Low Carbon Pulse - Edition 28

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS

Business as usual: Welcome to **Edition 28** of Low Carbon Pulse – sharing significant current news on progress towards net-zero greenhouse gas (***GHGs***) emissions globally. This edition covers the period from Monday September 20, 2021 to Sunday October 3, 2021 (inclusive of each day).

Please click here for **Edition 27** 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.

The third and fourth articles in the ***S2H2*** series will be published over the couple of months. The third article will be on ***Hydrogen Plans, Roadmaps, and Strategies***, and the fourth article will be on ***CCS / CCUS***.

Edition 28 of Low Carbon Pulse will be posted again on **October 8, 2021** for those reading later in the week.

An anniversary: Edition 1 of Low Carbon Pulse was published on October 6, 2020, covering the seven day period from September 27, 2020 to October 4, 2020. To mark the anniversary of **Edition 1**, the ***Global Ashurst Towards Zero Emissions*** team is preparing a review of the last 12 months, and a preview of the next 12 months, looking at key themes and trends. The review will link to Editions 1 to 28, consolidated into the ***Low Carbon Compendium***, and to each paper, report and study referenced in Low Carbon Pulse.

Progress to COP-26:

- **A Climate Week:**
  - **UN General Assembly:** The week beginning September 20, 2021, saw the United Nations General Assembly in full-session (alongside Climate Week NYC). This year's United Nations General Assembly is the first since 2014 to have the benefit of an assessment report from the Intergovernmental Panel on Climate Change (***IPCC***), the ***Sixth Assessment Report – Climate Change, The Physical Science Basis*** (***2021 Report***). While the ***2021 Report*** will not have changed the agenda, it has added a sense of urgency.

    In light of the ***2021 Report*** and the approach of COP-26 from November 2 to November 12, 2021, the business of the United Nations General Assembly focussed on climate change, and for the first time in 40 years, there was a leader-lead meeting under the auspices of the United Nations General Assembly (the ***UN High-Level Dialogue on Energy***).

There was some good news from the United Nations General Assembly. The Peoples Republic of China (***PRC***) announced that it will cease to provide support for the development of coal-fired power stations (under One-Belt-One-Road (***OBOR***)), and Turkey is to ratify the Paris Agreement (and on ratification all of the G20 countries will have ratified the Paris Agreement).

For a number years now, Climate Week NYC has been a fixture in the calendars of the great and good, coinciding with the United Nations General Assembly sessions.

- **Climate Week NYC:** Ahead of COP-26, this year's Climate Week NYC (***CWNYC***) may be regarded as a pre-COP-26 meeting, and of particular significance given the expectations ahead of COP-26. As will be apparent from the piece on **Trending Issues** (below) we have touched on some of the subject matter emerging from ***CWNYC***.

  As ***CWNYC*** drew to a close many organisations and publications provided their assessment of the week, and the actions and themes arising from it. Rather than seek to summarise the many actions and themes, a selection of links is included: breakthrough energy, canarymedia, GeekWire, ING, World Resources Institute, Impakter, GSK.

  During ***CWNYC***, the following came to the attention of the author of Low Carbon Pulse: National Grid (US electrical energy, natural gas and clean energy corporation, with networks across Massachusetts, New York and Rhode Island) shared its thinking on how best to develop the hydrogen economy in New York, including the use of Long Island as a hydrogen hub (see *Developing the Hydrogen Economy in New York*).

- **One week NYC, the next Milan:** As the United Nations General Assembly and ***CWNYC*** concluded their climate change agenda, the focus ahead of COP-26 increased with a formal three day Pre-COP-26 meeting the following week in Milan, Italy (noted in Edition 15 of Low Carbon Pulse). It is clear that there is an ever increasing weight of expectation, ahead of COP-26.

• Trending Issues:

- **Tracking to 2.7^{o}C:** UN Secretary General, Mr Antonio Guterres pulled no punches in his address to the United Nations General Assembly. Mr Guterres expressed extreme concern, critically, that the world is on a catastrophic pathway to a ***2.7^{o}C*** increase in average global temperatures compared to pre-industrial times (***Catastrophic Pathway***) without significant and immediate increases in the rate of ***GHG*** emission reductions. As is readily apparent from the science based reports: greater ***GHG*** emission reductions are needed, and the rate of those reductions needs to increase. No matter the direction from which discussion is approached, the discussion needs to coalesce around "greater and faster reductions".

- **Keeping fossil fuels in the ground:** It appears likely that at COP-26 an alliance will be established called the ***Beyond Oil and Gas Alliance***: an alliance of countries that will seek to persuade other countries not to develop oil and natural gas reserves, even those proposing to use CCS and CCUS. At the moment, Costa Rica and Denmark are co-leading the move to establish the ***Beyond Oil and Gas Alliance***. In December 2020, Denmark committed to cease licensing natural gas and oil exploration. Both Costa Rica and Denmark recognise the magnitude of the task to persuade countries to take the same step taken by Denmark.

- **Natural gas, in or out or in until phased out?**

  - **High prices driving debate:** The role of natural gas in progress towards the achievement of ***NZE*** has been a matter of debate for some time. That debate is now front-and-centre ahead of COP-26.

    The central position assumed by the debate is a function of the high price of natural gas as both a fuel and a feedstock in global markets, the resulting impact on electrical energy prices, and, in some markets, the impact of a downturn in fertiliser production, and the reduction in manufactured carbon dioxide as a by-product of fertiliser production (see Edition 27 of Low Carbon Pulse under ***CO_2* storage and use**.)

    As noted in Edition 27 of Low Carbon Pulse, the reasons for the current high levels of natural gas prices are multiple, and multi-faceted. There are many papers, reports and studies (and theories) about natural gas prices. On September 30, 2021 and October 1, 2021 LNG spot prices and natural gas prices in Europe reached record levels. The Oxford Institute for Energy Studies publication, ***Why Are Gas Prices So High?*** (***OIES Report***) is a dispassionate take on the dynamics, including the context.

  - **Natural gas and *GHG* emissions:** The extraction, processing, transportation, and use of natural gives rise to methane (***CH_4***) and carbon dioxide (***CO_2***) emissions. Progress towards achievement of ***NZE*** requires the reduction in ***CH_4*** and ***CO_2*** emissions: this is achieved as human activities are decarbonised, which in turn requires the installation of up to 10,000 GW of dispatchable renewable electrical energy and the production of up to 600 million metric tonnes per annum (***mmtpa***) of hydrogen (as fuel and as feedstock for hydrogen based fuels), and storage solutions for renewable electrical energy (***BESS***) and hydrogen and hydrogen-based fuels (***HESS***). The required build-out of renewable electrical energy capacity is going to take time, and there is a role for natural gas in the meantime.

  - **Natural gas integral to energy transition:** For some time, Global Ashurst Towards Zero Emissions team members have held the view that natural gas is a transition fuel. Among other things, this is informed by the everyday roles that those team members have working on natural gas and LNG project developments around the world, while at the same time working on the development of renewable electrical energy projects, and hydrogen and hydrogen-based fuel and feedstock projects.

    Three members of the Global Ashurst Towards Zero Emissions team authored an article in August 2020 entitled ***The Future of LNG and Natural Gas Infrastructure***, expressing the view that natural gas should be regarded as integral to energy transition to achieve ***NZE***. The basis for this assessment is outlined in that article, but at its core is the need to continue electrification, the role of natural gas fired power generation in "filling the gap" until sufficient renewable electrical energy and hydrogen and hydrogen-based fuel and feedstock capacity has been developed, and the impact of any foreclosure on

the use of natural gas as a matter of policy – increased tightness in the supply of natural gas, and the price pressure that will result.

- **Tightening and tight natural gas supply:** Given the medium to long term sentiment around the use of natural gas, including as manifest in some existing policy settings, the supply side of the market will not respond to the current and prospective tightness in supply by the development of new natural gas resources, rather the supply side will use the higher natural gas prices to invest in progress towards ***NZE*** (and to generate healthy rates of return to shareholders).

  In the context of the Ashurst August 2020 publication, and since, the perspective of the author of Low Carbon Pulse is that pragmatism is required, because natural gas is required for electrical energy generation and as a feedstock to produce Blue Hydrogen. The issue is, for how long.

  At various points, Low Carbon Pulse has expressed this perspective. In the context of keeping the lights on, accelerating development of renewable electrical energy, and continuing in the context of the development of supply of and demand for hydrogen and hydrogen-based fuels in tandem, the role for Government, both as policy setter and as participant, has been noted (most recently in Edition 27 of Low Carbon Pulse under ***Roles to be played to reduce GHG emissions***). Over the weekend of October 2 and 3, the UK Prime Minister Mr. Boris Johnson "hit the nail on the head": accelerate the rate of development of renewable electrical energy, and the faster this is done, the shorter the transition for natural gas.

  The policy settings and the role of Government as a participant need to be woven into broader energy strategies. This is known, and is happening in a good number of countries with increasing success, but there seems to be a blind spot or reluctance to look to see a role for natural gas.

- **Pragmatism required, critically from Governments:** There is not a right or wrong in this debate, it is a debate from which pragmatic policy setting and market definition needs to emerge, including encouraging the development of lower to low carbon intensive natural gas resources (reservoirs with lower or low ***CO_2***), carbon capture and storage or carbon capture and use, as part of Government CCS / CCUS sponsored developments, continuing, and accelerating the increased regulation of fugitive emissions (including monitoring, and carbon pricing signals), and having an integrated, and clear, energy plan on a country by country, and, as appropriate, on an economic bloc by economic bloc, basis.

  The role of CCS / CCUS in extracting and processing of natural gas, and in production of liquified natural gas (***LNG***), is an area that offers considerable potential to reduce ***GHG*** emissions, at least in respect of Scope 1 emissions. In respect of ***GHG*** emissions arising on use of natural gas, this is a policy setting best left for the country in which the natural gas is used, including through a carbon price and other policy settings, including the use of negative ***GHG*** emission initiatives (***NGHGIs***). Continuing a narrative commenced in Edition 27 of Low Carbon Pulse, deployment of ***NGHGIs*** is an area for immediate action, with the use of ***NGHGIs*** to lessen the impact of natural gas, and, as the role of natural gas lessens through energy transition, the benefit of those ***NGHGIs*** will be realised globally on an ongoing basis.

- **Energy Planning required:** As noted above, broader energy strategies are needed. As noted by Mr Mark Carney, former Governor of the Bank of England, and currently a United Nations Envoy on Climate Change, it is the responsibility of governments to set policy to achieve the required response to climate change through "clear, credible and predictable regulation" (see Edition 22 of Low Carbon Pulse, under ***Free Markets will respond to policy settings, but do not set policy***). The imperatives of energy markets are not energy transition to achieve ***NZE***, while ensuring energy security!

  On September 25, 2021, the CEO of ENI SpA, Mr Claudio Descalzi is reported to have told La Republica newspaper that the European Union (***EU***) needs a long term energy plan, critically, to achieve energy security. It is difficult to argue with this. (ENI SpA is a leading global international energy corporation.)

  Among other things, any energy plan could provide certainty for the supply of natural gas in a way that provides natural gas producers with certainty under term supply contracts, and that dovetails with the development of renewable electrical energy and ***BESS***, and hydrogen and hydrogen-based fuel and feedstock and ***HESS***, and ultimately the phasing out of natural gas use, other than in circumstances in which its production and use achieves outcomes consistent with ***NZE***.

  In the evolutionary chain of progress to ***NZE***, there is a missing link, an energy plan, implemented by "clear, credible and predictable regulation".

- ***UN High-Level Dialogue on Energy*****:** On September 24, 2021, the ***UN High Level Dialogue on Energy*** took place, the first meeting of its kind in 40 years. While it was high energy, the general consensus from the news feeds was that the energy levels need to increase in the lead up to and at COP-26.

  In the context of the ***UN High Level Dialogue on Energy***, it is reported that USD 400 billion of new commitments were announced to increase the level of renewable electrical energy development, and new electrical technologies (including for cooking). The following link is to the United Nations, UN News, Climate and Environment, coverage, and a high-level summary of the new commitments.

  As noted in previous editions of Low Carbon Pulse, the focus of Low Carbon Pulse is not to track the achievement of the UN Sustainable Development Goals, but a key feature of the ***UN High Level Dialogue on Energy*** was the achievement of Sustainable Development Goal 7 (clean energy access for all by 2030).

  This is relevant both from the economic and social development perspective and from the ***NZE*** perspective: at the same time as countries are progressing to reduce ***GHG*** emissions, the level of electrification needs to increase globally, to provide electricity to the 800 million to 1.2 billion people who currently do not have access to electrical energy. (The author notes that the 800 million figure is used most frequently.)

It is important to understand that the transition from fossil fuel to renewable sources of electrical energy is taking place at the same time as hundreds of millions of people will have access to electrical energy for the first time.

In other words, in a world seeking to achieve ***NZE***, this is not a zero sum game of itself, because at the same time that we are trying to replace fossil fuel electrical energy generation with renewable electrical energy generation capacity, we are trying to increase access to electrical energy to those that do not have access. Add to this the likely role of natural gas, and it is not a zero-sum game in terms of being able to use renewable electrical energy to achieve these outcomes.

In this context, natural gas appears likely to have a key role to play in the electrification of developed and developing countries with increasing population growth and urbanisation (including countries like Bangladesh and Pakistan) where the deployment of gas-fired powered stations may be regarded as more likely achieve a balance between electrification and ***GHG*** emissions on a planned basis, not to the exclusion of renewable electrical energy, but alongside it.

- **Increased reductions and rate of them:** As noted in Editions 26 and 27 of Low Carbon Pulse, there is a real and ready understanding that it is going to be a challenge to peak, and then to reduce, ***GHG*** emissions so as to limit the increase in average temperature globally to ***1.5^{o}C*** above pre-industrial levels (what Low Carbon Pulse has called the ***Stretch Goal***), and, currently, it is more likely that we will enter the ***1.5^{o}C*** to ***2^{o}C*** range (the ***Stabilisation Goal***). In other words, the achievement of the ***Stretch Goal*** is nearly out of reach, and the achievement of the ***Stabilisation Goal*** is "touch and go" at best.

