# Low Carbon Pulse - Edition 19

## GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS

Welcome to Edition 19 of Low Carbon Pulse – sharing significant current news on progress towards net-zero emissions globally. This edition covers the period from Monday May 31, 2021 to Sunday June 13, 2021 (inclusive of each day).

Please click here for the previous Edition of Low Carbon Pulse. Please also click here and here for the first two articles in the ***Shift to Hydrogen Series*** (***S2H2***)***: Elemental Change*** series: the *S2H2* series provides a narrative and perspective on hydrogen generally. Please **click** here for the first feature in the ***Hydrogen for Industry*** (***H24I***): the *H24I* features provide an industry by industry narrative and perspective.

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## G7 Leaders' Summit Outcomes:

Over three days, June 11, 12 and 13, in Carbis Bay, Cornwall, England, the leaders of the Group of Seven (***G7***) met: the *G7* comprises Canada, France, Germany, Italy, Japan, the UK and the US. The Carbis Bay G7 Summit Communique, provides a summary of the agreed action agenda for the *G7*, (and greater detail on thinking around policy settings). The agreed agenda comprises six actions.

In the context of net-zero emissions (***NZE***), there are two actions, with the *G7* committing to:

- " … net zero no later than 2050, halving our collective emissions over the two decades to 2030, increasing and improving climate finance to 2025, and to conserve or protect at least 30 percent of our land and oceans by 2030"; and
- "develop a new partnership to build back better for the world, through a step change in our approach to investment for infrastructure, including through an initiative for clean and green growth. We are resolved to deepen our current partnership to a new deal with Africa, including by magnifying support from the International Monetary Fund for countries most in need to support our aim to reach a total global ambition of [USD] 100 billion".

Directionally, these actions are not a surprise, having been flagged for a while (see Low Carbon Pulses 14 to 18). The aim to provide up to USD 100 billion in funding is in the nature of a re-commitment. Reflecting a continuing theme, more needs to be done, and it is hoped that ahead of COP 26 in November greater momentum is achieved.

## India on the road

- ## India and UK:

  **Time for partnering:** It continues to be a theme of progress towards net-zero emissions that developed countries that have made progress towards achievement of *NZE* need to be doing more, and should be working with developing countries, in particular those with more pressing needs to achieve increased electrification. It is difficult to think of two countries that fit this description better than India and the UK.

**India and UK partnering:** On June 1, 2021 it was announced that India and the UK have enhanced their existing partnership to provide for cooperation in sharing thinking around policy settings, which in turn will respond to, and drive, technology development and investment as both countries progress to electrified and hydrogen economies. More broadly, and in the context of specific outcomes, the provision and sourcing of sustainable finance will be a key part of electrification and the development of a hydrogen economy, in particular clean energy and clean transport technologies and solutions, and the shift to green and to greened businesses.

This is consistent with the projected global growth in electrical energy needs (driving electrification) and transport needs (as passenger transport levels double, and freight transport more than doubles, by 2050). In India as above rail operations are electrified, and move to battery and fuel cell technologies, and the level of ownership of private vehicles increases, huge quantities of renewable electrical energy will be required, both to charge battery electric vehicles (***BEVs***) and to produce Green Hydrogen for fuel cell electrical vehicles (***FCEVs***) to power and to propel all modes of transport over time. As one of the developing countries most progressed to *NZE*, the UK is well-placed, some may say, perfectly placed, to partner with India for decades to come.

**Policy settings and commercial benefit:** The closer partnership between India and the UK is part of continued strategic thinking from leadership in both countries.

In India, the strategic objective has been established for some time: in November 2020, Indian Prime Minister, Mr Narendra Modi, contemplated a "comprehensive National Hydrogen Energy Mission". Editions 14 and 16 noted the continued progress towards this objective. A report from the Energy and Resource Institute anticipates that "by 2050, 80% of India's hydrogen will be produced by renewable electricity and electrolysis". In this context, utility scale solar photovoltaic will be key, but roof-top solar will have an increasing role in electrification. Please also see the IEA's report entitled *Unlocking the Economic Potential of Rooftop Solar PV in India*.

In the UK, in November 2020, UK Prime Minister, Mr Boris Johnson, announced the ten point plan for a Green Revolution. The ten point plan provides the headlines off-which hang a full suite of policy settings and financial funding and support initiatives in the UK. Of the ten points, Driving the Growth of Low Carbon Hydrogen, Accelerating the Shift to Zero Emission Vehicles, Investing in Carbon Capture, Usage and Storage, and Green Finance and Innovation, and the underlying policy settings, appear to provide immediate opportunities for partnering.

The UK policy settings continue: on June 5, 2021 was announced that entities bidding for UK government contracts, must be committed to *NZE*.

**See:** *Roadmap 2030 for India-UK future relations launched during India-UK Virtual Summit*

- ## Three-wheeling:

On June 4, 2021 it was announced Hydrogen in Motion (of Canada) and h2e Power Systems (a producer of mobility technology, including fuel cell technology) are partnering in the development of the first hydrogen powered and propelled three wheel vehicle. This builds on the existing partnership between Hydrogen in Motion and the Government of India (specifically, the Technology Development Board) to develop hydrogen three wheel vehicles, making use of a financial funding initiative to support development of both technology and vehicles.

The development of a three wheel vehicle powered and propelled by hydrogen makes perfect sense in the context of any country with densely populated urban centres: densely populated urban areas have demand potential, and provide a clear line of sight for the supply side to a concentrated demand side. For supply side to respond, government funding and support is likely to be required, including, possibly, to act as an intermediate buyer and supplier of hydrogen, and to act as a, or the, developer of hydrogen refuelling infrastructure (***HRI***) (which will have to be wide-spread and safe). In an environmental policy setting environment, the use of ***FCEVs*** address a trifecta - greenhouse gas emissions, air pollution and noise: three birds, one three wheeler.

**See:** *Hydrogen-Powered Three-Wheeler Under Development By H2E Power Systems*

- ## Carbon Pricing for India:

The International Monetary Fund (***IMF***) has stated that the a carbon price of USD 75 per tonne is required by 2030 to provide a suitably calibrated carbon price (as a cost) to ensure that that cost of carbon (as a negative externality) results in use of lower, low or no GHG emission technologies. In passing, it is noted that this level of carbon price was in the context of the Stabilisation Goal, rather than the Stretch Goal, and as such the carbon price needs to be higher to achieve the Stretch Goal. Also, in passing, it is noted that if trends in some markets for carbon credits to off-set against acquittal obligations or voluntary commitments continue current trajectories, the market may prove that the suggested *IMF* carbon price is on the low side.

As outlined in Edition 12 of Low Carbon Pulse (under ***Emissions Trading Schemes and Carbon Taxes*** *(each a* ***Carbon Price****)*), a carbon price is typically achieved through the use of a cap-and-trade emissions trading scheme (***ETS***) or a carbon tax or taxes to discourage the use of carbon intensive feedstocks and fuels, or both. While India does not have an *ETS* it does have a number of policy settings that price carbon in some contexts. The PRC, EU and UK all have *ETS*s, each of which provide clear policy settings to drive the adoption of lower, low and no carbon technologies. India has an opportunity to support its policy settings by a targeted *ETS* encouraging timely adoption of low and no carbon technologies.

## EU has wind in its policy setting sails:

- ## A carbon price without borders - carbon border tax taking shape:

Edition 12 of Low Carbon Pulse reported on the vote by the European Parliament to approve the imposition of a carbon border carbon tax as a new impost or tax on goods that are imported from jurisdictions that do not have a carbon price – the Carbon Border Adjustment Mechanism (***CBAM***). It is understood that the European Commission is to release details of the proposed *CBAM* on July 14, 2021.

Further, it is understood that thinking around the *CBAM* includes a three year phase in, starting in 2023, completed by 2026. It is likely that the *CBAM* will apply to cement, fertiliser, aluminium and iron and steel: more of a whack for some, than for others. The imposition of the *CBAM* on these difficult to decarbonise industries is consistent with the clear underlying policy setting – to impose a carbon price for goods sourced from countries that do not have a carbon price, and as such do not have a policy setting that is driving decarbonisation of those difficult to decarbonise industries. While some commentators complain about the extraterritorial effect of the *CBAM*, the logic of the policy is undeniable, as is the response: GHG emissions have extraterritorial effect.

