Low Carbon Pulse - Edition 20

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS

Welcome to Edition 20 of Low Carbon Pulse – sharing significant current news on progress towards net-zero emissions globally. This edition covers the period from Monday June 14, 2021 to Sunday June 27, 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***); *H24I* features provide an industry by industry narrative and perspective.

Edition 20 will be posted again on **July 1, 2021** to pick-up those reading later in the week.

The Week Ahead:

Trading to commence on China ETS: During the week beginning June 21, 2021, it was reported widely that the PRC's emissions trading scheme is to commence trading before the end of June (see Editions 6, 9 and 12 of Low Carbon Pulse). On Sunday June 27, 2021 this remained the case.

The Month Ahead:

- **The first anniversary of *A hydrogen strategy for a climate neutral Europe* (*EUH2S*):** July 8, 2021 is the first anniversary of the release ***EUH2S***. Edition 21 of Low Carbon Pulse will reflect on progress during the first year after the release of ***EUH2S*** in respect of each Key Action.

  In some ways, this edition of Low Carbon Pulse "tees-up" some of the areas in which progress has been made and in which policy settings need to be developed and firmed-up.

- **EU to release cat among the pigeons (also known as *CBAM*):**

  On July 14, 2021 it is expected that the EU will release the developed policy settings for the Carbon Border Adjustment Mechanism (***CBAM***) (see Editions 12 and 19 of Low Carbon Pulse).

  If the July 14, 2021 timeline is achieved, Edition 21 or Edition 22 of Low Carbon Pulse will cover, in detail, the form and substance of *CBAM* in detail, and assess its likely implications. (Please click here for the link to the preliminary draft).

  While *CBAM* is one way of achieving the desired policy outcome, it is not the only way: everyone has a view, and for the purposes of a reasonably complete picture, see the Nova-Paper 15 outlining a tax on fossil fuels, rather than CO_2, as reported in Edition 19 of Low Carbon Pulse, the International Monetary Fund proposal under which each producer of GHG's should pay a carbon price, and yet another report supports CO_2 pricing so as to avoid a price cannibalisation scenario, solar versus wind.

- **Deadline for applications for ScotWind applications:** Edition 8 of Low Carbon Pulse reported on the ScotWind auction process. There is expected to be considerable activity ahead of the deadline for applications on July 16, 2021. Given the outcomes achieved by HM Treasury on February 8, 2021, in respect of Round 4 leasing

program (see Edition 9 of Low Carbon Pulse), the outcome of the ScotWind auction process will be eagerly awaited.

- **UK to release its Hydrogen Strategy before July 22:** It is being widely reported that during July the UK Government will release its Hydrogen Strategy (***UKH2S***): UK Energy Minister, Ms Anne-Marie Trevelyan, has indicated that the ***UKH2S*** will be published before Parliamentary recess. Early indicators on the thinking that will inform the ***UKH2S*** are in plain-sight as part of the 10-Point Plan for a Green Industrial Revolution, including the softer target of 1 GW of low carbon hydrogen production capacity by 2025, and firmer target of 5 GW by 2030.

  In recent times the Department for Business, Energy & Industrial Strategy (***BEIS***) has indicated that while the ***UKH2S*** is likely to be agnostic as to the colour of hydrogen, it will be clearly defined on carbon intensity (like the EU), and the ***UKH2S*** is likely to recognise that by 2050 final total energy consumption from low carbon hydrogen will need to be in the range of 250 to 460 TWh for the UK to achieve net-zero GHG emissions (***NZE***).

Japan continuing down the road to *NZE* invites ASEAN to join the journey:

- **Japan helping to drive ASEAN transition:** On June 21, 2021, at a virtual meeting of with ASEAN energy ministers (noting that ASEAN does not include Japan), the Japanese Minister of Economy, Trade and Industry (***METI***), Mr Hiroshi Kajiyama, outlined a number of suggested support measures for ASEAN countries. In recent times, Japan has been leaning forward on many policy settings (see Editions 2, 5, 6 and 12 of Low Carbon Pulse), and this is another example of Japan's broader commitment to achieving ***NZE***.
- **The AETI from METI:** The suggested support measures are proposed in the **Asian Energy Transition Initiative** (***AETI***) "as a package of Japanese support for realistic transitions in Asia towards carbon neutrality". As a prelude to news items later in this edition of Low Carbon Pulse, the ***AETI*** contemplates that projects will include the development of gas-fired power stations and liquified natural gas (***LNG***) receiving and re-gasification terminals, with natural gas (derived from *LNG*) an alternative to coal, and as a key energy transition fuel.

See: METI website

India continuing down the road looking to roof-tops and micro-grids:

India H2 Alliance expanding:

Establishment of India H2 Alliance: Editions 14 and 17 reported on the establishment and progress of the India Hydrogen Alliance (***IH2A***): the purpose of the ***IH2A*** is to work with the Government of India to develop a national hydrogen policy and roadmap for 2021-2030, to establish a national hydrogen task force, to identify large-scale hydrogen demonstration plants, to create a national hydrogen fund for India, and to create capacity for the production, storage, distribution and transportation and use of hydrogen.

On June 16, 2021 it was widely reported that the membership of the ***IH2A*** has expanded, with new members including corporation JSW Steel (part of the conglomerate, JSW Group), and CSIR National Chemicals Laboratory (Government of India owned) and Scottish Development International (Scottish Government funded organisation). JSW Steel is to lead the Work Group for Steel and Cement decarbonisation, with the decarbonisation of these two Difficult to Decarbonise industries a top priority as the Indian economy and population continues to grow, and urbanise, and as such demand for steel and cement continues to increase.

Roof-top solar for India:

The International Energy Agency (***IEA***) has published a report entitled ***Unlocking the Economic Potential of Rooftop Solar PV in India*** (the ***Key Report***), developed jointly with the Council of Energy, Environment and Water (***CEEW***) and the Ministry of New and Renewable Energy (***MNRE***). The development of roof-top solar photovoltaic (***RTS***) in India is highly prospective, but has yet to achieve real momentum.

The ***Key Report*** provides suggested policy settings that could increase the momentum to achieve roll-out of *RTS*, including encouraging aggregation of demand for the off-take of electrical energy from ***RTS***, providing access to grant and funding options to encourage deployment of ***RTS***, and streamlining payment of subsidies (a tried-and-tested policy setting globally). The ***Key Report*** provides a walk-up to achieving and increasing momentum.

Micro-grids India:

Edition 14 of Low Carbon Pulse reported on plans to develop up to 10,000 micro-grids in India using renewable resources: the use of micro-grids will increase electrification and displace use of diesel fuel.

On June 13, 2021, NTPC Limited (India's largest power company) commenced seeking expressions of interest globally to work with it on two pilot projects using fuel cell technology (***FCT***): one pilot ***FCT*** project is to use ***FCT*** to provide back-up electrical energy, i.e., storage, and the second pilot ***FCT*** project is to use ***FCT*** off-grid, in a captive use setting. Currently, both back-up, and off-grid, systems use diesel.

See: *NTPC invites EoI for hydrogen fuel cell pilots*

India hosts BRICS nations Green Hydrogen Summit:

It has been widely reported that on June 22 and 23, 2021, India hosted a summit of the BRICS nations (Brazil, Russia, India, China and South Africa) to allow sharing of initiatives and policy settings about development of Green Hydrogen production capacity and use. It is reported that the Green Hydrogen Summit was organised by NTPC Limited. One of the key themes was the need for the development of common international standards for Green Hydrogen, including for safety and transportation. Each BRICS nation has the resources to be a key player globally in the Green Hydrogen market.

On June 22, 2021, the Indian Minister of Power, Mr. RK Singh, stated that under a Renewables Purchase Obligation (***RPO***), some sectors of the economy would be required to purchase Green Hydrogen.

EU and UK:

- ### Backbone of hydrogen demand:

Headline: On June 15, 2021, at the launch of the European Hydrogen Backbone (***EHB***) initiative, a report was released (***EBR***) providing a perspective on the likely size and shape of hydrogen demand by 2050. The headline is that demand for hydrogen could reach 45% of the levels of natural gas use in 2019, with final total energy consumption (***TEC***) of hydrogen equating to 2,300 TWh a year, book-ended by a low-side estimate of 2,150 TWh ***TEC***, and a high-side estimate of 2,750 TWh ***TEC***.

Consensus arising: The ***EBR*** is consistent with "established thinking" that hydrogen has a crucial role to play as an energy carrier for use in the production of cement, chemicals and iron and steel. Across these Difficult to Decarbonise industries it is estimated that 1,200 TWh of energy will be used for high-heat temperature processes, and 200 Twh for medium to high-heat temperature use: hydrogen can be used as a high-heat temperature energy carrier, able to displace fossil, and other carbon intensive, feedstocks and fuels.

In addition to use in these Difficult to Decarbonise industries, hydrogen will be used to power and to propel vehicles (particularly heavy goods vehicles / trucks) using ***FCT***. Further, it is stated that hydrogen will be used as a fuel to produce dispatchable electrical energy or, as noted in the next paragraph, Hydrogen Energy Carrier Storage (***HECS***) (up to 600 TWh)) and, in some countries, to heat buildings (up to 600 TWh), including through district heating.

Efficiency in hydrogen use and storage: The ***EBR*** notes that while it would be possible for the EU and the UK to produce sufficient Green Hydrogen to satisfy this level of projected demand, this will require considerable investment in renewable electrical energy development. While production and supply of Green Hydrogen within the EU and the UK will fulfil some of the early policy setting thinking around energy security, it is likely to prove more expensive than sourcing Green Hydrogen from countries and regions with renewable energy sources better suited to the production of Green Hydrogen and, as a result, lower cost production.