  As noted above, UN Secretary General, Mr Antonio Guterres (in pulling no punches in his address to the United Nations General Assembly) said that the world is on a catastrophic pathway to a ***2.7^{o}C*** increase in average temperature globally (***Catastrophic Pathway***).

  In the context of the ***Stretch Goal***, ***Stabilisation Goal*** and the ***Catastrophic Pathway***, a S&P Global Sustainable Report (drawing on Platts Analytics Future Energy Outlooks analysis), emphasises what is required to be able to achieve medium and longer term targets: it is necessary to concentrate on what needs to be done in the near term, and to granularize it.

  In the twilight zone between near and medium term, the S&P Global Sustainable Report provides examples of what is required by 2025 to achieve the ***Stabilisation Goal***: for example, relative to 2019, by 2025, electrical energy from solar and wind sources need to increase by 98% and 133% respectively, the electrical energy sector and the transportation sector need to reduce ***GHG*** emissions by 7% and 1%, and on a country by country basis, the ***PRC*** needs to reduce ***GHG*** emissions from coal-fired electrical energy generation by 6%, and the US needs to reduce ***GHG*** emissions from coal by 2%, natural gas by 11%, and oil by 8%.

  These metrics are illustrative and, on their face, the achievement of them may appear straight-forward. Each sector and country needs to achieve reductions in ***GHG*** emissions by 2025. If the required reductions in ***GHG*** emissions are to be achieved by 2025, consistent with the achievement of targets by 2030 through 2050, we may avoid the ***Catastrophic Pathway***.

- ***NZE* not enough, *CDR* required now:** Edition 27 of Low Carbon Pulse covered the role of Carbon Credits / Permits. Boiling down the narrative in Edition 27 to its essentials, there is a need to commence negative ***GHG*** emission initiatives (***NGHGEIs***) as soon as possible.

  NGHGEIs should be used to achieve absolute reductions in ***GHG*** emissions (i.e., there are fewer ***GHG*** emissions in the climate system as a result of the initiative than before, hence the naming negative greenhouse gas emission initiatives).

  To achieve and to sustain absolute reductions, the reductions arising from any ***NGHGEI*** should not be capable of being used to off-set ***GHG*** emissions elsewhere.

  - **Point to reflect upon:** The *reduction* in ***GHG*** emissions is distinct from the *removal* of carbon dioxide (or Carbon Dioxide Removal (***CDR***)): the reduction in ***GHG*** emissions involves the decarbonisation of activities that would give rise to ***GHG*** emissions emitted to the climate system, but for that decarbonisation, ***CDR*** involves the removal of ***GHG*** emissions that have been emitted to the climate system. Both ***GHG*** emission reductions and ***CDR*** are contemplated in Article 4 of the Paris Agreement.

    The need for ***NGHGEIs*** reflects that fact that the achievement of ***NZE*** is not going to be sufficient to achieve the core objectives of the Paris Agreement (see the italicised text in respect of the extract from the text of Article 4).

CORE OBJECTIVES OF THE PARIS AGREEMENT	
Article 2:	**Article 4:**
(a) Holding the increase in global average temperatures to well below 2^{o}C [***Stabilisation Goal***] above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5^{o}C [***Stretch Goal***] above pre-industrial levels, recognising that this would significantly reduce the risk and impacts of climate change.	In order to achieve the long-term temperature goal set in Article 2, Parties aim *to reach global peaking of greenhouse gas emissions as soon as possible*, … and to undertake *rapid reductions thereafter in accordance with best available science*, so as to achieve a balance between anthropogenic emissions by sources and *removals to sinks in greenhouse gas in the second half of this century* … .

(**Note on Article 4**: Article 4 contemplates "peaking of greenhouse gas emissions as soon as possible and to undertake rapid reductions thereafter". This should not be read to preclude removal of ***CO_2*** (to sinks) to achieve reductions before peaking or before achievement of ***NZE***, in particular to preclude use of ***NGHGIs*** at any time.)

- **Ahead of COP 26:** As COP-26 approaches, certainly since the start of August 2021, this long standing objective, and the means to its achievement, ***NGHGIs***, has received increased news coverage, including recently a news item in Fortune magazine, under ***Net zero isn't enough. We need to get to net negative***.

  It is important to note that while the increased news coverage is new, the objective is not. Awareness of the need to achieve ***net negative gas house gas emissions*** is increasing, but it still appears to be filed in the "to do tray".

  As COP-26 approaches, the need for "net negative initiatives" appears to be moving from the "to do tray" into "pending". Hopefully, during COP-26, it will moved to the "do today tray". It is certainly on the agenda.

• Roles to be played to reduce *GHG* emissions – Role of *IECs* and *NOCs*

- **Concentration of *IECs* and *NOCs*:** As foreshadowed in previous editions of Low Carbon Pulse, ahead of COP-26, current and relevant matters will be considered in Low Carbon Pulse, including the roles to be played by key players.

  This Edition 28 of Low Carbon Pulse covers the roles of International Energy Companies (***IECs***) (formerly international oil and gas companies (***IOCs***)) and National Oil Companies (***NOCs***).

  This reflects their importance. While there are multiple roles to be played, by multiple players, in achieving progress towards ***NZE***, without the transition, some may say transformation, of the businesses of ***IECs*** and ***NOCs***, it is not possible to achieve ***NZE***. It is important to recognise that ***IECs*** and ***NOCs*** have a central role to play. To provide a balanced view, it is the world's use (a function of supply and demand) of hydrocarbon fuels that has contributed to climate change. This remains the case.

- **Background: *IECs*** and ***NOCs*** have long been essential to the production of energy carriers from hydrocarbons, including motor spirit (gasoline and petroleum) from oil to power and to propel motor vehicles and natural gas to heat homes and to fuel gas-fired power stations. Many of the world's largest corporations have been, and remain, oil and gas corporations. ***IECs*** and ***NOCs*** recognise that energy transition is upon them, and is critical to progressing to ***NZE***. Around 75% of global ***GHG*** emissions arise from the extraction, production and use of fossil fuels, principally, coal, and oil and natural gas.

  IECs and ***NOCs*** have the established infrastructure and supply chains (including means of distribution) to transition from the production and delivery of energy carriers derived and produced from hydrocarbons to hydrogen and hydrogen-based fuels as energy carriers. Also ***IECs*** and ***NOCs*** have the financial resources to affect energy transition over time: in part, this is a function of their sheer size and global reach. The ability of ***IECs*** and ***NOCs*** to raise and to deploy capital is essential to achieving progress towards ***NZE***.

  As noted in previous editions of Low Carbon Pulse, the Global Ashurst Towards Zero Emissions team favours policy settings to define the role and the rate of transition required of ***IECs*** and ***NOCs*** (and energy companies more broadly). As noted in Edition 26 of Low Carbon Pulse, courts have a role, but the role is best fulfilled in determining whether policy settings are constitutional and whether corporations have complied with laws and regulations effecting those policy settings.

- ***IECs* and *NOCs* key to achieving *NZE*:** The CEO of BlackRock, Mr Larry Fink, had it right when he commented in the context of the District Court in The Hague, the Netherlands finding that the Royal Dutch Shell Group must reduce its ***GHG*** emissions across Stages 1, 2 and 3 by at least 45%, by 2030, compared to 2019 (***RDS Case***):

  > *"[The **RDS Case**] doesn't change the global footprint, that's not a solution. We are doing a lot of greenwashing because we're not changing the carbon footprint of the world. We may change the carbon footprint of a company. What I worry about is that we're going to put all [the] pressure on public [bourse / stock exchange listed] companies and very little on the private [companies]."*

  Mr Fink went on to state that:

  > *"It's not about running away from the current hydrocarbon companies, it's working with them as they navigate the move forward"*.

- ***IECs* and *NOCs* - there at the start and at the finish: *IECs*** and ***NOCs*** have supplied hydrocarbons to match the demand side that consumes hydrocarbons.

  The production *and* use of hydrocarbons has contributed to climate change. ***IECs*** and ***NOCs*** have produced those hydrocarbons, and many ***IECs*** and ***NOCs*** are listed as "top polluters" (click here for a piece on the "top 20" global polluters since 1965). It is however too simple to blame the supply side. Pollution is a function of supply and demand, with the resulting use giving rise to the greatest contribution to ***GHG*** emissions. It is not time to demonise, it is time for collective responsibility, and accelerated action to reduce ***GHG*** emissions.

  NOCs account for more than 50% of global production of natural gas and oil production (and associated petroleum products) with the vast majority of the balance from ***IECs***. In many countries, the revenue from ***NOCs*** is vital, and as such the realisation of that revenue is critical. Also the royalties and taxes paid by ***IECs*** to host Governments is vital.

  The Gordian Knot is ensuring that there is sufficient supply of hydrocarbons while at the same time progressing to ***NZE***. On September 30, 2021, Executive Vice-President at Equinor, Mr Al Cook published a "clear sighted" article entitled ***Why National Companies are key partners in fighting climate change***.

  Key to achieving this balance is the investment by ***NOCs*** (and ***IECs***) in renewable energy projects.

- **The same in many ways, but different in others:** The core role of ***IECs*** and ***NOCs*** is to produce energy carriers. The core role will not change, but ***IECs*** and ***NOCs*** will expand (and many are already doing so) their business to include the development of renewable electrical energy capacity, both to supply electrical energy as electricity to the ultimate user of that electricity and to derive and to produce hydrogen and hydrogen-based fuels (while at the same time continuing to produce hydrocarbon energy carriers).

  In some areas of the world, ***IECs*** and ***NOCs*** are making material investments in the development of renewable electrical energy capacity in the form of photovoltaic solar and wind (on-shore and offshore).

  As might be expected, the patterns of development, and the thinking behind them, differ from corporation to corporation, and country to country. For example, in a number of countries within the Gulf Cooperation Council (***GCC***) countries, there is a clear recognition that photovoltaic solar is key to realising the value of hydrocarbons (including the production of Blue Hydrogen and Blue Ammonia) and the production of Green Hydrogen and Green Ammonia.

- **Check on progress:** Different ***IECs*** and ***NOCs*** are progressing at different rates, but each is responding to the policy settings to which it is subject. Each ***IEC*** listed on a bourse / stock-exchange is subject to scrutiny of the shareholders / stockholders, and their perspective on its direction of travel, and the speed at which it is travelling.

  As has been noted in previous editions of Low Carbon Pulse, the investors (institutional and "mums and dads"), are aware of the need for corporations in which they invest to have a plan to address the risk that arises from climate change, and in this context how that risk is being avoided or managed.

  The CEO of BlackRock, Mr Larry Fink, said back in February 2021, that:

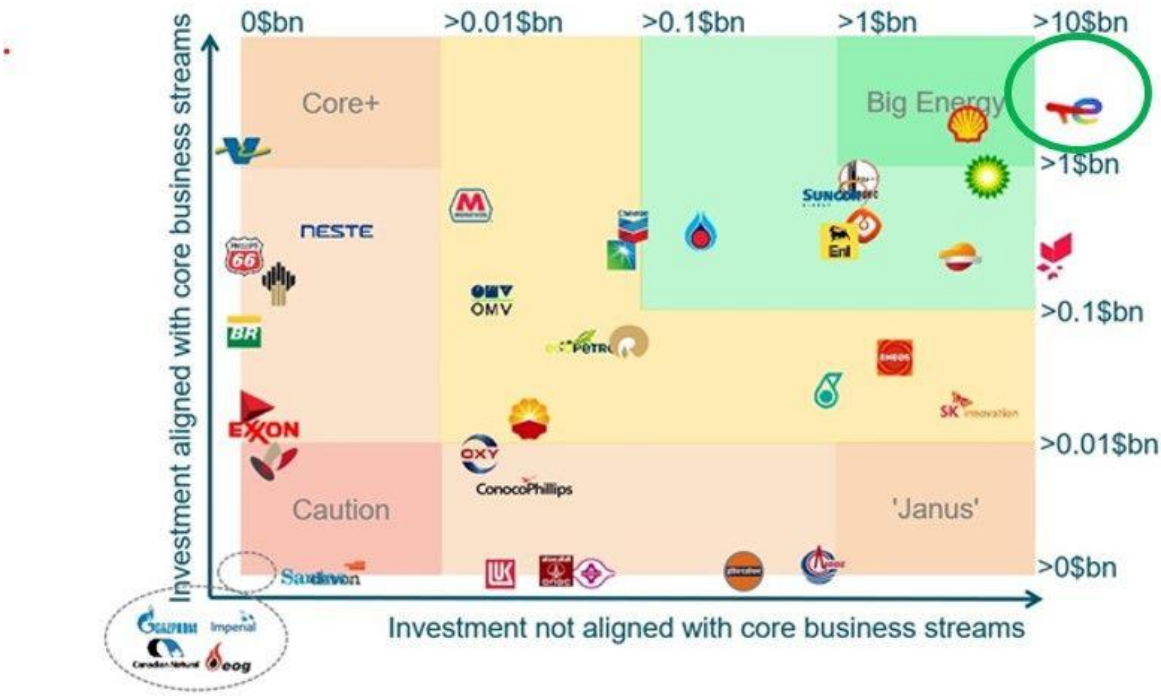
  > "*Given how central … energy transition will be to every company's growth prospects, we are asking companies to disclose a plan for how their business model will be compatible with a new - zero economy … We are asking how this plan is incorporated into [each company's] long term strategy and reviewed by [the] board of directors.*"
  >
  > "*We know that climate risk is investment risk … But we also believe that climate transition presents [a] historic investment opportunity*."

  More broadly of course, ***IECs*** are subject to the court of public opinion and any impact on reputation that may arise from any adverse publicity on the direction and speed of travel.

  BloombergNEF recently benchmarked a number of ***IECs*** and ***NOCs*** by reference to their investment strategies, broadly reflective of positioning in progress towards ***NZE***. The purpose of including this benchmarking is not to "call-out" any corporations, but to emphasise the progress that has been made.

  As ever, the benchmarking is backward looking, covering, as it does, the period from 2015 through to June 30, 2021. As such, recent announcements about commitments are not included: for example, the recent Chevron Corporation commitment of USD 10 billion capital investment by 2030 is not reflected.