The underlying commercial setting is clearer still: the production of these goods is carbon intensive, and as such not having a carbon price in the country of origin provides producers of these goods in each such country provides those producers with a unit cost advantage, and, likely, a price point advantage, over EU produced goods.

If the July 14, 2021 timeline is achieved, Edition 21 or Edition 22 of Low Carbon Pulse will cover the form and substance of the *CBAM* in detail, and assess its likely implications.

- ## A carbon price that crosses borders:

In September 2020, the European Parliament voted to include vessels of more than 5,000 gross tonnes in the EU *ETS* by 1 January 2022. The inclusion of vessels in the EU *ETS* is part of broader debate about how best to decarbonise the international shipping industry.

It has been widely reported that the Government of Japan has formally indicated its opposition to the extension of the EU *ETS* to international shipping, noting that the International Maritime Organisation (***IMO***) is best placed to develop measures to be applied to the international shipping industry at a global level, and that inclusion on international shipping vessels in the EU *ETS* may hinder progress.

Both the EU and Japan have had the benefit of reflecting on the *IMO* measures agreed in late 2020. It is fair to say that the measures agreed by the IMO were regarded by a number countries as achievable, but not ambitious (enough), and, to some countries, were disappointing.

- ## Time for a global carbon price on international shipping?

Depending on the source of information, global shipping is stated to give rise to between 1.7% and 3% of total global GHG emissions. This percentage is predicted to increase, principally as a function of increased world trade and a reduction in GHG emissions arising from the decarbonisation of other sectors and industries. Currently there is no global carbon price on international shipping, rather there is a patch-work of *ETS*s and carbon taxes globally, and as a result participants are affected differently.

From a policy setting perspective, a global carbon tax would appear the soundest approach to driving decarbonisation of the international shipping industry: as is the case with any carbon tax, it should be introduced overtime to allow the industry to prepare and so as to align and to accelerate with the technological development that is required to shift to lower, low and no carbon technologies, critically, fuels.

## Heavy weights on Hydrogen:

The unit cost of hydrogen (production, transportation and delivery to the point of use) may be a heavy weight slowing the development of the market for the lightest element. At the launch of the Hydrogen Act (see Edition 14 of Low Carbon Pulse) the secretary general of Hydrogen Europe (since 2016), Mr Jorgo Chatzimarkis added sparkle to the mix of thinking: "We need capital and operating expenditure ... to bring the price of renewable hydrogen from [the price of] champagne, to [that of] prosecco, and later table water". Some may say "tap water", noting that bottled water brought to table costs more per litre than motor spirit in many parts of the world.

The EU and its Member States are leading the world in providing funding and support for hydrogen projects, but it is likely that more is going to be needed, and there may need to be relaxation of state-aid rules (see Edition 18 of Low Carbon Pulse), and to make as many large-scale projects as possible Important Projects of Common Interest (***IPCEI***). It is difficult to counter the view that any large-scale hydrogen project is worthy of *IPCEI* status.

On June 11, 2021, EU Energy Ministers agreed to prolong EU support for some natural gas projects. This decision is part of wider policy setting debate and formulation, in particular the basis to classify any energy project as a project of common interest: in December 2020, the European Commission proposed rules to exclude natural gas and oil infrastructure.

## Sinopec plans to produce 500,000 tonnes of Green Hydrogen by 2025:

- **From Grey to Green:** Edition 5 of Low Carbon Pulse outlined the position of Sinopec as a producer of hydrogen using traditional technologies, producing over 3 mpta of hydrogen. Edition 18 of Low Carbon Pulse outlined the development by Sinopec of its first Green Hydrogen facility in Ordos, Inner Mongolia, which is to start producing Green Hydrogen by the end of 2022.

  While Sinopec is the world's largest refiner of petroleum products, it has recognised for some time that there is a need to shift to low and no carbon, including to align with achieving peak GHG emissions by 2030, and net-zero GHG emissions by 2060. Sinopec is not alone among Chinese companies in responding to this imperative.

- **From production to distribution:** Chinese state owned enterprise, Sinopec, has been focused on its strategic shift to Green Hydrogen, and its wholly-owned subsidiary, Sinopec Star Co,. Ltd (***Sinopec Star***), is working towards the achievement of this shift. It is planned that *Sinopec Star* will develop projects to produce 500,000 tpa of Green Hydrogen by the end of 2025.

  In the context of developing supply and demand in tandem, at the same time as Sinopec is developing its Green Hydrogen production capacity, through *Sinopec Star*, it is developing hydrogen refuelling infrastructure and stations (***HRI/Ss***). It is reported that Sinopec is working with Air Liquide in the roll-out of *HRI/Ss*.

## Competitiveness of Green Hydrogen assessed:

- **The Lucky Country:** A number of editions of Low Carbon Pulse have noted the advantages that certain countries and regions enjoy, and that will allow them to produce Green Hydrogen. One of those countries is Australia. Australia has world class on-shore solar and wind resources (as well as yet to be developed off-shore wind resources).
- **Build and Green:** The Chief Executive Officer of the Australian Renewable Energy Agency (***ARENA***), Mr Darren Miller, has expressed the view for some time that Australia has the renewable resources to become a global green energy giant. In this context, Mr Miller has expressed the view that Australia should develop its renewable energy capacity, first, to displace non-renewable electrical energy (current demand for electrical energy in Australia is less than 250 TWh annually), secondly, to produce Green Hydrogen to displace fossil fuels as energy carriers, and thirdly, to accelerate the production of Green Hydrogen for export as export markets develop.
- **The cost of Green Hydrogen:** The key to becoming a global green energy giant is the continued development of renewable electrical energy capacity, and achieving a cost of production of Green Hydrogen that is competitive with the energy carriers with which it will compete. While electrical energy produced from solar photovoltaic and from wind sources is now the lowest cost electrical energy in Australia (see a recent report by CSIRO and Australian Energy Market Operator (***AEMO***)), it is considered that the cost needs to fall further to allow acceleration of production to take place as export markets develop.
- **When might Green Hydrogen become cost competitive:** In late May 2021, the Commonwealth Government of Australia, Advisian and the Clean Energy Finance Corporation (***CEFC***), released a report entitled *Australian hydrogen market study – Sector analysis study* (***SAS***).

  Commissioned by the *CEFC*, the *SAS* is intended to provide "an appraisal of the economic gap between hydrogen supply and capacity to pay for each of the nominated demand sectors, both now and out to 2050".

  A number of key themes arise from the *SAS* as follows:

  - the key drivers for competitive Green Hydrogen costs include electrolyser capital cost trends, renewable energy costs and installation and operational efficiencies for electrolyser equipment;
  - the competitiveness of Green Hydrogen may accelerate as a result of broader market factors, such as the levelized costs of hydrogen being lower than forecast, fossil fuel prices being higher than forecast and the willingness of energy users to pay a premium for a clean energy alternative to fossil fuels;
  - in all sectors, low carbon hydrogen is expected to become more competitive towards 2050, due to parallel advances in production and distribution cost efficiency and end-use technology evolution;
  - in the near term, sectors that are at, or are approaching, commercialisation are line-haul vehicles, material handing and return to base vehicles (including buses), and remote power, with the expectation that mining vehicles will be commercialised towards 2030; and
  - by 2050, sectors in which hydrogen will be commercially viable are likely to include ferries, heavy rail haul, and light-haul vehicles, and natural gas networks (commercial and residential).

  *SAS* notes that clarification of "origin certification" expectations should be progressed as soon as possible.

  The Ashurst Global Towards Net-Zero Emissions team did not cover the *SAS* in Edition 18 because it contained a summary of key themes arising from the International Energy Agency (***IEA***) report, *Net Zero by 2050: A Roadmap for the Global Energy Sector (**IEA Roadmap**)*. It is fair to say that the *SAS* and the *IEA Roadmap* are both helpful, critically, it would appear that the consensus is that both appear to be based on sound modelling.

