct its third auction of Clean Energy Certificates (**CECs**) in Abu Dhabi on Monday March 14, 2022. The first **CEC** auction took place in September 2021, and the second in November 2021. It is reported that the auction of **CECs** as part of the **CEC** scheme has assisted greatly in the expansion of the market for EWECs' clean energy sources.
- **Jeddah the smarter city:** On February 24, 2022, [arabnews.com](#) reported (under [A \\$20bn Saudi project will transform Jeddah, with history, heritage and culture at its core](#)) on plans for a face lift of Jeddah, Saudi Arabia's Red Sea port city, to make Jeddah one of the most liveable cities by 2030. While described as a face lift, the plans go deeper, and will result in Jeddah being a smarter historical city.
- **Global low carbon deal:** [fuelcellsworlds.com](#) reported that in Dubai, United Arab Emirates (**UAE**) on March 2, 2022, Engie (leading international energy corporation) and POSCO (leading iron and steel producer, headquartered in the Republic of Korea) signed a memorandum of understanding to explore the development jointly of Green Hydrogen production plants and related infrastructure in the Middle East, Australia and in South America. As reported, Engie is to leverage its existing industrial-scale hydrogen value chain experience to support POSCO's production of hydrogen.

## Africa:

This section considers news items within the news cycle of this **Edition 36** of Low Carbon Pulse relating to Africa. Africa remains the continent with the most developing countries, the most **Least Developed Countries** and the most countries vulnerable to climate change, and the continent with some of the lowest levels of electrification.

- **African Development Bank steps-up:** On February 21, 2022, [energy-utilities.com](#) reported (under [African Development Bank to provide \\$ 379 m financing to Sahel solar scheme](#)) that the African Development Bank had approved a USD 379 million financing facility as part of the funding for the **Dessert to Power G5 Sahel scheme**. The **Dessert to Power G5 Sahel scheme** involves the delivery of electrical energy within Burkina Faso, Chad, Mali, Mauritania and Niger from a 500 MW photovoltaic facility, providing renewable electrical energy to around 695,000 households across the five countries. It is reported that the African Development Bank is to provide technical assistance for seven years, in addition to the financing facility.
- **Masdar in Tanzania:** On February 28, 2022, [energy-utilities.com](#) reported that Masdar (Abu Dhabi Future Energy Company) had signed an agreement with the Tanzania Electric Supply Company (Tanesco) to develop renewable electrical energy projects in Tanzania. The agreement between Masdar and Tanesco continues the forward-thinking engagement of Masdar regionally. In 2021, Masdar entered into a similarly forward looking agreement with Ethiopia.
- **Egypt to develop smart grid:** On February 28, 2022, [itp.net/business](#) reported that CISCO (leading information technology system corporation) and Schneider Electric (leading electrical energy system corporation) are to develop a smart grid for Egypt. It was recounted that the Ministry of Electricity and Renewable Energy and Schneider Electric had contracted to develop four control centres for the national grid in 2020.

It might be expected that the smart grid developed by Schneider Electric and CISCO will provide a benchmark for smart systems, deploying the latest technology from corporations at the forefront of operational technologies and information technologies.

- **Tunisia expanding solar capacity:** On March 2, 2022, [energy-utilities.com](#) reported (under [Tunisia prepares plan for 3.8 GW of solar capacity by 2030](#)) that the Tunisian Government is preparing a national strategy for photovoltaic solar installation with a view to reaching 3.8 GW of installed photovoltaic solar capacity by 2030.

## India and Indonesia:

*This section considers news items within the news cycle of Edition 36 of Low Carbon Pulse relating to India and Indonesia, two countries with increasing populations and urbanisation, attendant increased levels of electrification, and being the countries with the third and seventh most GHG emissions.*

- **Tata and RWE Giant Cause Way:** On February 21, 2022, it was reported widely that Tata Power Renewable Energy Limited (a wholly owned subsidiary of Indian power giant, Tata Power) and RWE Renewables GmbH (a world leader in off-shore wind field development, deployment and operation) had signed a memorandum of understanding (**MOU**). Viewed in the context of the good offshore-wind resources of India (with its 7,600 kilometres of coastline) and Government of India policy settings for installing 30 GW of off-shore wind field capacity by 2030, the **MOU**, is significant. The combination of Tata and RWE for these purposes is timely, with the Government of India progressing its policy settings, and the resulting regulator framework, and technical studies.
  - **Off-shore wind field development is highly prospective:** It is understood, among others, that technical studies are progressing in respect of Gujarat and Tamil Nadu. This reflects the assessment of the [World Bank](#) in respect of the prospectivity of off-shore wind field areas, with 215 GW of off-shore wind field capacity (83 GW floating and 112 fixed-bottom), with Gujarat and Tamil Nadu having the most prospective wind resources.
- Edition 21** of Low Carbon Pulse identified the off-shore areas most prospective for the development of off-shore wind field capacity: the coastlines off Andhra Pradesh (south-eastern coastal region of India), Gujarat (western coast of India), Karnataka (south-western India, with Arabian Sea and Indian Ocean coastlines), Maharashtra (western coast of India) and Tamil Nadu (south coast of India) offer the most prospective off-shore wind resources.
- **Adani and Ballard coalesce:** On February 21, 2022, it was reported widely that Adani Group (leading Indian conglomerate of global scale) and Ballard Power Systems (leading fuel cell technology corporation) signed a memorandum of understanding (**MOU**). Under the **MOU**, Adani and Ballard will consider the commercialisation of the production and use of fuel cells in a range of applications, focusing on industrial applications land mobility applications in India.

As reported in **Edition 28** of Low Carbon Pulse, Adani intends to invest in the development and deployment of Green Hydrogen production capacity in India:

"On September 22, 2021, it was reported widely that Adani Group intends to invest up to USD 20 billion over the next 10 years. On October 2, 2021, Adani Green Energy reported its acquisition of 5 GW of photovoltaic solar and wind assets from SB Energy India for USD 3.5 billion.

With Adani, Reliance and TATA each now committed materially and significantly to reduce GHG emissions, and the investment necessary to achieve this, it is clear that the might of India's private sector is now very much aligned with the public sector, including state owned corporations."

The great thing for India is that it has a number of corporations actively planning and positioning to develop the Indian hydrogen industry. In addition to Tata and Adana, Reliance Industries is well-placed to develop and to deploy capacity.

- **India and Australia clear intent:** On February 23, 2022, it was reported widely that India and Australia has signed a letter of intent for the purposes of cooperating to scale up the production of ultra-low cost photovoltaic solar and clean hydrogen.
- **A reminder and an update:** **Edition 35** of Low Carbon Pulse reported that on February 17, 2022, the Ministry of Power released the [key policy settings](#) for interim (or near term) hydrogen capacity development (**Near Term Hydrogen Strategy**), with **Edition 35** honing on the policy settings supporting Green Hydrogen (and Ammonia) production.

Since the announcement of the **Near Term Hydrogen Strategy**, there has been considerable analysis of it, and its impact on the cost of production hydrogen, with the consensus being that in the near term the costs of production of hydrogen will fall below USD 2 per kilogram by the mid-2020s, and as low as USD 1.50 per kilogram by 2030. As noted in **Edition 34** of Low Carbon Pulse, Reliance Industries is targeting a cost of production of USD 1.00 per kilogram of Green Hydrogen.

- **Policy settings continuing to progress, in line with industry:** On March 3, 2022, [energetica-india](#) reported that a proposal developed by Reliance, JSW Steel and Chart Industries, and the India Hydrogen Alliance, that had been provided to NITI Aayog and the Ministry of New and Renewable Energy (**MNRE**).

From the report in energetica, it has been proposed that a Public-Private H2Bharat Taskforce be established to identify and to develop at least five GW scale Green Hydrogen Hubs across India within the next 18 months.

In a clear sign of the excellent working relationship between the Government of India and business and industry in India, the CEO of NITI Aayog Mr Amitabh Kant, welcomed the proposal, commenting as follows:

"... the aim to bring down the cost of green hydrogen to \$2.5/kg by 2025 and \$1/kg by 2030. This is possible only by increasing the size and scale of hydrogen manufacturing. .... The H2Bharat Taskforce is an interesting proposal to kick-start green hydrogen project development at a large GW-scale. We welcome this voluntary initiative from the industry and look forward to collaborating on it".

- **India Hydrogen Alliance – February 2022:** Attached is the link to the February edition of [India H2 Monitor – February 2022](#). As noted in previous editions of Low Carbon Pulse, we intend to include the link rather than repeat the content of the **India H2 Monitor**.
- **Indonesia to develop Green Hydrogen & Ammonia and CCUS:** On March 4, 2022, [hydrogen-central.com](#) reported that First Deputy Minister of State-Owned Enterprises, Mr Pahala Mugraha Mansury stated: "We have developed the ammonia and biomass co-firing as well as the utilisation of carbon capture technology to reduce the usage of coal at [coal-fired] power plants".

For these purposes, it was reported that on March 2, 2022, PT Pupuk Indonesia (state-owned fertiliser corporation), PT Pertamina (state-owned national energy corporation) and Mitsubishi Corporation had signed a cooperation agreement to progress the development of Green Hydrogen and Ammonia production capacity.

## **Japan and Republic of Korea (ROK):**

*This section considers news items within the news cycle of this **Edition 36** Low Carbon Pulse relating to Japan and ROK, being the countries with the fifth and tenth most **GHG** emissions, and the greatest dependence on imported energy carriers.*

- **JERA demand for ammonia:**

- **Coal case:** [Editions 17](#) and [18](#) reported as follows:

"On May 24, 2021, it was announced that IHI and JERA have received notice of acceptance of their joint grant application to undertake a demonstration project to co-fire ammonia in the generation of thermal power.

The co-firing project commenced in June 2021, and will continue until March 2025, with the plan at that time to progress to commence co-firing at JERA's Unit 5, Hekinan Thermal Power Station from August to December 2021. [Note: This plan was fulfilled.] With the rate of co-firing to increase over time, so that by 2024, co-firing will be taking place at a rate of 20% Green Ammonia, 80% coal, at Unit 4, Hekinan Thermal Power Station.

As is a recurring theme reflected in Low Carbon Pulse, this is another world first for Japan - the first large scale ammonia and thermal coal co-firing project. The co-firing project is consistent with the policy settings in Japan."

- **Hot tender:**

- On February 18, 2022, it was reported widely that **JERA** is running a tender to procure hydrogen based ammonia as part of its plans to reduce **GHG** emissions arising from its coal-fired power generation. It is understood that the procurement is for the supply of 500,000 metric tonnes of ammonia from 2027 through to the 2040s, with around 30 prospective suppliers approached for the purposes of the tender.
- The tender from **JERA** is significant in providing demand that will underpin, or provide demand side support for, the development of supply side. The production of 500,000 metric tonnes of ammonia will require around 88,000 metric tonnes of hydrogen, which is then combined with nitrogen. 500,000 metric tonnes of ammonia equates to 20% of the mass of fuel to fire a 1 GW coal-fired power plant – the mass of fuel required to power Unit 4 at the Hekinan coal-fired power station.
- The narrative accompanying the tender has been that it is open to suppliers of either Blue Hydrogen or Green Hydrogen, or both, but if Blue Hydrogen is to be supplied, at least 60% of **GHG** emissions arising from the production of hydrogen must be captured and stored permanently.
- Low Carbon Pulse will report on the outcome of the tender.

- **Suiso Frontier reaches Hy touch Kobe:** On February 25, 2022, Kawasaki Heavy Industries, Ltd (**KHI**) announced that Suiso Frontier (built by **KHI**) had returned to Hy touch Kobe (the liquified hydrogen receiving terminal at Kobe, Japan, built by **KHI**).

As reported in [Editions 32, 33](#) and [34](#) of Low Carbon Pulse, the arrival of the Suiso Frontier marks the completion of the world's first ocean voyage to transport liquified hydrogen over a long distance.

- **BESSs to find place on the grid, someday:** In a report that "slipped by" the author of Low Carbon Pulse, in late January 2022, [asia.nikkei.com](#) reported that Japan is to require power utilities to allow the installation of **BESSs** operated by other corporations on their grids.

The Japanese Government is to make available financial support to allow the installation of **BESSs**, and in so doing provide incentives for the installation of **BESSs** to stabilise, and to preserve the integrity of grids, as the dispatch of renewable electrical energy over those grids continues to increase.