Oil and gas low-carbon investment strategies, 2015 to 1H 2021



- **Measuring and monitoring and reporting on progress:** While many ***IECs***, and ***NOCs***, measure and monitor ***GHG*** emissions (and many countries require them to do so), it is becoming increasingly clear that disclosure and reporting are going to be key, including in the context of any carbon border adjustment mechanisms to address carbon leakage, and to level the playing field.

- **Conclusion:** ***IECs*** and ***NOCs*** have a transformational role to play in progress to achieving ***NZE***, they are essential to it, in terms of the transition of their business models from hydrocarbon reservoirs to water reservoirs, with the ultimate destination remaining the bowser (or other point of ultimate delivery) and resulting transition from energy carriers derived and produced from hydrocarbons to energy carriers derived and produced from hydrogen (absent the carbon atoms), either as hydrogen or as a hydrogen based fuel.

Among other things, Edition 29 of Low Carbon Pulse will cover trending issues and consider the role of Government in decarbonising ***AFOLU*** and the development of bio-energy and BECCS and BECCUS (including bio-energy from waste), critically to facilitate the production of Blue Hydrogen and clean hydrogen, and the roles of Government and the private sector in working together. Edition 30 of Low Carbon Pulse will cover trending issues and consider the role of carbon credit trading and coal.

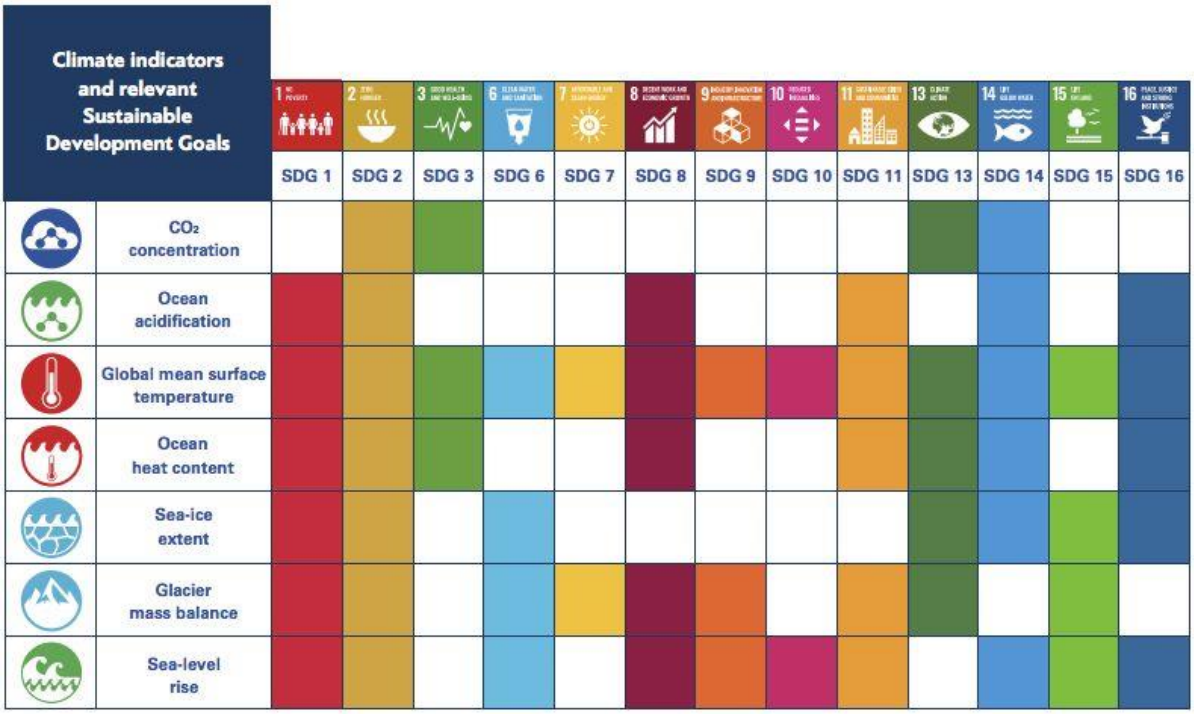
Climate change reported and explained:

- ***WMO Report***: As noted in Edition 27 of Low Carbon Pulse, each month the US National Oceanic and Atmospheric Administration (***NOAA***), among other things, reports on findings for the previous month. In the second edition of Low Carbon Pulse each month, we will cover the latest data from the ***NOAA*** report for the previous month. New data from the September ***NOAA*** report will be included in Edition 29 of Low Carbon Pulse.

  The World Meteorological Organization (***WMO***) has released a report (entitled ***Climate Indicator and Sustainable Development: Demonstrating the Interconnections***) on the impact of climate change. The ***WMO Report*** highlights the interconnected impact of increased CO_2 concentration in the climate system, average temperatures, ocean acidification and increasing temperature, sea-ice extent, sea-level rise and glacier mass balance. Like the ***2021 Report***, the ***WMO Report*** is science based, with analysis based on observation.

  The ***WMO Report*** goes further than the ***2021 Report*** in that it emphasises the cascading impact of climate change on achievement of sustainable development goals (***SDGs***). The ***WMO*** Secretary-General, Professor Petteri Taalas is quoted as having said: "*Increasing temperature will result in global and regional changes, leading to shifts in rainfall patterns and agricultural seasons. The intensification of El Niño events is also generating more droughts and floods*".

  The ***WMO Report*** is notable for the visual representation of its findings and the impact on the achievement of each of the ***SDGs***. The visual representation set out below, entitled ***Climate Indicators and relevant Sustainable Development Goals*** is an illustration of the power of a visual representation.



  The ***WMO Report*** will be considered in detail in the September Report on Reports (to be contained in Edition 30 of Low Carbon Pulse as an Appendix).

- **Climate and weather monitoring:** On September 28, 2021, in an excellent article in Politico (entitled ***Climate and weather monitoring from space: key to safeguarding lives and infrastructure***), it is noted that: "*Our planet and its people have been battered by extreme weather events throughout 2021: record temperatures, intense storms, floods, fires and droughts*" (see Editions 25, 26 and 27 of Low Carbon Pulse for the related facts and statistics, the meaning of "extreme weather event", and the projected consequences, of rising sea-levels).

  The Politico article reports that from 2010 to 2019, weather related events have displaced, on average, an estimated 23.1 million people each year. The article reminds us that the 15th Edition of Global Risks Report from the World Economic Forum considers that climate change (and the associated consequences of it) is one of the top five risks in terms of likelihood of occurrence. Edition 27 of Low Carbon Pulse reported on the World Bank

report which provides a forward looking estimate that by 2050 around 215 million people may be forced to migrate globally as a result of the effects of climate change (See *Groundswell report* from the World Bank).

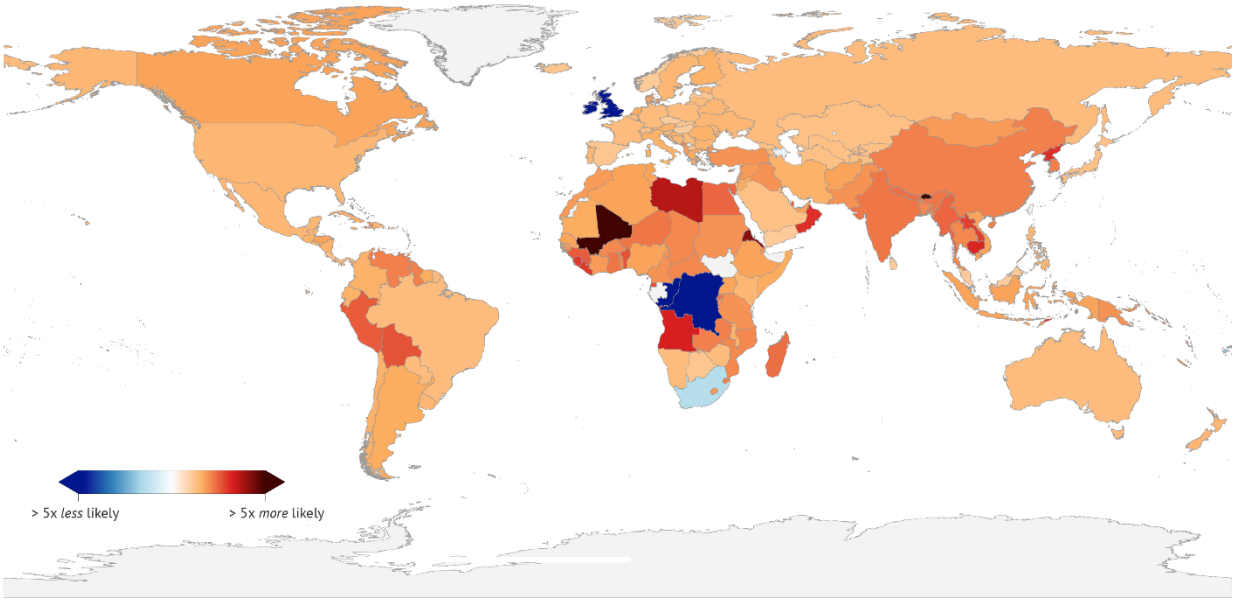
In the context of the facts and statistics, Politico, notes the importance of the collection of data, and the importance of that data being made available to allow informed planning and responses to the observed impacts of climate change. On 27 September 2021, one of the key organisations responsible for data collection and sharing, EUMETSAT, published its new strategy, *Destination 2030*.

As a straight-talking Texan known to the author said: "*When it rains, it rains too much, when it's hot, it's really hot, too hot. Y'all can deny the reason for it, but not the fact of it*". The reasons are known.

- **So what is 0.5°C among the global population:** Or asked another way, what is **0.5°C** among friends. In a helpful graphic from the World Wildlife Fund, the key differences are explained. This link takes you to the graphic. It is worth clicking on the link.
- **Extreme weather and extreme weather events:** Editions 26 and 27 of Low Carbon Pulse reflected on reporting of climate change, in particular the loose use of "extreme weather event".

  In light of recent extreme weather, and extreme weather events, there has been a focus on what this might mean for current, and future generations. The journal, Science, has recently reported on a new study that finds that extreme weather and extreme weather events are going to be experienced with greater frequency by younger generations, with children born in 2020 likely to experience extreme weather events, on average, two to seven times more frequently than those born in 1960. As might be expected, and, unfortunately, as we have come to expect, younger generations in lower income countries will be affected to the greatest extent.

  The projections appear to the author of Low Carbon Pulse to be based on assumptions consistent with those of UN Secretary General, Mr Antonio Guterres' ***Catastrophic Pathway*** of up to a ***2.7°C*** increase in average temperatures globally, but it is noted that the ***2021 Report*** is used as a point of reference. Whatever the basis of the assumptions, those born in 1960 can no doubt reflect from memory on the increase in extreme weather events, and extreme weather more generally. If the memory fails, the science does not.



Multiplication factor of extreme weather events in a world where current nationally determined contributions (NDCs) are met, and a world at 1.5C warming. Dark red shows extreme weather events will be five or more times more likely. Dark blue shows extreme weather events will be five or more times less likely. Note for heatwaves the scale is x10. Interactive by Joe Goodman for Carbon Brief based on data from Thiery et al (2021).

- **Climate change tops the list of the concerns of insurers:** As the world progresses to some level of normality, the risks associated with climate change have returned to the top of the risks that concern insurers.

  Edition 27 of Low Carbon Pulse noted that Edition 28 of Low Carbon Pulse would consider the ways in which countries and areas of countries are adapting to the effects of climate change, and the medium to long term consequences of adaptation by reference to the Paris Agreement and the ***2021 Report***. Edition 30 of Low Carbon Pulse will cover this.

Visualisation and Listening Platforms and Tools, and useful materials:

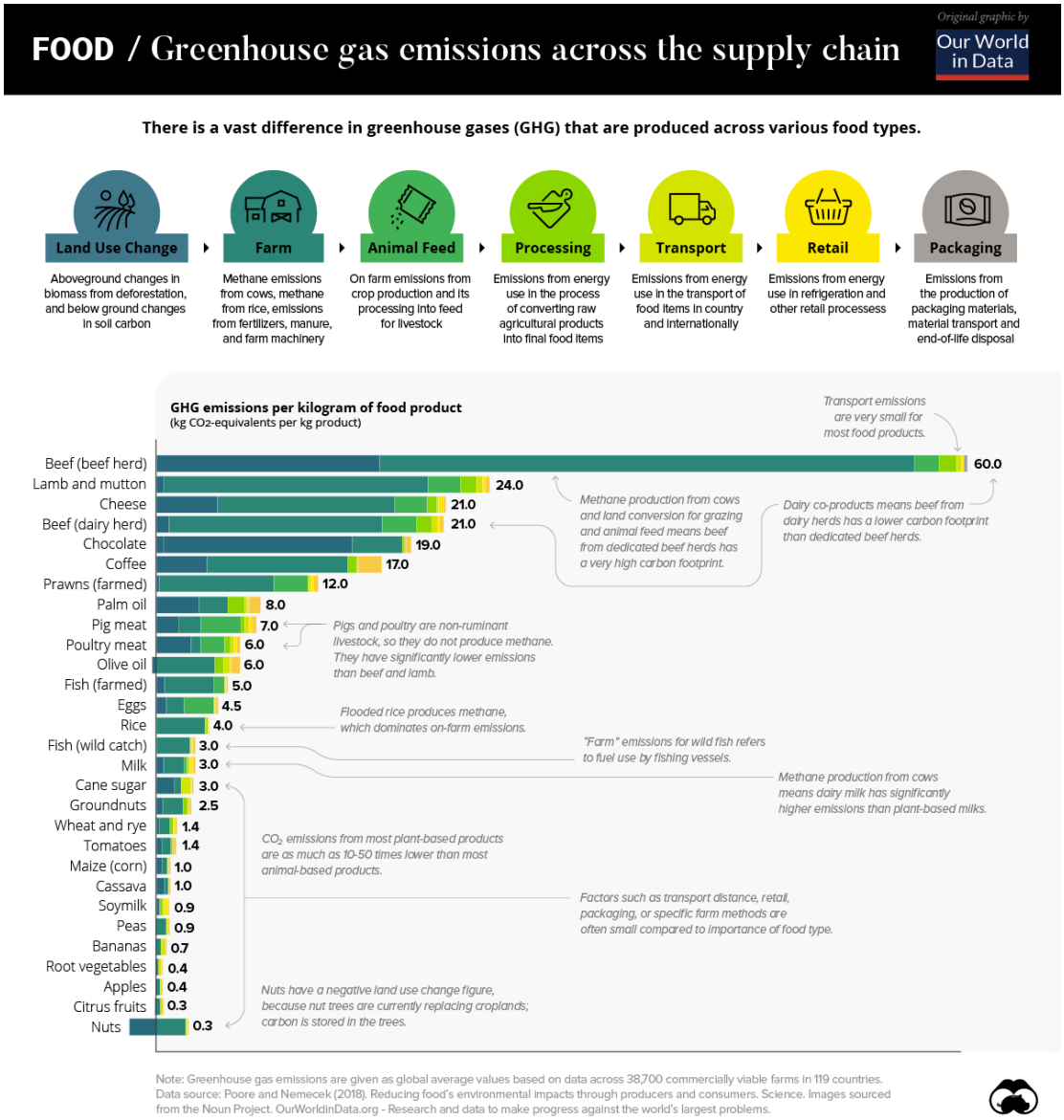
- **Visual Capitalist – Green Corporations:** The following link shows the top ***50 US corporations that use the most Green Power*** (as a percentage of their power use), with the associated article. (The data for the bar chart from the Visual Capitalist is the Environmental Protection Authority in the US.)