## Mission Innovation – a window to innovation opened wider:

**Mission Possible:** Mission Innovation (***MI***) was announced at COP 21 by Mr Bill Gates. *MI* was established to provide a structure for the public and private sectors to come together to accelerate clean energy innovation to address climate change. Currently, *MI* has 25 members, including the EU. *MI* links to the private sector through the Breakthrough Energy Coalition, a group of private sector investors, of whom one is Mr Gates.

The *MI* identified eight innovation challenges, one of which (**IC8**) is "Renewable and clean hydrogen". Members of *MI* reaffirmed their commitment with a second phase of *MI*, **Mission Innovation 2.0** (***MI 2.0***).

On June 2, 2021, in Santiago, Chile, *MI 2.0* launched a decade of clean energy innovation to accelerate achieving the Paris Agreement Goals, including "To increase the cost-competitiveness of clean hydrogen by reducing end-to-end costs to USD 2 per kg by 2030", i.e., the cost delivered to bowser, not the cost of production.

**In the world of hydrogen, cooperation is key:** As part of *MI 2.0*, on June 2, 2021, the Zero-Emission Shipping Mission (***ZESM***) was outlined. The *ZESM* is intended to accelerate international public-private collaboration to scale-up and to deploy new green maritime solutions. The Governments of Denmark, Norway and the US are to lead the *ZESM*, working with the Global Maritime Forum, and the Maersk McKinney Moller Center for Zero Carbon Shipping (see Edition 16 of Low Carbon Pulse).

The roles of Denmark, Norway and the US are key, both as shipping nations, and as countries that offer fertile ground for technological innovation. US Secretary of Energy, Ms Jennifer Granholm stated: "*Through fearless technological innovation, ambitious clean energy deployments, and constructive international collaboration, we can build a net-zero carbon economy …*".

**Goals of ZESM:** The *ZESM* has three principal goals:

1. to develop, demonstrate and deploy zero-emission fuels, ships and fuel infrastructure in a coordinated fashion along the full value chain;

2. by 2030, to have developed ships capable of running on hydrogen-based fuels (being zero-emission fuels) – such has green hydrogen, green ammonia, green methanol, and advanced biofuels – that make up at least 5% of the global deep-sea fleet, measured by fuel consumption; and
3. by 2030, to have at least 200 of these "well-to-wake" zero-emission fuelled ships in service and utilizing these fuels across their main deep-sea shipping routes.

**Global Maritime Forum:** Managing Director of Global Maritime Forum, Ms Johannah Christensen (noting that the role of the Global Maritime Forum is key to the *ZESM*) said:

> "*Shipping is on the verge of a clean energy revolution. To set the global maritime industry on a climate-aligned course and meet the goals of the Paris Agreement, zero-emission vessels need to be the dominant and competitive choice by the end of the [current] decade. The Zero Emission Shipping Mission will accelerate public and private efforts around the world to make a zero-emissions fleet a reality by 2030*".

**Global Hydrogen Ports Coalition launched:** Finally, also on June 2, 2021, at the *Innovating to Net Zero Summit* in Santiago, Chile, the Global Hydrogen Ports Coalition was launched. An industry, headed to hydrogen based fuels.

## US, AUS and Indonesia ranges of scenarios to net-zero emissions (*NZE*):

- **Scenario nous State-side:** While it is increasingly difficult to find a fold-out paper roadmap, and nearly impossible to buy an A to Z, there is no shortage of satellite navigation products and there is no shortage of *NZE* roadmaps. One *NZE* roadmap worth navigating cyber-space for is the Princeton University, *Net Zero America Report* (***NZEA***).

  The *NZEA* provides five scenarios that may result in to *NZE* (some may call them pathways to), and the costs and benefits of each of them. The *NZEA* provides a helpful representation, in map form, of the current renewable electrical energy "footprint today", and the "footprint needed by 2050".

- **Scenario nous lands down-under:** In addition to attracting broad attention within the US, the *NZEA* has attracted attention around the world, including in Australia.

  On June 4, 2021, it was reported that Net Zero Australia (***NZAu***), a collaborative partnership among the University of Melbourne, the University of Queensland and Princeton University, and management consultancy Nous Group, is to use the nous learned from the development of *NZEA* to develop a similar "scenario set" for Australia. It is reported that *NZAu* is to continue work until 2023, and will issue interim findings along the way, with the purpose to present costs and benefits of each scenario considered by it.

  *NZau* is sponsored by APA Group, Dow, Future Energy Exports Cooperative Research Centre, Minderoo Foundation (settled by Forest Family interests), and Worley Parsons.

- **Scenario for *NZE* for Indonesia by 2050:** In previous editions of Low Carbon Pulse, it has been noted that Indonesia is considering committing to *NZE* by 2070. On May 31, 2021, a report (*Deep Decarbonization of Indonesia's Energy System* by 2050) was published by the Institute for Essential Services Reform (Jakarta), Agora Energiewende (Germany) and Lappeenranta-Lahti University of Technology or *LUT* (Finland). The headline from the report is that to achieve *NZE* by 2050, Indonesia will have to develop 1.49 TW (or 1,490 GW) of renewable energy capacity, 80% of that renewable electrical energy being solar photovoltaic.

## US roadmap taking shape …

## • may go via nuclear power stations …

In June 2 2021, two titans of the corporate world, Mr Bill Gates, and Mr Warren Buffet announced the development of the first Natrium (a small advanced modular reactor) (***NSMAR***) on the site of a coal-fired power station in Wyoming. TerraPower (founded by Mr Gates) and PacifiCorp (owned by Mr Buffet's investment vehicle, Berkshire Hathaway) are to co-develop *NSMAR*. *NSMAR* is a 345 MW nuclear power station that will use uranium as its fuel, and, *NSMAR*, as a salt-cooled fast reactor, will use molten salt-based energy storage.

**See:** *Bill Gates' next generation nuclear reactor to be built in Wyoming*

## • … and within earshot will definitely include hydrogen of many colours:

**The hydrogen ear-shot:** On June 6, 2021, US Department of Energy Secretary, Ms Jennifer Granholm outlined the objectives of the US to achieve low cost Green Hydrogen – a reduction of 80% in the cost of Green Hydrogen by 2030 (***80 by 30***).

At the Leaders' Summit in April 2021 Secretary Granholm said of achieving *NZE* that: "*This is our generation's moon shot*". This resonated (see Edition 15 of Low Carbon Pulse).

Oddly to some within ear-shot, Secretary Granholm provided "an ear-shot". To some, the adoption of a more contemporary allusion to a shot may have resonated with an existential imperative – it was not to be. Secretary Granholm has coined the term "ear-shot" for each significant Biden Administration energy policy setting aimed to achieve progress to *NZE*. The hydrogen ear-shot, is aimed at reducing the cost of 1 kg of Green Hydrogen to USD 1.00 by 2030, recognising the need for the deployment of people to achieve and to support this outcome.

**Clean Hydrogen:** As is often the case, the phrase Green Hydrogen has been bandied around in some headlines accompanying the hydrogen ear-shot.

As described by Secretary Granholm, the hydrogen ear-shot is about the use of:

1. renewable electrical energy (being Green Hydrogen if water is electrolysed using that renewable energy);
2. nuclear power (being Pink Hydrogen if nuclear power is used, and Purple Hydrogen if steam from nuclear power generation is used, to produce hydrogen using electrolysis); and
3. thermal conversion (Blue Hydrogen if CCS / CCUS is used, and Turquoise Hydrogen if pyrolysis technology is used, and carbon is captured as carbon black).

All of these technologies produce renewable hydrogen and most of them will produce clean hydrogen as described by Secretary Granholm:

> "*The hydrogen [ear-] shot set[s] an ambitious yet achievable cost target to accelerate innovations and spur demand [for] clean hydrogen. Clean hydrogen is a game changer. … It will help decarbonise high-polluting heavy-duty and industrial sectors, while delivering good-paying jobs and realising a net-zero economy by 2050*".

This is a positive policy target, which it is hoped will be developed further in the next short-while, critically, by the provision of guide-rails and policy settings to allow demand and supply to develop in tandem.

## BESS round-up:

- **Best thinking on BESS:** In a report (*Economic Potential of Diurnal Storage in the US Power Sector*) from the Storage Futures Study (***SFS***) from the National Renewable Energy Laboratory (***NREL***) the scale of the potential for utility-scale diurnal state is outlined. (The *NREL* is a valuable service of research.)