As noted in previous editions of Low Carbon Pulse, while hydrogen can be used to produce dispatchable energy, it will be interesting to see how this prospective use develops given thinking of policy settings and the thinking of development / policy banks: current trends reflect the view that hydrogen should not be used as a fuel for base load dispatchable energy, rather hydrogen (suited as it is to storage) is best used to provide ***HECS***. The ***EBR*** recognises the use of hydrogen for ***HECS*** in the context of use of hydrogen to produce dispatchable energy only, not to provide a fuel for base-load dispatchable energy.

- ### EU pipeline of infrastructure projects eye-popping:

A reminder of policy settings and hydrogen roadmaps: On July 8 2020, the EU released its ***A hydrogen strategy for a climate neutral Europe*** (***EUH2S***) (contained in Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and Committee Regions). The Key Action from the ***EUH2S*** were:

- Create Investment Agenda for EU, including supporting strategic investments in clean hydrogen from 2021;
- Boost demand for and scale up production, including exploring demand side policy settings;
- Design an enabling and supportive framework, including planning for hydrogen infrastructure development;
- Promote research and innovation technologies; and
- Develop the international dimension, critically the supply side.

First anniversary approaches: As the first anniversary of the ***EUH2S*** approaches, an eye popping number of large-scale hydrogen projects have been announced. This reflects real progress, but there remain some policy settings to be developed and implemented, one of these being the interface between natural gas and hydrogen, which is a key interface as that large-scale infrastructure is developed and other infrastructure repurposed, including pipelines (see below under ***The Role of Natural Gas***).

Getting longer in infrastructure: Attached is a link that shows the location and nature of the current and planned hydrogen projects.

The ***EHB*** is key to the transmission and distribution of hydrogen across the EU.

Getting ready for supply and distribution:

In recent editions of Low Carbon Pulse, the importance of the activities of early movers has been noted. In the context of northern Europe and the UK early port movers continue to move, and to look, forward to develop the means of supply to, storage and distribution from ports of import.

- In early June 2021, the Port of Amsterdam outlined plans to import up to 1 Mtpa of hydrogen.

  This initiative demonstrates the role of sea-ports as hydrogen hubs, and in this role, the importance of ports developing hydrogen receival, storage and send-out infrastructure ahead of the need for that infrastructure. A number of ports are leading the way, including the Amsterdam and Rotterdam, Antwerp, Hamburg, Immingham, and Los Angeles. As is noted towards the end of this edition of Low Carbon Pulse, airports are now responding to the anticipated demand and use of hydrogen, and as such, with the private sector, responding by looking to supply and to distribute.
- In mid-June 2021 to late June, the Port of Rotterdam is continuing its world leading pace setting. Key to this is the Port's development of its own backbone to allow it to be the import port of choice. On the Port's website a helpful schematic (entitled ***Hydrogen Economy on Rotterdam Starts with Backbone***) details the "backbone and nervous system" that is to distribute hydrogen from the Port to points of connection and to points of use.

- It is not possible for Low Carbon Pulse to report on every development, but the Port of Rotterdam may be regarded as leading the way in matching supply to demand and the delivery of hydrogen: within the news cycle of this edition of Low Carbon Pulse the following are noteworthy:
  - On June 15, 2021, a pre-feasibility study was released that indicated that shipping Green Hydrogen from Iceland to the Port of Rotterdam would be feasible by the second half of the current decade. Landsvirkjun (the National Power Company of Iceland) and the Port of Rotterdam are working on this; and
  - On June 16, 2021, it was reported that the Port of Rotterdam and Rotterdam Rijn Pijpleiding Maatschappij are to develop jointly a feasibility study to develop pipelines capable of carrying hydrogen (and other products), connecting the Port of Rotterdam to Chemelot and the North Rhone-Westphalia, and to the ***EHB***.

  See: Port of Rotterdam Website

Implication of *EHB:* a means to many ends:

The "launch" of the ***EHB*** was momentous both of itself, and for the discussion that it has sparked, and that will continue, including discussion around the need to develop underground storage capacity for hydrogen (including using salt-caverns and compression technologies) to provide inventory management and assurance, and security, of supply, and the development of a hydrogen market to ensure supply to match demand.

See: Uniper website

Germany and Australia:

- **Germany and Australia sign alliance:** On June 13, 2021, Germany and Australia signed a bilateral alliance agreement (***BAA***), a bilateral trade agreement (of sorts), relating to hydrogen production, and trade in hydrogen, and the facilitation of a renewable energy-based hydrogen supply chain between the two countries.

  The ***BAA*** recognises the commitment of Germany to the development of sources of Green Hydrogen supply to match the demand that it is anticipating will develop in response to its policy settings, and the position of Australia as a prospective supplier of Green Hydrogen.

- **Australia Guarantee of Origin Scheme:** On June 21, 2021, a discussion paper was released, entitled "***A Hydrogen Guarantee of Origin scheme for Australia***". Submissions in respect of the paper are invited by July 30, 2021.

  For Australia, as a prospective world-scale exporter of hydrogen and hydrogen-based fuels (including to Germany), an effective and accepted assurance scheme to certify the origin / source, and carbon intensity, of hydrogen and hydrogen-based fuel production is essential both for bi-lateral export contracts (to support the development projects) and to facilitate the development of a market for hydrogen and hydrogen-based fuels, including ammonia and methanol.

The Role of Natural Gas:

- **The energy mix required to achieve *NZE*:**

  A number of matters have emerged as axiomatic in the context of progress towards ***NZE***, one of them is that there is no one-size-fits-all energy mix that is going to result in the achievement of ***NZE***, globally or jurisdictionally: just as there is no one pathway to ***NZE*** (see below under ***Mid-Year Reflection on Flagship Reports***).

  While the development of renewable electrical energy (***REE***), and the displacement of coal, is going to be key to progress towards ***NZE***, the quantity of ***REE*** required to achieve electrification of existing and new electrical energy load (responding to both population growth and increased electrification to increase the access rate to electrical energy), while at the same time developing sufficient ***REE*** for the production of Green Hydrogen, touches the edges of comprehension, and as such stretches the comprehension of many as to whether it is achievable at a rate that will match the anticipated load.

  The development of ***REE*** is going to take time. The development of ***REE*** should be the key focus of policy settings. During the time taken for ***REE*** to be developed, other transitions are likely to take place, including from coal-fired capacity, to gas-fired capacity, including using CCS / CCUS.

- **Natural gas part of the energy mix required to achieve *NZE***:

  In addition to the development of ***REE***, BECCS / BECCUS (in the production of bio-energy), CCS / CCUS (in the production of Blue Hydrogen, and as such Blue Ammonia), Direct Air Capture (**DAC**), and hydrogen and hydrogen-based fuel production capacity needs to be developed (critically for Green Hydrogen, and as such Green Ammonia).

  It is to be expected that natural gas will have a role to play as feedstock for the production of Blue Hydrogen (and as such Blue Ammonia) and to remain a fuel source for gas-fired power stations, including those that over time move to fire blended natural gas and hydrogen or to co-fire. As such, natural gas is going to be part of the energy mix, albeit with its use likely to decrease (and, indeed its use must decrease) over time.

  There is a burning debate in some jurisdictions around the development of new gas-fired power stations. For many, this is a head and heartburn debate, with a tension between the need to generate electrical energy and the need to decarbonise the generation of electrical energy. What this is likely to mean in practice is that natural gas has a role to play in energy transition, but the role needs to be understood, and to the extent practicable, carbon must be captured and stored.

- **The role and use of natural gas will be subject to debate for as long as it part of the energy mix:**

  Following the meeting of EU Energy Ministers at the end of May 2021, the debate about the use of natural gas has continued. There is clear recognition that natural gas is needed as part of the energy mix, that overtime its

use must decrease, and that policy settings should not prefer, or subsidise or support, new gas-fired power projects.

In the EU, natural gas continues to be needed as an energy carrier (to some a transition "bridging fuel"). Just as CCS / CCUS and hydrogen storage is on the agenda, it seems increasingly likely that underground gas storage is likely to emerge as an agenda item, critically because of the reduction in natural gas in storage during the Northern Hemisphere winter, 2020/21 as LNG was diverted to North Asia. Further, the use of natural gas a feedstock to produce Blue Ammonia remains a policy setting that remains fluid, even if the lexicon includes fossil-based hydrogen with carbon capture.

It is helpful to note that even some of the most determined and progressive countries making huge strides to achieving ***NZE*** by 2050 have not foreclosed on the use, or the role of natural gas, even in their hydrogen roadmaps, plans and strategies.

At the risk of touching the "third rail" of policy setting orthodoxy, if GHG emissions can be captured and stored permanently, or captured and used to achieve lower, low or no carbon outcomes, and there is need for electrical energy or natural gas is needed as a feedstock, there may be a continued role of natural gas after 2050, and into the second half of this century. As noted above and below, viewing CO_2 as resource has to be a key touchstone of policy settings, and will inform the role of natural gas.

Mid-year reflection on Flagship Reports:

- **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 (and Blue Hydrogen for that matter). One of the lucky countries is Australia. Australia has world class on-shore solar and wind resources (as well as yet to be developed off-shore wind resources), and States and Territories that continue to provide material funding commitment to progress to ***NZE*** (for example, NSW's AUD 380 million funding commitment announced on June 17, 2021).

  Australia is lucky for other reasons, including the amount of intellectual horse-power, and rigour, that is being applied in the context of progress to ***NZE***. In mid-June 2021, HySource published a feature article, ***Net Zero Emissions by 2050 and the Role of Hydrogen*** (***HySource Feature***), providing a really good eight page summary of the key high-level takeaways from the ***IRENA Pathway*** and ***IEA Roadmap***.