  The key takeaway is the number of US corporations already sourcing 100% of their power use from Green Power (as a subset of renewable energy), and that a number of corporations are sourcing more than 100% of their power use from Green Power. Sourcing Green Power is one part of the jigsaw puzzle for each corporation to achieve ***NZE*** across Stage 1, Stage 2 and Stage 3 emissions. The achievement of ***NZE*** across all Stages is the more challenging jigsaw puzzle.

- **Hydrogen Europe – source of information:** Hydrogen Europe (***HE***, representing industry participants and national association members from across the entire hydrogen chain) has established the **#FCHObservatory** (Fuel Cells and Hydrogen Observatory). The **#FCHObservatory** is data rich: for example, it provides up to date information on established hydrogen refuelling infrastructure and stations across Europe. The membership of ***HE*** continues to grow: logo page.
- **The *1.5°C* series:** This section of Low Carbon Pulse is fast becoming the location of information sources that the author finds interesting and useful. Shell has an energy podcast series to which the author listens. The Shell podcast ***The world and 1.5°C: what will it take to … transform the energy system*** is well worth a listen.
- **COP-26 Materials:** Ahead of COP-26, Low Carbon Pulse will include reference materials that the author has come across that may be regarded as helpful reading for those attending COP-26 or following progress: ***The Oxford Institute for Energy Studies – Oxford Energy Forum - September 2021: Issue 129***; and ***COP-26 Presidency Compilation of 2021-2025 Climate Finance Commitments***.

AFOLU GHG emission reductions and waste to biofuels:

- ***AFOLU* – hard to decarbonise:** Edition 27 of Low Carbon Pulse noted that future editions of Low Carbon Pulse would report on, and consider, ***GHG*** emissions arising from agriculture, forestry and other land use (***AFOLU***), and the food system generally. To set the scene for consideration of ***GHG*** emissions arising from the food system, there is a useful graphic (from Our World in Data) that provides a high-level depiction of the Carbon Footprint of the Food Supply Chain. Edition 29 of Low Carbon Pulse will delve deeper.



- **Deadwood stage coming on over the hill:** On September 20, 2021, scitechdaily.com, reported (under ***Deadwood Releasing 10.9 Gt of Carbon Every Year – More Than All Fossil Fuel Emissions Combined***) that decaying wood releases around 10.9 Gt (10.9 billion tonnes) of carbon worldwide a year. The report is based on the findings from a study undertaken by a team at the Australian National University (***ANU***). It is important to note that the ***GHG*** emissions from deadwood are not counted within the 50 Gt of ***CO_2***-e emissions arising each year, but illustrates that a change in the forests of the world can impact climate change.

While the implications of the study are still being digested, it is clear that "climate change and the loss of insects have the potential to alter the decomposition of wood, and therefore, carbon and nutrient cycles".

- **Decarbonising agriculture:** In many countries, some may say in most countries, agriculture has cultural, political and social significance. In the interests of food security and political expediency, in many countries agriculture receives direct and indirect funding support, including policy settings intended to ensure value to certain crops.

  Given these dynamics, the decarbonisation of the agriculture sector is best regarded, and is best calibrated, on a country by country, area by area, basis. At the core of decarbonisation of agriculture is land use, raising livestock and growing crops best suited to the environment in which they are grown, including the return of land to the wild (and paying for the benefit of doing so) and ceasing to grow crops other than for food. Also, collection of waste from livestock and crops is key.

  Key to decarbonising is achieving a balance between ***GHG*** emissions arising from agriculture and using negative ***GHG*** emission initiatives such that ***GHG*** emissions arising are matched by ***GHG*** emissions removed from the climate system. This approach avoids or mitigates the need to introduce some of the more challenging policy settings that may go to cultural, political and social dynamics that may limit progress.

- **Bio-energy as part of decarbonising *AFOLU*:**
  - **The role of bio-energy:** The Global Ashurst Towards Zero Emissions team notes that both the International Energy Agency (***IEA***) ***Net Zero by 2050: A Roadmap for the Global Energy Sector*** (***IEA Roadmap***) and the International Renewable Energy Agency (***IRENA***) ***World Energy Transition Outlook*** (***WETO***) see bio-energy as a key part to achieving progress towards ***NZE***.

    The ***IEA Roadmap*** saw the development of the use of bio-energy as a key risk in the implementation of its ***IEA Roadmap***, on the basis that achieving the proportion of world energy use assumed by the ***IEA Roadmap*** from bio-energy was regarded as less likely, more difficult than other sources contributing to the **Sources of feedstock:** Bio-energy can be derived and produced from any biomass, including agriculture (crop and livestock) waste, food system waste (including arising from the food industry and at the point of commercial or domestic consumption) and wastewater.

    Ever mindful of health, safety and welfare, and environmental protection, policy settings are required to maximise the waste that can be used as feedstocks from which to derive bio-energy.
  - **Regulation of feedstock and reduction of methane:** In the ***EU***, use of waste as a feedstock requires the Renewable Energy Directive (***RED***) to recognise a particular source of waste as a renewable energy feedstock. The ***EU*** is a key reference point.
  - **Methane reduction:** Depending on the technology used, the production of bio-energy from biomass can reduce methane (***CH_4***) emissions. This importance of the reduction in ***CH_4*** emissions in explained in Edition 27 of Low Carbon Pulse. Reflecting this, the ***EU*** and US have recently committed (in the ***Global Methane Pledge***) to reduce ***CH_4*** emissions by a third within the next decade (see Edition 27 of Low Carbon Pulse).

    The broader ***AFOLU*** and waste and waste water sectors are estimated as giving rise to up to 95% of anthropogenic ***CH_4*** emissions globally. Given the impact of ***CH_4*** emissions on climate change, there is an immediate and present reason to capture the life-cycle of carbon in the broader ***AFOLU*** and waste and waste water cycles. This is best framed and achieved through Government collection and consolidation initiatives. These will include the derivation and production of biogas, and biomethane for pipeline gas, from waste to displace natural gas over time. Further, if ***CO_2*** arising on the production and use of biogas or any other biofuel is captured and used, and matched by new growth biomass to absorb an equivalent mass of ***CO_2*** arising on oxidation / use of that biogas or other biofuel, the promise of bio-energy will realised.

    In the agricultural sector, policy settings of this kind become the core of an environmentally and economically sustainable sector, including by use of the digestate arising from the derivation and production of bio-gas, and the use of cover crops and perennial crops. As noted in a publication from the European Biogas Association, the use of digestate offers a means of soil improvement both for crops and for rehabilitation. The parts of a closed loop exist; policy settings need to facilitate the closing of the loop.

GCC counties update:

- **United Arab Emirates and UK aligned:** Edition 27 of Low Carbon Pulse reported that ADNOC Group (leading national oil company), BP (leading international energy corporation) and Masdar (Abu Dhabi Future Energy Company) entered into framework agreements. It is understood that the framework agreements provide the basis for the development of two clean hydrogen hubs, each of 1 GW, one in the UAE, the other in the UK.

  During September 2021, the UAE and the UK signed a memorandum of understanding (***MOU***) to accelerate cooperation between the UAE and the UK. Dr Sultan Al Jaber, Minister of Industry and Advanced Technology (and chair of Masdar), for the UAE, and Mr James Cleverly, Minister of State for Middle East and North Africa, for the UK, signed the ***MOU***.

- **UAE perfectly placed for hydrogen production:** Managing Director and group chief executive of ADNOC, Dr Sultan Al Jaber is a busy person.

  Dr Sultan Al Jaber has emphasised the current infrastructure advantage that the UAE has for the production of Blue Hydrogen: "*By leveraging our existing gas infrastructure and commercial scale CCUS capabilities, the UAE can and will become a major player in the emerging blue hydrogen market*".

  The UAE has no shortage of natural gas reserves from which to produce Blue Hydrogen. Dr Sultan Al Jaber notes: "*Today, gas provides almost one quarter of the world's energy supply and will continue to play a critical roles in the global energy system*". As noted in sibling publications of Low Carbon Pulse, producers of LNG can become producers of LNG and Blue Hydrogen.

- ***KAS*, major investor in renewables:** On September 22, 2021, thenationalnews, Business Section, reported (under ***Saudi Arabia to channel 50% of investments into renewable energy, PIF governor says***) that the Kingdom of Saudi Arabia (***KAS***) plans to deploy 50% of its investments in renewable electrical energy, and sustainable energy sources.

  Chair of the Public Investment Fund and of Saudi Aramco, Mr Yasir Al Rumayyan noted "*the [**KAS**] aims to deploy 50 per cent of its investments in renewable and sustainable power sources, more than two-thirds from investments. We are one of the most efficient countries when it comes to sustainability and renewable energy*".

  As noted above, to achieve progress towards ***NZE***, it is necessary for ***NOCs*** (and ***IECs***) to invest in renewable projects, and sustainable projects.
- **"A" Team:** On September 28, 2021, it was reported widely that Saudi Aramco (the world's largest corporation by value), ACWA Power (leading developer, investor and owner operator of power and water assets) and Air Products (one of the big three leading global industrial gas corporations, with Air Liquide and Linde) have established a joint venture company (***JVC***) to develop a new project to produce hydrogen and electrical energy at Jazan Economic City (Jazan, also Jizan, is a port city).

  The ***JVC*** will contract with Saudi Aramco to purchase assets from Saudi Aramco, with Saudi Aramco supplying feedstock to the ***JVC***, with the ***JVC*** producing electrical energy, heat and steam, and hydrogen.

  The hydrogen produced will be used across Saudi Arabia. It is expected that completion of the sale and purchase of the assets, and funding for the project, will occur during October 2021. It is understood that the Saudi Industrial Development Fund and 23 lenders (domestic and international) are providing USD 7.2 billion.

India moves to centre stage:

- **India and US Hydrogen Task Force:** In the lead up to the Leaders' Summit in April 2021, US Special Presidential Envoy for Climate Mr John Kerry was a busy fella. In the lead up to the Leaders' Summit, Mr Kerry met with Indian Prime Minister, Mr Narendra Modi. At that time, closer cooperation was flagged.

  On September 27, 2021, the two countries launched a new public-private task force to increase the rate of development of renewable electrical energy. It is understood that the Hydrogen Task Force will soon be joined by the Biofuels Task Force. Both task forces are to be enabled by the Indian Strategic Clean Energy Partnership (***SCEP***) and the US Department of Energy (***DOE***).
- **Indian Prime Minister Centre Stage:** On September 25, 2021, Indian Prime Minister, Mr Narendra Modi addressed the United Nations General Assembly in New York. Mr Modi confirmed the commitment given by India to install 450 GW of renewable electrical energy capacity by 2030, and to develop and to implement the National Hydrogen Energy Mission so as to scale up production to 1 million metric tonnes of hydrogen a year by 2030.

  In addition to these existing commitments, commitments to the Production Linked Incentive Scheme were announced, adding 10 GW of photovoltaic manufacturing capacity by 2025, 15 million metric tonnes per annum of compressed natural gas, sourced from biogas by 2024, and to achieve 20% ethanol blending by 2025/26.
- **India Centre Stage for inbound investment:** On September 21, 2021, The Economic Times (of India) reported that Petroleum Nasional Berhad (***Petronas***), Malaysia's national oil company, is looking to invest in renewable energy projects in India for a "substantial" proportion of its planned development of 3 GW of renewable energy by 2024.

  Head of New Energy at Petronas, Mr Jay Mariyappan said that: "*Our overall target is three gigawatts by 2024 in terms of capacity; a substantial part of that will be within India*".

  It is understood that ***Petronas*** has had discussions with Tata in respect of possible renewable energy projects. Edition 20 of Low Carbon Pulse reported on plans of PTT (PTT Public Company Limited, Thai state owned oil and gas corporation) to invest in the renewable and sustainable energy sector in India.
- **India Centre Stage for private sector domestic investment:** On September 22, 2021, it was reported widely that Adani Group intends to invest up to USD 20 billion over the next 10 years. On October 2, 2021, Adani Green Energy reported its acquisition of 5 GW of photovoltaic solar and wind assets from SB Energy India for USD 3.5 billion.

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

  See: Adani Group Website
- **Indian economy continues to need to grow:** In delivering a presentation on hydrogen to one of the Seven Sisters in February 2021, the author of Low Carbon Pulse was asked to identify the biggest challenge to progress towards achieving ***NZE***. The author responded to note that countries like the ***PRC*** and India needed to continue to grow so as to achieve continued economic development, while at the same time seeking to decarbonise the means of that growth. This response was conditioned to note that the challenge could be overcome.

  On September 27, 2021, Chair of India Oil Corp (***IOC***), Mr Shrikant Madhav Vaidya, announced ***IOC*** plans to increase its refining capacity within India. It has long been known that India would need to add around 100 million metric tonnes per annum (***mmtpa***) to its refining capacity, currently around 250 ***mmtpa***.