## **PRC and Russia:**

*This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the **PRC** and Russia, being countries that give rise to the most and the fourth most **GHG** emissions.*

- **Energy Storage PRC Focus:** On February 25, 2022, [scmp.com](#) reported (under [Climate Change: China to slash costs of energy storage systems for industry to leapfrog the world by 2030, according to five-year plan](#)) that the **PRC** plans to cut the cost of energy storage systems by 2025, including by the use of compressed air storage (**CAS** – see [Edition 21](#) of Low Carbon Pulse for background on **CAS**). The plan is outlined in a five-year plan drafted by the National Development and Reform Commission (**NDRC**) and the National Energy Administration (**NEA**).
- **State Grid Corporation of China (SGCC):** [Edition 35](#) of Low Carbon Pulse reported on virtual event held by the International Renewable Energy Agency (**IRENA**) and the SGCC, [Facilitating the Transition Toward Smart Electrification with Renewables in China](#). The virtual event complemented the report prepared jointly by **IRENA** and [State Grid Smart Electrification with Renewables: Driving the transformation of energy services](#). The [January and February Report on Reports](#) will outline the findings from [Smart Electrification with Renewables: Driving the transformation of energy services](#).

One of the key element of **Smart Electrification with Renewables: Driving the transformation of energy services** is the development of energy storage across the electricity grids owned and operated by **SGCC**. On March 2, 2022, it was reported in the People's Daily that **SGCC** intends to develop and to deploy up to 100 GW of **BESS** by 2030, and up to 100 GW of pumped storage capacity (up from 26.3 GW currently).

- **A reminder of the plans:**

- **During the week beginning February 28, 2022:** it was reported widely that the **PRC** plans to develop and to deploy hydrogen refuelling infrastructure at 2000 sites across China, and for 1 million FCEV in China, by 2035.
- As part of continued progress, on March 4, 2022, it was announced by [Air Liquide](#) that it had contracted with Shenergy and Shanghai Chemical Industrial Park to accelerate the development of the production and use of hydrogen in Shanghai and the Yangtze River Delta.
- **On March 5, 2022:** [Reuters](#) reported that the **PRC** has firmed up plans to develop and to deploy 450 GW of new photovoltaic solar and wind capacity in the Gobi Desert, and other desert regions: Director of **NDRC**, Mr He Lifeng said:

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

While the development and deployment of photovoltaic solar and wind power in the Gobi Desert has been flagged (for example, see [Edition 21](#) of Low Carbon Pulse) for some time, the confirmation from **NDRC** at the National People's Congress can be viewed as a firm policy setting.

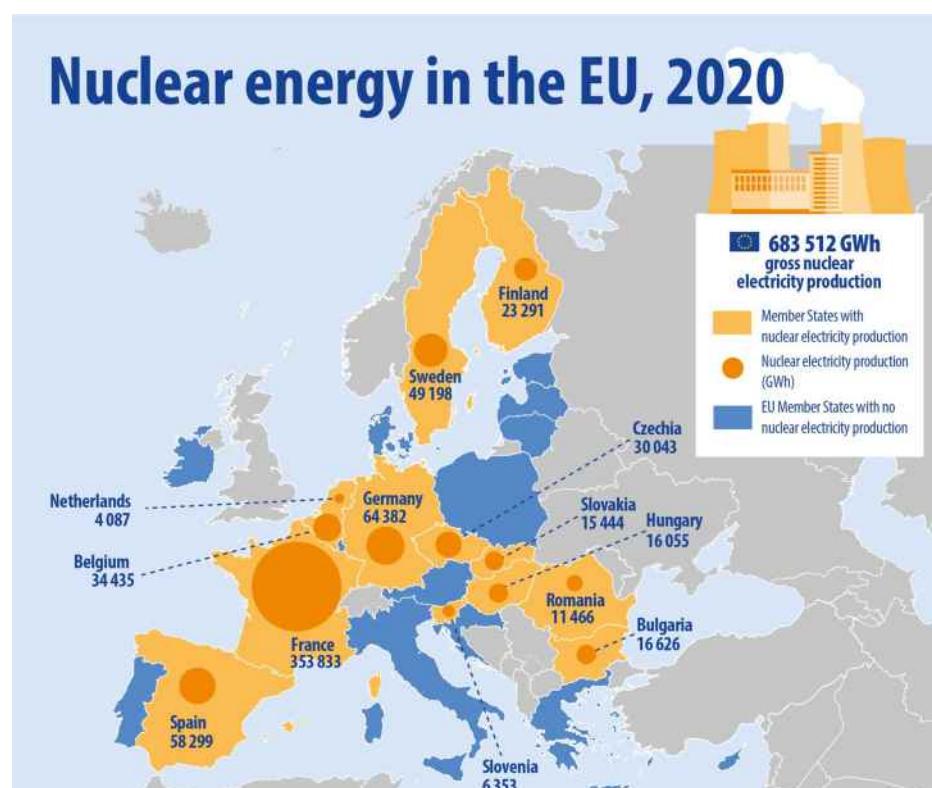
It is understood that the construction of 100 GW of photovoltaic solar capacity is already underway in the Gobi Desert. As noted in previous editions of Low Carbon Pulse, the renewable electrical energy generated in the Gobi Desert, and other desert regions, will be transmitted to the load for that electrical energy using ultra-high voltage direct current transmission systems.

## Europe and UK:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to countries within the European Union (**EU**) and the **EU** itself (as an economic bloc) and the UK given geographical proximity, and similar policy settings and progress towards **NZE**. In combination, countries comprising the **EU** give rise to the most **GHG** emissions after the Peoples Republic of China (**PRC**) and the US. The UK is a top-twenty **GHG** emitter, but has been a front-runner in progress towards **NZE**.

- **Nuclear Energy In Europe:** [Edition 35](#) of Low Carbon Pulse reported on the plans of France to develop and deploy six new nuclear reactors to generate electrical energy.

By way of reminder, the map below provides a summary of installed nuclear energy capacity across the **EU**.



### 14 EU Member States without nuclear electricity production:

Denmark, Estonia, Ireland, Greece, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Austria, Poland, Portugal

Administrative boundaries: © EuroGeographics © UN-FAO © Turkstat  
Cartography: Eurostat – IMAGE, 1/2022

[ec.europa.eu/eurostat](http://ec.europa.eu/eurostat)

- **Finland flagging big**

- **Edition 31 of Low Carbon Pulse** reported as follows:

- "Finland in focus: Edition 4 of Low Carbon Pulse included a piece on Finland as follows:

"Business Finland (a public organisation directed by the Finnish Ministry of Employment and Economy) has published a **National Hydrogen Roadmap for Finland**.

The **Roadmap** is clear as to historical, current and future uses:

*"Hydrogen has been used as an industrial chemical for more than 100 years. Today ... used to manufacture ammonia, and ... fertilizers, as well as methanol and hydrogen peroxide, both vital feedstocks for a wide variety of different chemical products ... Producing hydrogen via low or totally carbon-free ways, and using this "good" low-carbon hydrogen to replace hydrogen with a larger carbon footprint, we can reduce carbon emissions ... ."*

Hydrogen is seen as playing a key role in Finland's national goal of carbon neutrality by 2035. The **Roadmap** does not contain policy settings, rather it, and each initiative contemplated by it, is intended to provide a "knowledge base for further work" including shaping policy settings for Finland, and "determining the role of hydrogen in the national energy and climate policy".

As with the **DOE Hydrogen Program Plan**, the Finnish **National Hydrogen Roadmap** provides a good analysis of the role that hydrogen can play across sectors, and the scale of the demand side of the prospective market for hydrogen, and in the case of the **Roadmap** the role that Finnish business can play across the hydrogen value chain."

See: [Hydrogen Roadmap for Finland](#)

- **European Commission funding for CCS:** On November 17, 2021, the European Commission committed funding support, from the newly established €1.1 billion Innovation Fund, for the production of clean-hydrogen at a refinery at Porvoo, Finland, with the capture of **CO<sub>2</sub>** and its storage in the North Sea in geological formations below the sea-bed, with the electrical energy required being produced by renewable sources.
- **Momentum accelerating:** On November 22, 2021, it was reported widely that Finland is progressing to develop a number of initiatives that will make it a leading hydrogen economy. One initiative involves the development and deployment of large-scale hydrogen production capacity around the Gulf of Bothnia and the Baltic Sea, with the Gulf of Bothnia regarded as highly prospective for hydrogen production, storage, use and transportation."
- **Raahe in the race:** On February 23, 2022, it was reported widely that the City of Raahe is to become a major location for the development of three hydrogen production, and storage, projects. For the purposes of hauling hydrogen from Raahe, while early days, there is a plan to develop a dedicated hydrogen sub-marine pipeline across the northern Baltic Sea. The hydrogen pipeline will transport hydrogen from the City of Raahe to Sweden to Germany.

As reported in previous editions of Low Carbon Pulse (see **Edition 33** of Low Carbon Pulse).

- **Belgium and UK alignment:** On February 24, 2022, it was reported widely that Belgium and the UK had signed an energy cooperation agreement providing for each country to work closely on initiatives to achieve decarbonisation, including future energy interconnection, carbon capture, use and storage, low carbon hydrogen production, and off-shore wind field development.

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

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

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

## Americas:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the US, Brazil, Canada, and Mexico, being countries that give rise to the second, sixth, ninth and eleventh most **GHG** emissions.

- **Mountain States hub:** On February 25, 2022, it was reported widely that Colorado, New Mexico, Utah and Wyoming had signed a memorandum of understanding to develop a regional clean hydrogen hub, and in so doing position more effectively in seek funding from the **IIAJA**.

**By way of reminder:** The largest hydrogen program in the **IIAJA** provides the US (**DOE**) with USD 8 billion to provide support for at least four hydrogen hubs that are able to demonstrate that their development and deployment will contribute to production of clean hydrogen (being hydrogen that gives rise to less than 2 kg of **CO<sub>2</sub>** for each 1 kg of hydrogen produced) and to multiple uses of that clean hydrogen. The **IIAJA** prescribes that at least one hydrogen hub will use fossil fuel feedstock to produce hydrogen, one will use renewables and one will use nuclear.

Also there is funding to support lowering the cost of production of Green Hydrogen with the goal of achieving a cost of USD 2 per kg by 2026 and for research, development and demonstration (**RDD**) to develop and deliver clean hydrogen production, delivery, storage and use technologies. Finally, the **IIAJA** contemplates the development of a national hydrogen strategy and roadmap to facilitate large-scale, and wide-spread, production, delivery, storage and use of clean hydrogen.

- **Edition 35** of Low Carbon Pulse reported that the US **DOE** had gone live on the implementation of the **Infrastructure Investment and Jobs Act (IIAJA)** also known as the **Bipartisan Infrastructure Law (BIL)**, with the initiatives in the **IIAJA** now being rolled out including:
  - **Clean Hydrogen RDD goes live:** On February 9, 2022, the US Department of Energy (**DOE**), through the Office of Fossil Energy and Carbon Management (**FCEM**), announced formally the roll-out of the USD 24 million in federal funding for research and development and front-end engineering and design that will advance the adoption of clean hydrogen as a carbon free fuel for electrical energy generation, industrial use and transportation. This is the first step in the provision of funding for **RDD**.
  - **EV charger funding goes live:** On February 10, 2022, the Biden Administration rolled out its plan to allocate USD 5 billion to fund the development and deployment of electric vehicle chargers over the coming five years. This initiative is part of a policy initiative that earmarked USD 7.5 billion to roll-out a nationwide electric vehicle charging network of 500,000 electric vehicle chargers. The initiative includes the designation of alternative fuel corridors.
  - **Clean Hydrogen Project Process goes live:** On February 15, 2022, the US **DOE** announced that it requires information on the development of hydrogen hubs across the US, with at least four hydrogen hubs contemplated.

## France and Germany:

*This section considers news items within the news cycle of this Edition 36 of Low Carbon Pulse relating to France and Germany.*

- **Germany aims for 100% renewables by 2035:** On February 28, 2022, [electrive.com](#) reported that the German Federal Government wants to progress to 100% renewable electrical energy by 2035. The accelerated target contrasts with the previous target of moving away from fossil fuels "well before 2040". To achieve this goal the German Federal Government is understood to be progressing amendments to the Renewable Energy Sources Act (**EEG**). It is understood that the **EEG** is ready, and that it will contemplate (and provide a path to) the achievement of photovoltaic solar and wind power reaching 80% of electrical energy used by 2030. By 2030, it is expected that Germany's on-shore wind farm capacity will have doubled to 110 GW of installed capacity, with off-shore wind field capacity to reach at least 30 GW of installed capacity (equivalent to the output of 10 nuclear energy power stations). Photovoltaic solar installed capacity is planned to reach 200 GW by 2030. Low Carbon Pulse will follow the progress of the amendment of the **EEG** and the policy settings that will result from it.
- **Other news items in the news cycle of this Edition 36 are covered elsewhere:** Other sections of this **Edition 36** of Low Carbon Pulse cover news items relating to Germany, critically the news that the German Federal Government, Kreditanstalt fur Wiederaufbau (**KfW**) is to become a shareholder in the LNG terminal at Brunsbuettel.