  HySource is something of a brains trust, bringing together the **Australian Hydrogen Council**, **CSIRO** (Federal Government research body and brains trust), **Future Fuels CRC** (a research centre), and **NERA** (or **National Energy Resources Australia**, an independent, not for profit, organisation funded by the Federal Government).
- **When might Green Hydrogen become cost competitive:** in Edition 19 of Low Carbon Pulse, it was reported that 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* provides "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". Edition 19 notes the key themes that arise from the *SAS*.
- **Reflections on the *IRENA* and *IEA*:**

  The purpose of the ***HySource Feature*** is to reflect on the two major global flagship reports of the first part of 2050:

  - International Renewable Energy Agency (***IRENA***): ***World Energy Transition Outlook: 1.5°C Pathway: Preview*** (***IRENA Pathway***) (see Edition 13 of Low Carbon Pulse); and
  - International Energy Agency (***IEA***) special report, ***Net Zero by 2050: A Roadmap for the Global Energy Sector*** (***IEA Roadmap***) (see Edition 18 of Low Carbon Pulse).
- **Reflections contained in *HySource Feature*:**

  The key reflections contained in the ***HySource Feature*** are as follows, noting that some of them will be familiar to readers of Low Carbon Pulse. Both the ***IRENA Pathway*** and the ***IEA Roadmap***:

  - are important, each representing a possible pathway to ***NZE***, not the pathway: criticism of the ***Pathway*** and ***Roadmap*** have not embraced this, it has not suited some narratives and perspectives to do so;
  - emphasize the need to increase the rate of GHG emission reduction, while remaining optimistic about the ability to progress to ***NZE*** by 2050 to achieve the Stretch Goal under the Paris Agreement remains; and
  - have different themes, but those themes can be summarized as actions that need to be taken to achieve ***NZE***: (**i**) Conversation and improved efficiency; (**ii**) Renewable electrical energy deployment required "lots of it", critically the scale and speed of deployment; (**iii**) Electrification of energy end-use sectors; (**iv**) Hydrogen and hydrogen-based fuel deployment is required, critically both Blue Green Hydrogen and Green Hydrogen are required; and (**v**) Bioenergy, and BECCS and BECCUS and CCS and CCUS are required.

"Worst is yet to come", unless greater and faster reductions:

Intentionally, Low Carbon Pulse does not take a critical view of any country or corporation, seeing any progress towards ***NZE*** as a good thing, and seeking to take a positive perspective generally. If Low Carbon Pulse has any theme or themes, however, it is that a greater mass of GHG emissions arising need to be reduced to a greater extent, and faster, than currently, and for this purpose the means of decarbonisation need to accelerate, including the development of the supply and demand for hydrogen in tandem.

The heading to this section is taken from the draft report prepared by the United Nations' Intergovernmental Panel on Climate Change (***IPCC***) (reported as leaked to Agence France-Presse (***AFP***)). ***AFP*** states that the ***IPCC*** report is not in its final form, but it is reported by ***AFP*** to contain, at over 4,000 pages, a comprehensive analysis of the impact life on earth of climate change, critically, if either Goal under the Paris Agreement is not achieved.

See: *AFP has world scoop on a draft climate science report*

Reporting on reports:

In the lead-up to the Northern Hemisphere Summer, reports are being published thick and fast: for the ***NZE*** follower or professional, no shortage of reading for inclusion in the holiday luggage.

While Low Carbon Pulse seeks to cover the findings of each report in summary, in future links to reports will be included at the end of each edition (as we have done in this edition), and short summaries of each report will be published outside the publishing cycle of the Low Carbon Pulse, probably at the end of each month.

BESS and BECCS round-up:

- **BECCS to source CO_2: does this give us another acronym? BECCUS?:** On June 18, 2021 it was announced that Ørsted has identified the existing bioenergy Avedore power station (***APS***) as a source of CO_2: the *APS* is a 100 MW straw-fired power station that is owned and operated by Ørsted. It is understood that the intention is to increase the capacity of ***APS*** to 1 GW and to capture and source up to 850,000 tpa of CO_2.

  The captured CO_2 would be used as feedstock for the production of e-fuels, e-methanol and e-kerosene, as part of the Green Fuels for Denmark (***GFFD***) policy setting thereby making this a ***PtX plant***. ***GFFD*** was recently named as an Important Project of Common European Interest (***IPCEI***), which itself is part of the broader EU policy settings consistent with the ***EUH2S***. All EU roadmaps lead from Brussels via the Paris Agreement.

  It is fascinating to see, and to reflect, on this development, consistent as it is with the development of the bioenergy industry: to many in the bioenergy industry there has been an inconvenient truth – while sourcing feedstock or fuel from a renewable source, that source is carbon intensive, with GHG emissions arising on its oxidation, or on its processing and treatment releasing GHG emissions. The capture of the GHG emissions is now firmly on the bioenergy industry radar. Also, it is becoming clear that CO_2 is starting to be viewed as a resource.

  In addition, Ørsted and HOFOR (utility company serving Greater Copenhagen), have agreed to work towards the off-take by Ørsted of renewable energy electrical energy produced by HOFOR's 250 MW Aflandshage off-shore wind field project located in the Oresund Strait (***Aflandshage Project***). Also it has been agreed that HOFOR may locate a substation to step-down the electrical current from ***Aflandshage Project*** on site at the ***APS***.

  See: *Ørsted plans carbon capture at Avedøre Power Station as part of the Green Fuels for Denmark project*

- **BECCS outcomes:** In a report published on June 17, 2021 (on the ***Impact of carbon dioxide removal technologies on deep decarbonization of the electric power sector***) a finding is that: "*adding carbon removal to a mix of [already lower or] low-carbon generation technologies lowers the costs of deep decarbonization. … Bioenergy with carbon capture is selected for net-zero electric sector emissions targets, but direct air capture deployment [making sense and increasing] as biomass supply costs rise*". The report is well-worth a read, especially for those working in the bioenergy / waste industry.

  The report provides a clear headed perspective on the speed at which bioenergy projects using carbon capture and storage can be deployed, and as such is aligned to the findings of the ***IEA Roadmap***: the ***IEA Roadmap*** contemplates that bioenergy / BECCS (and CCS / CCUS) will be critical to achieving ***NZE*** by 2050.

  As noted in Edition 19 of Low Carbon Pulse, among other things, the next article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series will cover BECCS and BECCUS, and all carbon dioxide removal (***CDR***) technologies, including DACs.

  See: *Impact of carbon dioxide removal technologies on deep decarbonization of the electric power sector*

- **Bioenergy and BECCS and BECCUS:** Bioenergy is a term used to describe the use of renewable feedstock principally derived from waste (gaseous, liquid and solid) to derive a feedstock or fuel from which it is possible to derive or to produce an energy carrier (gaseous, liquid or solid).

  Sources of feedstock include principally, agricultural, forestry and other land use waste, the organic fracture of municipal solid waste, and commercial and industrial waste and construction and demolition waste (and other sources described in Chapters 5 and 7 the ***Ashurst – Waste to-Wealth Compendium*** and in the first feature in the ***Hydrogen for Industry*** (***H24I***) series of features, ***Hydrogen from Waste***.

  The technologies used to derive and produce energy from waste include anaerobic digestion (to produce biogas and if reformed biomethane – see Chapter 5 of the ***Ashurst - Waste-to-Wealth Compendium***), and waste to energy or energy from waste thermal treatment technologies (including mass combustion, gasification, pyrolysis, and plasma - see Chapter 2 of the ***Ashurst - Waste-to-Wealth Compendium***) (and those technologies described in Chapter 7 of the ***Ashurst - Waste-to-Wealth Compendium***. (Part 1 of Fuel and Feedstock Resource Recovery - Energy Carriers from Waste), the ***H24I*** series of features, ***Hydrogen from Waste*** and the soon to be published Part 2 of energy carriers from waste).

- **The arrival of the "battolyser":** June 24, 2021, is notable for the arrival of the **battolyser**: the word connotes the use of an electrolyser to produce hydrogen when renewable electrical energy costs are low, to store it, and when renewable electrical energy costs are high, the stored hydrogen will be used to provide electrical energy.

  See: *Dutch Hydrogen Battery Goes Commercial*

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.

CCS / CCUS round-up:

- **Clean Air Task Force (*CATF*) tracking CCS / CCUS:** On June 14, 2021, ***CATF*** (never caught napping) released its ***Europe Carbon Capture Project Activity Map***. It is well-worth navigating.
- **From the Northern Lights Project a CCS + Initiative (*CCS + I*):** On June 16, 2021, an alliance of corporations and other entities announced the establishment and launch of the ***CCS + I*** a venture intended to

leverage carbon markets, including through scaling-up decarbonisation and carbon dioxide removal: it is reported that core to ***CCS + I*** is developing accounting and technologies for CCS / CCUS, to ensure that projects are underpinned by robust cradle-to-grave life-cycle assessments (***LCA***). ***CCI + I*** comprises the North Lights Project, TotalEnergies, Oxy Low Carbon Ventures, South Pole, Perspectives Climate Group and Carbon Finance Labs.

See: *New carbon market initiative to scale-up carbon capture and storage solutions*

- **Singapore chilled about CCUS and hydrogen:** On June 23, 2021, it was reported that five key agencies in Singapore are considering together the findings of two reports, one on CCUS, the other on hydrogen. The agencies are the Civil Aviation Authority of Singapore (***CAAS***), Economic Development Board (***EDB***), Energy Market Authority (***EMA***), the Maritime and Port Authority (***MPA***), and National Climate Change Secretariat (***NCCS***). They are taking an integrated approach to determine how hydrogen and CCUS may reduce Singapore's GHG footprint.