  As noted in Edition 13 of Low Carbon Pulse, factors that inform the location of, and size of, Battery Electric Storage Systems (***BESSs***), include the energy density per square kilometre: in this context, a long-range *BESS* (i.e., being a *BESS* having capacity to supply electrical energy for over 6 hours), is likely to be used less in areas of high or higher energy density.

  The *SFS* adds to the thinking on *BESS*s, this time on diurnal *BESS*s (i.e., being a BESS having capacity to supply electrical energy for up to 12 hours) finding that *BESS*s add most value to the grid, and deployment increases, when the overall conditions allow the provision of multiple services to the grid, and there is greater solar photovoltaic installed capacity proximate to that part of the grid. The lead author of *SFS*, Mr Will Frazier, noted that: "*To realize cost-optimal storage deployment, the power will need to allow storage to provide capacity and energy time-shifting services*."

  **See:** *Grid-Scale U.S. Energy Storage Capacity Could Grow Five-Fold By 2050*

- **Best current outcomes with *BESS*:** A previous Ashurst publication outlined the Alamitos Battery Energy Storage System. The backstory to the *Alamitos BESS* is probably less well-known, and the story is resonating globally in different jurisdictions and for different reasons: the *Alamitos BESS* is part of a combined choice of *BESS* and combined cycle gas turbine (***CCGT***) as part of a strategy that has resulted in lower demand for gas-fired electrical energy capacity on the shuttering of the San Ofre nuclear power plant. A continuing theme in decarbonization and energy transition is that the combination of technologies that is regarded as the best near to medium term outcome, may not be the ultimate net-zero GHG emission outcome.

  **See:** *Battery storage as peaking capacity: How Alamitos changed the game for California*

- ***BESS*s go archipelago:** On June 11, 2021, it was widely reported that Greece and the Maldives are moving to procure *BESS*s across their island archipelagos. While the procurements are of differing scales, 700 MW (extent of storage to be confirmed) for Greece, and 40 MW (of 40 MWh) for the Maldives, the logic for their procurement and deployment is the same, progress towards the displacement of fossil fuel capacity.

Edition 20 or Edition 21 of Low Carbon Pulse will provide background on compressed air storage (***CAS***), another mooted means of energy storage that is being explored in some jurisdictions.

## BECCS round-up

**Bioenergy's role in *NZE*:** As part of extending the coverage of Low Carbon Pulse, a greater number of news items will be included to cover the role of bioenergy in progress towards net-zero.

**BECCS role in *NZE*:** As many readers will know, bioenergy is not clean unless carbon is captured and stored. With the projected increase in the use of agricultural and forestry waste, and increased use of waste and waste water (see **H24I – Hydrogen from Waste**), Bioenergy with Carbon Capture and Storage (***BECCS***) will be key.

***BECCS* in practice:**

- **Better outcomes with *BECCS*:** On June 7, 2021 Bechtel (leading EPC solution contractor, with particular expertise on CCS / CCUS) and Drax (among other things, owner of the electrical energy assets in the UK, and the US, including bioenergy), announced a strategic agreement to create *BECCS* plants around the world.

  The announcement of this strategic agreement may be regarded as entirely consistent with Drax's conversion of its coal-fired power station in Selby, North Yorkshire, England (the UK's largest power station) (***SPS***) in to what has been described as the largest decarbonisation project in Europe.

- **Great outcome with MHI:** On June 10, 2021, it was announced that Drax and Mitsubishi Heavy Industries (***MHI***) had entered into a long-term agreement under which Drax is to use (under licence) *MHI* technology to capture carbon at *SPS*.

By the use of *BECCS*, Drax anticipates that it the *SPS* will be carbon negative by 2030: capturing and storing around 8 mpta of $CO_2$.

(The Ashurst Global Towards Net-Zero Emissions team includes practitioners who act on bioenergy (including bagasse and other biomass), waste, waste water projects globally. Some of those team members have also worked on carbon capture in the context of liquified natural gas projects and carbon neutral LNG cargoes.)

## CCS / CCUS round-up:

- **Longship stretching stroke and Northern Lights starting to dazzle:** Edition 2 of Low Carbon Pulse outlined the Longship Project: the Longship Project includes the Equinor, Shell and TOTALenergies Northern Lights Project to capture $CO_2$ from industrial sources (cement and waste to energy), transported by $CO_2$ carrier to the Oygarden Facility (with Equinor procuring the development of the Oygarden Facility), and then piped 100 kms for injection 2.6 km below the seabed of the North Sea.

Ahead of the completion of the Northern Lights Project, the Project is being expanded, with the development of further sub-surface storage fields, with plans to drill for a new off-shore injection well in 2022.

**See:** Northern Lights website

- **Pointed three pronged plan from Neptune Energy:** For some time, it has been apparent that Neptune Energy has been working-up a plan to use its three depleted gas fields, the L10-A, L10-B and L10-E areas, in the Dutch sector of the North Sea, for a carbon capture and storage project. Neptune Energy has recently announced that it is undertaking a feasibility study in respect of the L10 area.

  **See:** *L10 Area CCS development, Dutch North Sea*

  **Carbon capture, *use / utilisation* and storage**: News items on CCS and CCUS tend to focus on *carbon capture and storage*, rather than the *use / utilisation* of the carbon-dioxide captured. What are the possible uses? And will products produced from CCS / CCUS be saleable? The current uses of $CO_2$ include the production of dry ice and carbonating drinks, and for medical procedures. Also $CO_2$ can be used to produce plastics (including containers for use to store foods, and in furniture), concrete and e-fuels / future fuels.

  If $CO_2$ is used as a feedstock / raw material to create a product, on the production of that product the $CO_2$ is stable, and does not give rise to GHG emissions unless that product is oxidized. In the third article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series, all uses of $CO_2$ will be considered, including to produce e-fuels / future fuels.

- **Carbon neutral cement plant – Slite of hand:** On June 2, 2021, Heidelberg Cement Group (***HCG***) announced the development of the world's first carbon-neutral cement plant: this is reported to involve the augmentation and upgrade of *HCG*'s existing cement production facility at Slite, Gotland Island, Sweden. The plant produces 1.8 mtpa of $CO_2$. From 2030 these $CO_2$ emissions will be captured and stored. It is understood that the Slite project will benefit from the use of CCS technology by *HCG* at Brevik, Norway.

  For detail about cement production and the GHG emissions arising please see *The Shift to Hydrogen (S2H2): Elemental Change – What Needs to be Decarbonised?* And what role can hydrogen play?

  **See:** *HeidelbergCement to build the world's first carbon-neutral cement plant*

- **Increasing $CO_2$ levels need to be matched by ever increasing $CO_2$ capture:** On June 7, 2021 it was widely reported that in May 2021 the level of $CO_2$ in the atmosphere reached the highest level (419 ppm) since measurement began in the late 1950's at the US National Oceanic and Atmospheric Administration's Mauna Loa weather station, Hawaii, and is at the highest level in over 4.5 million years.

  While the rate of investment in CCS / CCUS projects appears to be increasing, the development of CCS / CCUS needs to accelerate. In the third article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series, all forms of CCS / CCUS will be considered, as will the scale of CCS / CCUS required to be developed.

- **Gulf Coast keeps giving:** On June 8, 2021, it was widely reported that Storegga Geotechnologies and Talos Energy had entered into a joint venture to evaluate and to develop carbon capture and storage opportunities along the US Gulf Coast and in the Gulf of Mexico. The most prospective areas are along the Gulf Coast, critically, the coasts of the four States of Alabama, Louisiana, Mississippi and Texas. As has been noted in a number of editions of Low Carbon Pulse, Storegga is very much a leader in CCS / CCUS.

## E-fuel / Future fuel round-up:

- **A great start to June:** On June 1, 2021, it was announced that Shell had awarded Worley Parsons (a leading engineering corporation) a contract in respect of the development of a 200 MW electrolyser as part of the development of a Green Hydrogen production facility (***GHPF***) to be located in Rotterdam, the Netherlands. From 2023, the *GHPF* will produce an estimated 50,000 to 60,000 kgs (or 50 to 60 tonnes) a day of Green Hydrogen. The Green Hydrogen will be used to decarbonise activities at Shell's Pernis Refinery, and it is anticipated that it will provide fuel for heavy transportation activities.