## Australia:

*This section considers news items that have arisen within the news cycle of this Edition 36 Low Carbon Pulse relating to Australia, a top-twenty **GHG** emitting country, and a developed country with the highest **GHG** emissions per capita.*

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

- **Dalrymple Bay Hydrogen Project:** On February 24, 2022, it was reported widely that a funding agreement had been signed by Brookfield Infrastructure Group, DBHex Management Pty Ltd, Itochu Corporation and North Queensland Bulk Ports Corporation. The purpose of the funding agreement is reported to be the completion of detailed feasibility in respect of the proposed **Dalrymple Bay Hydrogen Project**. The funding agreement, and the completion of the detailed feasibility study that it will allow, builds on the **MoU** signed among the parties in August 2021. It is likely that **Dalrymple Bay Hydrogen Project** will benefit from being located within one of the Queensland Renewable Energy Zones (**QREZs**).
- **By way of reminder:** **Edition 20** of Low Carbon Pulse reported that Australian Future Energy (**AFE**) announced that it had entered into a memorandum of understanding (**MoU**) with leading Japanese trading house, Itochu Corporation. AFE intends to develop the USD 750 million Gladstone Energy and Ammonia Project (**GEAP**), and is reportedly close to commencing front end engineering and design (**FEED**). It is reported that under the **MoU**, Itochu Corporation will consider potential investment in **GEAP** and the role that Itochu may have in the marketing of hydrogen-based fuels produced by **GEAP**. The **GEAP** is intended to produce 230,000 metric tonnes per annum of ammonia and 91,000 metric tonnes per annum of hydrogen.
- **FFI power linked:** On February 25, 2022, it was reported widely that Fortescue Future Industries (**FFI**, a wholly-owned subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO), Powerlink (a state-owned enterprise) and Economic Development Queensland have an agreed arrangement that will provide the means to transmit renewable energy to **FFI's** Gibson Island 50,000 metric tonnes per annum Green Hydrogen production plant.
- **Orica and Origin plan Hunter Valley Hydrogen Hub:** On February 28, 2022, it was reported widely that Orica (among other things, leading manufacturer of ammonium nitrate) and Origin Energy (one of the Big Three integrated energy corporations in Australia) had signed a memorandum of understanding (**MOU**) to undertake a feasibility study in respect of the establishment of a Hunter Valley Hydrogen Hub. As noted in previous editions of Low Carbon Pulse, the Hunter Valley is one of the areas of New South Wales (and Queensland) best known for world class coal-mines. The Green Hydrogen produced would be used to displace natural gas currently used by Orica at Koongang Island, Newcastle, New South Wales facility, with the Green Hydrogen being combined with nitrogen. One of the key elements of the reporting around the **MOU** is that the water to be used as the feedstock to produce Green Hydrogen is to be sourced from waste water, with the recycled water to be electrolysed using a 55 MW

electrolyser. In countries (and regions) scarce in fresh water, or with competing needs for water, the use of waste water is now being considered actively. The three sources of water for Green Hydrogen production are: fresh water, waste water to produce recycled water or sea-water to produce desalinated water.

**By way of reminder:** On February 16, 2022, Origin Energy announced that its 2,880 MW Eraring power station, in NSW, would close by August 2025 (seven years ahead of previous its planned closure). Eraring is the largest remaining coal-fired power station in Australia. As reported previously in Low Carbon Pulse, Origin Energy intends to install a 700 MW / 1,400 MWh **BESS**, on the site of the decommissioned power station.

- **Government of Tasmania rings progress:** On March 1, 2022, it was reported widely that the Government of Tasmania (Australia's Island State) is to develop a Green Hydrogen Hub in the Bell Bay region of Tasmania. Previous editions of Low Carbon Pulse have reported on the development Green Hydrogen and Green Ammonia projects in the Bell Bay region (see [Editions 4, 18 and 20](#) of Low Carbon Pulse).
- **Government of Victoria circles off-shore wind:** On March 4, 2022, the Government of Victoria [announced](#) its off-shore wind field (**OWF**) targets, with first electrical energy by 2028, and 9 GW of installed off-shore wind field capacity by 2040. As noted in previous editions of Low Carbon Pulse, Australia has some of the best off-shore wind resources in the world, and the State of Victoria has some of the best wind resources of the Australian states.

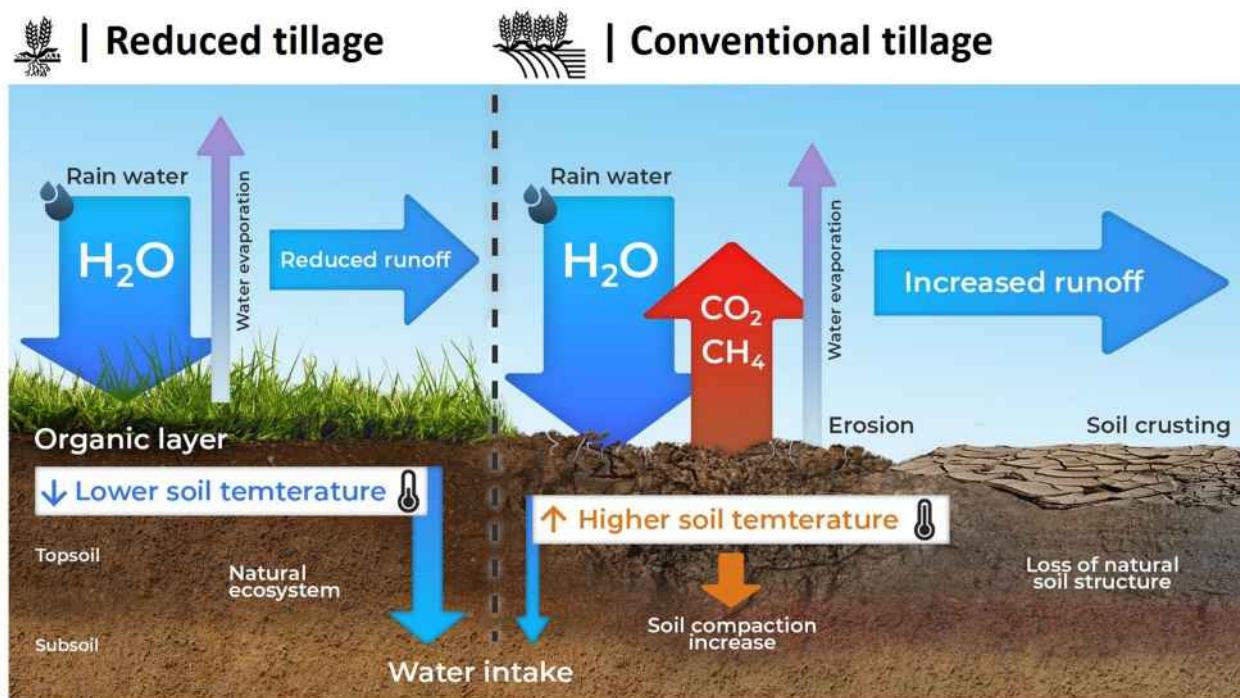
The detail of the policy settings of the Government of Victoria are in its [\*\*Offshore Wind Policy Directions Paper\*\*](#).

2028	2032	2035	2040
First electrical energy	At least 2 GW of OWF capacity	At least 4 GW of OWF capacity	At least 9 GW of OWF capacity

## Blue and Green Carbon Initiatives and Biodiversity:

This section considers news items that have arisen within the news cycle of this **Edition 36** Low Carbon Pulse relating to the Blue Carbon and Green Carbon initiatives and Biodiversity.

- **Blue Carbon habitats need to be mapped:** On March 3, 2022, The Irish Times reported on the initiative from environmentalists to map comprehensively and to preserve the seagrass beds. The article is well-worth a read, both for the commentary on seagrass ecosystems around the Republic of Ireland, and more broadly. While the value of seagrass beds is well-established to provide habitat for marine life and bird species, the value of seagrass as a primary means of carbon storage is receiving increasing attention in the Republic of Ireland. The Irish Times article notes that while seagrass covers around 0.1% of the ocean floor, seagrass stores 13% of carbon stored in the oceans. With the increasing awareness of the role of seagrass (as one of the means of Blue Carbon storage) is the realisation that one third of Blue Carbon sinks (including salt marshes and mangrove swamps) have been lost since 1990.
- **Until now this has not been a question:** The infographic below illustrates the impact of the answer to the question – to till or not to till?



The tillage of soil impacts the characteristics of soil and the release and the retention of **GHG** as a function of decomposition of the organic matter arising from land use. As ever, there is a balance – there are benefits in leaving residue and not tilling, including insulating soil from radiative heat, and the decomposing residue can provide structure as the organic matter combines with the soil over time.

## Bioenergy and heat-recovery:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to bioenergy, being energy, whether in gaseous, liquid or solid form, derived or produced from biomass. **Bioenergy** includes any energy derived or produced from biomass (organic matter arising from the life-cycle of any living thing, flora or fauna, including from organic waste streams), whether in gaseous, liquid or solid form. In addition, recovered heat and waste heat (derived from any source, including waste water) has been added to this section.

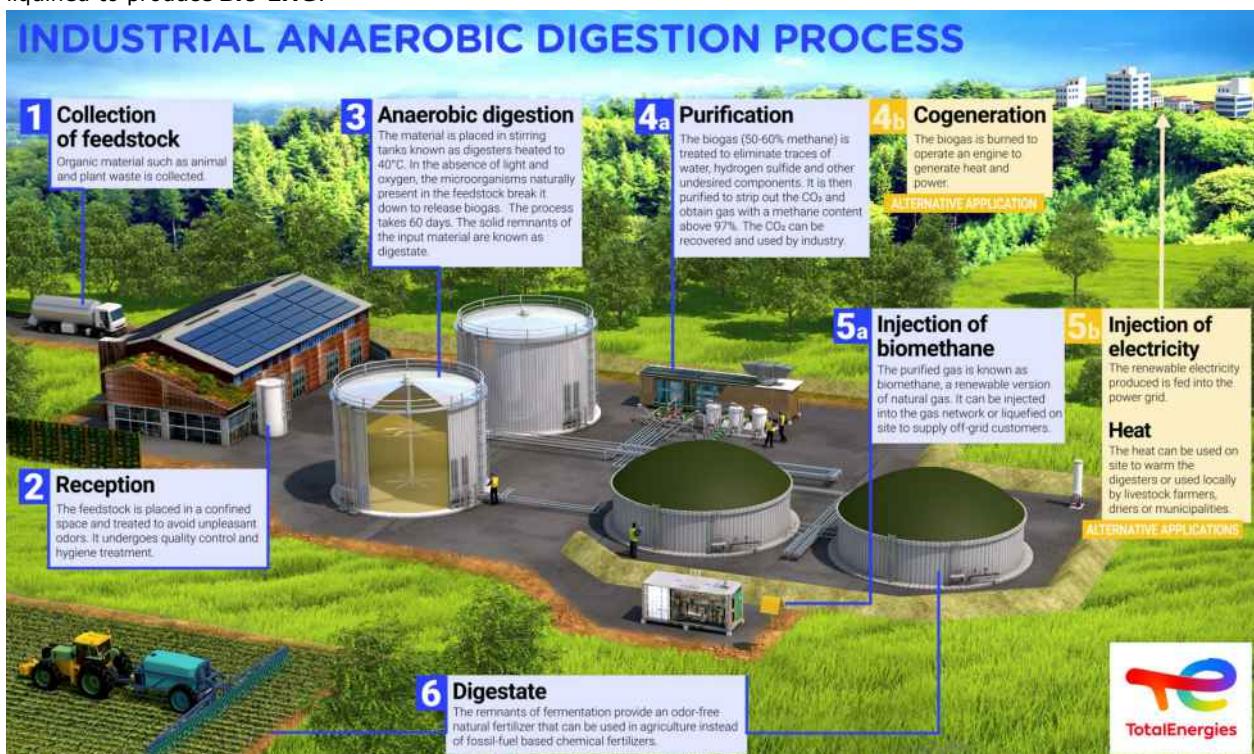
From recent activity and reporting, it appears likely that the avoidance of waste heat energy, and the recovery of waste heat energy will become a priority under the first pillar as a part of Energy Efficiency (**IEA**) and Energy conservation and efficiency (**IRENA**). By some estimates, up to 67%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

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

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

As a sibling to the **TotalEnergies' Aerobic Digestion Ecosystem infographic**, the infographic below provides an excellent overview of a biogas plant using anaerobic digestion technology to derive biogas from organic biomass (feedstock).