  Identified next steps appear likely to be:

  - **CCUS:** Considering chemical processes that allow carbon capture without underground storage (noting that Singapore does not have significant underground structures for storage), and in so doing consider capture and use, and partnering with other countries, including Australia;
  - **Hydrogen (and hydrogen-based fuels):** Considering the use of hydrogen and hydrogen-based fuels, in particular in the maritime and shipping sector, recognising the constraints that exist on wide-spread adoption of hydrogen, unless and until it becomes cost competitive as an imported energy carrier.

  Given Singapore's size and resources, at the moment, it seems unlikely that Singapore will produce Green Hydrogen. There may be some opportunity for the production of Blue Hydrogen. Given the need for CCUS, the need for the development of refuelling hydrogen infrastructure, the world class public transport system, and the nature of use of motor vehicles, it would appear less likely that ***FCEV*** will achieve wide-spread use in the transport sector in comparison to ***BEV*** use, other than possible specialist vehicles at ports, air and sea.
- **"An important week for #CCUS in Southeast Asia":**
  - **CCUS opportunities in SEA:** On June 23, 2021 (or thereabouts), the ***IEA*** published a technology report entitled ***Carbon capture, utilisation and storage: the opportunity in Southeast Asia*** (***CCUS Report***). The ***CCUS Report*** notes the increased activity around CCUS facility development globally, and that in SEA seven potential CCUS projects (***Seven SEA Projects***) have been identified - in Indonesia, Malaysia, Singapore and Timor-Leste. The ***CCUS Report*** frames the possible size and scope of CCUS projects (including the ***Seven SEA Projects***) opportunities within the region, and the need for cooperation.
  - **Asia CCUS Network** (***ACN***): The ***CCUS Report*** was published to coincide with the establishment of the ***ACN***. The ***ACN*** has been established to facilitate collaboration to develop and to deploy CCUS regionally. ***ACN*** was launched by ***METI*** and the Economic Research Institute for ASEAN and East Asia (***ERIA***).

  See: ***IEA*** website; Executive Director at IEA, Mr Fatih Birol.
- **Carbon Engineering (*CE*) and Storegga Geotechnologies (*SG*) sea-bed fellows:** On June 24, 2021, the MIT Technology Review reported that ***CE*** and ***SG*** are to develop a direct air capture (***DAC***) and storage (***DACS***) project likely to be located in North East Scotland, close to renewable electrical energy sources so as to allow storage of captured CO_2 in sub-seabed structures. As reported, the ***DACS*** project is to be operational by 2026.

  See: *What it will take to achieve affordable carbon removal*
- ***IEA* drops DACS report:** in a particularly busy period of publication, the ***IEA*** has dropped a tracking report, entitled ***Direct Air Capture, more efforts needed*** . The ***DACS Report*** ties back to the ***IEA Roadmap***.

E-fuel / Future fuel round-up:

- **Egypt to quicken the outlook:** On June 14, 2021, it was reported that the Ministry of Electricity and Renewable Energy in Egypt is committed to source 42% of total energy produced in Egypt from renewable sources by 2035. In addition, Egypt's Minister of Electricity and Renewable Energy, Mr Mohamed Shaker, has announced that Egypt is planning to invest up to USD 4 billion in a Green Hydrogen Project (***EGHP***).

  The ***EGHP*** is at feasibility stage. Work being undertaken during the feasibility stage is with the Sovereign Fund of Egypt and other key ministries, including the Ministry of Petroleum and Mineral Resources. It is reported that the feasibility work was to be presented during the week beginning June 21, 2021; as at Sunday, June 27, 2021 there was no further news on progress. Further, Mr Shaker has indicated that an area covering more than 7,000 km^2 has been identified as the location for the development of renewable electrical energy, with up to 90 GW planned.

  See: *International companies to invest in Egyptian green hydrogen projects, says minister*
- **The great start to June continues:** On June 17, 2021, it was announced that EI-H2 (see Edition 17 of Low Carbon Pulse) had awarded Worley Parsons (see Edition 18 of Low Carbon Pulse) a contract in respect of the development of the concept design for the 50 MW electrolyser at Aghada, County Cork, Ireland, as the next step in the development of the Aghada Green Hydrogen production facility (***AGHPF***). From the end of 2023, the *AGHPF* will produce an estimated 20 tpd of Green Hydrogen. For EI-H2 this may be regarded as the first of an number of Green Hydrogen projects to be developed across Ireland: Ireland has high-quality renewable wind and water resources.

  Ireland (as a Member States of the EU) has the resources to produce Green Hydrogen to help the EU achieve its targets for hydrogen production as part of progress towards ***NZE***, although as noted above, it likely that Green Hydrogen produced in other regions of the world is likely to be more efficient. For Worley Parsons (a leading Australian high-value design and engineering company), the award of the contract for the *AGHPF* continues to reflect its status as a "go-to" design and development contractor – continuing to land them from down-under.

See: *EI-H2 Appointed Worley for 50MW Green Hydrogen Facility in Ireland, €120M Project*

- **Itochu and Future Energy:** On June 21, 2021, 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 tpa of ammonia and 91,000 tpa of hydrogen.

- **Ground breaking development:** Edition 9 of Low Carbon Pulse reported on the development by Hyosung Corporation and Linde of a world-scale hydrogen liquefaction facility in Ulsan, South Korea, using Linde's technology to liquify hydrogen arising from the Hyosung Chemical plant. On June 21, 2021, ground was broken at site in Ulsan. On completion the facility will produce around 30 tpd of hydrogen (and up to 13,000 tpa). This is an exciting development for both Hyosung and Linde, and more broadly.

  See: *Hyosung breaks ground for world's largest liquid hydrogen plant*

  As noted in Edition 19 of Low Carbon Pulse, Hyosung, along with Hyundai and POSCO, is a founding member of the Korean Hydrogen Council, announced during the first part of June, and to be launched in September 2021.

- **Fortescue Future Industries (*FFI*) closer on Bell Bay:** Edition 18 of Low Carbon Pulse (under ***Bell Bay Ringing***) reported on the various Green Hydrogen and Green Ammonia arrangements being entered into by project proponents at Bell Bay, Tasmania. On June 22, 2021, one of the proponents, ***FFI*** signed an option agreement with Tasmanian Ports Corporation for ***FFI***'s proposed 250 MW Green Hydrogen project.

- **Oman's aim is true:** Edition 18 of Low Carbon Pulse (under ***Oman Goes Green By Blue***) reported on the Oman Green Energy Hub. On June 16, 2021, the scale of the plans for Oman (a Gulf Cooperation Council (***GCC***) country) became clearer, in light of an interview given to S&P Global Platts, by CEO of OQ (a state owned oil and gas company), Mr Salim al-Huthali.

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

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

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

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

  Mr Salim al-Huthali went on to state that OQ is developing projects to produce: "… both blue ammonia and blue hydrogen .. The blue ammonia project can be accelerated … it is a matter of capturing the CO_2 and obtaining certification that it qualifies [as blue hydrogen and as such] as blue ammonia and can be sold to the market at blue ammonia".

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

  See: *Oman's OQ aims to replace 40% of its 3 GW of power consumption with renewables*

- **New petroleum:** On June 24, 2021, pv magazine asked "Has the Gulf discovered the new petrol?" in an article reflecting on the record low tariffs arising from reverse auctions in the Gulf since the start of 2020, and the implications of them. The article notes (what folk in the ***GCC*** countries already know), production of Green Hydrogen and Blue Hydrogen production in the ***GCC*** region is likely to achieve cost parity sooner rather than later.

  See: *'Low-cost renewable hydrogen may already be in reach'*

Black Gold and Blue and Green Gold:

The white hot logic of OQ applies equally to each other ***GCC*** country. The black gold that has provided prosperity is to be joined (not replaced) by the Blue Gold of Blue Hydrogen and Ammonia, and the Green Gold of Green Hydrogen and Ammonia: there is gold in and on, as well as under, them there hills and dunes. As might be expected, ***GCC*** countries are agnostic as to the colour of this Gold.

In the first article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series, entitled ***Why H_2? Why Now?***, the Gulf region was identified as one of the most prospective areas for renewable electrical energy production and as such for the production of Green Hydrogen and Green Ammonia.

This is proving to be the case. Also it is becoming clear that the Gulf region knows the value of its hydro-carbon reserves, and how to extract the greatest value from them. For the Gulf region, and each ***GCC*** country the road to ***NZE*** will continue to yield prosperity, if you will, a road paved with Gold.

The highly prospective outlook for the ***GCC*** countries is recognised in a recent report. While there are no surprises in the report, it consolidates thinking and provides a blue print for how to realise the promise.

See: *The Potential for Green Hydrogen in the GCC Region*

Green Metals:

- **First fossil fuel free iron and steel projection:** Editions 13 and 16 reported on the development of what is billed as the world's first fossil free steel plant located at Svartoberget, in Lulea, Sweden (***HYBRIT***). The

development of ***HYBRIT*** is being undertaken in alliance with SSAB, LKAB, and Vattenfall (see Editions 13 and 16 of Low Carbon Pulse). Effectively, the ***HYBRIT*** partners have developed a "mine-to-mill-to-manufacture" supply chain.

- **Pilot to commercial scale:** The ***HYBRIT*** plant at Svartoberget, in Lulea, is a pilot plant which had proved up green sponge iron production. ***HYBRIT*** Development AB, owned by SSAB, LKAB, and Vattenfall, is developing a commercial, world scale, plant at Gallivare (see Edition 13 of Low Carbon Pulse).
- **Production assurance:** On June 17, 2021, it was announced that to achieve more efficient storage of the hydrogen produced for use in the manufacture of Green Steel hydrogen, that hydrogen will be compressed, and for this purpose ***HYBRIT*** has contracted with Howden Group (leading air and gas handling company) for the supply by Howden of a high-pressure diaphragm compression system. Depending on which information source is used, the production of steel is responsible for between 7 and 9% of global GHG emissions (see second article in ***The Shift to Hydrogen (S2H2): Elemental Change*** series entitled ***What needs to be decarbonised? And what role can hydrogen play?*** for the scope, size and shape of the global steel industry.)
- **High Light – world first:** On June 21, 2021 it was announced that ***HYBRIT*** had completed the first production test of sponge iron (or direct reduction iron (DRI): see Edition 10 of Low Carbon Pulse), using hydrogen instead of coking coal to remove oxygen thereby avoiding the CO_2 arising. This is a world first.