  **See:** *Shell awards Worley contract to help create a green hydrogen factory in the Netherlands*

- **Haldor Topsoe – mobilising the Green Giant:** On June 2, 2021, Haldor Topsoe announced the establishment of a Green Hydrogen business that will enable it to accelerate all aspects of its Green Hydrogen business: for example, Edition 11 of Low Carbon Pulse reported on the development of a solid-oxide electrolyser cell (***SOEC***) technology by Haldor Topose with a reported efficiency of 90% and Edition 18 reported on the development of the 500 MW and up to 5 GW Gigafactory (one of four Giga-factories announced in 2021) to produce those *SOEC*s. Haldor Topsoe is expected to continue its run of successful involvement in Green Hydrogen projects.

  **See:** *Haldor Topsoe establishes focused green hydrogen organization to accelerate electrolysis business*

- **World's largest hydrogen off-take agreement signed:** On June 4, 2021, it was announced that SGH2 Energy had signed an agreement under which it is to supply 3,850 tonnes of hydrogen a year, for 10 years, to refuelling stations. The hydrogen will be produced at SGH2 Energy's planned bioenergy (biogenic from biomass) facility located in the City of Lancaster, north of Los Angeles, California: the facility is to be developed as a public private partnership (between SGH2 Energy and the City of Lancaster), and will use gasification technology, and, what appears to be, enhanced plasma technology. Completion of the facility is scheduled for mid-2023.

  The hydrogen produced from the facility will be compressed, and transported using tube-tanker trailers. It is estimated that every 24 hours 11 tanker trailers will deliver compressed hydrogen to hydrogen refuelling stations across Southern California.

  Previous editions of Low Carbon Pulse have outlined the use of waste (and wastewater) to produce hydrogen in an urban setting. The first feature in the *Hydrogen for Industry* series is devoted to hydrogen to waste, including explaining the technologies that may be used, and the chemistry of each. The SGH2 Energy project may be regarded as being at the vanguard of increased use of bioenergy as a feedstock for renewable hydrogen.

(It has been reported that the hydrogen is to be characterised as "carbon-negative" because the use of waste as feedstock avoids the landfilling of that waste, and the release of $CH_4$: this is not an unknown analysis, but in the context of decarbonisation policy settings, a clearer analysis would be the mass of GHG produced on production of the hydrogen, rather than the mass of GHG avoided by not using landfill.)

**See:** *World's largest 'green hydrogen' offtake deal signed in California by waste-to-H2 start-up*

- **Japan Inc to recycle $CO_2$:** A continuing theme noted in Low Carbon Pulse has been the consistent and fruitful engagement between the Government of Japan and Japanese corporations (***Japan Inc***). In early June 2021, it was reported widely that the Government of Japan is to lead a public-private initiative to use $CO_2$ as a feedstock from which to produce low to no GHG emission fuel by 2050: the base technology involves methanation - the use of $CO_2$ to produce $CH_4$. As noted above, in the third article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series, all uses of $CO_2$ will be considered, including to produce e-fuels / future fuel.

  The Ministry of Economy, Trade and Industry (***METI***) is to establish a council to involve the private sector in this "hydrogen economy building initiative". It is understood that the council will comprise representatives from Tokyo Gas, Tokyo Electric Power Co., JFE Steel and Nippon Steel (noting that steel companies produce $CO_2$ and can use $CH_4$ produced from $CO_2$), Mitsubishi Corporation, Denso (auto-parts manufacturer and supplier), and Nippon Yusen, and the Development Bank of Japan. Nineteen corporations from the private sector have been identified as being critical to this initiative.

  **See:** *Japan Inc enlisted to help convert carbon dioxide into methane*

- **Yara and Trafigura to navigate in tandem:** As noted in a number of editions of Low Carbon Pulse, and each of its sister publications, the development of supply and demand in tandem is critical to the development of the market for hydrogen and for ammonia. In early June, Yara announced its collaboration with Trafigura to work together to achieve the transition to the hydrogen economy.

  **See:** *Trafigura and Yara Sign Memorandum of Understanding to Explore Opportunities for Joint Business in Clean Ammonia*

- **Green fields for Greenfield Green Hydrogen in Queensland:**
  - **Fields of Green:** On June 8, 2021 it was widely reported that the Queensland Government (one of the early moving and forward looking Australian's States) had agreed to the location of a 3 GW Green Hydrogen facility (***Gladstone 3G*** or ***G3G***) within the Gladstone State Development Area (***GSDA***): Stanwell Corporation (a Queensland state owned corporation) has an option in respect of the land on which *G3G* may be located.

    *G3G* is an export scale facility, reflecting the joint venture between Iwatani Corporation (a first moving and forward thinking Japanese corporation) and Stanwell Corporation. The Port of Gladstone (from which coal, alumina, aluminium, bauxite, cement, and liquid ammonia are currently exported), would provide an ideal port for the liquefaction of hydrogen, and its export.
  - **Green Grid:** Given the scale of *G3G*, given current electrolyser technologies, between 5 and 6 GW of renewable energy capacity will be required. It is expected that renewable electrical energy will be sourced from the proposed Central Queensland Renewable Energy Hub, at least in part.
  - **Key to avoid grid-lock:** The support of government is key to the development of Green Hydrogen facilities, particularly on this scale. The Government of Queensland appears intent on positioning the State of Queensland as a key jurisdiction for the production of Green Hydrogen for export.
  - **Green for Greening:** On June 10, 2021, the Queensland Government announced that it will establish a USD 1.7 billion clean energy fund "to supercharge" the continued development of the State's renewable energy industry and broader policy objective to green all sectors.
- **Canada continues to increase $H_2$ PC:** On June 9, 2021, the Government of Canada and the Province of Alberta announced plans to work with Air Products (one of the world's leading industrial gases companies) to develop a USD 1.3 billion net-zero hydrogen production and liquefaction facility in Edmonton, planned to be operational by 2024. Canada continues to develop steadily its hydrogen production capacity. This project continues the progress of Canada as a leading hydrogen and hydrogen fuel based producer.

  **See:** *Air Products Announces Multi-Billion Dollar Net-Zero Hydrogen Energy Complex in Edmonton, Alberta, Canada*

- **Plug Power continues to plug and play:** A number of editions of Low Carbon Pulse have mentioned Plug Power, as it continues as an integrated provider of hydrogen solutions globally. On June 10, 2021, it was announced that Plug Power plans to develop a Green Hydrogen production facility in Camden Country, Georgia, US. The Green Hydrogen production facility will produce 15 tonnes of liquefied hydrogen a day to be sold for use by the transport sector. Plug Power continues to lead the way in developing merchant Green Hydrogen facilities.

  **See:** *Plug Power unveils plans for a liquid green hydrogen plant in Camden County, Georgia; one step closer to producing over 500 tonnes of hydrogen daily*

In Edition 20 or Edition 21 of Low Carbon Pulse, the prospective role of Gulf Cooperation Council (***GCC***) countries in the production of Green Hydrogen will be considered.

## Green Metals:

- In late May 2021, six of the leading lenders to the steel industry, Citi, Goldman Sachs, ING, Société Générale, Standard Chartered, and Unicredit, established the Steel Climate-Aligned Finance Working Group (***SCAFWG***) to focus on, and to provide direction towards the decarbonisation of the steel industry.

  Among other things, the *SCAFWG* will develop a financing agreement aligned to the Paris Agreement. As might be expected, a number of initiatives are contemplated to decarbonise the steel industry, critically, electrification, energy storage, future fuels, and CCS / CCUS.

As the financing agreement develops, future editions of Low Carbon Pulse will cover those developments. It is anticipated that the Poseidon Principles (in place for the financing of the maritime shipping industry), will guide the development of the financing agreement.

- **Blueing of the Russian steel industry:** On June 4, 2021, it was reported that Novatek and PAO Severstal have signed a memorandum of understanding to develop a pilot project for the production, and supply, of Blue Hydrogen. The Blue Hydrogen can be used as a standalone high temperature fuel or it can be blended with natural gas. In due course, it is intended that the use Blue Hydrogen will displace the use natural gas.