  The increased production of hydrocarbons using increasing refining capacity will result in increased ***GHG*** emissions. Mr Vaidya intends to seek to mitigate the extent of increased ***GHG*** emissions arising from the use of the new refining capacity by the use of renewable electrical energy to provide electrical energy required for that production.

  See: IOC website

- **India, Japan, US and Australia climate change announcement:** On September 24, 2021, following a meeting of the leaders of India, Japan, the US and Australia (the so-called Quad), it was announced that the Quad countries are: **1**. to cooperate to allow the development of a green-shipping network, with each country to work with each other country to reduce ***GHG*** emissions arising from the shipping value chain; **2**. to establish a Clean Hydrogen Partnership, including for the purposes of technology development and scaling up of hydrogen production on an efficient basis, with the intention to stimulate demand to accelerate trade in clean hydrogen in the Indo-Pacific region; and **3**. to increase the Indo-Pacific region's resilience to climate change by improving climate change information sharing and disaster-resilient infrastructure.

  Please see the White House's communique: *Fact Sheet: Quad Leaders' Summit*.

Australia – A Curate's Egg:

- **Background:** Australia is the lucky country, blessed with two of the three key creators of wealth in real economies: agricultural capacity and natural resources (the third key creator of wealth being manufacturing capacity). Traditionally, natural resources have included metals and minerals (including iron ore), fossil fuels (including coal (thermal and metallurgical) and natural gas (liquified and exported).

  Natural resources now include Australia's natural renewable resources - world class solar and wind (on-shore and off-shore) resources. These natural renewable resources are now the focus of the progress made by Australia. Australia is progressing to matching 100% of load with dispatch from renewable energy sources. Also Australia is the source of renewable energy sources that will export renewable electrical energy into South East Asia (using HVDC interconnectors) and drive electrolysers to produce Green Hydrogen and Green Ammonia.
- **Scrutiny of Australia:** And yet, the Federal Government of Australia has yet to commit to meaningful ***GHG*** emission targets or to ***NZE*** by 2050. As a result, for some time, the Federal Government of Australia has been under scrutiny by the international community and its own citizens. At once, both the lucky country, and the recalcitrant country, a country that could lead, but a country that chooses not to do so.

  As is often the case, things are not always as they seem: the Commonwealth of Australia is a federation of States and Territories, and those States and Territories are progressing with their own ***GHG*** emission reduction targets and are committed to achieving ***NZE***.

  Most recently, New South Wales (***NSW***), Australia's most populous State, announced that it would increase its reductions in ***GHG*** emissions by 15% from 35% to 50% by 2030 compared to 2050, with the eye catching prediction that ***NSW*** would attract AUD 35 billion in investment as a result. It was a busy week for policy setting in ***NSW*** with the release of a report entitled ***Development of a hydrogen industry in New South Wales*** on September 30, 2021. (The September Report on Reports will consider the report.)

  The State of South Australia remains the stand-out performer in terms of solar, wind and battery (***SWB***). Throughout 2021, South Australia has demonstrated that 100% ***SWB*** matching load is becoming a reality across a GW-scale grid. On Saturday 2, 2021, at 11.10 am, photovoltaic solar (roof-top and utility) achieved 106.1% of the load across South Australia, and continued to match load for nearly an hour.

  Key to the development of ***SWB*** across Australia has been the role of the private sector, with both domestic and international investment key to progress the development of the renewable electrical energy industry with the original Federal Government policy settings (to encourage the development of the renewable electrical energy industry) having long-since passed their "use by dates".
- **Balance being struck:** The oft stated reason given by the current Federal Government for not committing to meaningful ***GHG*** emission reduction targets or to ***NZE*** is that Australia is committed to the means of achieving ***GHG*** emission reduction, through technology and funding support, and that Australia does not need to commit to achieve ***GHG*** emission reductions or ***NZE***.

  Whatever one's view of this stated logic, were the Federal Government of Australia to commit to increase ***GHG*** emission reductions and to achieving ***NZE***, the level of private sector investment would increase, perhaps, borrowing a phrase, that investment would be turbo-charged. This said, the Federal Government of Australia is providing funding support across a number of technologies.

  On September 30, 2021, the Federal Energy Minister, Mr Angus Taylor announced AUD 250 million (circa USD 180 million) in funding for the development (AUD 150 million) and deployment (AUD 100 million) of CCS as part of the Emissions Reduction Fund. More generally, the Federal Government of Australia provides funding support, including through the Australian Renewable Energy Agency (***ARENA***), see Edition 17 of Low Carbon Pulse (under ***ARENA opens the hydrogen funding tray***), the Clean Energy Finance Corporation (***CEFC***) and the National Australia Infrastructure Facility (***NAIF***).
- **From No Target to Big Targets:** Where the Federal Government of Australia has been non-committal, some of its high-profile and most successful business leaders are developing renewable energy projects domestically and internationally, including for the purposes of the development of Green Hydrogen and Ammonia production.

  First among equals is Dr Andrew Forrest, AO, (founder of Fortescue Metals Group, one of the Big Three Australian iron ore producers). Dr Forrest continues to lead, at pace, and its doing so both within Australia and overseas.

  During the week beginning September 27, 2021, Dr Forrest and, former Prime Minister of the Commonwealth of Australia, Mr Malcolm Turnbull combined to establish the Green Hydrogen Organisation (***GH2***), with Mr Turnbull as its inaugural chair and Dr Forrest a founding member of the ***GH2*** board. This is a high powered duo.
- **Unlocking Australia's hydrogen opportunity:** On September 27, 2021, the Australian Hydrogen Council (comprising energy corporations, infrastructure investors and vehicle manufactures promoting the role of hydrogen as an energy carrier) released a publication entitled, ***Unlocking Australia's hydrogen opportunity***. The September Report on Report will cover the publication in detail.

German progress continues, home and on the seas:

- **Germany rolls out model:** During the week-beginning September 27, 2021, the Ordinance on the Allocation of Other Energy Production Areas in the Exclusive Economic Zone (***SoEnergieV***) entered into force. The ***SoEnergieV*** allows for the testing of hydrogen produced off-shore (and ultimately development).

  SoEnergieV states the bases for the allocation of areas within the exclusive economic zone for production of hydrogen using off-shore wind. Under the ***SoEnergieV***, the German Federal Maritime and Hydrographic Agency is responsible for allocation.

  It is understood that areas will be allocated through tender processes, starting in 2022. Successful tenderers will be granted a right to apply for zoning within the area the subject of the grant to allow development.

  SoEnergieV may be regarded as being born of the three Flagship Projects undertaken by the German Federal Government, amongst other things, which have proved up the viability of the production of hydrogen off-shore.

- **Importance of framework and funding support:** Editions 25 to 27 of Low Carbon Pulse have covered the approach taken by the German Federal Government, with three Flagship Projects (in its Flagship Program) at the core of the development of a framework within which Government and the private sector are dedicated to developing the hydrogen economy:
  - **H2Giga:** the development of large-scale use of electrolysers (using serial construction of standardised electrolyser technology) to electrolyse water using renewable electrical energy to produce Green Hydrogen. Thyssenkrupp is responsible for the coordination of **H2Giga**;
  - **H2Mare:** investigating the use of use off-shore / off-grid renewable wind electrical energy to produce hydrogen and hydrogen-based fuels: effectively, a dedicated, integrated, closed electrical energy to Green Hydrogen production energy loop. **H2Mare** comprises four joint projects: **1**. OffgridWind, **2**. H2Wind, **3**. PtX-Wind, and **4**. TransferWind. Siemens Energy is responsible for the coordination of **H2Mare**; and
  - **TransHyDe:** reaching transportation of hydrogen over short, medium and long distances, and comprising four demonstration projects: **1**. Hydrogen Transport in High Pressure Vessels, **2**. Hydrogen-Liquid Transport, **3**. Hydrogen Transport in Existing and New Gas Pipelines, and **4**. Transport of Hydrogen Bound in Ammonia or liquid organic hydrogen carrier (***LOHC***), a carrier medium.
- **Glass and silver demand:** On September 29, 2021, pv-magazine.com, in an article titled ***How much glass is needed for a terawatt-scale PV***, reported on the findings of researchers in Germany who determined how much glass and silver would be required to allow the installation of photovoltaic capacity under two scenarios: **1**. 20 TW by 2050, and 80 GW by 2100; and **2**. 80 TW by 2050 and 170 by 2101. For those who want to get to grips with the scale of a key part of progress to ***NZE***, the article is well-worth a read.

PRC continues to lead the way:

- **PRC pulls back from development of coal-fired power:** On September 22, 2021, President of the ***PRC***, Mr Xi Jinping announced to the United Nations General Assembly, by video, that the ***PRC*** would cease to fund and to develop coal-fired power stations as part its ***OBOR*** assistance program.

  At the same time as making the commitment to cease funding coal-fired power stations developments, Mr Xi said that the ***PRC***, would "*step up support for developing countries in developing green and low carbon energy*".

- **Asian Infrastructure Investment Bank (*AIIB*) and *IRENA* aligned:** On September 22, 2021, it was reported widely that ***AIIB*** and ***IRENA*** had signed a memorandum of understanding under which they commit to work with each other to support energy transition across Asia and to mobilise private sector capital for this purpose.

  See: AIIB's press release; IRENA's website

- **China Three Gorges and TOTALEnergies combination:** On September 28, 2021, it was reported widely that China Three Gorges Corporation and TotalEnergies had established a joint venture to develop electric mobility infrastructure across Hubei and Wuhan provinces, with plans to develop and to deploy 11,000 high-power battery electric charging points (***BCI***) for use by battery electric vehicles (***BEVs***). As is noted below, the PRC is leading the world in many aspects of ***BEVs***.

  The intention is to have developed and deployed the ***BCIs*** by 2025. Each ***BCI*** is to comprise 60 kW and 120 kW charging points, with hosting capacity for between 20 to 50 ***BEVs***.

  As noted in previous editions of Low Carbon Pulse, TOTALEnergies has been developing and deploying ***BCI*** (and hydrogen refuelling infrastructure) globally: the 11,000 ***BCI*** in Hubei and Wuhan join deployed and planned deployment of ***BCI*** as follows: Amsterdam, 22,000, Antwerp 3,000. London, 1,700, Paris 2,300, and Singapore, 1,500 (following the recent acquisition).

  See: *TotalEnergies joins forces with China Three Gorges Corporation to Develop More than 11,000 High Power Charge Points for Electric Vehicles in Wuhan and Hubei Province*

- **IEA's perspective on achieving carbon neutrality in PRC:** On September 30, 2021, the International Energy Agency (***IEA***) published ***An Energy Sector Roadmap to Carbon Neutrality in China*** (***IEA PRC Roadmap***).

  The headline from the ***IEA PRC Roadmap*** is that the ***PRC*** has the means to accomplish: "*fast clean energy transition … and [in so doing] increase the world's chances of limiting the rise in global [average temperatures] to 1.5^{O}C*".

  The ***IEA PRC Roadmap*** will be covered in detail in the September Report on Report (to be included as an Appendix to Edition 30 of Low Carbon Pulse).

- **Wood Mackenzie:** In addition to the IEA, Wood Mackenzie published new research (entitled ***China wind power outlook 2021-2030***) and an opinion piece entitled ***Wind power to play a key role in achieving China's carbon neutral goal***.

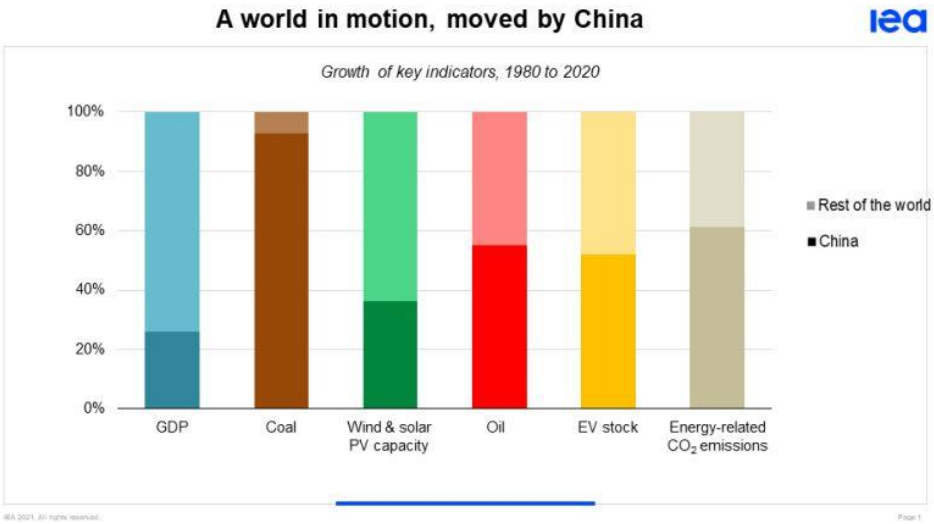
  The Wood Mackenzie research concludes that by 2030 the ***PRC*** will have cumulative grid-connected wind capacity of 689 GW, accounting for 67% of the then installed wind generation capacity, as things stand. This will require the installation of a further 408 GW of wind capacity between 2021 and 2030.

  As always, the research from Wood Mackenzie is excellent, and well-worth a read. As is the case with ***the IEA PRC Roadmap***, the September Report on Reports will include detailed coverage of the Wood Mackenzie research.

- ***PRC* belting along the road:** The economy of the ***PRC*** has become a behemoth over the last 40 years: with 25% of global growth, more than one third of photovoltaic solar installation, 50% of all ***BEVs*** and 70% of ***BEV*** manufacturing.

  The growth has been fuelled by 90% of the net increase in demand for coal (thermal and metallurgical), 50% of the increase in global demand for oil, resulting in 60% of the total growth in ***GHG*** emissions.