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



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

- **Eni commences bio-ethanol production:** On February 16, 2022, Eni announced that it had commenced the production of bio-ethanol from lignocellulosic biomass at its Crescentino plant using Proesa® technology. As announced, the Crescentino plant (**Versalis Plant**) is self-sustaining, processing up to 200,000 metric tonnes of biomass a year to produce up to 25,000 metric tonnes of bio-ethanol a year. The processing of the biomass producing renewable electrical energy which is used to produce steam used by the **Versalis Plant**, which processes short supply chain biomass and lignin. The Proesa® technology produces bio-gas using a thermal process (rather than an aerobic process).

## BESS and HESS (and energy storage):

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to battery electric storage systems (**BESSs**) and hydrogen energy storage systems (**HESSs**). In addition to **BESSs** and **HESSs**, other forms of energy storage systems are covered, including use of compressed air energy storage (**CAES**) and pumped storage. In this context, long duration energy storage (**LDES**) is considered, being energy technology that is able to allow the off-take electrical energy out of storage for a duration of more than four hours. In the brave new world described in **Edition 13** of Low Carbon Pulse: "BESS storage of 10/12/24 hours is being contemplated for business users, and up to 72 hours for telecommunications companies, including to guard against the consequences of land-borne weather events". The **November and December Report on Report** provides a summary of the LDES Council and McKinsey report from November 2021.

BESS and HESS (and energy storage) news items arising from the news cycle covered by this Edition 36 of Low Carbon Pulse have been covered in other sections (see "**BESSs to find place on the grid, someday**", "**State Grid Corporation of China (SGCC)**", "**Orica and Origin plan Hunter Valley Hydrogen Hub**", and "**Peabody to pivot**").

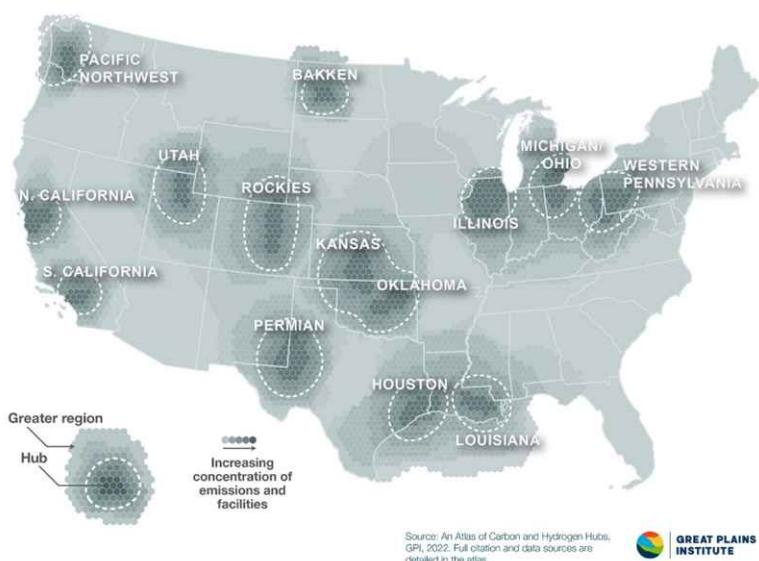
## Carbon Accounting, Carbon Capture and Carbon Capture and Use and CDR:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to carbon accounting and carbon dioxide removal (**CDR**), including bioenergy carbon capture (**BECCs**), bioenergy carbon capture use and storage (**BECCUS**), carbon capture and storage (**CCS**), carbon capture use and storage (**CCUS**) and direct air capture (**DACS**). Effective accounting for carbon arising and **CDR** go hand-in-hand. By way of background **CDR** is recognised in the 2021 Report as including: afforestation, soil carbon sequestration, bioenergy with carbon capture and storage (**BECCS**), wet land restoration, ocean fertilisation, ocean alkalination, enhanced terrestrial weathering and direct air capture and storage (**DACS**) are all means of **CO<sub>2</sub>** 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 **CO<sub>2</sub>** each year through **CCS**, **CCUS** and **CDR**. **CCS** and **CCUS** (and **BECCS** and **BECCUS**) involve the capture at the source of **CO<sub>2</sub>**, preventing release to the climate system. The following provides a helpful overview of carbon capture as things currently stand.

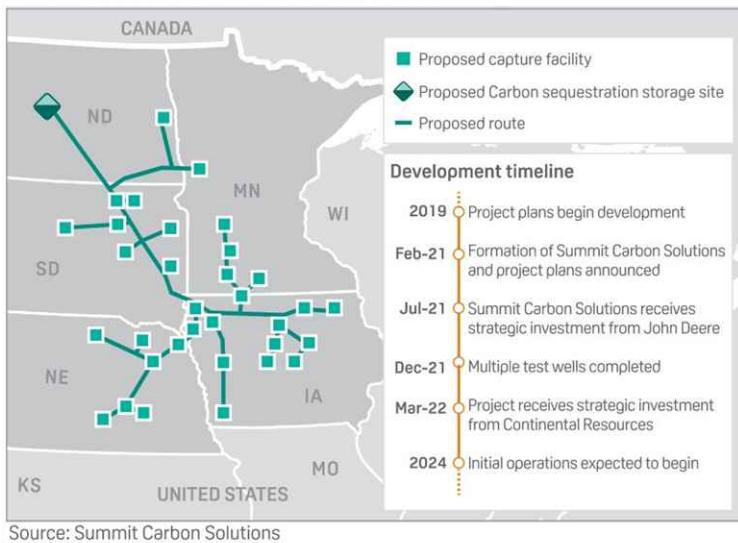
**ExxonMobil expands CCS in Wyoming:** On February 25, 2022, [ExxonMobil](#) announced FID to expand carbon capture capacity at its LaBarge facility in Wyoming. The expansion will increase **CO<sub>2</sub>** capture by 1.2 million metric tonnes a year.

- **CO<sub>2</sub> project at Port of Antwerp:** The [Port of Antwerp](#) has announced progress on the initiative involving the Port of Antwerp, Air Liquide and Fluxys, and BASF, Borealis, INEOS, and TotalEnergies that commenced in 2019. The initiative in 2019 involved undertaking a feasibility study in respect of Antwerp@C, with the feasibility study being completed in 2021. Engineering studies are now to be undertaken, including to assess the development of infrastructure to serve as a backbone throughout the Port of Antwerp along industrial zones. The Antwerp@C **CO<sub>2</sub>** project is to capture and to export **CO<sub>2</sub>**, with the **CO<sub>2</sub>** to be stored permanently.  
Air Liquide, Fluxys and Port of Antwerp subsidiary, Pipelink, have organised an **Open Season** to assess and to map demand for **CO<sub>2</sub>** service provision initially and in the near term.
- **Mapping CO<sub>2</sub> storage in the US:** Edition 34 of Low Carbon Pulse reported on the [Atlas of Carbon and Hydrogen Hubs from the Great Plains Institute](#). The US DOE has a [Carbon Storage Atlas](#). The good folk at the Great Plains Institute sued the DOE **Carbon Storage Atlas** to produce the following map.



- **Continental Resources progressing:** On March 3 and 4, 2022, it was reported widely that Continental Resources is to invest USD 250 million to develop "the largest carbon capture and sequestration project of its kind in the world". Prospectively, the CCS project will source up to 8 million metric tonnes of **CO<sub>2</sub>** annually from up to 31 ethanol plants in the mid-west of the US.

## SUMMIT CARBON SOLUTIONS TO CAPTURE CARBON FROM 31 MIDWEST ETHANOL PLANTS



- INPEX confirms plans for CCS:** On March 3 and 4, 2022, it was reported widely that INPEX (Japan's largest oil and gas exploration and production corporation) intends to seek to progress the development of a CCS project off-shore Darwin, Northern Territory, as part of its plans to achieve its commitment to NZE – Net Zero 2050.

### Carbon Credits and Hydrogen Markets and Trading:

*This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the creation of carbon credits, the role of carbon credits, and the trading of them. Also this section covers the development of hydrogen markets and trading (bilateral and likely wholesale).*

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

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

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

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

*This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the development of production capacity to derive and to produce **E-fuels** (energy carriers derived or produced using renewable energy) and Future Fuels (energy carriers derived and produced that are characterised as clean carbon or low carbon fuels). **E-fuels** include Green Hydrogen and Green Ammonia, and **Future Fuels** include Blue Hydrogen and Blue Ammonia.*

- Green Wilhelmshaven® Hydrogen Project:** Previous editions of Low Carbon Pulse had reported on Wilhelmshaven as follows:
  - "Wilhelmshaven Grey Plans:** On January 24, 2022, AtlasInvest (a corporation that invests in both conventional oil and gas and renewable projects) announced plans to develop a €2.5 billion hydrogen facility that will derive hydrogen from methane (i.e., Liquid Natural Gas or LNG) imported from **GCC countries**.

The hydrogen facility will be located within the hinterland of the Port of Wilhelmshaven. It is reported that the hydrogen facility will have capacity to produce up to 500,000 metric tonnes of hydrogen per year. It is understood that CCS / CCUS is not contemplated, and as such the hydrogen produced will be Grey Hydrogen.

By way of reminder, **Edition 14** of Low Carbon Pulse reported that on April 15, 2021, Uniper (German utility giant) planned to develop a hydrogen hub located in Wilhelmshaven (**Green Wilhelmshaven**) comprising a receiving terminal for Green Ammonia, then using a cracker to derive Green Hydrogen. The plans included a 410 MW electrolyser. On full development, it was estimated that the facilities at **Green Wilhelmshaven** would produce up to 295,000 metric tonnes per year of Green Hydrogen.

In **Edition 14** it was noted that the decision of Uniper to develop **Green Wilhelmshaven** may end its plans to import LNG using a floating storage and regasification unit at Jade Bay, in Wilhelmshaven. Given the plans of AtlasInvest, it would seem likely that Wilhelmshaven may become a key Green Hydrogen and Grey Hydrogen Hub.

- LNG Terminals progressing:** On February 27 and 28, 2022, it was reported widely that the German Federal Government had asked Uniper to resume its plans to develop an LNG receiving terminal in Wilhelmshaven as the

Federal German Government develops its thinking around energy security. As originally planned, Uniper intended to develop a 7.3 million metric tonnes per annum floating storage receiving terminal (**FSRU**).

In addition to a **FSRU** at Wilhelmshaven, the Federal German Government wants to develop and deploy an LNG receiving terminal at Brunsbuettel. The LNG receiving terminal at Brunsbuettel has been planned for a while by joint venturers Gasunie (a Dutch natural gas infrastructure and transportation company) and Oiltanking (a logistics service provider of tank terminals for petroleum products, chemicals, and gases), a subsidiary of Marquard & Bahls AG, with Vopak reported as passive in the joint venture. It is understood that RWE expressed interest in use of the LNG receiving terminal at Brunsbuettel to re-gasify LNG imported from Australia.

German Chancellor, Mr Olaf Scholz said: "We have decided [quicky to] build two LNG terminals at Brunsbuettel and Wilhelmshaven", the speed of that decision became apparent.

On March 5, 2022, Vopak [announced](#) (under [\*\*German LNG Terminal in implementation phase with new shareholder structure\*\*](#)) that the shareholders of German LNG Terminal GmbH and the German Federal Government had agreed on key points to allow progress of the LNG receiving terminal at Brunsbuettel. On March 4, 2022, Gasunie and Kreditanstalt fur Wiederaufbau (**KfW**), acting for the German Federal Government, signed a memorandum of understanding to start construction jointly of the LNG receiving terminal at Brunsbuettel, with **KfW** to join German LNG Terminal GmbH as a shareholder, with Oiltanking and Vopak to leave as shareholders by May 2022.

The participation of the German Federal Government, through **KfW**, and the project implementation role taken by Gasunie, in the development of LNG receiving terminal at Brunsbuettel is extremely significant in all the circumstances.