  **See:** *NOVATEK Signed Cooperation Agreement with Leningrad Region; Severstal and NOVATEK to partner on hydrogen and alternative energy*

## Hydrogen Cities, Councils, Hubs, Infrastructure and Valleys:

Previous editions of Low Carbon Pulse have outlined the development Hydrogen Hubs, Infrastructure and Valleys. In future editions of Low Carbon Pulse, Hydrogen City, Council, Hub, Infrastructure and Valley news items will be clustered under one heading:

- **Eastern Germany mapping**: On June 1, 2021, Gascade Gastransport GmbH (a leading high-pressure gas transmission grid operator) and Ontras Gastransport GmbH (Germany's second largest gas transmission system operator) announced plans to develop a new hydrogen-hub for eastern Germany, with the hub to include a 475 km hydrogen pipeline network (***HPP***) converted from natural gas. It is anticipated that the *HPP* will be completed by 2026, and on completion will connect to Mecklenburg-Western Pomerania, Brandenburg, Saxony, Saxony-Anhalt and Berlin.

  **See:** *GASCADE and ONTRAS to Launch Hydrogen Hub for Eastern Germany* and *Gascade, Ontras to establish hydrogen hub for Eastern Germany with 475km pipeline grid*

- **Italy continues infrastructure development:** On June 2, 2021, it was confirmed that a 440 km pipeline forming part of Snam's high-pressure gas transmission and distribution network in Italy is to be certified to transport 100% of its capacity as hydrogen gas. In May 2021, Snam achieved a world first - testing a 30% hydrogen, 70% natural gas, blended gas mix.

  **See:** *Corinth Pipeworks delivers first hydrogen-certified pipeline project for Snam's high pressure gas network in Italy*

- **Great Plains take-off:** June 2, 2021, Bakken Energy and Mitsubishi Power Americas, Inc., announced that they had signed a strategic partnership agreement to create a clean hydrogen hub in North Dakota, US (***CHH***). The *CHH* is to comprise clean hydrogen production, storage, and transportation facilities, to deliver clean hydrogen to the point of use. The intention of Bakken Energy is to produce Blue Hydrogen from natural gas, so as to become, in the words of Bakken Energy CEO, Mr Mike Hopkins: "*the largest and lowest cost producer of clean hydrogen in the United States*".

  Mitsubishi has been active in the development of hydrogen hubs in the US, with the Californian Project (City of Los Angeles), Magnum Development in Utah, and the Texas Brine project.

  **See:** *Mitsubishi, Bakken Energy aim to develop blue hydrogen hub in North Dakota*

- **City for a new Future:**Edition 17 of Low Carbon Pulse reported on the Woven City – City of the Future (to be at the base of Mount Fiji, Shizuoka Prefecture, Japan).

  On June 4, 2021, Toyota Motor Company announced plans to model a city for a new future. The "city for a new future" is planned by reference to a city of 300,000 people located within the Fukushima Prefecture. Effectively the work being done by Toyota, and its partners, including Hino and Isuzu, is to develop a model for a city that is to use hydrogen, including to model the delivery of goods within the city.

  **See:** *Fukushima Prefecture and Toyota Begin Discussions Aimed at Building a Hydrogen-based City of the Future in Fukushima Prefecture*

- **Mission Innovation on Hydrogen Valleys**: On June 2, 2021 *MI 2.0* (though its Hydrogen Valley Platform) released a paper detailing the emerging use and benefit of hydrogen valleys.

- **Korean Hydrogen Council:** On June 10, 2021, Hyundai, Hyosung, and POSCO announced the launch of an industry wide body - the Korean Hydrogen Council. The Council will be launched officially in September 2021 as the K-Hydrogen Council. The Chair of Hyundai Motor Group, Mr Chung Euisun, stated that the goal of the K-Hydrogen Council is "*to foster the widespread use of clean energy across industries and advance a hydrogen-based society*". As was the case with the Japanese Hydrogen Association (see Editions 2 and 5 of Low Carbon Pulse for outline of JH2A), Low Carbon Pulse will report on K-Hydrogen Council on its official launch.

- **HyNet North West's net worth:** On June 11, 2021, it was widely reported that consultation has begun across the North West of England and North Wales in respect of the development of infrastructure necessary to proceed with the carbon capture and storage project in Liverpool Bay, using depleted natural gas fields operated by Eni UK Ltd. A key part of the necessary infrastructure development is the construction of a new $CO_2$ pipeline that will connect to an existing natural gas pipeline that is to be repurposed.

  **See:** *Consultation begins on huge carbon capture scheme that would see 20 mile long pipeline built through Deeside*

## Off-shore wind to steel:

- **Ørsted forges relationship with POSCO**: In late May 2021, it was announced that global renewable giant, Ørsted, plans to develop 1.6 GW of off-shore wind field projects off Incheon, South Korea, to the west of Seoul, in the West Sea (or Yellow Sea). South Korean steel giant, POSCO has announced that it "will support the development" by Ørsted, as part of a broader strategic objective of "*working to discover renewable hydrogen business opportunities*."

The plans are reflected in a memorandum of understanding (***MOU***). The *MOU* builds on the strong existing relationship between these leading corporations. POSCO is no stranger to innovation, including the own-use import of LNG in the mid-2000's, and in March 2021 teaming with Origin Energy for the supply Green Hydrogen, likely to be sourced from the proposed project in Townsville, Queensland.

**See:** *Ørsted and POSCO sign MoU to strengthen collaboration on offshore wind and renewable hydrogen in Korea*

- **Ørsted ringing the bell on the off-shore homestead:** Ørsted has been leading the way in the development of renewable energy, with 12 GW of renewable energy capacity installed. In a series of announcements during the first week of June 2021, Ørsted outlined its plans to accelerate the development of its business to 50 GW of installed renewable energy capacity by 2030.

  In outlining these plans, Ørsted has made use of the phrase "green energy major". Ørsted Chief Executive Officer and Group President, Mr Mads Nipper, said: "*Our aspiration is to become the world's leading green energy major by 2030 … it's our clear aspiration to remain the global market leader in offshore wind*".

  **See:** *Ørsted aims for net-positive biodiversity impact from new projects commissioned from 2030; Mads Nipper – What would the world miss if your company did not exist?*

## Sustainable Energy Round-up:

- **Germany continues apace:** On June 2, 2021, it was reported that Germany is to accelerate the development of solar and wind renewable electrical energy. Reuters reported that a new draft law contemplates the expansion of planned onshore solar to 150 GW (from 100 GW currently planned, and 54.4 GW in 2020) and onshore wind to 95 GW (from 71 GW currently planned, and 52 GW in 2020) of installed capacity by 2030.

  The reported planned expansion can be viewed as a direct response to the judgment of the German Constitutional Court on April 30, 2021 reported on in Edition 17 of Low Carbon Pulse: the effect of the judgment has been to force the Federal Government of Germany to provide for increased GHG emission reduction targets leading up to 2030, having previously "off-loaded" responsibility for GHG emissions reductions to after 2030.

  **See:** *Germany to speed up wind and solar energy expansion - draft*

- **Pumped about pumped storage:** Pumped storage has long been the mainstay of grid integrity and storage, and balancing overnight electrical load: the long-established model was to install pumped storage at strategic locations on a grid to allow response to peaking of load, and then to use electrical energy to pump water back into storage over-night. As gross-pool markets developed this continued to make sense because of the lower pool prices overnight at times of lower load, with base load coal-fired power stations dispatched.

  In the last 25 years or so, in the PRC, State Grid has used pumped storage as an integral part of its grid design, allowing it to invest effectively across its grid on an integrated basis. This has continued as other renewable electrical energy load has been developed, and has facilitated that development. In effect, pumped storage, is "A Big Battery" (See Edition 6 of Low Carbon Pulse, under ***Pumped Storage – a global opportunity***.)

  With increased renewable electrical energy connected to grids, the underlying technical reasons for pumped storage remain, but the timing of the pumping water back into storage has changed. In many jurisdictions with solar photovoltaic capacity, pool prices dip during the day, and provide a window of lower pool prices to allow water to be pumped back into storage.

  As noted before, there is a global atlas detailing 600,000 possible locations for hydro-electric facilities (which seems to include pumped-storage). On June 8, 2021, leading Australian renewables news publication, "RenewEconomy – Clean Energy News and Analysis" published a pumped-storage map for Australia. (Also RenewEconomy has published an offshore wind field map for Australia.)