  The bar chart below is illustrates these facts and statistics:



- **Singing the praises of the battery electric:** The list of corporations below provides a snap shot of the current leading manufacturers of batteries:

RANK	CELL SUPPLIER	EV MAKER SERVED / UNDER CONTRACT	GWH	% MARKET SHARE	% GROWTH, 2016 - 2020
1	**Contemporary Amperex Technology Co. (CATL)**	BMW, Dongfeng Motor Corp., Honda, SAIC Motor Corp., Stellantis, Tesla, Volkswagen Group, Volvo Car Group	21.6	26	3,400
2	**LG Energy Solution**	General Motors, Groupe Renault, Stellantis, Tesla, Volvo, VW Group	21.4	26	1,193
3	**Panasonic**	Tesla, Toyota	14.1	17	214
4	**Samsung SDI**	BMW, Ford, Stellantis, VW Group	5.5	7	399
5	**BYD Co.**	BYD, Ford	5.5	7	113
6	**SK Innovation**	Daimler, Ford, Hyundai, Kia	3.4	4	226
7	**China Aviation Lithium Battery (CALB)**	GAC Motor, Zhejiang Geely Holding Group Co.	2.7	3	321
8	**Gotion High-Tech**	Chery Automobile Co., SAIC, VW Group	1.4	2	23
9	**Automotive Energy Supply Corp. (AESC)**	Groupe Renault, Nissan	1.4	2	46
10	**Ruipu Energy Co. (REPT)**	Dongfeng, Yudo Auto	0.6	1	100

Sources: Adamas Intelligence, BusinessKorea, Electrive, BMW, Ford, Honda, Volvo

US Update:

- **Background:** As noted in Edition 26 of Low Carbon Pulse, the front section of each edition of Low Carbon Pulse has been dedicated to news items on policy settings consistent with progress towards the achievement of ***NZE*** among the countries that emit the greatest mass of ***GHG*** emissions.

  Countries with the greatest mass of emissions have the heaviest lifting to do to achieve ***NZE*** by mid-century, or, as is becoming increasingly clear, before 2050 in the case of G7 and the G20 countries.

  These countries, and in the case of the ***EU***, these blocs, include the ***PRC***, ***EU***, the US, Russia, Japan, India, and Republic of Korea.

  Having reacceded to the Paris Agreement on January 20, 2021, the US has made considerable progress. Edition 30 of Low Carbon Pulse will include, as part of the September Report on Reports, details of all material developments. This Edition 28 of Low Carbon Pulse, outlines the most recent and material initiative, and progress on the passage of the USD 3.5 trillion Budget Reconciliation legislation.

- ***EPA* freezes out *HFCs***: The Environmental Protection Agency (***EPA***) announced on September 24, 2021, a requirement to reduce ***GHG*** emissions that have the highest global warming potential – the hydrofluorocarbons (***HFCs***), a group of industrial chemicals used primarily for cooling and refrigeration. The ***HFCs*** reduction requirement imposes an obligation to phase down (85% within 15 years from the introduction of the requirement) and then phase out the production and use of ***HFCs***.

  The ***HFCs*** reduction requirement is to be implemented using an allowance and trading program: from October 1, 2021, corporations are allocated allowances to produce and to import of ***HFCs*** and ***HFC*** related products. The ***EPA*** estimates that from implementation to 2050, the ***HFC*** reduction requirement will avoid 4.5 gt of ***CO_2-e*** to the climate system, or, stated another way, on current facts and statistics, a mass of ***CO_2-e GHG*** emissions equal to three years of ***GHG*** emissions from the US power generation sector. Interestingly, the ***HFC*** reduction requirement has been welcomed across the board in the US.

- **Headline progress on US 3.5 trillion bill:** Editions 23 and 25 of Low Carbon Pulse covered the progress and passage of the Infrastructure Investment and Jobs Act (***IIAJA***), and anticipated that the passage of the IIAJA was to be followed by the USD 3.5 trillion 2022 Budget Reconciliation legislation.

  As has been reported widely, the passage of the USD 3.5 trillion Budget Reconciliation legislation is proving to be a challenge. As at October 3, 2021, the Democratic Party leaders were seeking to pare-back the amount of the Budget, and, as such, some of the initiatives to address climate change.

Republic of Korea (ROK) News:

Korean H_2 Business Summit and Korean Hydrogen Council: Edition 27 of Low Carbon Pulse reported that on September 8, 2021, the ***Korean H_2 Business Summit*** had been established. Edition 19 of Low Carbon Pulse reported that the Korean Hydrogen Council would be established in September, 2021. The ***Korean H_2 Business Summit***, is the Korean Hydrogen Council - they are one and the same. The author could have made this clearer in Edition 27.

Bio-energy (including BECCS and BECCUS) update:

- **Background:** As noted in previous editions of Low Carbon Pulse (and touched on above), **bio-energy** is energy derived or produced from biomass, whether in gaseous, liquid or solid form. Bio-energy is derived from organic matter, but not fossilised organic matter. Organic matter contains carbon. (For background on biomass see this article by Iman Ghosh.)

  Note: For the production of bio-energy to be carbon-neutral, it must be combined with carbon capture and storage, ***BECCS***, or with carbon capture and use or storage, ***BECCUS***. For ***BECCS*** to make a contribution to a reduction in ***GHG*** emissions, it must displace another electrical energy source or energy carrier source, and, in any event, it must result in a carbon neutral outcome (rather than a carbon removal outcome) so as not to give rise to an increase in ***GHG*** emissions.

- **Importance of these dynamics:** The purpose of repeating these dynamics is to ensure that it is understood that the use of bio-energy as an integral part of progress to achieving ***NZE*** is about effective collection systems for bio-energy feedstocks (all carbon intensive), the capture and storage of ***CO_2*** arising from the production of them, and ensuring, through monitoring and verification, that the ***CO_2*** arising on use of bio-fuels is absorbed by renewable biomass growth. This is the basis of achieving carbon-neutrality in fact, rather than in concept.

  There are many sources of biomass. One of the most fertile grounds is waste arising from the growth of crops, the rearing of livestock, waste arising in the food supply chain (from field to fork) and waste and waste water.

- **Bio-energy projects**:
  - **Smaller scale in South Australia:** A key feature of bio-energy projects is that they come in all shapes and sizes. On September 24, 2021, The Port Lincoln Times, covering news relevant to the town of Port Lincoln, in South Australia reported on the signing of a memorandum of understanding (***MOU***) between Eyre Peninsula Cooperative Bulk Handling (***EPCBH***) and H2U, under which EPCBH and H2U will assess options for the production locally of Green Hydrogen and Green Ammonia;
  - **Shell and TOTALEnergies:** In many ways, Shell and TOTALEnergies may be regarded as two of the ***IECs*** making most progress towards achievement of ***NZE*** across their Stage 1, 2 and 3 ***GHG*** emission profiles, and this progress includes the development of bio-fuels as part of part of broader bio-energy initiatives. The starting point for the commitment to biofuels is that depending on source and technologies used to derive and to produce them, they result in up to 50% less ***CO_2*** in production.

    IECs are well-placed to produce biofuels because that have existing refining infrastructure that is able to be repurposed to produce biofuels, and the understanding of how to develop biofuel refining facilities;

- **Shell – on the moove:** On September 29, 2021, Shell announced that it had produced renewable natural gas (***RNG***) from cattle / cow manure and other agricultural residues. The ***RNG*** is processed further to derive biomethane (suitable for injection into pipeline systems as pipeline natural gas) and subject to compression to produce compressed natural gas (***CNG***) or renewable compressed natural gas (***R-CNG***). Shell is developing two like facilities;

  See: *Shell starts production at Shell New Energies Junction City, its first US renewable natural gas facility*
- **TOTAL moved in:** TOTAL Energies is in the process of making this transition, including in 2019 at Le Mede, and with the commencement of production of Grandpuits refinery in 2024; and
- **Biomethane enters GRDF network:** On September 30, 2021, injection of biomethane into the GRDF Network commenced. The biomethane meets the specification for pipeline natural gas, but is not fossil fuel derived, it is derived from organic waste to produce biogas, then processed further to produce biomethane.

CCS / CCUS and difficult to decarbonize round-up:

- ***OEIS* on CCS:** On September 24, 2021, the Oxford Institute of Energy Studies (***OIES***) released a paper, entitled ***Carbon Capture and Storage: The Perspective of Oil and Gas Producing Countries***.

  As is always the case with ***OIES*** publications, the perspectives and findings are thought provoking, and as such it is well-worth a read. At a high-level the key findings are: CCS could play a central role for oil and natural gas producing and exporting countries, the cost of CCS could be shared between producers and users, there is a need for policy settings that encourage the deployment of CCS on the basis of a clear cost outcome for users, direct and indirect, and a clear revenue outcome for owners and operators of CCS, with the Paris Agreement having a key role to play (in particular Article 6).
- **Woodmac on CCS:** On September 28, 2021, Wood Mackenzie provided an update on the cost of CCS, in an opinion piece, entitled ***Carbon capture and storage: how far can costs fall?*** which provides access to the proprietary report. Wood Mackenzie emphasises again the need to reduce ***GHG*** emissions by 1.8 Gtpa of ***CO_2-e*** a year for 30 years to achieve ***NZE*** and to limit the increase in average temperatures globally to ***1.5^oC*** (to meet its ***Accelerated Energy Transition*** scenarios). As reported in previous editions of Low Carbon Pulse, Wood Mackenzie's view is that between 4 and 6 Gtpa of ***CO_2*** needs to be captured and stored for these purposes.

  As is becoming increasingly apparent, the use of carbon clusters is going to be key to achieving a price point that will make CCS affordable and encourage the use of CCS. For these purposes, Wood Mackenzie provides levelized costs for carbon cluster CCS projects and standalone CCS projects.
- ***CO_2* to Storage:** The city of Houston is committed to achieving ***NZE*** by 2050. Leading oil, natural gas, petrochemical and refining corporations, Calpine, Chevron, Dow, ExxonMobil, INEOS, Linde, LyondellBasel, Marathon Petroleum, NRG Energy, Phillips 66 and Valero, have stated jointly (see ExxonMobil's press release here) that the key to achieving ***NZE*** by 2050 is the use of CCS.

  On September 23, 2021, Mr Erik Oswald, in energyfactor (by ExxonMobil) has written a clear and direct piece noting that to develop and to deploy CCS is going to require support from Government, at all levels, including policy settings to regulate the safe injection of ***CO_2*** to ensure that capture is permanent, to provide and extend funding support to encourage development (likely based on tax credits, rather than direct grant funding), and to provide funding support in respect of the development or repurposing of shared infrastructure. What Mr Oswald is describing is not unique to the development of CCS in the US: these policy settings are required around the world, within countries, and in some areas, across countries.
- **California mandates 40% reduction in carbon-intensity of cement:** During the week beginning September 20, 2021, California Governor, Mr Gavin Newsom, signed SB 596 which mandates the reduction of carbon emissions per ton of cement produced by 40% by 2035, compared to 2019.

  In addition, SB 596 requires the California Air Resources Board to develop a net-zero emissions strategy to decarbonise the production of cement completely by 2050. The second article in the Shift to Hydrogen (***S2H2***) series provides details on the mass of GHG arising from the production of cement and concrete globally.

  The cement production industry needs to decarbonise the production of clinker as the process of producing clinker releases ***CO_2***. Decarbonisation of the production of clinker can be achieved by the use of high-heat temperature non-fossil fuels, and the capture of ***CO_2*** arising naturally from the limestone used to produce the clinker.

  The decarbonisation of the cement industry requires the displacement of fossil fuels with high-heat temperature non-fossil fuels or non-carbon intensive fuels, such as hydrogen. ***CO_2*** arises from the production of clinker as follows: ***CO_2*** arises from both the use of fossil fuels or carbon intensive fuels and the production of clinker from limestone, i.e., calcium carbonate (***$CaCO_3$***) – for every molecule of **$CaCO_3$** used to produce cement, one molecule of ***CO_2*** arises. As such cement requires both the reduction in carbon intensive fuels and the capture of ***CO_2***.

  On October 1, 2021, Nicole Kobie published an article entitled ***Concrete is a climate disaster. It's time to clean it up***. The article's facts and statistics are consistent with ***S2H2***, but the narrative is forward looking in terms of reducing the mass of ***CO_2*** arising from cement production, and the injection of ***CO_2***.into concrete.
- **Decarbonisation of cement production in Lancashire, England:** On September 30, 2021, it was reported in the constructionindex.co.uk, that Hansen Cement has produced clinker using a 100% net zero mix of heat-temperature fuels in its cement kiln.

  The 100% net zero mix comprised 39% hydrogen, 12% meat and bone meal (***MBM***) and 29% glycerine. The hydrogen used was Grey Hydrogen. It was noted that while Grey Hydrogen was used to provide up the use of the 100% net zero mix, Green Hydrogen would be used over the long term.

  As will be apparent from this Edition 28 of Low Carbon Pulse, and previous Edition 27 of Low Carbon Pulse, the concept of 100% net zero mix needs to be approached with care.

Energy Storage round-up (including BESS and grid forming batteries):

Edifying site: On September 22, 2021, Edify Energy (leading renewable energy project developer) was granted approval to develop a Green Hydrogen production facility of up to 1 GW, and a behind the meter, photovoltaic and ***BESS*** facility at the Landsdown Eco-Industrial Precinct, in Townsville. As is the case with most Green Hydrogen production facilities, the Edify Energy project will start with a 10 MW pilot facility.

E-Fuels / Future Fuels:

- **Plug Power, keeps plugging away:** On September 20, 2021, it was reported widely that one of the first movers in the development of supply side Green Hydrogen, Plug Power Inc., is continuing its roll-out of Green Hydrogen production capacity in the US with the development of a production facility in Fresno County, California (***Fresno Facility***), in California's Central Valley, which, while an agricultural heartland, is increasingly water stressed.

  It is reported that the ***Fresno Facility*** will produce up to 30 metric tonnes of Green Hydrogen a day (***30 mtpd***), using renewable electrical energy from a 300 MW photovoltaic solar farm, and using Plug Power PEM electrolysers. It understood that the **Fresno *Facility*** will make use of water from a waste water treatment plant in the city of Mendota, Fresno County.

  As noted in previous editions of Low Carbon Pulse, while a ***30 mtpd*** facility may not appear significant in a global context, what is significant is the Plug Power is continuing to develop Green Hydrogen production facilities to provide supply to match demand on an area by area basis across the US. Further, the combination of Green Hydrogen production with the development of waste water treatment plant is about as good as it gets at the moment. As noted in previous editions of Low Carbon Pulse, the use of waste and waste water as a feedstock for the production of hydrogen has material and significant potential globally. The ***Fresno Facility*** underscores this.