- **Wilhelmshaven Green Plans:**

- On February 21, 2022, it was reported widely that Uniper and Salzgitter AG (global manufacturer of steel and technology products) had agreed arrangements for supply of Green Hydrogen from Uniper's **Green Wilhelmshaven® Hydrogen Project** to the Salzgitter SALCOS® project (see [Editions 14](#) and [34](#) of Low Carbon Pulse): **SALCOS** being **Salzgitter Low CO2-Steelmaking**.
- On March 2, 2022, it was reported in [rechargenews.com](#) that Tree Energy Solutions (**TES**) intends to develop a "green gas" terminal within Wilhelmshaven to accept deliveries of carbon neutral liquified e-methane (**e-CH<sub>4</sub>**). The plan is to commence operation of the green gas terminal before Q4 2025. It is reported that the **e-CH<sub>4</sub>** would be produced using captured **CO<sub>2</sub>** combined with low-cost renewable hydrogen (**H<sub>2</sub>**), with the methanation of the **CO<sub>2</sub>** and the **H<sub>2</sub>** undertaken using the Sabatier Methanisation Process. It is understood that the **TES** green gas terminal would be able to received LNG.

- **Green Wilhelmshaven® Hydrogen Project:** By way of an update, it is apparent that the plans of Uniper for **Green Wilhelmshaven** include the development of a Green Ammonia receiving and **hydrogenation** terminal, and a Green Hydrogen production facility comprising 1 GW electrolyser capacity.

Echoing the longstanding narrative of Low Carbon Pulse, Mr Gunnar Grobler of Salzgitter AG stated: "We are aligning Salzgitter AG to low **CO<sub>2</sub>** production processes and the circular economy ... The secure and economically viable sourcing of Green Hydrogen is a fundamental pre-requisite on our journey toward SALCOS ...".

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

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

- **SAF in sound: Mosjøen, Norway:** On February 28, 2022, [norsk-e-fuel.com](#) announced plans to develop a sustainable / synthetic aviation fuel (**SAF**) production plant in Mosjøen, Norway, signing an agreement with the municipality of Vefsn and Mosjøen og Omegn Naeringsselskap KF (**MON**). The **SAF** production plant is to produce **SAF** from **CO<sub>2</sub>** and water, powered by renewable electrical energy from the Mosjøen area. The **CO<sub>2</sub>** will be sourced from direct air capture (**DAC**), using technology developed by Climeworks (see [Editions 25](#) and [26](#) of Low Carbon Pulse) and electrolyzers provided by Sunfire (see [Editions 29](#) and [34](#) of Low Carbon Pulse).

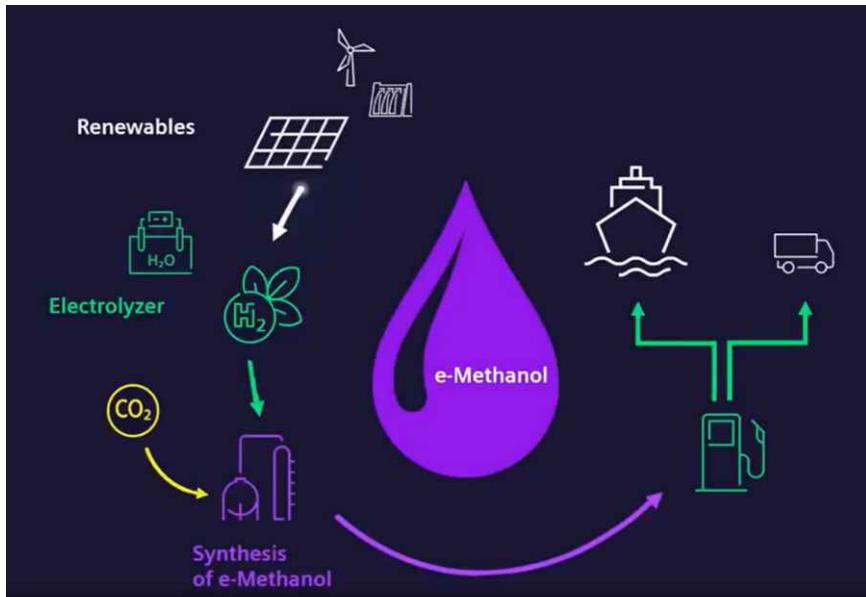
The Norsk e-Fuel consortium comprises, Climeworks, Sunfire, Valinor AS (green energy investment corporation headquartered in Norway, and parent company of Norsk Vind), and Paul Wurth / SMS Group (leading engineering, procurement and construction corporation).

- **Florida commits to Green Hydrogen:** On March 1, 2022, it was reported widely that the Florida Power & Light Company is to develop and to deploy a Green Hydrogen production plant using a 25 MW electrolyser supplied by Cummins Inc. The Green Hydrogen production plant is to be located within the Cavendish NextGen Hydrogen Hub.

- **FFI and Covestro contract:** On March 1, 2022, it was reported widely, and [covestro.com](#) announced, that **FFI** and Covestro (leading plastics manufacturer headquartered in Germany) had contracted for the sale and purchase of 100,000 metric tonnes a year of Green Hydrogen starting in 2024.

- **ExxonMobil turns blue:** On March 2, 2022, [h2.view.com](#) reported (under [\*\*ExxonMobil unveils ambitious blue hydrogen targets for integrated refining and petrochemical site\*\*](#)) on plans of ExxonMobil to produce one billion cubic feet of Blue Hydrogen daily at its petrochemical and refining site, Baytown, Texas. The Blue Hydrogen would be used as feedstock at the olefins plant at Baytown. CCS will be key to the plans, with up to 10 million metric tonnes of **CO<sub>2</sub>** per annum to be captured.

**European Energy progressing to scale e-Methanol production:** On March 3, 2022, it was reported widely that European Energy had agreed to procure from Siemens Energy a 50 MW electrolyser (using proton exchange membrane technology) to produce Green Hydrogen to combine with **CO<sub>2</sub>** to produce e-Methanol in Kassø, Denmark, located close to the source of renewable electrical energy to power the electrolyser, a 300 MW photovoltaic solar farm owned by European Energy.



The e-Methanol production project will supply e-Methanol to AP Moller Maersk and to Circle K. As noted in previous editions of Low Carbon Pulse, one of the key risks for AP Moller Maersk in procuring dual fuel container ships was the supply of sufficient clean or low carbon methanol.

**Edition 26** of Low Carbon Pulse reported on the decision of AP Moller Maersk to order eight dual fuel container vessels, capable of being powered and propelled by methanol. In reporting on this decision it was noted that AP Moller – Maersk was aware of the need to continue to procure supplies of methanol.

- **Takasago Hydrogen Park:** **Edition 35** of Low Carbon Pulse reported on Mitsubishi Heavy Industries (**MHI**) is to establish the **Takasago Hydrogen Park** to produce hydrogen that **MHI** will use to allow it to develop and to commercialise its hydrogen gas turbine technology. **Takasago Hydrogen Park** will use electrolyser technology to produce Green Hydrogen, and it will produce hydrogen from the thermal treatment of methane (Grey without CCS / CCUS, Blue Hydrogen, without CCS / CCUS).

On February 22, 2022, **MHI** made its own [announcement](#) which included the following infographic:



- **Gulf Coast Green Fuels Hub:** On February 22, 2022, [h2-view.com](#) reported Apex Clean Energy (see **Edition 35** of Low Carbon Pulse) had signed a memorandum of understanding with the Port of Corpus Christi Authority and EPIC Midstream to consider the development of a GW scale green fuels hub, at the hub of which would be Green Hydrogen production capacity.

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

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of:

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

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

- **Northvolt transformation:** On February 25, 2022, [northvolt](#) (under [Northvolt to transform closed paper mill in Sweden into new Gigafactory](#)) announced that it plans to develop the Kvarnsveden Mill and the area surrounding it at Borlange, Sweden. As announced, northvolt is to use the site to manufacture battery cells - up to 100 GWh of cathode material annually.
- **Delta Corridor:** On February 25, 2022, it was reported that the Delta Corridor has the support of the Dutch Government: the Delta Corridor comprises a pipeline system between Maasvlakte (Rotterdam – see [Editions 30, 31](#) and [33](#) of Low Carbon Pulse for background on Maasvlakte) and the Ruhr region of northern Germany. The Delta Corridor is one of nine projects within the [Dutch Multi-Year Program for Infrastructure Energy and Climate](#) (Miek).



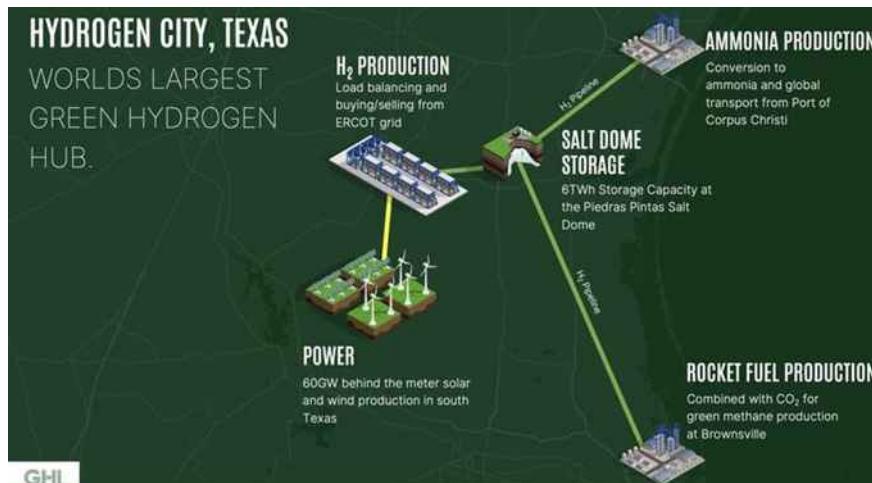
**Giga-factory turns soil in Queensland, Australia:** Edition [29](#) of Low Carbon Pulse reported on the commitment of FFI and Plug Power to develop a giga-factory in Australia as follows:

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

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

On February 28, 2022, it was reported widely that Dr Andrew Forrest AO had attended a ceremony to mark the commencement of construction of the **Green Energy Manufacturing Centre** or **GEM**. The **GEM** will manufacture electrolysers, batteries, electrical cabling, photovoltaic solar panels, and wind turbines at Gladstone, Queensland.

- **Hydrogen City, Texas:** On March 3, 2022, the plans of Green Hydrogen International were reported widely - the development of a 60 GW green hydrogen megaproject in the US State of Texas (**Hydrogen City**). The plans include the production of 2.5 million metric tonnes of Green Hydrogen a year, and the use of Piedras Pintas Salt Dome as a **HESS**.



- **BP and Equinor South Brooklyn Marine Terminal:** On March 3, 2022, the Mayor of New York City, Mr Eric Adams, announced plans to redevelop the South Brooklyn Marine Terminal as the location for facilities to support off-shore wind development and operation and maintenance of the Beacon Wind (see **Edition 8** of Low Carbon Pulse) and Empire Wind (see **Edition 20** of Low Carbon Pulse) off-shore wind field projects. The redeveloped terminal will be called the Sustainable South Brooklyn Marine Terminal.
- **UN Environment Program reports on cities:** On March 4, 2022, the UNEP published [\*\*\*Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions\*\*\*](#). The report will be considered in the **March and April Report on Reports**.

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

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the extraction of metals and minerals necessary for the decarbonisation of activities to progress towards achievement of **NZE**, the use of **E-fuels** and **Future Fuels** to power and to propel vehicles used to extract and to transport metals and minerals, and the use of E-fuels and Future Fuels to process and to treat those metals and minerals. Also this section considers the Difficult to Decarbonise industries, including the iron and steel sector.

- **Vale and Hunan Valin Group alignment:** On February 23, 2022, a number of new sources reported that Vale SA (one of the world's largest mining and resources corporations) had signed a memorandum of understanding with Hunan Valin Group. Vale SA is seeking to reduce its Scope 3 emissions by 15% by 2035, and this initiative is understood to be part of the planning.
- **Supply / Value Chains from waste:** On February 26, 2022, the [post-gazette.com](#) published an article written by Ms Jennifer Wilcox, entitled [\*\*\*Creating a mineral supply chain from mining wastes\*\*\*](#). The article is well-worth a read. The premise of the article is one that is applicable on a global scale: spoil / waste arising from mining operations (and power operations for that matter) is stored on open-sites, sites that require rehabilitation. At many sites, metals and minerals are present, including rare earth elements (**REEs**). The challenge is the development of scalable technology, and accompanying viable economics, to recover metals and minerals from the spoil / waste. Again, this is a global challenge. This is an area in which governments have a role to play in providing funding support to allow the development of technologies that recover metals and minerals from all waste stream on a scalable and viable basis.
- **Peabody to pivot:** On March 2, 2022, it was reported widely that Peabody Coal has entered into a joint venture with Riverstone Credit Partners, **R3 Renewables**, to develop up to 3.3 GW of photovoltaic solar capacity and 1.6 GW of **BESS** capacity by the mid-2020s. The photovoltaic solar and **BESS** capacity is to be located on, or close to, land on which coal mining operations have been undertaken, starting with land in the US States of Indiana and Illinois.