- **Damming - The Drowned and the Saved (after Primo Levi):** Just as pumped storage is part of the energy mix essential to achieving net-zero emissions, so too is the use large-scale hydroelectric energy generation, both dammed (including with pumped storage) and run of river. The generation of electrical energy from dams is achieving increasing attention in a number of jurisdictions, and in the US and Australia has achieved particular attention during the news cycle of this edition of Low Carbon Pulse.

  In the ever innovative State of Queensland, Australia, the State Government is considering whether to develop a pumped storage facility at the existing Borumba Dam, and Powerlink (a government owned corporation) is undertaking a detailed cost and design analysis.

  **See:** *Borumba hydro to deliver reliable supply and 2000 jobs*

## Wind round-up:

- **From the land of the windmill to the sea of the windmill:** On June 3, 2021, the Netherlands announced that studies are being undertaken in respect of eight areas in the Dutch sector of the North Sea. It is understood that the areas being studied have the potential to add an additional 64.9 GW of offshore wind field installed capacity.

  **See:** The Netherlands Enterprise Agency (RVO) website

- **Is it a wind sail, a wind wall, a wind wave – no it is a *Wind Catcher System*:** On June 8, 2021 many news feeds reported on a new floating off-shore wind field project technology, with the scale of the technology presented in comparison to the Eiffel Tower, the Statue of Liberty, aircraft and cruise ships.

  The headlines for the *Wind Catcher System* are that it is competitive with fixed-bottom off-shore wind capital costs, and is five times as efficient as a conventional wind turbines.

- **Closing the gap by using the Gulf:** On June 9, 2021, it was widely reported that the US Department of the Interior will assess the development of off-shore wind fields on the Gulf Mexico Outer Continental Shelf (***OCS***). It is reported that the Bureau of Ocean Energy Management (***BOEM***) issued a Request for Interest (***RFI***) on June 11, 2021, relating to four of the five States with coastlines onto the Gulf, Alabama, Louisiana, Mississippi and Texas.

As has been noted before in Low Carbon Pulse, the off-shore areas of the east and west coasts of the US, and the Gulf Coast and the Gulf of Mexico are highly prospective, and have the benefit of being close to load.

- **Floating off-shore wind for the Gulf of Roses:** On June 10, 2021, BlueFloat Energy announced its plan to develop a 1 GW floating off-shore wind field off the coast of Emporda, close to the Gulf of Roses, Catalonia.

  **See:** *BlueFloat Energy Plans to Build 1 GW Floating Wind Farm in Spain*

- **Bass Strait Wind Tunnel:** On June 11, 2021, plans to develop two giga-scale off-shore wind projects emerged: Brookvale Energy is planning to develop up to 2 GW of off-shore wind field capacity off Tasmania, and Floatation Energy is planning to develop up to 1.5 GW of off-shore wind field capacity off Victoria. As reported in Editions 17 and 16 of Low Carbon Pulse, off-shore wind development are relatively new in Australia, but is gathering pace.

  **See:** *Two massive offshore wind farms proposed for Bass Strait*

## Solar round up:

On June 4, 2021 plans were announced for the development of three off-grid solar facilities in the Democratic Republic of Congo (***DRC***). The off-grid solar facilities are planned to provide electrical energy to the cities of Bumba, Gemena and Isiro. The cities are located in the north of the *DRC*. The off-grid solar facilities are to be developed by an international consortium of corporations, AEE Power (Spain), Eranove (France) and Gridworks (UK), under a concession granted by the Ministry of Hydraulic Resources and Electricity of the DRC. The award of the concession comes under the Essor Access to Energy Initiative, to which the Government is committed.

**See:** *DR Congo Goes With Solar Off Grid To Power 3 Northern Cities*

## Port and Land Transport round-up – shout outs to early movers:

- **Port of first call:** Editions 5 and 17 outlined the progress of the Port of Los Angeles to its greening. On June 8, 2021 it was announced that five FCEVs Class 8 trucks, developed by Kenworth Truck, using fuel cell technology developed by Toyota, and two hydrogen refuelling stations (***HRS***), developed by Shell, are now operational within the precincts of the Port.

  These initiatives are part of the Shore to Shore project (see Edition 5 of Low Carbon Pulse). While the scale of these deployments may be regarded as small in the broader context of the operation of the Port, as with other initiatives around the world, the role of first movers is critical: in addition to Shell, Toyota, and Kenworth, Tenaris and NEL are involved in the Shore to Shore project. Also, as noted in Edition 17 of Low Carbon Pulse, the Port of Los Angeles has contracted with Nikola Corporation for 30 Nikola *BEV*s and 70 Nikola *FCEV*s.

  **See:** *Port of Los Angeles Rolls Out Hydrogen Fuel Cell Electric Freight Demonstration*

- **First Bus *HRS* in the Netherlands:** In early June 2021, Royal Dutch Shell opened its first *HRS* for buses. Of itself this may not appear significant, but taken with the role of Shell in developing the supply of hydrogen and *HRS* across Europe (Germany and UK) and North America (Canada and the US). As noted in Edition 18 of Low Carbon Pulse, Shell is working with Daimler to develop hydrogen supply and *HRS*s in tandem with the Daimler's development of *FCEV*s.

  **See:** *Shell opens its first operational hydrogen refilling point for buses in Groningen*

- **First movers, moving incrementally:** As noted frequently, supply of hydrogen needs to develop in tandem with demand for hydrogen. A number of corporations, including BP, Daimler, Everfuel, Hyundai, Hyzon, Plug Power, Shell, Toyota, and Volvo, in the transport sector, and ports, such as the Port of Los Angeles and Port of Rotterdam, are showing the importance, and effectiveness, of in tandem development. As such, while the absolute numbers of units sold, and *HRS*s opened, may appear relatively small, the demand for *FCEV*s and the means of refuelling *FCEV*s is developing at an increasing rate, being a rate that is consistent with, if not a little bit ahead of, the anticipated development of the supply and demand sides of this part of the hydrogen market.

## Shipping news forecast:

- **FCT Ferries:**
  - **Who paid for the ferry, man**? On June 2, 2021, Switch Maritime announced that its ferry, MV Sea Change, will commence operation in San Francisco Bay in Q3 of 2021. The MV Sea Change will be powered and propelled by *FCT* using compressed hydrogen gas (at 250 bar or 3,600 pounds per square inch), and will carry 84 passengers and 246 kg of hydrogen (the mass of four average sized passengers). The *FCT* will produce electrical energy at 360 Kw, and battery pack will provide up to 100 KWh of additional energy.

    **See:** Switch Maritime Website
  - **How is the ferryman going to be paid? By pre-baking demand:**
    - Edition 12 of Low Carbon Pulse (under ***More Northern Europe News***) outlined the agreement between Linde and Norled under which Linde was to supply liquid hydrogen and associated hydrogen storage and delivery systems in respect of the ferry, MF Hydra, which is to carry both passengers and vehicles.
    - On June 4, 2021, Caledonian Maritime Assets Ltd (***CMAL***) announced plans to develop a sea-going ferry to be powered and propelled using *FCT*. *CMAL* (owned by the government of Scotland) has contracted with Aqualisbraemar LOC Group (***ALG***) to develop a concept design.

      *CMAL* and *ALG* will work together on the development of the concept design, with *CMAL* seeing a need for a "double-ended sea-going passenger and car ferry, with capacity for 120 passengers and 16 cars or 2 trucks". This need reflects thinking that the ferry would travel between Kirkwall and Shapinsay (both in Orkney Islands).

      **See** *Scottish-led HySeas III project aims to build Europe's first sea-going ferry powered by hydrogen fuel cells*

- **Hydrogen and Methanol:** In early June, Hydrogen Europe published a policy paper entitled *How Hydrogen Can Help Decarbonise the Maritime Sector*. The paper concludes that hydrogen and hydrogen based fuels (critically, ammonia) can contribute significantly "*to the decarbonisation and also mitigate air pollution of the worldwide [maritime fleet]*". This will not be a surprise to many readers, but tends to confirm the thinking that has developed over the last 12 to 15 months.