  This is a wonderful model: kudos to all, and a "shout out" to Plug Power Inc., whose CEO, Mr Andy Marsh said: "*Plug Power is … committed [fully] to a green hydrogen future and is investing heavily on building a green hydrogen ecosystem to support our customers' efforts to achieve their sustainability goals*".

  This is a demonstration, at micro-level, of the need to develop supply and demand in tandem, with supply a little ahead of demand, (completing the metaphor) supply occupying the front-seat of the tandem, demand the back. Plug Power is demonstrating that a private sector corporation is able to lead the way, developing and deploying incrementally in the medium term, which 2030 appears to have become, to produce 1,000 ***mtpd*** across its US network of hydrogen production facilities, and such close to 400,000 metric tonnes a year.

  See: *Plug Power to Build Largest Green Hydrogen Production Facility on the West Coast*

- **Paraguay – a place in the sun:** Edition 25 of Low Carbon Pulse reported on the release of the International Energy Agency (***IEA***) report on the development of hydrogen capacity in Latin America, entitled ***Hydrogen in Latin America***. The report was considered in further detail in the August Report on Report (as an Appendix to Edition 27 of Low Carbon Pulse). On September 21, 2021, the International Renewable Energy Agency (***IRENA***) released a report entitled ***Renewables Readiness Assessment Paraguay*** (***Paraguay Report***).

- **INEOS continues progress to *NZE*:** Previous editions of Low Carbon Pulse (see Editions 22 and 23 for most recent coverage) have reported on the commitments made by ***INEOS*** (UK based international conglomerate) and PetroChina International, including commitments to capture at least 1 million metric tonnes of ***CO_2*** from activities at Grangemouth petrochemical and refining facilities (***Grangemouth Facilities***) in Scotland.

  These activities are significant of themselves, and because of their importance to the ***Scottish Cluster*** (see Edition 23 of Low Carbon Pulse), including the ***Acorn Project***. The carbon capture and other initiatives are intended to reduce ***GHG*** emissions from the ***Grangemouth Facilities*** by 60% by 2030.

  On September 22, 2021, ***INEOS*** announced plans to augment the ***Grangemouth Facilities*** to allow use of hydrogen as a feedstock and fuel. This augmentation will require the investment of GBP 1 billion. ***INEOS***'s stated intention is to progress to ***NZE*** by 2045, in line with the policy setting of the Scottish Government.

- ***PORA* richer for DOI:** On September 24, 2021, Port of Rotterdam Authority (***PORA***) and the DeltaPort Niederrhainhä fen (the combined activities of these two inland ports providing leading a logistics hub), EON (international energy company), Kreis Wesel (a district of Germany), Nordfrost (leading logistics service provider) and Thyssengas (gas pipeline operator) announced entry into an declaration of intent (***DOI***) to enable inland ports in North Ruhr to act as a regional hub for the import of hydrogen from the Port of Rotterdam.

  North Rhine-Westphalia Minister for Economic Affairs, Innovation, Digitalisation and Energy, Mr Andreas Pinkwart noted: "*That the significance of this project goes way beyond our region*". ***PORA*** Commercial Director Mr Emile Hoogsteden said: "*We want to help [in] developing a Cool Corridor, a regular inland shipping connection for reefer containers between Rotterdam and the Ruhr area*".

  The ***DOI*** is consistent with the development of North Rhine-Westphalia as the focal point of hydrogen hubbing.

- **Eustream tripling up:** Edition 27 of Low Carbon Pulse reported that Eustream (Slovakian based natural gas pipeline network owner and operator) has joined a joint venture to develop a supply chain from Green Hydrogen production facilities in Ukraine to Austria and Germany, and other central European markets (***H2EU+Store***). ***H2EU+Store*** comprises key players, including Bayerngas GmbH, Bayernets GmbH, Eco-Optima LLC, Open Grid Europe GmbH and RAG Austria AG.

  On September 24, 2021, it was reported widely that Eustream, EP Infrastructure, NAFTA and RWE are assessing the use of their gas transmission pipelines to haul Blue Hydrogen from a Blue Hydrogen production facility in Slovakia. The repurposed Eustream gas transmission system would be used to haul the Blue Hydrogen into Austria and Germany. This assessment will be combined with the work being done on ***H2EU+Store***, and ***CEHC*** (see next paragraph) and work will be done in Austria, Czech Republic, Germany and Ukraine as the key

jurisdictions. The thinking is that the Blue Hydrogen haulage will precede that of Green Hydrogen, with blending of Blue Hydrogen with natural gas during 2023.

The combination of gas transmission operators, or TSOs (comprising Eustream, Gas TSO (Ukraine TSO), Net4gas (the Czech TSO) and OGE (a German TSO) has been christened as ***Central European Hydrogen Corridor*** (***CEHC***). From various sources, it is stated that the ***CEHH*** will be able to haul up to 120 GWh per day by 2030 from Ukraine via Slovakia and the Czech Republic, delivering hydrogen to areas of high demand for hydrogen.

- **MingYang mega-wind turbine factory:** Edition 26 of Low Carbon Pulse reported on the development of the MingYang MySE 16.0-242 (***My Mega***) wind turbine. On September 24, 2021, MingYang announced plans to develop a factory in Germany. If these plans come to fruition, this would be a first for a ***PRC*** company, and it would be great boost for the wind turbine industry generally.

  See: MingYang website

- **Repurposing of infrastructure and use of established designs:** On September 24, 2021, it was reported widely that Viscofan (world leading supplier of casings / containers, for meat products) had conducted tests successfully using Green Hydrogen to displace natural gas as the fuel source in one of its boilers in Cáseda Spain. The use of Green Hydrogen to displace natural gas is an integral part of the plans of Viscofan to decarbonise its activities. The challenge for Viscofan is the supply of Green Hydrogen to allow it to effect decarbonisation.

  See: Viscofan website

- **Great Interest in Southern Green Hydrogen project:** Editions 22 and 23 of Low Carbon Pulse reported on the Tiwai Point, Southland, New Zealand, ***Southern Green Hydrogen project***, proposed to be developed with the Tiwai Aluminium Smelter in Invercargill on New Zealand's South Island.

  As noted in Edition 22 of Low Carbon Pulse, Contact Energy (***CE***) and Meridian Energy (***ME***) are proposing to develop the ***Southern Green Hydrogen*** project. Having been advised by McKinsey & Co of the potential of the project, ***CE*** and ***ME*** have tested the market for interest, and the market is reported to have responded in a way that demonstrates considerable interest for the Green Hydrogen that may be produced at the project, and as such provide a basis to underpin it.

- **A world first in French Guiana – prospective global application:** On September 29, 2021, Fuelcellsworks.com, reported under ***HDF Energy Breaks Ground on World's Largest Green Hydrogen-Power Project*** that HDF Energy (global pioneer in hydrogen power), and its equity partners, Meridiam (infrastructure fund) and SARA (petroleum operator and member of the Rubis Group) broke ground on the development of the CEOG Renewstable®Power Plant (***COEG***). ***COEG*** is reported to be the world's first multi-megawatt hydrogen power plant, and the largest Green Hydrogen intermittent ***HESS*** (with 128 MWh of energy storage capacity).

  The ***COEG*** is significant because it can be replicated globally – it is the right scope and scale, and it is dispatchable 24/7. It has been project financed on the basis of a credit worthy off-taker of the renewable electrical energy from ***COEG*** under a 25 year power purchase agreement, ***EDF***, a first tier engineering procurement and construction (***EPC***) contractor, Siemens Energy, and a first tier electrolyser technology supplier, McPhy (French headquartered, leading supplier of electrolysers and associated technology). The electrical energy to power the electrolyser is sourced from photovoltaic solar capacity.

  COEG is being duplicated in 20 countries, including Australia, Indonesia, Mexico, and South Africa.

- **Mitsui, Wesfarmers, Japan Oil and Metals National Corporation combine for feasibility study:** On October 1, 2021, it was reported widely that Mitsui & Co. (leading Japanese trading house, through its extended Australian group) and Wesfarmers Chemicals Energy and Fertilisers (leading Australian diversified conglomerate, which includes energy and fertiliser production interests), with Japan Oil and Metals National Corporation, are undertaking jointly a feasibility study to assess the development of low carbon ammonia supply chain.

  The study will consider the use of natural gas to produce Blue Hydrogen, with a depleted natural gas field in Western Australia to be used to store ***CO_2***, with the Blue Hydrogen then used as feedstock to produce Blue Ammonia. The electrical energy required would be sourced from photovoltaic solar and wind sources. The headline is that the feasibility study will consider the potential to produce up to 1 ***mmtpa*** of Blue Ammonia.

  See: Mitsui website

- **In late news**: As Edition 28 of Low Carbon Pulse was being finalised on October 4, 2021, the ***IEA*** released its ***Global Hydrogen Review 2021***. The ***Global Hydrogen Review 2021*** will be considered in detail in the September Report on Reports, to be included as the Appendix to Edition 30 of Low Carbon Pulse. Also, ENOES and Fortescue Metals Group and Fortescue Future Industries reported that they are working on the development of a Japan-Australia ***CO_2***-free hydrogen Supply Chain, and the Ammonia Energy Association reported on the scope of the potential of Mexico to produce green maritime fuels.

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

- **Greenlink Interconnector:** On September 22, 2021, it was reported that Greenlink Interconnector Limited (the developer of the 500 MW, 190 km, high voltage direct current (***HVDC***) ***Greenlink Interconnector*** between the Republic of Ireland and the UK) had signed a design, procurement and construction contract with Siemens Energy and Sumitomo Energy under which Siemens and Sumitomo will deliver the ***Greenlink Interconnector***.

  While not yet a trend, the use of ***HVDC*** interconnection between sources of renewable electrical energy and load for that electrical energy appears to provide a means of developing world scale projects in parts of the world that do not have sufficient load to parts of the world that do.

  As noted below, the ***Sun Cable Project Making Progress*** and ***The X-Factor***, interconnectors of 3,500 kms in length are being developed.

  See: *Siemens Energy and Sumitomo Electric awarded EPC contract for Ireland-UK interconnector*

- **Gasunie Salt Cavern Storage:** On September 23, 2021, Gasunie announced that it completed successfully the conversion of a portion of a salt cavern used for natural gas storage into a hydrogen storage facility.

  While further testing is to be undertaken, Gasunie is to continue the development of storage in salt caverns. It is anticipated that the first salt cavern will be operational by 2026 for commercial use.

  As noted in previous editions of Low Carbon Pulse, the development of hydrogen storage facilities is required as a key element to the commercial use of hydrogen by large users (including for the high-heat temperature process undertaken by the cement, chemical, petrochemicals and refining, glass and iron and steel industries) and to allow the use of hydrogen across networks.

  Gas Infrastructure Europe (***GIE***) released a study entitled ***Picturing the value of underground gas storage to the European hydrogen system / Guidehouse study*** *(**GIE Study**)*. The ***GIE Study*** confirms what has been known for some time, that for the hydrogen economy to be established at a functional level hydrogen storage is required.

  See: *Successful start of hydrogen storage demonstration project strengthens hydrogen development*

- **Giga-factory update:** It has been the plan for a while to include a feature on giga-factories in an edition of Low Carbon Pulse. Given the space and word count taken by outlining trends and matters of policy ahead of COP-26 Editions 25, 26 and 27, and this Edition 28 have been weighty. A future edition of Low Carbon Pulse will include a feature on both giga factories and charging and refuelling infrastructure.

Wind round-up:

- **Australia winds-up**: A number of editions of Low Carbon Pulse have covered the highly prospective nature of the development of the off-shore wind industry (***OWI***) in Australia, and the recognition of the Federal Government of Australia of the need for legislation to allow the development of the ***OWI***. As noted, while Australia has some of the best renewable energy resources in the world on-shore, it has world class off-shore wind resources as well. This section picks up on the emerging news from the increasingly prospective ***OWI***.
  - **Australis Energy winds-up:** On September 20, 2021, is was reported widely that Australis Energy subsidiary SA Offshore Windfarm has submitted an application for the development of a 600 MW off-shore wind field development off the coast of South Australia (approximately 10 kms off the South Australian coast). This follows the application in June for the development a 495 MW off-shore wind field off the coast of Victoria, and the application in April (see Edition 14 of Low Carbon Pulse) for a 300 MW off-shore wind field development off the coast of Western Australia; and
  - **Oceanex Energy quantifies the potential:** During the week beginning September 27, 2021, the results of a report commissioned by Oceanex Energy were shared, informing its decision to develop two 2 GW off-shore wind field developments, one off the coast of the Hunter Valley, the other off the coast of the Illawarra (two coal producing areas in NSW). This announcement coincided with the announcement by the NSW Government to reduce ***GHG*** emissions across the State of NSW by 50% by 2050 (see ***Australia – the Curates Egg***).
- **Another floating off-shore wind commissioned:** On September 21, 2021, it was reported widely that the Kincardine Offshore Windfarm Ltd (***KOWL*** project sponsor of the ***Kincardine Project***) had commenced the dispatch of electrical energy under its power purchase agreement with Statkraft (leading renewable energy generation corporation) which has agreed to purchase 100% of the renewable electrical energy from the ***Kincardine Project***, reported to be the world's largest floating off-shore wind field project.

  See: *Statkraft helps world's largest floating wind farm find its customers*

- **Ørsted outlines its development plans submitted in ScotWind Leading program:** Edition 27 of Low Carbon Pulse reported details of the development plans of Ocean Winds (an EDP and Engie 50:50 joint venture) and Aker Offshore Wind for a 6 GW floating off-shore wind field in the Outer Moray Firth, off shore of Scotland.

  During the week commencing September 20, 2021, it was reported widely that Ørsted (global renewable energy giant) intends to progress its floating off-shore wind field development plans with expenditure plans of up to GBP 12 billion. Ørsted is a consortium with BlueFloat Energy (leading off-shore wind developer) and Falck Renewables (leading Italian renewable energy developer).

  It is understood that the details shared reflect the terms of the Ocean Winds, Aker Offshore Wind and Ørsted responses to the ScotWind Leasing Scheme (bids for which closed on July 16, 2021, which are covered in Edition 22 of Low Carbon Pulse).