  See: *Howden provides hydrogen storage compression solution for the world's first pilot plant for fossil-free steel*
- **Howden and NEL frame working relationship:** On June 24, 2021, it was announced that Howden and NEL have signed a Framework Agreement under which Howden and NEL will work together to develop compression technology to compress hydrogen produced by NEL electrolysers. (As noted in previous editions of Low Carbon Pulse, one of the means of transporting hydrogen efficiently is use of tube-tanker trailers from point of production to point of use. For NEL this continues its strategy of contracting with leading technology providers to enable it to contract to provide "whole Green Hydrogen project solutions": as noted in Edition 17 of Low Carbon Pulse NEL is working with First Solar to develop integrated and supervisory control systems to achieve electrical energy efficiency.

  See: Howden website and NEL website

- **Rio Tinto studies use of hydrogen in alumina refining:** Edition 19 of Low Carbon Pulse reported on the use of natural gas in the calcination process inherent in much alumina refining. On June 15, 2021, it was widely reported that Rio Tinto is to undertake a study in the use of hydrogen in alumina refining at its Yarwun refinery, Gladstone, Queensland. This study has the support of the Australian Federal Government, through ARENA grant funding. As noted in previous editions of Low Carbon Pulse, ARENA provides support for renewable technologies.

  See: *Renewable hydrogen could reduce emissions in alumina refining*
- **Rio Tinto and Schneider Electric ink clean metals deal:** On June 23, 2021, it was reported that Rio Tinto and Schneider Electric have entered into an agreement for Schneider to purchase aluminium, borates, copper and iron ore mined and produced by Rio Tinto using renewable electrical energy, and other low carbon technologies.

  See: *Rio Tinto partners with Schneider Electric to drive decarbonisation through circular and sustainable market ecosystem*
- **Volvo moving at speed:** On June 16, 2021 it was reported that Volvo (owned by Chinese car maker, Zhejiang Geely Holding Group) intends to start to manufacture cars made without steel produced using fossil fuels by 2026 (***Clean Steel***). For these purposes, as might be expected from the news items about ***HYBRIT***, Volvo has signed a letter of intent with SSAB for this purpose.

  The use of ***Clean Steel*** to manufacture cars, is another step on the road to achieving Volvo's commitment to be climate neutral (across all three Scopes of GHG emissions by 2040). Consistent with this commitment, Volvo has committed itself to manufacture only battery electric vehicles (***BEVs***) by 2030, and to develop fuel cell electric vehicles (***FCEVs***) with Daimler (see Edition 17 of Low Carbon Pulse – ***Volvo and Daimler back-into FCEV***).

  See: *Volvo Cars is first car maker to explore fossil-free steel with SSAB*
- **Volvo at the double:** On June 22, 2021 it was reported that Volvo AB, with Hitachi ABB Power Grids Sweden, H2 Green Steel, Ovako AB and NEL ASA are to develop a 17 MW fossil fuel free hydrogen facility at Ovako AB's steel mill in Hofors, Sweden. (The development of the facility is distinct from other projects in which each corporation is involved, and is supported by the Swedish Energy Agency.)

  By way of reminder: February 23, 2021, H2 Green Steel was announced as a green steel venture (see Editions 11 and 12 of Low Carbon Pulse), proposing development of a 5 mtpa green steel facility, with the project having Important Project of European Common Interest (***IPECI***) status. As noted in Edition 12 of Low Carbon Pulse, H2 Green Steel is backed by, among others, Mr Daniel Ek (founder of Spotify), Scania and Vargas. Other equity investors in the H2 Steel include the Agnelli, Maersk, and Wallenberg families, and Mercedes-Benz and the IKEA foundation.
- **The greening of car manufacture:** Edition 9 of Low Carbon Pulse reported on the "lower emission metal" deal between BMW and Emirates Global Aluminium. On June 16. 2021 it was reported that BMW is continuing the greening of its car manufacture with the development of its first ***FCEV*** passenger car: it has been reported that BMW has started road-testing a ***FCEV*** powered and propelled car to determine the potential of ***FCEVs***.

  See: *New Batteries for the New Class*

- **How much Green Hydrogen is needed:** The World Economic Forum (among other things, the organisation that established the Hydrogen Council), has released a report outlining steel production from 1970 to 2020. Please click here for a visual representation of global steel production.

  In 2020, 1,864 mt (or 1.864 billion tonnes) of crude steel was produced globally. This is consistent with the detail in ***The Shift to Hydrogen (S2H2): Elemental Change***, which provides a sense of how much Green Hydrogen, and as such renewable electrical energy is required "to green" the production of that quantity of steel. It is estimated that by 2050, annual production of steel will increase to 2,750 mtpa (or 2.75 btpa).

Hydrogen Cities, Councils, Hubs, Infrastructure and Valleys:

- **How Green is the Hydrogen Valley:** On June 18, 2021, Euractiv published an article entitled "***'Hydrogen Valley' projects sprout up across Europe***". While there is nothing new in this news, what is new, and what is news, is that a report on hydrogen valleys has been published. The report characterises hydrogen valleys (***H2Vs***), as smaller-scale, medium-scale and larger-scale. The report covers over 20 ***H2V*** projects in the EU and the UK, and 34 globally, across 19 countries. This report follows hot-on-the-heels of the report referred to in Edition 19 of Low Carbon Pulse detailing the emerging use and benefit of hydrogen valleys.

  See: *'Hydrogen valley' projects sprout up across Europe*

- **Giga-factories and hydrogen refuelling infrastructure**: Factories manufacturing electrolysers and hydrogen refuelling infrastructure and stations are critical to the development of the hydrogen economy. Future editions of Low Carbon Pulse will monitor both the levels of manufacture from factories, and the development of new factories.

  On June 22, 2021, McPhy (the French electrolyser and hydrogen station manufacturer) announced that it would increase manufacturing capacity of hydrogen stations from 20 units to 150 units a year. For these purposes, McPhy is to develop a new manufacturing facility in Grenoble (in the Grenoble-Alpes Metropole region), France.

  See: *McPhy opens a new industrial site in Grenoble and will increase its hydrogen station production capacity sevenfold*

- **Decarbonising construction sites:** Construction activity gives rise to noise, to pollution and to GHG emissions. A policy setting that is emerging is the decarbonisation of activities undertaken at construction sites: it is estimated that 10% of GHG emissions globally arise from construction activities. In Oslo, Norway, it is estimated that 7% of its total GHG emissions arising in the city arise from construction activities.

  See: *The Scandinavian way to zero-carbon construction*

- **Italian North African Hub:** Edition 19 of Low Carbon Pulse reported on the development of a pipeline network to carry hydrogen. For a number of reasons, Italy has joined Spain, in being thought of as hub between Europe, as the market for Green Hydrogen use, and North Africa, as a Green Hydrogen producing region. This is an area that Low Carbon Pulse will follow.

- **HyNet North West's net worth increasing:** Edition 19 of Low Carbon Pulse outlined the scope 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.

  On June 23, 2021, HyNet announced plans for the development of a zero carbon power plant in collaboration with InterGen at the site of its existing Rocksavage power station (***RPS***), a gas-fired power station in Runcorn, Cheshire, England. As announced, the intention is to blend hydrogen with natural gas at ***RPS***.

  See: *Hynet North West and Intergen Announce Plans for a Zero Carbon Power Plant*

- **Four Giga Factories For India:** On June 24, 2021, Reliance Industries Limited (***RIL***) (world scale, Indian conglomerate) Chairman, Mr Mukesh Ambani announced that the company is to develop four giga factories. Mr Ambani announced that: "Reliance will develop four giga factories which will manufacture and [integrate fully] all critical components of the new energy ecosystem".

  The development of the four giga factories is part of ***RIL***s broader plans for the new energy ecosystem. These plans include the installation of 100 GW of solar capacity by 2030, critically in the context of roof-top solar and micro-grid installations (see above ***India continuing down the road looking to roof-tops and micro-grids: Roof-top solar for India*** and ***Micro-grids for India***).

  See: Reliance website

Sustainable Energy Round-up:

- **Brazil at pace::** It has been widely reported that Brazil has received tender responses in respect of 1,694 projects to provide nearly 94 GW of electrical energy (including 58 GW of renewable electrical energy).

  The prize for successful tenderers is the award of long-term power purchase agreements (as part of the A5 auction), with the term differing depending on the fuel or source: 25 years for hydro-electric power, 20 years for any fuel or source (other than hydro-electric and solar and wind), and 15 years for solar and wind.

  The A.5 auction process is scheduled for September, 30, 2021. A future edition of Low Carbon Pulse (likely marking the first anniversary of Low Carbon Pulse), will cover the outcome of the auction process.

  See: *Brazil registers nearly 58 GW of renewables for Sept 30 tender*

- **Fortescue Metals Group (*FMG*) increasing the global pace:** On September 25, 2020, Dr Andrew Forrest, AO (founder of ***FMG***) signed an agreement with the Democratic Republic of Congo (***DCR***). On June 15, 2021, it was reported that the Government of DCR announced that FMG is to develop the 4.8 GW Grand Inga hydroelectric power project.