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

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of wind power generation capacity, on-shore and off-shore (fixed bottom and floating).

- **Poland off-shore wind progress:**
  - **Further three off-shore wind field in play:** On February 18, 2022 the Ministry of Infrastructure invited applications for three more off-shore wind field concessions (following the processes that started on January 21, 2022 and February 8, 2022). At the moment, there are three 60 day windows open for applications. It is reported that there are 11 areas for which applications may be submitted to build and to operate off-shore wind fields and energy islands: these areas are the nine the subject of current application processes, and two in respect of which windows were opened in Q4 of 2021.

On February 25, 2022, [offshoreWIND.biz](#) reported (under [Ørsted and PGE Seek More Room Offshore Poland](#)) that on February 23, 2022, Ørsted and **PGE** had applied for off-shore wind field capacity directly adjacent to the 2.5 GW Baltica Offshore wind project (see [Editions 14](#) and [18](#) of Low Carbon Pulse for coverage of Baltica 2 and 3).

- **By way of reminder:** Edition [35](#) of Low Carbon Pulse reported that **PKN Orlen** (a Polish based oil refiner and petroleum retailer, see [Editions 20](#) and [34](#) of Low Carbon Pulse) and Polska Grupa Energetyczna (**PGE**) has submitted multiple applications for permits to develop off-shore wind field capacity in areas recently designated for development in the Polish sector of the Baltic Sea.

**PKN Orlen** has submitted applications for seven areas, covering around 3 GW of installed capacity. **PGE** has submitted applications for six areas, with two applications submitted jointly with Enea and one jointly with Tauron.

- **Swedish Fair Wind :**

- **OX2 given legs offshore shore:**

- On December 30, 2021, [offshorewind.biz](#) reported that OX2 had applied for a Natura 2000 permit to develop the 1.8 GW Triton off-shore wind field, located within the economic zone off the coast of Skåne, Sweden.
- On January 17, 2021, [offshorewind.biz](#) reported that OX2 had been granted exploration permits for two off-shore wind fields in the Gulf of Bothnia Exclusive Economic Zone (**EEZ**): the permits were granted at a plenary session of the Finnish Government, and are in respect the Halla project (approximately 35 km off-shore the city of Raahe) and Laine project (approximately 30 km off-shore of the adjacent cities of Kokkola and Pietarsaari).
- On February 22, 2022, [offshorewind.biz](#) reported that OX2 has applied for a permit to construct the 1.8 GW Triton off-shore wind field project. On grant of the permit, the 1.8 GW Triton project will be constructed 30 kilometres south of Ystad, comprising 129 wind turbines, each with a maximum height of 370 metres. As reported, the 1.8 GW Triton project will be able to generate up to 7.5 TWh of renewable electrical energy a year. This will represent great progress in the context of the plans and policy settings of the Swedish Government outlined below (under **By way of reminder**).

- **By way of reminder:** Edition [35](#) of Low Carbon Pulse reported that the Swedish Government is to identify suitable areas to develop off-shore wind fields for the purposes of generating 120 TWh annually from sources of renewable electrical energy (noting that the electrical energy consumption of Sweden is 140 TWh annually).

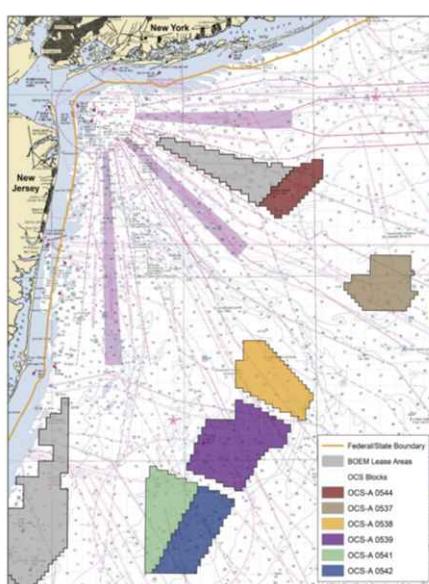
It is understood that the Swedish Energy Agency (**SEA**) has identified, and reported on, three areas – located in the Baltic Sea, the Gulf of Bothnia and the North Sea having wind resources of between 20 to 30 TWh annually. The **SEA** will work with the Swedish Maritime Administration (**SMA**) to identify areas from which 90 TWh annually can be generated. The **SEA** is to report on progress by no later than March 2023, the **SMA** no later than December 2024.

- **US off-shore wind off nearly off the scales:** As noted on page 1 above, the hammer fell on the first auction process run for the award of lease areas to develop off-shore wind fields in US Federal waters.

- **February 23 2022 will stay long in the memory:** As reported in [Edition 33](#) of Low Carbon Pulse, the auction process for the development of off-shore wind field development for the New York Bight would commence on February 23, 2022 with six areas up for bids by developers (**Lease Areas**). The auction process is the domain of the Bureau of Ocean Energy Management (**BOEM**).

The auction process commenced on February 23, 2022. During the first day of the auction process there were 21 rounds of bidding: see [renewableenergyworld](#) (under [New York Bight offshore wind auction advances as bids total \\$1.5 billion](#)).

### Potential Energy Impact of the New York Bight Lease Areas



	DEVELOPABLE ACRES	INSTALLATION CAPACITY (MW) <sup>(1)</sup>	POWER PRODUCTION (MWh/yr) <sup>(2)</sup>	HOMES POWERED <sup>(3)</sup>
OCS-A 0544	43,056	523	1,831,628	182,954
OCS-A 0537	71,522	868	3,042,588	303,911
OCS-A 0538	79,438	964	3,379,340	337,548
OCS-A 0539	114,277	1,387	4,861,411	485,586
OCS-A 0541	76,139	924	3,238,998	323,530
OCS-A 0542	76,894	934	3,271,116	326,738

<sup>(1)</sup> Megawatts (MW) based upon 3MW/sqkm

<sup>(2)</sup> Based upon 350 homes per MW

<sup>(3)</sup> Formula = Capacity (MW) \* 8760 (hrs/yr) \* 0.4 (capacity factor)

On February 24, 2022 (day two of the auction process), the **BOEM** suspended bidding after the rounds of bidding did not result in winners.

On February 25, 2022 (day three of the auction process), the **BOEM** continued, and completed the auction process – after three days, and 64 rounds of biddings. The headline was that the auction process had resulted in the award of the six **Lease Areas** for an aggregate of final bid prices of USD 4.37 billion.

LEASE AREA AND CAPACITY	SUCCESSFUL BIDDER AND BID
OCS-A 0539 / 1.38 GW to 3 GW	Bight Wind Holdings, LLC (National Grid & RWE Renewables) USD 1.1 billion
OCS-A 0538 / 964 MW to 1.5 GW	Attentive Energy (EnBW and TotalEnergies with Total now having 100%) USD 795 million
OCS-A 0541 / 925 MW to 1.2 GW	Atlantic Shores Offshore Wind Bight LLC (EDF and Shell) USD 780 million
OCS-A 0537 / 870 MW to 1.1 GW	OW Ocean Winds East LLC (EDP Renewables and Engie) USD 765 million
OCS-A 0541 / 925 MW to 970 GW	Invenergy Wind Offshore LLC USD 645 million
OCS-A 0544 / 525 to 700 MW	Mid-Atlantic Offshore Wind LLC (CIP) USD 285 million

- **The auction process:** There were 25 corporations that had pre-qualified to bid. Each pre-qualified bidder could bid for one or more **Lease Area**. If there were two or more live bids for any Lease Area, a further round of the auction process took place. At the start of each round, the **BOEM** increased the bid price for each **Lease Area**.
- **By way of reminder:**
  - **Edition 29** of Low Carbon Pulse reported that on October 14, 2021, the Biden Administration announced plans to allow the development of seven off-shore wind fields along the East, Gulf and West Coasts of the US: **1.** Gulf of Maine, **2.** **New York Bight** (between Long Island and New Jersey), **3.** Central Atlantic, **4.** the Carolinas, **5.** the Gulf of Mexico, **6.** California and **7.** Oregon.
  - **Edition 33** of Low Carbon Pulse reported that On December 17, 2021, the **BOEM** had completed its assessment of the development of the 800,000 acre **New York Bight**, allowing the lease of off-shore wind fields with capacity of up to 7 GW of new renewable electrical energy.
- **From New York Bight to Oregon:** On February 25, 2022, it was reported widely the **BOEM** has moved on from the New York Bight auction process to sizing and shaping of the offshore wind leases off the coast of the US State of Oregon: **BOEM** has identified three Call Areas, thinking around which is now being finessed to define Wind Energy Areas.



- **Germany off-shore tender commences:** On February 25, 2022, the Network Agency of the German Federal Government (Bundesnetzagentur) commenced the tender process for up to 980 MW of off-shore wind capacity. The

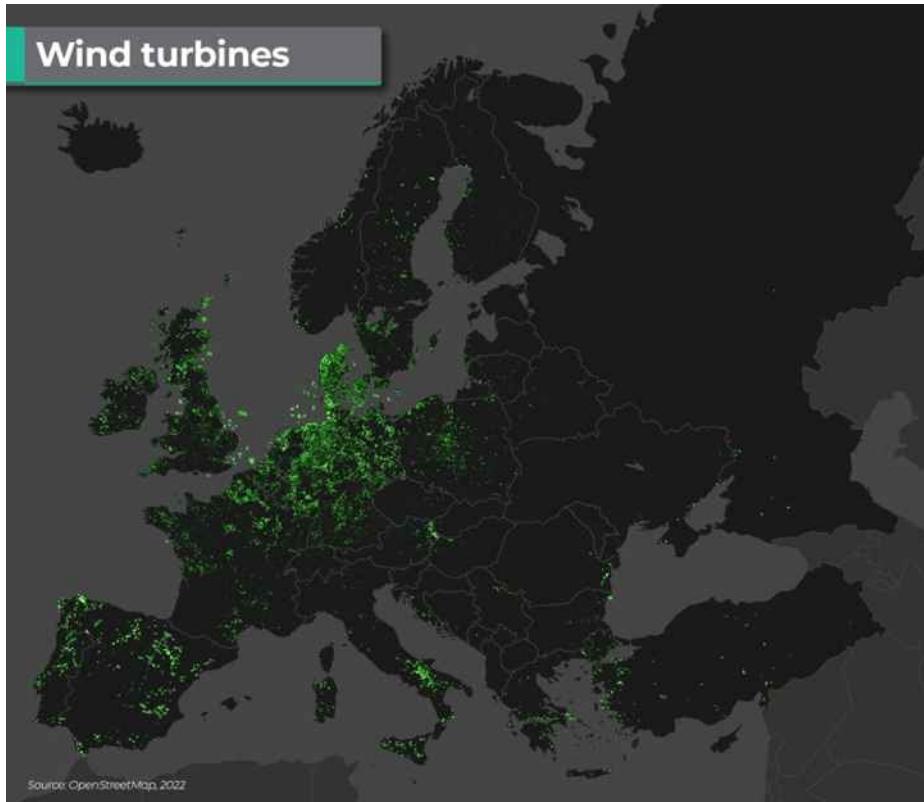
bidder with the bid that requires the least funding support will be successful. Bids must be submitted on or before September 1, 2022.

- **Netherlands off-shore expands renewable energy plans:** On February 25, 2022, Rijksdienst voor Ondernemend (RVO) Nederland (anglesized to the Enterprise Agency) published a [report](#) (entitled the [\*Netherlands System Integration Offshore Wind 2030-2040\*](#)). The RVO is proceeding on that basis that by 2040 there will be 38.5 GW of installed off-shore wind field capacity, moving to 72 GW by 2050 (under one scenario – the national scenario) and 31 GW, moving to 38, 42 GW or 43 GW of installed capacity by 2050 (under three other scenarios).

**By way of reminder:** Edition [29](#) of Low Carbon Pulse noted that on October 6, 2021, it was reported that the RVO is procuring the undertaking of metocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the IJmuiden Ver Investigation Area (**IVIA**).

The **IVIA** is one of three off-shore areas identified in the Dutch Offshore Wind Energy Roadmap 2030. The **IVIA** is 62 kms off the west coast of the Netherlands, having an area of 400 km<sup>2</sup>. The **IVIA** has four lots in all, with **IVOA** I and II to be tendered in to 2023, and **IVOA** III and IV to be tendered in to 2025.