  See: Ørsted website

- **SSE Renewables scoping Berwick Bank:** On September 26, 2021, The Scotsman, published under an article entitled ***Giant offshore wind farm in Fourth would be the UK's largest and could power all Scottish homes twice over***. A big headline, for a big story, about a big project. The Scotsman reported that SSE Renewables is planning a 4.1 GW off-shore wind field project (***Berwick Bank Super Project*** or ***BBSP***) within the Firth of Forth, 40 kms off the East Lothian and Fife coastlines.

  The ***BBSP*** is reported to combine the earlier Berwick Bank and Marr Bank proposals, covering a combined area of 1,313 km^2. The location of landfall, and connection to the grid, has been secured at Branxton, near Torness, in East Lothian. If the ***BBSP*** is consented to by the Scottish Government in Q1 of 2022, it is anticipated that the ***BBSP*** could be operational by 2026.

- **Ørsted outlines its development plans for Swedish wind:** On September 29, 2021, Ørsted announced that it plans to proceed with the development of the 1.5 GW Skåne Havsvingpark off-shore wind field project (***Skane Havsvingpark*** Project or ***SHP***) off the coast of Sweden, in the Swedish sector of the Baltic Sea, 22 km south of Skåne. On development of the ***SHP***, it will be capable of suppling half the current electrical load of Skåne. For the purposes of proceeding with the ***SHP***, Ørsted has submitted an environmental impact assessment. The Baltic

Sea is considered to highly prospective for the development of off-shore wind fields: Ørsted considering that the Baltic Sea region has the potential for up to 90 GW of off-shore wind field capacity.

See: Ørsted website

- **From Scotland to Italy:** On October 1, 2021, Falck Renewables (leading Italian renewable energy developer) and BlueFloat Energy (leading off-shore wind developer) announced that they have entered into a 50:50 joint venture for the purposes developing off-shore wind field (***OWF***) projects off the coast of Italy.

  It is reported that the first project is a 1.2 GW ***OWF*** off Brindisi (***Kailia Energia Project***), with projected annual generation dispatch of up to 3.5 TWh. For the ***Kailia Energia Project*** to proceed, authorisation will have to be obtained from the Ministero per la Transizione Ecologica and a maritime concession granted by the Ministero delle Infrastructurre and the Port Authority of the Southern Adriatic Sea.

  See: BlueFlat press release; Falck Renewables press release

Solar and Sustainable Energy Round-up:

- **Kaban Green Power Hub achieves Financial Close:** On September 20, 2021 it was reported widely that Neoen (global leading renewable energy company) had achieved financial close for its AUD 370 million, 157 MW and 320 km transmission line project (***Kaban Green Power Hub*** or ***KGPH***) within the Northern Queensland Renewable Energy Zone. It is understood that this will enable Neoen to supply renewable electrical energy to Cleanco (Queensland state government renewable electrical energy consolidation company). It is reported that BNP Paribas, HSBC, MUFG, NAB and Nord L/B have provided project finance for the ***KGPH***.
- **Lord Howe Island milestone:** On September 20, 2021, reneweconomy, reported that the micro-grid on Lord Howe Island (off Australia), comprising a photovoltaic solar facility and a ***BESS*** (a Tesla Powerpack), has been operating for six months. It is reported that the use of the micro-grid has reduced diesel use on Lord Howe Island by two-thirds. While the scale of the micro-grid is not significant in a global sense, the installation of the micro-grid and its use has implications for other islands within the Asia Pacific region.
- **Sun Cable making continued progress:** Previous editions of Low Carbon Pulse have reported on the development of the ***Sun Cable Project*** (see Editions 2, 3, 13 and 26): currently the size and shape of the ***Sun Cable Project*** is as follows: 20 GW of installed photovoltaic solar capacity and between 36 and 42 GWh of ***BESS***, with the electrical energy dispatched and delivered through a high voltage direct current (***HVDC***) cable from Darwin to Singapore. For these purposes the ***HVDC*** cable has to be laid through the territorial waters of the Republic of Indonesia, and this requires the approval of the Government of Indonesia.

  On September 23, 2021, it was announced by Sun Cable that it had been granted approval by the Government of Indonesia (in the form of a sub-sea cable permit), for the proposed route of the ***HVDC*** through Indonesian territorial waters. The ***Sun Cable Project*** and the Australia-Asia PowerLink (***AAPowerLink***) continues to make progress to realisation of the planned first dispatch date of 2028.
- **The X-Factor:** Edition 16 of Low Carbon Pulse reported on the proposed development of a 10.5 GW photovoltaic solar (7 GW) and wind (3.5 GW) renewable energy and a 5 GW / 20 GWh ***BESS*** project (***Morocco Project***) proposed by Xlinks (a renewable energy development corporation based in the UK) to be located in Morocco, North Africa, with the electrical energy generated by the ***Morocco Project*** to be transmitted to the UK using a 3,800 km ***HVDC*** (***Morocco UK Interconnector***). It is stated that the ***Morocco UK Interconnector*** will be able to deliver 3.6 GW for an average of more than 20 hours a day.

  The length the ***Morocco UK Interconnector*** is similar to the length of the ***AAPowerLink*** from Darwin to Singapore (noting that the electrical energy from the ***Sun Cable Project*** is to be transmitted 700 km from a 17-20 GWp solar farm with approximately 36-42 GWh battery energy storage located near Elliott, NT, to Darwin before going sub-sea). The ***Morocco UK Interconnector*** would trace the Moroccan and Spanish coasts, crossing the Bay of Biscay, and the English Channel, making land-fall at Alverdiscott, Devon, England, and possibly Pembroke, Wales.

  Edition 3 of Low Carbon Pulse (under ***Interconnection***) outlines the key financial modelling issues arising from the use of ***HVDC*** cables for interconnection, in particular if over 3,500 kms in length.
- **Africa WindPower established:** On September 30, 2021, Global Wind Energy Council (***GWEC***) announced a regional body to represent the wind industry, Africa WindPower (***AWP***). The purpose of ***AWP*** is to provide a platform for dialogue between Government and industry stakeholders across Africa.

  According to an International Finance Corporation report, Africa has 59,000 GW of wind resources (on shore and off-shore combined), and as such the potential to match 250 times over the current load across Africa. As reported in previous editions of Low Carbon Pulse, Africa is similarly blessed with solar and hydroelectric and pumped storage potential. As is the case with all reports in respect of renewable energy resources, the reports provide reason for confidence, but the reason for confidence has to be firmed up against the practical, in particular the location of the resources and the location of the load.

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

- **Engine technology:** While there tends to be focus on battery electric vehicles (***BEVs***) and fuel cell electric vehicles (***FCEVs***) in the context of progress towards achievement of ***NZE***, it is apparent that the internal combustion engine (***ICE***) may have a new lease of life using hydrogen as a fuel. On September 23, 2021, Cummins announced that it is progressing its ***ICE*** program to develop 6.7-litre (for use in medium-trucks) and 15-litre ***ICEs*** (for use in heavy-duty, long-distance trucks).

  The development program is proceeding with funding support from the UK Government's Advanced Propulsion Centre initiative. Cummins President of Engine Business, Mr Srikanth Padmanabhan places the ***ICE*** development program in context with ***BEV*** and ***FCEV***: "*Reducing well-to-wheels carbon emissions requires innovation of both energy sources and power solutions. While cases for battery electric and fuel cell electric powertrains are*

promising, the pairing of green hydrogen in the proven technology of internal combustion engines, provides an important complement to future zero emissions solutions".

- **Cummins is not alone:** On September 27, 2021, Kawasaki Heavy Industries (***KHI*** being one of the highest value and largest scale engineering corporations leading the transition across the hydrogen economy, as is the case with Cummins), is working on the development of hydrogen-fuelled ***ICEs***. As reported by H2View on September 27, 2021, by Executive Officer at ***KHI***, Dr Motohiko Nishimura hydrogen-fuelled ***ICEs*** may be regarded as "superior to fuel cells" for some uses: "*In terms of durability and reliability [hydrogen-fuelled **ICEs** are superior to fuel-cells, making [hydrogen-fuelled **ICEs**] suitable for heavy-duty use on ships, heavy machinery and long distance buses and trucks*."
- **Keeping track of rolling stock**: Edition 27 of Low Carbon Pulse reported that the Alstom Coradia iLint passenger train debuted on French railways. On September 24, 2021, in the publication, The Local, Martin Greenacre (in an article entitled (***5 things to know about hydrogen trains coming to France***), outlines the implications of the use of Coradia lLint passenger train in France.

  Mr Greenacre provides historical background, noting that Alstom has been developing fuel cell technology (***FCT***) for use in trains since 2013 and providing some current facts and statistics: that SNCF has ordered ***FCT*** trains for use on its regional and slower, non-electrified, lines, that the Coradia iLint is assembled at Salzgitter, Germany, that the two ***FCT*** trains are in use in Germany, with another 41 to begin regular service in Germany during 2022 and 2023, and finally that the ***FCT*** trains are in use in Austria, Italy, the Netherlands and Sweden.

  The article is worth a read.
- **Taking the hy-road:**
  - **MANing up:** MAN (leading engine technology, bus heavy and goods vehicle / truck corporation, and a subsidiary of Volkswagen Audi Group) announced that it is transitioning from diesel to electric drive buses and heavy goods vehicles / trucks by 2024.
  - **Mercedes Benz and Daimler trucks splitting up:** On October 1, 2021, Daimler announced that its truck division is to split from Mercedes Benz. It anticipated that the split will be effected from February 1, 2022. Daimler is expected to become named Mercedes-Benz Group AG with the truck division to become Daimler Trucks. The split may be regarded as consistent with the increased focus of Daimler Trucks on fuel cell electric technologies (***FCT***) and fuel cell electric vehicles (***FCEVs***), including the tie up with Volvo reported in Edition 17 of Low Carbon Pulse and the tie-up of Shell in respect of the development of hydrogen refuelling infrastructure (***HRI***), with Shell to develop and to deploy 150 ***HRI*** by 2030, and Daimler's plan to have delivered 5,000 heavy goods vehicles / trucks using ***FCT*** by 2030 (see Editions 17 and 18 of Low Carbon Pulse).

Aviation and Airports:

- **Airbus, Air Liquide and VINCI Airports H2 Airport :** On September 21, 2021, Airbus, Air Liquide and VINCI Airports announced plans to develop a pilot project at the Lyon-Saint Exupery airport. As noted in previous editions of Low Carbon Pulse, hydrogen has considerable potential airside and landside, and airborne. The planned pilot project is understood to involve the development and deployment of hydrogen storage and delivery systems. If the pilot project proves feasible, VINCI Airports across Europe are likely to adopt the storage and delivery systems overtime.
- **Airbus reports hydrogen the aviation fuel of tomorrow:** Airbus has released a report on the use of hydrogen in the aviation industry (***Hydrogen: An energy carrier to fuel the climate-neutral aviation of tomorrow***). Chief Operating Officer of Airbus, Mr Mark Bentall is reported as having said: "Hydrogen offers us the biggest potential to reach that zero emissions target and our net zero ambitions".
- **Shell and Deloitte, from road to air:** Shell and Deloitte have produced a paper entitled ***Decarbonising Aviation: Cleared for Take-off, Industry Perspectives*** (***Cleared for Take-off***). The September Report on Reports will cover the key findings from ***Cleared for Take-off***.

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 organisation, title / subject matter, and link.

ORGANISATION	TITLE / SUBJECT MATTER
Airbus	***Hydrogen: An energy carrier to fuel the climate-neutral aviation of tomorrow***
Australian Hydrogen Council	***Unlocking Australia's hydrogen opportunity***
Gas Infrastructure Europe (***GIE***)	***Picturing the value of underground gas storage to the European hydrogen system / Guidehouse study***
International Energy Agency (***IEA***)	***Hydrogen in Latin America***
International Renewable Energy Agency (***IRENA***)	***Renewables Readiness Assessment Paraguay***
Nature	***The contribution of insects to global forest deadwood decomposition***

NSW Parliament Legislative Council	***Development of a hydrogen industry in New South Wales***
Shell and Deloitte	***Decarbonising Aviation: Cleared for Take-off, Industry Perspectives***
Oxford Institute for Energy Studies	***Why Are Gas Prices So High***
Oxford Institute for Energy Studies	***Carbon Capture and Storage: The Perspective of Oil and Gas Producing Countries***
World Meteorological Organization	***Climate Indicator and Sustainable Development: Demonstrating the Interconnections***

Key Contacts

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

Michael Harrison
Senior Partner, Energy, Resources and Infrastructure

M +65 9728 8562 /+61 439 512 384/ +61 414 968 707
michael.x.harrison@ashurst.com

Daniel Reinbott
Partner

T +65 6416 9529
M +65 9728 8672
daniel.reinbott@ashurst.com

Dan Brown
Partner

T +61 7 3259 7149
M +61 401 564 654
dan.brown@ashurst.com

Michael Burns
Partner

T +44 20 7859 2089
M +44 7717 840 646
michael.burns@ashurst.com

Antony Skinner
Partner

T +44 20 7859 1360
M +44 7917 635 974
antony.skinner@ashurst.com

Eleanor Reeves
Partner

T +44 20 7859 1210
M +44 7823 340 854
eleanor.reeves@ashurst.com

Richard Guit
Global Co-Head, International Projects

T +65 6602 9153
M +65 9728 7943
richard.guit@ashurst.com

Peter Vaughan
Partner

T +61 8 9366 8173
M +61 412 909 489
peter.vaughan@ashurst.com

Paul Curnow
Partner

T +61 2 9258 5738
M +61 434 074 591
paul.curnow@ashurst.com

Anna-Marie Slot
Global Environmental, Social and Governance Partner

T +44 20 7859 3724
M +44 7788 710 892
anna-marie.slot@ashurst.com

David Wadham
Office Managing Partner, Tokyo

T +81 3 5405 6203
M +81 90 4828 5191
david.wadham@ashurst.com

Andrew Roche
Partner

T +65 64160272
M +65 97287452
andrew.roche@ashurst.com

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Low Carbon Pulse – Edition 28 – October 5, 2021.The author of (and researcher for) each edition of Low Carbon Pulse is Michael Harrison.