  See FMG website

- **Canadian General Fusion:** On June 17, 2021, it was reported by the BBC that Canada General Fusion (a company with backing of Amazon) intends to develop a demonstration nuclear fusion reactor in Oxfordshire, England. The BBC report follows a report on June 1, 2021 that the UK Government is planning to develop a regulatory regime to allow the development of nuclear fusion as part of its broad, and world leading, regulatory regime supporting progress towards ***NZE***, consistent with recommendation of the Regulatory Horizons Council Report of Fusion Energy.

  See: *Nuclear energy: Fusion plant backed by Jeff Bezos to be built in UK*

- **PPT sees Global Power Synergy in renewables, and positioning globally:** On June 22, 2021, it was reported that PTT Public Company Limited (state-owned oil and gas company, known as PTT) is committing USD 635 million to renewable energy developments in Asia, including the key markets of China and India. PTT has set itself the target of increasing the proportion of generated power from 12% to 30%. For the purposes of making these investments, PTT has established subsidiary, Global Power Synergy (***GPS***): ***GPS*** is 75% owned by PTT.

  See: *Power unit of Thailand's PTT makes $635m pivot to Asia green energy*

- **Global costs arena for renewables energy, by IRENA:** On June 22, 2021 (or thereabouts), the International Renewable Energy Agency (***IRENA***) published a report entitled ***Renewable Power Generation Costs in 2020***.

  The headlines from the ***IRENA*** report are that the:

  - global weighted-average levelized cost of electricity (LCOE) from new installed capacity continues to fall (compared to 2019) as follows: solar (CSP) by 16%, utility-scale solar (***USPV***) by 7%, and on-shore wind by 13%, and off-shore wind by 9%; and
  - operating costs of the existing 800 GW of installed coal-fired capacity globally are higher than those of ***USPV*** and on-shore wind: displacing coal with renewable electrical energy would reduce operating costs by USD 32 billion, and reduce annual GHG emissions by around 3 Gt (3,000 million tonnes, 3 billion tonnes).

  As might be expected, ***lower operating costs*** headline has received considerable immediate attention. It is important to note that the analysis does not deal with the unamortised / stranded capital costs of displacement.

  In the same week as the ***IRENA*** report, the ***IEA*** published its Statistics Report – ***Energy Prices: Overview – High-Quality data on end-use energy prices***. Both reports are well-worth a read.

- **Australian Federal Government slows pace on world scale project:** A number of editions of Low Carbon Pulse have reported on the proposed development of the Asian Renewable Energy Hub (***AREH***), in the Pilbara Region of Western Australian. Having been given Major Project Status by the Federal Government, to facilitate the development ***AREH***, the Federal Government has slowed the pace of progress of *AREH* on the basis of its prospective impact on wetlands. It is expected that ***AREH*** will take on board the concerns raised, and that ***AREH*** will proceed in a modified form.

  See: *Asian Renewable Energy Hub Revised Proposal*

- **Iran's mountains and valleys, and plains:** On June 24, 2021, Oil Price published an article entitled, ***Will Iran Emerge As A Renewable Energy Breakout Story?***. The article works at three levels, first, to provide an update on Irans's progress to ***NZE***, secondly, that climate change can affect choices of renewable energy technology, in this case run of river hydro, and thirdly, as a reminder that all countries need to progress to ***NZE***.

  See: *Will Iran Emerge As A Renewable Energy Breakout Story?*

- **Iraq and Masdar on the same plain:** On June 25, 2021, it was announced that the Government of Iraq and Masdar (Abu Dhabi Future Energy Company) had signed a strategic agreement to develop at least 2 GW of solar projects in Iraq. This may be regarded as an illustration of countries assisting each other to progress to ***NZE***.

  See: *Masdar signs strategic agreement to develop solar projects in Republic of Iraq*

- **Kazakh Invest National Company increases pace to world scale projects:** On June 25, 2021, Kazakh Invest National Company and Svevind (a privately-owned corporation, based in Germany) signed an memorandum of understanding (***MoU***) to develop mega-scale Green Hydrogen production facilities in Kazakhstan. The ***MOU*** contemplates the development of up to 45 GW of renewable solar photovoltaic and wind farms to supply electrical energy to up to 30 GW of electrolysers, to produce up to 3 mtpa of Green Hydrogen.

  See: *SVEVIND and Kazakh Invest National Company JSC sign a memorandum of understanding*

- **Sub-sea cables are live:** On June 14, 2021, it was announced that the North Sea Link, connecting Norway and the UK was operational, carrying a current of electrical energy using high voltage direct current cable (***HVDC***).

  On June 24, 2021, the Australian Financial Review revisited the suggestion of the PRC President, Mr Xi Jinping (made to the United Nations) of a "global energy internet" or "submarine super-grids" using ultra-high-voltage direct current (***UHVDC***) transmission lines.

Wind round-up:

- **Tail wind for floating off-shore in Spain:** On June 14, 2021, Saitec (among other things, an off-shore technology company) presented the initial project documentation as part of the Environmental Impact Assessment process, for the purposes of gaining approval to develop a 45 MW a floating off-shore wind field project 10 kms off Bilbao, Vizcaya Province (***BOVP***). The intention for the ***BOVP*** is to be operational by 2025.

  In Edition 19 of the Low Carbon Pulse, 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. Spain has world class renewable resources, both on on-shore and off-shore.

  See: *Saitec Unveils Floating Wind Project Off Bilbao*

- **Japan first floating off-shore wind field to progress:** On June 14, 2021, it was widely reported that the Ministry of Economy, Trade and Industry (***METI***) and the Ministry of Land, Infrastructure and Tourism (***MLIT***)

had appointed a consortium to develop the 16.8 MW floating off-shore wind field project, off Goto City, Nagasaki Prefecture. The consortium (called ***Goto City Offshore Wind Power Generation LLC***) comprises Chubu Electric Power, ENEOS Corporation, INPEX, Kansai Electric Power, Osaka Gas, and Toda Corporation (the leader of the consortium).

The appointment of ***Goto City Offshore Wind Power Generation LLC*** followed the completion of an auction process commenced in 2020 (under the Renewable Sea Area Utilization Law), and closing in late December 2020. The area off-shore of the Goto coast is one of 11 areas identified by ***METI*** and ***MLIT*** as prospective for off-shore wind field development. Edition 19 of Low Carbon Pulse reported on the Akita and Chubu area auction processes, being auctions for the development of fixed bottom off-shore wind fields, rather than floating.

See: *Toda-led group wins auction for 16.8-MW floating wind project in Japan*; METI; MLIT and Toda Corporation

- **Baltic hot spot heats-up:** Editions 8, 14 and 18 of Low Carbon Pulse have reported on the development of off-shore wind-field projects in the Baltic, with the development underpinned by the use of contracts for differences (***CFDs***). On June 16, 2021, it was reported that Baltic Power had been awarded a ***CFD***. (Baltic Power is an incorporated joint venture between PKN Orlen (a Polish based oil refiner and petroleum retailer), holding 51%, and Northland Power, Inc. (a Canadian based utility corporation), holding 49%.)

  This is the third ***CfD*** awarded in 2021 under the Offshore Act (see Editions 8 and 14 of Low Carbon Pulse). As noted in Edition 18 of Low Carbon Pulse, the award of ***CfD***s is seen as a key to enabling Poland to achieve its target of develop up to 10.9 GW of off-shore wind capacity by 2027: with auctions for 5.9 GW by the end of by 2021, and two further tranches to be auctioned by 2025 and 2027.

  See: *Northland Power Achieves Key Baltic Power Milestone With 25-Year Award of Contract for Difference in Poland*

- **Open book on Empire Wind:** On June 18, 2021, it was widely reported that the Bureau of Ocean Energy Management (***BOEM***) is to conduct an environmental review of the BP and Equinor Empire Wind off-shore wind field project (***EWOP***) off the coastlines of the US states of New Jersey (17 miles east of Long Branch) and New York (12 miles south of Long Island). (BP and Equinor are reported as being 50/50 joint venturers in Empire Wind LLC.) This process starts with a notice of intent leading to the preparation of an Environmental Impact Statement of the construction and operations plan (***COP***) developed by Empire Wind LLC.

  As has been noted before in Low Carbon Pulse, among others, the off-shore areas of the east coast of the US are highly prospective, having the benefit of being close to load. Assuming approval of the ***EWOP***, its development is consistent with the policy objectives of the state of New York to have installed 9 GW of off-shore wind capacity by 2035, and the US to have installed 30 GW off-shore wind capacity by 2035.

  See: *BOEM Announces Upcoming Environmental Review for a Proposed Wind Project Offshore New York and New Jersey*

- **North and South Utsira bottom or floating forecast news:**
  - **Status check:** Edition 18 of Low Carbon Pulse reported on the Utsira Nord and Solige Norsjo II areas (known on UK shipping forecasts, as North Utsira and South Utsira) in the Norwegian sector of the North Sea. Together, Utsira Nord and Solige Norsjo II have wind resource potential of up to 4.5 GW of installed capacity. The Norwegian Government (Ministry of Petroleum and Energy) has indicated that Utsira Nord is suitable for floating off-shore wind and that Solige Norsjo II must be developed without any state-aid.
  - **BP and Aker Offshore Wind and Statkraft:** On June 14, 2021, it was announced that BP is partnering with Aker Offshore Wind and Statkraft in a consortium to apply to develop a fixed bottom off-shore wind field in the Solige Norsjo II area.

    See: *bp, Aker and Statkraft join forces for offshore wind in the Norwegian North Sea*
  - **Shell and BKK and Lyse bottom out and float:** On June 17, 2021, it was announced that Shell intends to partner with Norwegian hydro-electric companies, BKK and Lyse, to apply to develop off-shore wind field projects in both the Utsira Nord and and Solige Norsjo II areas. It is understood that the partners are contemplating the development of floating off-shore wind field capacity in the Utsira Nord area, and each partner has a clear view about the quality of the wind resources in the North Sea.