**Wind turbines in Europe:** On March 4, 2022, the author came across the following graphic representing wind farms across Europe - the brighter the green dot, the greater the intensity of electrical energy produced by the wind farm



- **ROCKING off-shore ROK:** Edition [34](#) of Low Carbon Pulse noted that on January 25, 2022, Korea Floating Wind (comprising Aker Offshore Wind (33.3%) and Ocean Winds (66.7%), had been granted its first Electricity Business Licence (**EBL**) for 870 MW in respect of its off-shore wind field. At that time, the CEO of Aker Offshore Wind, Mr Phillippe Kavagyan stated: "*We are very pleased by this timely grant of the first Electric Business Licence, confirming that strong support that we receive in South Korea to make offshore wind a national ambition.*"

On March 4, 2022, it was reported widely that that Korea Floating Wind had been granted its second **EBL** for 450 MW in respect of its off-shore wind field. Ocean Winds announced the grant of the second **EBL**, and noted:

"obtaining the second **EBL** represents another key step towards realising the world's first large scale commercial floating wind project. The **EBL** is a mandatory requirement to generate and to supply electricity in South Korea ... [Korea Floating Wind] now holds a 1.32 GW EBL [of] capacity".

The grant of the second **EBL** allows continued development, on an exclusive basis, of the East Blue Power area, Korea Floating Wind working with its partner Kumyang Green Power. Looking ahead, the intention is to achieve operational completion by 2028, having achieved financial close in 2024".

By way of reminder:

- **Edition 25** of Low Carbon Pulse reported that the Green Investment Group Limited (**GIG**) and TotalEnergies had been granted an electricity business licence (**EBL**) from the Ministry of Trade, Industry and Energy. The grant of an **EPL** allows the development, on an exclusive basis, of the first phase (504 MW) of the three phase 1.5 GW off-shore floating wind field project off Ulsan, South Korea; and
- **Edition 26** of Low Carbon Pulse reported that Shell Overseas Investment B.V. had announced its joint venture with CoensHexicon Co. Ltd, with Shell an 80% equity participant, CoensHexicon, a 20%, equity participant, to develop and then to operate the 1.4 GW Ulsan **OWF** project (the **MunmuBaram Project**).
- **Edition 32** of Low Carbon (under **MunmuBaram licensed**), the **MunmuBaram Project** has been granted an Electricity Business Licence (**EBL**), for its floating off-shore wind field project development.

## Solar and Sustainability (including NZE Waste):

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development of solar power generation capacity, on-shore (photovoltaic and concentrated) and floating. Also this section covers relating to the development of facilities and technologies to process and to recycle **NZE Waste**. Also this section considers the treatment of residual **NZE Waste**.

- **EDP SEA:** On February 24, 2022, it was reported widely that EDP Renewables (a leading global renewable energy corporation, headquartered in Portugal) is to invest USD 10 billion in Singapore and South East Asia (**SEA**).

**EDP** has concluded its acquisition of 91% of Sunseap (a Singapore renewable energy corporation – see **Editions 13, 14, and 22** of Low Carbon Pulse).

## Land Mobility / Transport:

This section considers news items that have arisen within the news cycle of this **Edition 36** of Low Carbon Pulse relating to the development and deployment of land vehicles, buses and coaches, cars, industrial vehicles and trucks, and trains.

### • Buses and coaches:

- **Hexagon Purus to supply hydrogen buses to Poland:** On February 24, 2022, it was reported widely that Hexagon Purus (a leading hydrogen system technology provider) is to supply high-pressure hydrogen systems for use in buses powered and propelled by fuel-cell electrical technology.
- **Santiago, Chile electrifying:** On February 25, 2022, it was reported widely that by June 2022 Santiago will have 1,775 electric buses running across the city. In addition to electromobility in Santiago, regions of Chile are progressing to electromobility.
- **MAN moves into electrolyzers:** During the news cycle of this **Edition 36** of Low Carbon Pulse, MAN Energy Solutions (a subsidiary of Volkswagen) [announced](#) plans to move into the market for electrolyzers, investing €500 million to produce polymer electrolyte membrane electrolyzers "as quickly as possible". This may be regarded as a significant development because the application of the manufacturing and fabrication capacity of MAN Energy Solutions will increase significantly the supply of electrolyzers.

### • Cars (including taxis):

- **HCE coming:** Since the turn of the calendar year 2022, a number of news items have appeared indicating that progress is being made to develop hydrogen combustion engines (**HCEs**). The author was planning to include a summary of progress in this **Edition 36** of Low Carbon Pulse.

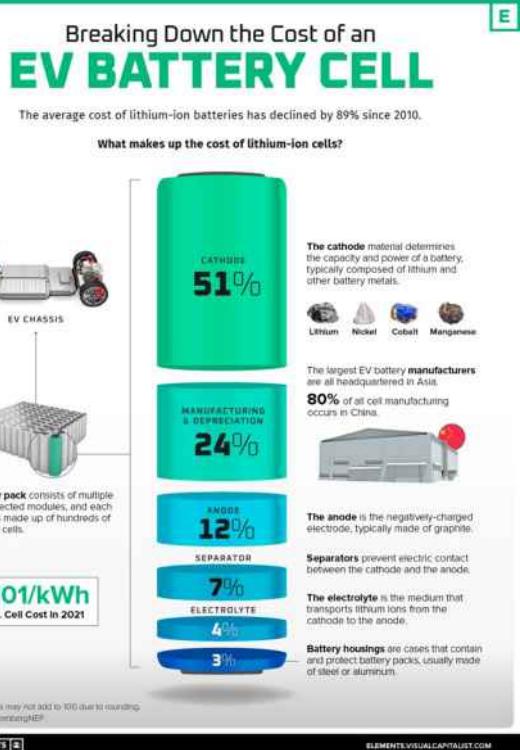
On February 24, 2022, [fuelcellworks.com](#) published an article (under [\*\*Hydrogen Combustion Engines Are Coming\*\*](#)) that provides a useful summary of the current state of play: Cummins Inc, Renault, Toyota and Yamaha have announced progress to develop **Hydrogen Combustion Engines** or **HCEs** (that combust hydrogen to power and to propel vehicles, rather than using fuel-cell technology to derive electrical energy from hydrogen). One can sense the displacement of **petrol head**, with **hydrogen head**.

- **Wireless charging coming:** On March 4, 2022, it was [reported](#) widely that the Swedish city of Gothenburg is to test wireless charging of taxis, allowing continuous charging of taxis without the need to drivers to spend time recharging.

### • Fuel Cell and Battery Technology:

- **First hybrid fuel cell system:** On March 1, 2022, it was reported widely that Acciona and AFC Energy had announced the development of a hybrid hydrogen fuel cell system (**HFC**). The **HFC** will be deployed at a construction site of Acciona so as to decarbonise the site. It is understood that the **HFC** is based in Anion Exchange Membrane technology of AFC Energy, and will allow the use of green methanol.

- **Breakdown of the costs of EV battery cells:** The following infographic is helpful to understand the cost of electrical vehicle battery costs:



- **Industrial Vehicles and Trucks:**

- **Sweden first hydrogen trucks on the way:** On February 23, 2022, it was reported widely that MaserFrakt (leading transport group) had placed orders for two Hyzon HyMax-250 fuel cell trucks, having a range of 680 kilometres. This is continued and further progress for MaserFrakt which already has 750 vehicles in its transport fleet powered and propelled without the use of fossil fuels.
- **Van Kessel Group hydrogen trailers on the way:** On February 23, 2022, it was reported widely that the Van Kessel Group (headquartered in the Netherlands) had ordered five hydrogen trailers from Wystrach GmbH (a subsidiary of Hexagon Purus, a leading hydrogen system technology provider). It is understood that each trailer has capacity to transport 400 kilograms of compressed hydrogen (at 300 bar).  
Van Kessel Group will use the hydrogen trailers to deliver hydrogen to sites installed with its Greenpoint Hysolar refuelling infrastructure. In addition to the Greenpoint Hysolar refuelling infrastructure in operation at Nieuwegein, Van Kessel Group is developing refuelling infrastructure at Dordrecht, Ede, and Oude-Tonge.
- **Aberdeen (and UK) first fuel cell waste truck on the way:** On February 25, 2022, it was reported widely that Aberdeen, Scotland, is to procure a waste truck powered and propelled using fuel-cell technology. This procurement is a further step in the forward looking thinking of Aberdeen City Council.

- **Recharging and refuelling infrastructure:**

- **CVX and Iwatani:** On February 24, 2022, it was reported widely that Chevron Corporation and Iwatani Corporation of America have agreed to install hydrogen refuelling infrastructure at 30 locations in California by 2026.  
As might be expected, the hydrogen refuelling infrastructure is to be located at existing CVX sites, with hydrogen to be sourced from the CVX refinery at Richmond, California, and from hydrogen production plants to be developed. Iwatani is to operate and to maintain the hydrogen refuelling infrastructure and provide logistics and transportation services.
- **CP90 opens:** On February 28, 2022, Linde Engineering announced that the first CP90 hydrogen refuelling station in the US had opened in Oakland, California. The CP90 hydrogen refuelling station provides up to three times more capacity than existing hydrogen refuelling stations elsewhere in California.
- **Interstate 10 project develops:** On February 28, 2022, [h2-view.com](http://h2-view.com) reported that Ameresco (a cleantech integrator and renewable energy asset developer, owner and operator) is to participate in the Guidehouse Clean Hydrogen Economy consortium (which includes Bank of America, Citi Group, Cummins Inc, Linde and Walmart). By participating in the consortium, Ameresco is seeking to advance Green Hydrogen as "a low-carbon, scalable fuel source for the heavy transportation sectors in Los Angeles and Phoenix along the I-10 corridor".
- **New Energies Service Station:** On March 1, 2022, the Australian Renewable Energy Agency (**ARENA**) announced that it is providing funding support for Viva Energy Australia (**VEA**), to allow **VEA** to develop, build and operate a New Energies Service Station (**NESS**) located at a site in Geelong, Victoria.

The **VEA NESS** will provide recharging facilities for **BEVs** and refuelling facilities for **FCEVs** over the road from **VEA's** petroleum refining facilities in Geelong. **VEA** will develop and deploy a 2 MW electrolyser to produce Green Hydrogen for use at the **NESS**.

**ARENA** is providing funding support to **VEA** to acquire 15 **FCEVs**, which will use the Green Hydrogen produced by **VEA**, thereby providing demand. The **NESS** will be the first of its kind, open to the public as a dedicated heavy goods vehicle recharging and refuelling station for **BEVs** and **FCEVs**.

In addition to demand from **VEA**, Barwon Water, Cleanaway Waste Management Group, ComfortDelGro, Australia, and Toll Group have committed to the purchase of **FCEVs**, including to power and to propel prime movers to transport municipal solid waste and waste water. This innovative approach to the development of supply and demand is significant, providing a model for like developments and deployments elsewhere.

- **Trains:**

**Infinity Train:** On March 1, 2022, it was reported widely that Dr Andrew Forrest, AO (chair of Fortescue Metals Group) had acquired Williams Advanced Engineering to enable FMG to develop a train power system that will not require any recharging – the so called Infinity Train.

As reported, the train power system will capture energy to recharge batteries on the declines along the route traversed by the trains. FMG has 54 locomotives and 16 train sets.

## **Ports Progress and Shipping Forecast:**

*This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the development and deployment of production and storage capacity, and infrastructure, at ports for E-Fuels / Future Fuels (including Hydrogen Hubs) and to capture and to store or to use of carbon, or both (including Carbon Clusters), and the connection of port infrastructure to the hinterland.*

*Also this section considers news items that relate to the development of infrastructure at ports, including to allow the development of off-shore wind fields.*

- **Ferries:**

Within the news cycle covered by this **Edition 36** of Low Carbon Pulse, no news items have come to light on Ferries that may be regarded as significant for the purposes of Low Carbon Pulse.

- **Green Ports:**

**H2 Gate to H2A:** On February 24, 2022, it was reported widely that H2 Gate (comprising Evos, Hydrogenious, Hysilabs, and Electriq Global), with the Port of Amsterdam, is committed to the development and deployment of 100% a Green Hydrogen supply / value chain from the Port of Amsterdam. It is understood that the intention is to make use of multiple means of carriage / transportation of hydrogen.