## Airports and Aviation:

**Airport solar landing strips:** Edition 18 of Low Carbon Pulse (under **Solar round up**) reported in the use of airports as ideal locations for solar photovoltaic projects, including roof-top solar. On June 1, 2021 Abu Dhabi Airports and Masdar announced the completion of the use of roof-top solar at the Abu Dhabi International Airport. It is to be expected that airports around the world will install roof-top solar, including in innovative ways on, and around, car parks.

## Carbon credits  emission trading schemes, and off-sets:

There appears to be an ever increasing interest in the use of carbon credits to acquit obligations under emission trading schemes (***ETSs***) and other policy settings intended to achieve the adoption of lower, low or no carbon technologies (***NOs***), and to satisfy GHG emission reduction commitments assumed voluntarily, by use of offsetting (rather than decarbonisation or in combination with decarbonisation).

- **A gaggle of exchanges:** Edition 18 of Low Carbon Pulse outlined the establishment of the Global Carbon Exchange to be located in Singapore.

  On June 1, 2021, it was announced that Fortum (Finnish state-owned utility company) and Nasdaq (financial services and trading company) had agreed to develop a trading platform for trading carbon removal credits. For these purposes, Nasdaq has taken a majority stake in Puro.earth (a start-up backed by Fortum). The concept of carbon removal credits has been developed by Puro.earth, with carbon removal verified by a tradeable $CO_2$ Removal Certificate (***CORC***). *CORCs* are granted in respect of technologies verified as having an effect over the long-term to remove carbon, including storage of carbon in solid structures made from industrial waste.

  For Puro.earth, access to the Nasdaq network and trading platform provides access to the global market. For Nasdaq, *CORCs* provide corporates with high-quality carbon abatement certificates.

  **See:** *Nasdaq and Fortum join forces to develop carbon removal market*

- **Surge in demand for high quality carbon credits:** There is clearly a demand for high-quality carbon credits (and the certificates that support them), as manifest recently by higher prices for carbon credits (including *ETS* certificates). Under certain *ETS*s and *NOs* it is possible to use carbon credits not issued under that scheme to acquit an obligation under it (but the ability to do so tends to be limited). As noted in Edition 16 of Low Carbon Pulse, the use of carbon credits in this way is likely to come under increased scrutiny over time.

In the next article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series, the use of carbon credits and negative GHG emission initiatives (see Edition 9 of Low Carbon Pulse under ***Negative GHG Emissions … not new, but higher profile likely***) will be considered in the context of a broad analysis of the means and tools available to capture carbon and to store it.

## Net-zero – a round-up and an arc:

- **DIF Capital Partners to make a DIFference:** On June 3, 2021, DIF Capital Partners committed to Net Zero by 2050. Consistent with this commitment, among other things, DIF is to measure GHG emissions and to identify pathways to achieving *NZE* by 2050 or sooner, and continue its global investment program in renewable electrical energy and related infrastructure.

  In addition to the commitment to Net Zero, DIF has become a signatory to the Institutional Investors Group on Climate Change (***IIGCC***). The *IIGCC* is intended to ensure that investors can maximise the contribution that they make so as to ensure that the Stretch Goal is achieved under the Paris Agreement.

  **See:** *DIF Capital Partners commits to Net Zero emissions today*

- **Racing on the Road to *NZE*:**

  On June 8, 2021, "visualcapitalist.com" published a really helpful visual arc detailing the commitments of countries to net-zero emissions (***NZE***). Please click here to view the visual arc.

## Hydrogen Use by mode in heavy transport:

In response to requests for more detailed coverage in certain areas, future editions of Low Carbon Pulse will include narratives on those areas, and will reinstate the Zero Hero sections, covering countries that are progressing to *NZE*.

## • Trains and hydrogen:

**Electrification key to decarbonisation:** The use of trains to transport passengers is the most efficient mode of transport, and to transport freight the second most efficient. The rail sector is estimated to give rise to 1.7% of global GHG emissions, equal to approximately 800,000 mtpa of GHG emissions.

The decarbonisation of the transport sector may be regarded as less problematic than other sectors: the time taken to achieve electrification using electrical energy from renewable sources will be key. But there are some rail corridors on which electrification may be regarded as a less affordable / more expensive option than the use of trains powered and propelled by fuel cell technology (***FCT***), but for *FCT* to be used train operating companies will want to understand that there is a sustainable supply of hydrogen, at a sustainable price.

As noted above (in the pieces on India), there may be a role for government as an intermediate buyer and supplier of hydrogen, and as a developer of hydrogen storage and refuelling infrastructure. Once the market is at a point of sustainability, government can of course, realise its investment, and recycle capital.

**Corridor by corridor:** This is the case even in the EU. While the facts and statistics relevant to each corridor will be determinative, it is possible to see the use of hydrogen to fuel *FCT* on freight routes in certain countries to displace the use of diesel, and in a country such as India where the electrification of its extensive network may be a task undertaken over time, and where dual powered trains can be used.

If *FCT* is used, and the hydrogen used is Blue or Green, noting that *FCT* is agnostic as to the colour of hydrogen used, the use of *FCT* on a corridor is less expensive / more affordable than electrification and it is to be expected that *FCT* may be used. In addition, it appears increasingly likely that to allow flexibility trains will be dual powered, electrified for use on electrified corridors and *FCT* for non-electrified corridors, and, as is the case with ferries, it is likely that *FCT* will deploy electrical batteries too.

**Comparative costs:** A recent Wall Street Journal article notes that the total lifetime cost (***TLC***) of ownership of trains using *FCT* is comparable with that of diesel and electrified corridors. Consistent with the International Energy Agency (***IEA***) report, the WSJ note that the use of FCT is "particularly useful on routes that aren't busy enough to [justify] overhead electrification". Also it is possible to retrofit with *FCT*.

As is noted consistently, the challenge that needs to be addressed is for the supply of hydrogen to match the demand for the use of *FCT* in trains. Long standing industrial gas suppliers, Air Liquide, Air Products and Linde are investing heavily in hydrogen production facilities, as are international oil companies (or more appropriately nowadays, international energy companies), including BP, Eni, Equinor, Shell and Total, with Chevron and Exxon Mobil now in pursuit.

- ## Trucks and hydrogen:

**Hydrogen has a key role to play:** Global freight traffic is expected to double, and by some estimates, to increase 2.5 times, by 2050. While road freight corridors may not be as readily apparent as rail corridors, they should be – they are the major arterial roads between ports and warehousing and other consolidation and distribution hubs, and the point of delivery.

These major arterial roads are established, and the use of them known and predictable. The Oak Ridge National Laboratory, US, has studied and reported on the use of *FCT* for the haulage of freight by trucks, reporting that: "*Hydrogen fuel cells are ideal for the trucking industry because the refuelling time and driving range are comparable to [fossil fuel powered and propelled trucks] and travel routes are predictable, which lowers the barrier[s] for developing fuelling infrastructure*".

**But supply and demand for hydrogen needs to develop:** As reported in previous editions of Low Carbon Pulse, across the EU hydrogen-freight-corridors (***HFCs***) are being "developed" in the sense that hydrogen refuelling infrastructure (***HRI***) and hydrogen refuelling stations (***HRS***) are planned and are being installed on a coordinated basis so as to pre-empt the demand for their services from heavy goods fuel cell electrical vehicles (***HGFCEVs***). It is anticipated that by 2025, within the EU, up to 1,500 kms of *HFCs* will have been developed.

It has long been understood that the useable energy in 1 kg in hydrogen is around 2.5 that of liquid fossil fuels, or stated another way, 1 kg contains useable energy equivalent to nearly 4 litres of diesel. As such hydrogen, by mass, is more efficient than fossil fuels by orders of magnitude. Also, the time taken to refuel an *HGFCEV* is comparable to the time taken to refuel a vehicle powered and propelled by an ICE.

It follows that for road freight the use of *FCT* is likely to increase. The ever-present challenge will be development of the supply of hydrogen in tandem with the development of demand for the use of *FCT*.

**Edition 20 or Edition 21 of Low Carbon Pulse will consider, and include detail around policy settings, and cover Buses and Ferries.**

***The author of Low Carbon Pulse is Michael Harrison.***

## 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.


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