    Also BBK, CEO, Ms Jannicke Hilland provided an interesting perspective on the interface between hydro-electric and wind: "[When these off-shore wind fields produce electrical energy], we can hold back the water in our reservoirs, we can cover the demand for power by phasing in hydro-production".

    See: *Shell, local partners to bid for wind licences offshore Norway*

- **Old acquaintances combine again for new gig:** On June 16, 2021, it was widely reported that international energy company, TotalEnergies, Green Investment Group (***GIG***), and Renewable Infrastructure Development Group are to bid jointly in the ScotWind off-shore wind field leasing round (see Edition 8 of Low Carbon Pulse). TotalEnergies and ***GIG*** are well-acquainted, having bid, and won jointly a number tenders. TotalEnergies has an existing interest in the off-shore wind project, Seagreen 1 (see Edition 4 of Low Carbon Pulse).

- **Floating Scottish Wind being funnelled:** On June 18, 2021, renewable giant, Copenhagen Infrastructure Partners (***CIP***) announced that it had revived plans to develop a 100 MW floating off-shore wind field project off Dounreay, Caithness, Scotland (the ***Pentland Off-shore Wind*** project or ***POWP***), using Highland Wind Limited (in which ***CIP*** is majority shareholder).***CIP*** anticipates financial close in 2024, and commissioning in 2026.

  Scotland, a country of high-land and hard rain (after Aztec Camera), has some of the best off-shore wind resources in the world, and is close to load. As floating wind field technology develops it is to be expected that those resources will be developed. Edition 14 of Low Carbon Pulse notes the success of early mover, HyWind.

  See: *CIP Revives Floating Wind Project Offshore Scotland*

- **North Carolina looking off-shore:** On June 18, 2021, the Governor of North Carolina, Mr Ray Cooper, issued an executive order targeting the development of off-shore wind field capacity off the coast of the eastern sea-board State. Mr Cooper is targeting the development of 2.9 GW of installed off-shore wind field capacity by 2030, and 8 GW by 2040. This continues the development of the world class off-shore wind resources off the US.

  See: *Governor Cooper Commits to Offshore Wind Power as North Carolina Creates Jobs by Transitioning to a Clean Energy Economy*

- **Strong off-shore winds:** In a number of reports and editorials, the current and projected investment levels of investment in off shore wind fields globally have featured strongly, in particular in Asia: it estimated, as mid-2021 approaches, that 500 GW of off-shore wind capacity has either been installed or new capacity development announced.

  See: *Report: Asia-Pacific Set to Overtake Europe in Offshore Wind Power*

Solar round up:

- **Solar on Semakau:** On June 17, 2021, JTC Corporation (a Singapore Government Agency) and Shell announced that they had signed a non-binding Memorandum of Understanding (***MOU***) to explore jointly the possible development of a solar farm on part of the Semakau Landfill, off-shore of Singapore. (The Semakau Landfill is used to landfill bottom ash and other residual material from Singapore's waste-to-energy facilities.) It is reported that the ***MOU*** is supported by Singapore's National Environment Agency and Energy Market Authority.

  See: *JTC & Shell to Explore Semakau Solar Farm to meet Singapore's Growing Clean Energy Needs*

- **Electrification of Africa: abundance of sun and rain, in search of capture:**

  The electrification of Africa has been in the news of late, principally as a number of conferences have highlighted the need to increase the rate of electrification, but in a way that is consistent with achieving ***NZE***.

  - **Solar in Mozambique:** On June 14, 2021, it was reported that the Norwegian and UK governments have provided support for a smaller scale solar and battery electric storage project in Mozambique, but nevertheless described as utility-scale. The support was provided by Globeleq (a renewables entity, owned by the Norwegian and UK Governments).

    This is the first independent utility-scale solar project in Mozambique. In addition to the backing of Globeleq, the project has received grant funding from the Private Infrastructure Development Group (***PIDG***), which is itself funded by the International Finance Corporation and the Governments of Australia, Germany, the Netherlands, Sweden, Switzerland, and the UK.

    See: *UK and Norwegian governments back solar-plus-storage in Mozambique*

  - **Solar in Tanzania:** On June 15, 2021, it was reported that an agreement had been reached by the French Government's French Development Agency (***AFD***) with the Tanzanian Government to fund the development of a 150 MW power plant in Kishapu, Shinyanga, northern Tanzania.

    The stated purpose of this project is to increase the security of electrical energy supply and to diversify the sources of supply of the Tanzania Electric Supply Company Ltd (***Tanesco***), critically to address the impact of the dry season on electrical energy sourced from hydroelectric sources available for on-grid dispatch. It is reported that 43% (561.8 MW) of ***Tanesco***'s installed capacity is hydroelectric, and 57% (693.3 MW) diesel and gas (with a further 52.2 MW of diesel capacity off-grid).

    See: *AFD to Finance the First Grid Connected Solar Photovoltaic Power Plant in Tanzania and the Modernization of Electricity Network*

  - **Solar in Africa:** A long-standing theme on progress to ***NZE*** is that at the same time as progress is made, the access rate to electrical energy needs to increase: the ***IEA*** estimates, conservatively, that around 800 million people globally do not have access to electrical energy.

    It is understood that in Tanzania the access rate is 32.7%, with 67.3% of the population (7.7 million people) without access to electrical energy. The need for electrification is particularly acute in Africa: close to 600 million people did not have access to electrical energy in Sub-Saharan Africa in 2020, projected to increase to 630 million people by 2030. The development of off-grid solar is an area in which the developed world can make a difference: as will be apparent from the next news item, that the technology exists to achieve 100% electrification off-grid.

- **100% solar at Onslow WA:** On June 18, 2021 is was widely reported that the Horizon Power (a Western Australian state-owned power company) has satisfied the load of Onslow, on the Western Australian coast, using solar and ***BESS***. This is the first successful testing of a scale, and scalable, off-grid, micro-grid.

  See: *Onslow Microgrid Powered Hydrocarbon Free*

Port News and Shipping Forecasts:

- **Ports of Auckland Limited (*POAL*) and Obayashi team:** On June 23, 2021, ***POAL*** announced that ***POAL*** and Obayashi are to joint venture with a view to the development of refuelling infrastructure at the Port to allow the displacement of fossil fuel use for port vehicles and buses within Auckland.

  See: POAL website

- **First Hydrogen Cargo Vessel Sails Closer:** On June 23, 2021 Statkraft and Skagerak Energi reported their appointment to supply Green Hydrogen for a vessel planned by HeidelBerg Cement and Felleskjopet. Under the Green Shipping Program, HeidelBerg Cement and Felleskjopet are planning to develop of a zero-emission bulk vessel (***ZEBV***) to transport grain from Eastern Norway to Western Norway, and gravel and rock on the return voyage: ***ZEBV*** is to be powered and propelled using Green Hydrogen and rotor sails.

  See Statkraft website

- **Mid-Summer Nights Dreaming about reports:** "I have had dreams" (after Bottom) … what visions I have seen" (after Titania) from the scoop of reports in June. The pick of the scoop, is ***Hydrogen Europe's How Hydrogen Can Help Decarbonise the Maritime Sector*** . The report provides a clear perspective on required policy settings, and provides a balanced perspective on the use of hydrogen, noting the importance of energy density, and the need for supply to develop in tandem with demand.

Land Transport (automobiles, buses, trains and trucks) round-up:

- **GMC on track - BEV for Trains:** On June 15, 2021, it was announced that General Motors Corporation (***GMC***) had entered into arrangements with Wabtec Corporation to develop a battery electric locomotive.

  See: *Wabtec and GM to Develop Advanced Ultium Battery and HYDROTEC Hydrogen Fuel Cell Solutions for Rail Industry*

- **On the high road:**
  - **Hyundai at home around Munich:** On June 25, 2021, it was announced that Hyundai had delivered to its first Elec City Fuel Cell bus for use in testing on the roads of Munich.
  - **Hyzon Motor Inc at home around Christmas Creek, Western Australia:** On June 22, 2021, it was announced that Hyzon's FCT custom-built coach had passed tests for use in the hostile mining environment of Western Australia: it is reported that Fortescue Metals Group (leading iron ore company founded by Dr Andrew Forrest, AO) has ordered up to 10 of the coaches.
  - **Woodside Energy Limited (*WEL*) joins Hyzon Zero Carbon Alliance** (***HZCA***)**:** On June 25, 2021, it was announced that ***WEL*** (leading Australian oil and gas company) had become a member of the ***HZCA***. The ***HZCA*** was launched on April 22, 2021 to drive the development of a hydrogen mobility supply chain globally. ***WEL*** joins other exceptional corporations, including Ark Energy, AXA, Bank of America, Hiringa Energy, Modern Group, NEOM, Raven SR, ReCarbon, and TotalEnergies.
  - **Nikola:** On June 22, 2021, it was announced that Nikola had acquired a stake in an Indiana Hydrogen Plant. This initiative demonstrates the need for vehicles manufacturers to be assured of supply to satisfy the demand for hydrogen that their vehicles will create, and follows the approach Hyzon and Raven SR outlined in Edition 16 of the Low Carbon Pulse.