- **By way of reminder:** As reported in **Edition 30** of Low Carbon Pulse, Amsterdam has launched a Hydrogen Hub (**AHH**). The **AHH** involves collaboration by the Port of Amsterdam, Amsterdam Airport, Schiphol, Vattenfall, Liander, NZKG, Gasunie, Oram Nobian and the province of North Holland and the municipalities of Amsterdam and Zaanstad. In is understood that the principal aim of the hub is achieve the large-scale transition of the Amsterdam Area and North Sea Canal Area into a hydrogen economy by 2050 through the import and export of hydrogen.

- **Green Shipping:**

- **FKAB Marine Design approved:** On February 21, 2022, [fuelcellworks.com](http://fuelcellworks.com) reported that Swedish ship designer, FKAB Marine Design had received Approval in Principle (**AiP**) for its hydrogen powered and propelled MR Tanker. As reported, this is the first **AiP** of a design using technology that is current and viable, and that achieves IMO 2050 targets. The design combines **CH<sub>4</sub>** (present in LNG, and used as fuel) with steam to produce **CO<sub>2</sub>** and **H<sub>2</sub>**: using gas reforming technology of Helibo, **CH<sub>4</sub>** molecules are split into **CO<sub>2</sub>** and **H<sub>2</sub>**, with the **H<sub>2</sub>** used to fuel internal combustion engines and fuel cells using the hybrid marine power and propulsion system technology of ABB. The MR Tanker has been developed jointly by ABB and Helbio (as subsidiary of Metacon AB, a company specialized in development, manufacturing and marketing of Hydrogen and Energy Systems primarily from renewable sources).

- **ABB and Ballard – all aboard:** On February 23, 2022, Ballard Power Systems (at [ballard.com](http://ballard.com), under **Ballard & ABB Approval in Principle for High-Power Fuel Cell Concept to Power Ships**) announced that ABB and Ballard Power System, working together, had received approval in principle (**AiP**) from DNV (leasing classification society, headquartered in Høvik, Norway) for fuel-cell concept developed jointly by ABB and Ballard Power Systems.

The **AiP** is in respect of a fuel-cell concept that is capable of generating 3 MW or 4,000 horse power of electrical energy. For ABB and Ballard Power Systems the **AiP** allows them to proceed to progress the further development of the concept to commercialisation.

## **Airports and Aviation:**

*This section considers news items that have arisen within the news cycle of this Edition 36 of Low Carbon Pulse relating to the development and deployment of technology at airports and in the aviation sector to decarbonise the airports and the aviation industry.*

- **SAF in the knowledge:** **Edition 36** of Low Carbon Pulse was long on news on sustainable / synthetic aviation fuel (**SAF**), a fair amount of the news involving Neste.

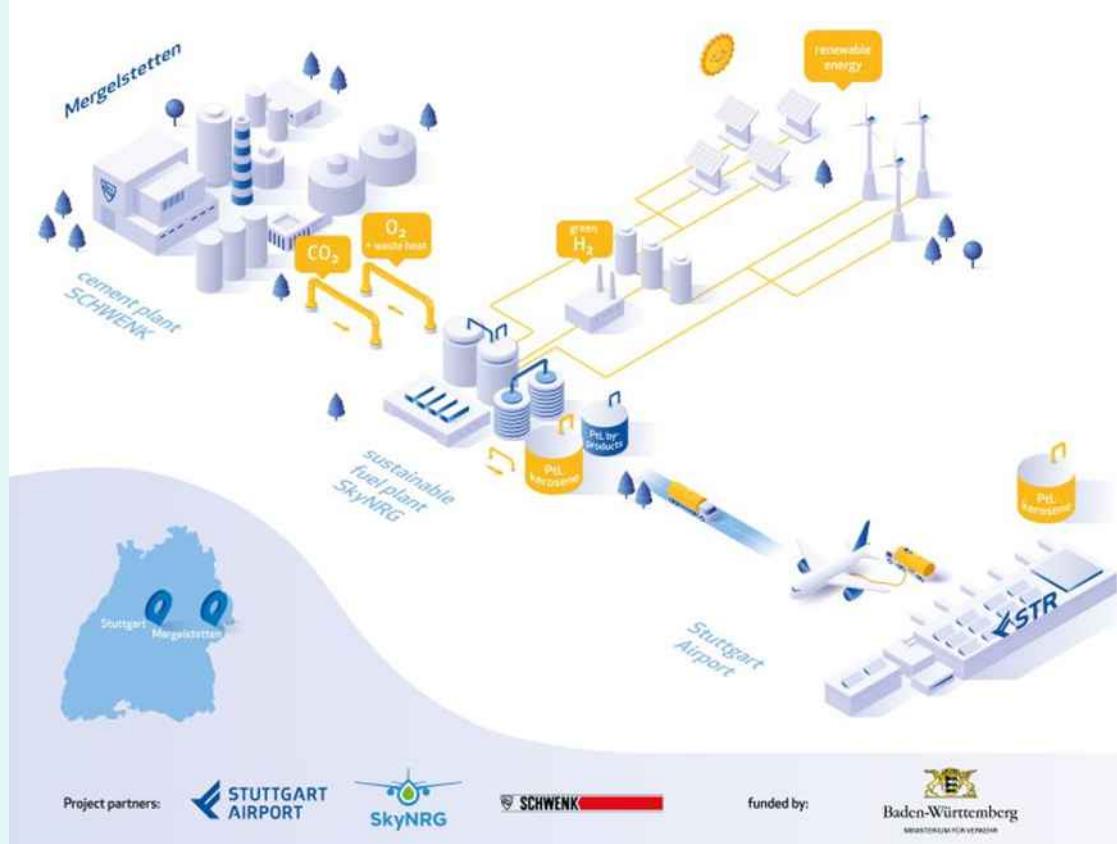
On February 23, 2022, [Neste](http://Neste) announced (under [Using waste as a resource to fight climate change](#)) that it was teaming Mahoney Environmental to source used cooking oil from 45,000 restaurants across the US to produce **SAF**. In passing, it is encouraging to understand the scale that is contemplated as being necessary.

Among other things, Neste and Mahoney are working with Dallas Fort Worth International Airport (**DFW IA**) for the purposes of helping **DFW IA** achieve its target of **NZE** by 2030.

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

1. commercial aircraft are not permitted to use **SAF** on its own to propel aircraft (a maximum blend ratio of 50% fossil fuel to 50% **SAF** is permitted);
2. the process to produce **SAF** – there is only one commercially scalable production progress – 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 **CO<sub>2</sub>-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 **CO<sub>2</sub>**, captured from the production of cement, combined with **H<sub>2</sub>**. The following infographic provides an overview of the sources of feedstock and the technologies used in the production of synthetic kerosene.



- Airbus moves to H<sub>2</sub> engines:**

- Edition 35** of Low Carbon Pulse, reported that Airbus Industries may manufacture engines powered by hydrogen. On February 23, 2022, it was reported widely that Airbus Industries and CFM International (a 50/50 joint venture between GE Aviation and Safran Aircraft Engines) are working together to test the use of hydrogen to power engines to propel aircraft.
  - Edition 32** of Low Carbon Pulse reported that Airbus Industries intends to develop a zero-emission hydrogen powered and propelled commercial aircraft by 2035. On February 22 and 23, 2022, it was reported widely that by 2035 Airbus Industries intends to fly a hydrogen-powered and propelled Airbus A380.
- The announcement that the Airbus A380 was to be the Airbus Industries aircraft resulted in multiple diagrams, the most helpful of which is as follows:



**By way of reminder:** Airbus Industries announced its thinking around progress to use of hydrogen to power and propel aircraft at the end of Q3 of 2020 ("Zero-e"). The announced thinking was accompanied by an outline of [three hydrogen powered aircraft concepts](#):

1. Turbofan;
2. Turboprop; and
3. Blended-Wing Body (BWB).

- **Update on ZeroAvia schedule:** Edition [33](#) of Low Carbon Pulse reported as follows:

On February 21, 2022, [hydrogen-central.com](#) reported (in something of an update), that the first hydrogen powered and propelled flight from Rotterdam to London was expected in 2024. The report impressed on the reader that: "Together with ZeroAvia, Royal Schiphol Group and Rotterdam The Hague Airport are working hard so that the first zero-emission flights with hydrogen can depart from Rotterdam to London in 2024".

- **ANA and JAL commit to SAF:** On March 2, 2022, it was reported widely that All Nippon Airways Co (**ANA**) and Japan Airlines Co (**JAL**), and a further 14 corporations, had established **Act for Sky**. **Act for Sky** has been established to promote production of **SAF** using cooking oil, and other technologies to derive and to produce **SAF** from other sources of waste.
- **TotalEnergies producing SAF:** On March 3, 2022, TotalEnergies [announced](#) that it is producing **SAF** at its biojet fuel production facilities in La Mède (its biorefinery at Bouches-du-Rhône) and at Oudalle (Seine-Maritime). The production of **SAF** by TotalEnergies allows it to match the demand for **SAF** arising from the policy setting in France requiring the use of **SAF** to satisfy at least 1% of demand for aviation fuel.

## 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
India Hydrogen Alliance	<a href="#"><u>India H2 Monitor – February 2022</u></a>
International Panel on Climate Change ( <b>IPCC</b> )	<a href="#"><u>Climate Change 2022: Impacts, Adaptation and Vulnerability</u></a>
International Energy Agency ( <b>IEA</b> )	<a href="#"><u>Global Methane Tracker 2022</u></a>
IRENA and State Grid	<a href="#"><u>Smart Electrification with Renewables: Driving the transformation of energy services</u></a>
National Oceanic and Atmospheric Administration (NOAA)	<a href="#"><u>2022 Sea Level Rise Technical Report</u></a>
Nature	<a href="#"><u>Observed poleward freshwater transport since 1970</u></a>
Rijksdienst voor Ondernemend ( <b>RVO</b> ) Nederland	<a href="#"><u>Netherlands System Integration Offshore Wind 2030-2040</u></a>
S&P Global Platts	<a href="#"><u>Hydrogen Price Wall</u></a>
UNEP	<a href="#"><u>Smart, Sustainable and Resilient cities: the Power of Nature Based Solutions</u></a>
Rijksdienst voor Ondernemend ( <b>RVO</b> ) Nederland	<a href="#"><u>Netherlands System Integration Offshore Wind 2030-2040</u></a>

## Key Contacts

We bring together lawyers of the highest calibre with the technical knowledge, industry experience and regional know-how to provide the incisive advice our clients need.

**Michael Harrison**

Senior Partner, Energy, Resources and Infrastructure

M +65 9728 8562 /+61 439 512 384/  
+61 414 968 707  
[michael.x.harrison@ashurst.com](mailto:michael.x.harrison@ashurst.com)

**Richard Guit**

Global Co-Head, International Projects

T +65 6602 9153  
M +65 9728 7943  
[richard.guit@ashurst.com](mailto:richard.guit@ashurst.com)

**Daniel Reinbott**

Partner

T +65 6416 9529  
M +65 9728 8672  
[daniel.reinbott@ashurst.com](mailto:daniel.reinbott@ashurst.com)

**Andrew Roche**

Partner

T +65 64160272  
M +65 97287452  
[andrew.roche@ashurst.com](mailto:andrew.roche@ashurst.com)

**Eleanor Reeves**

Partner

T +44 20 7859 1210  
M +44 7823 340 854  
[eleanor.reeves@ashurst.com](mailto:eleanor.reeves@ashurst.com)

**Caroline Lindsey**

Partner

T +61 8 9366 8109  
M +61 417 788 649  
[caroline.lindsey@ashurst.com](mailto:caroline.lindsey@ashurst.com)

**Dan Brown**

Partner

T +61 7 3259 7149  
M +61 401 564 654  
[dan.brown@ashurst.com](mailto:dan.brown@ashurst.com)

**Paul Curnow**

Partner

T +61 2 9258 5738  
M +61 434 074 591  
[paul.curnow@ashurst.com](mailto:paul.curnow@ashurst.com)

**Michael Burns**

Partner

T +44 20 7859 2089  
M +44 7717 840 646  
[michael.burns@ashurst.com](mailto:michael.burns@ashurst.com)

**Anna-Marie Slot**

Global Environmental, Social and Governance Partner

T +44 20 7859 3724  
M +44 7788 710 892  
[anna-marie.slot@ashurst.com](mailto:anna-marie.slot@ashurst.com)

**Antony Skinner**

Partner

T +44 20 7859 1360  
M +44 7917 635 974  
[antony.skinner@ashurst.com](mailto:antony.skinner@ashurst.com)

**David Wadham**

Office Managing Partner, Tokyo

T +81 3 5405 6203  
M +81 90 4828 5191  
[david.wadham@ashurst.com](mailto:david.wadham@ashurst.com)

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