  See: *Hyundai Motor's Elec City Fuel Cell Bus Begins Trial Service in Munich, Germany; Road warrior: Hyzon Motors passes durability test for Australian mining company, delivering the world's first hydrogen-powered coach fleet; Hyzon Zero Carbon Alliance welcomes Australia's leading natural gas producer, Woodside Energy; Nikola Invests $50 Million in Wabash Valley Resources to Produce Clean Hydrogen in the Midwest for Zero-Emission Nikola Trucks*

Airports and Aviation:

- **Airbus, Air Liquide and Group ADP think clean hydrogen:** On June 21, 2021, it was reported widely that Airbus, Air Liquide and Group ADP have signed a memorandum of understanding (***MoU***) under which they plan to work together to prepare for the use of hydrogen to power and to propel commercial aircraft. The ***MoU*** the deals with the production, supply, and delivery / distribution of clean hydrogen.

  Edition 18 of Low Carbon Pulse mentioned this in passing (***Paris circles 11 projects to transform Paris' airports into hydrogen hubs***). It would seem that Airbus, Air Liquide and Group ADP are going to work as part of this initiative, critically the work being done in respect of Paris-Charles de Gaulle and Paris-Orly to identify the infrastructure development requirements.

- **Airbus thinks tanks:** On June 14, 2021, it was reported that Airbus has started to work on the development of hydrogen fuel tanks. The development work is being undertaken at two Zero-Emission Development Centres (***ZDECs***), one at Bremen, Germany, the other at Nantes, France. The development of cryogenic fuel tanks is critical to the development of a hydrogen propelled (and powered) Zero-e aeroplane (***ZEA***) that Airbus is aiming to develop by 2035 (in September 2020 Airbus released a description of three hydrogen concept aeroplanes). The development work is intended to be completed by 2023 to allow a test flight of the ***ZEA*** scheduled for 2025.

  See: *Airbus Starts Work on Hydrogen Fuel Tanks for Airliners*

- ***GMC* off road, in search of flush:**

  Airborne *FCT*: ***GMC*** is known for manufacture of automobiles – on road and off-road vehicles. In addition, ***GMC*** manufactures engines and power units for maritime vessels and for trains. GMC has developed a hydrogen technology – Hydrotec fuel cell technology (***FCT***) systems. On June 18, 2021, it was widely reported that *GMC* is to work with Liebherr-Aerospace (part of the Liebherr Group, owned by the Liebherr family), to develop power systems for aeroplanes. (Those familiar with Low Carbon Pulse will have noted, in respect of each mode of transport, that "powering and propelling" is used, this is because all modes of transport (with the obvious exception of the bicycle) require energy to power them and to propel them.)

  Use of *FCT*: Aeroplanes have (internal) power systems to provide the energy necessary to operate "the electrics" within the aeroplane, including to operate the air-conditioning systems (including to circulate and to humidify the air within the aeroplane), the galley systems, the hydraulics, and the water systems (potable and waste). Aeroplanes have (external) propulsion systems to propel them (jet or turbo-propulsion engines). ***GMC*** and Liebherr are developing power systems to use ***FCT*** that will produce water to be used on board aeroplanes.

  Great Quote: In one of the quotes of 2021 so far, GM Executive Director of Global Hydrotec, Mr Charlie Freese provides an unforgettable factoid: "The average aircraft takes off with two tons of water just to flush the toilet. We can now make water in flight".

  Good Observation: The keen-eyed observer will note that ***GMC*** is charging ahead with its ***FCT*** for planes and trains, but not automobiles. The reason for this is explained by ***GMC***'s GM Executive Director of Global Hydrotec,

Mr Charlie Freese: "Having the ability to provide both [***BEV*** and ***FCEV***] technologies lets you see where the technology fits best, and not have to try to force a square peg into a round hole. … Batteries are great for a lot of power, and the hydrogen fuel cell is great for a lot of energy on board, and the two are great complements". This does not mean that ***GMC*** will not develop an automobile using ***FCT***, but it will wait until the hydrogen supply is widespread. Another example of the need for supply to precede demand.

Negative Emissions Initiatives and Carbon Credits, and off-sets:

- **Sharper modelling focus at BlackRock:** Previous editions of Low Carbon Pulse have reported on the importance to BlackRock of understanding that each corporation in which it invests has a net-zero GHG emissions strategy that its board has approved and endorsed, and to which it is committed (see Editions 9 and 10 of Low Carbon Pulse). On June 17, 2021, BlackRock announced that it had acquired Baringa Partners Climate Change Scenario Model for integration into BlackRock's Aladdin Climate technology, as part of a long-term partnership. This transaction recognises that climate risk is an investment risk, micro, and macro.

  See: *BlackRock to Acquire Baringa Partners' Climate Change Scenario Model Through New Long-Term Partnership*

- **Sharper definition on key issues:**
  - On June 21, 2021, a study entitled ***Asymmetry in climate – carbon cycle response to positive and negative CO_2 emissions*** was released. The key take-away from the study is that impact on average temperature of CO_2 emissions and negative CO_2 emission initiatives are assumed by many to be the same, with one tonne of CO_2 emitted, being neutralised by one tonne captured. Any assumption of symmetry is not sound: it is not appropriate to assume that the impact on temperature of one tonne of CO_2 emitted, is neutralised by the removal of one tonne of CO_2. In light of this, use of negative CO_2 emission initiatives is likely to be subject to closer scrutiny in respect of the use of carbon credits acquit CO_2 obligations;
  - On June 22, 2021, there was some commentary that emphasised the need to understand what is meant by ***carbon neutrality*** and by ***net zero***, particularly in the context of achieving ***NZE***. As readers of Low Carbon Pulse will know, at an organisational level: (**i**) ***net-zero*** emissions is measured across each Scope of GHG emission, Scopes 1 to 3, with any positive net outcome to be off-set by negative CO_2 initiatives to remove that positive net outcome, and (**ii**) ***carbon neutrality*** refers to being carbon natural across each of Scope 1 and 2, with any positive net outcome to be off-set using carbon credits to off-set.
- **World Economic Forum recirculates:** On June 17, 2021, the World Economic Forum posted an article by Sebastian Cox, that takes a different perspective on carbon, from the perspective of trees, and as such viewing carbon as a resource. The article is well-worth a read.
- **Carbon above and below ground:** On June 24, 2021, the New Scientist published an article entitled ***Global vegetation stores decade of human carbon emissions underground***. The title of the article provides a fair idea of its substance: the key finding is that on average 24% of the mass of biomass is underground - forests (22%), grasslands (67%) and scrubland (47%). Previous estimates have been within a 20 to 30% range. The research on which the article is based provides good data for negative GHG emission initiatives.

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 storage of it.

Net-zero – a round-up and net-zero commitments in the round:

- **Rolls-Royce outlines plans to reach Net-Zero by 2050:** On June 17, 2021, Rolls-Royce (a leading manufacturer of power and propulsion systems) outlined plans to progress net-zero emissions by 2050.

  See: *Rolls-Royce puts net zero carbon by 2050 at the heart of future innovation and growth*

- **Awake and ready for, and on the road to *NZE*:** On June 22, 2021, Schlumberger announced its commitment to achieve net-zero emission by 2050, compared to 2019. The announcement states: "With minimal reliance on off-sets, the plan is focused on reducing Scope 1, 2 and 3 emissions across the oil and gas value chain …". In accordance with best practice, the roadmap to ***NZE*** is staged, with a 30% reduction in Scope 1 and 2 emissions by 2025, 50% reduction in Scope 1 and 2, and 30% reduction in Scope 3 by 2030, and ***NZE*** by 2050.
- **Keeping close to Racing on the Road to *NZE*:** Edition 19 of Low Carbon Pulse included a really helpful arc from the "visualcapitalist.com" detailing the commitments of countries to net-zero emissions (***NZE***). A link the visual arc is attached.

  Attached is a link to a graphic developed in respect of Fortune Global 500 companies.

NZE reports:

As noted above, at the end of future editions of Low Carbon Pulse reports that have been reviewed for the purpose of that edition of Low Carbon Pulse will be listed, by title and link.

ORGANIZATION	TITLE / SUBJECT BATTER
Commonwealth Government of Australia, Advisian and the Clean Energy Finance Corporation (***CEFC***),	*Australian hydrogen market study – Sector analysis study*
Dii & Roland Berger	The Potential for Green Hydrogen in the GCC Region
Electric Power Research Institute	*Impact of carbon dioxide removal technologies on deep decarbonization of the electric power sector*
European Hydrogen Backbone	*Analysing future demand, supply, and transport of hydrogen*
Hydrogen Europe	*Hydrogen Europe's How Hydrogen Can Help Decarbonise the Maritime Sector*
Hydrogen Valley Platform	*Hydrogen Valleys: Insights into the emerging hydrogen economies around the world*
Hysource	*Net Zero Emissions by 2050 and the Role of Hydrogen*
International Energy Agency (***IEA***)	*Unlocking the Economic Potential of Rooftop Solar PV in India*
International Energy Agency (***IEA***)	*Net Zero by 2050: A Roadmap for the Global Energy Sector (IEA Roadmap).*
International Energy Agency (***IEA***)	*Energy Prices: Overview – High-Quality data on end-use energy prices*.
International Energy Agency (***IEA***)	*Carbon capture, utilisation and storage: the opportunity in Southeast Asia*
International Renewable Energy Agency (***IRENA***)	*World Energy Transition Outlook: 1.5^{O}C Pathway: Preview*
International Renewable Energy Agency (***IRENA***)	*Renewable Power Generation Costs in 2020*
KBR	*Study of Hydrogen Imports and Downstream Applications for Singapore*
Navigant	*Carbon Capture, Utilisation and Storage, (CCUS): Decarbonisation Pathways for Singapore's Energy and ChemicalsSectors*
Regulatory Horizons Council	Regulatory Horizons Council Report of Fusion Energy
Zickfeld, K., Azevedo, D., Mathesius, S. et al.	*Asymmetry in climate – carbon cycle response to positive and negative CO_2 emissions*

The author of Low Carbon Pulse is Michael Harrison.

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

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