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Low Carbon Pulse - Edition 29

GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS

Welcome to **Edition 29** of Low Carbon Pulse – sharing significant current and recent news on progress towards net-zero greenhouse gas (***GHG***) emissions (***NZE***). This edition is split into two parts:

- the Friday Edition: covering Government announcements and policy issues; and
- the Sunday Edition: including all material and significant project announcements for the period from Monday October 4, 2021 to Saturday October 30, 2021 (inclusive of each day).

Please click here for **Edition 28** of Low Carbon Pulse, and click here for the ***Low Carbon Pulse Compendium***, which comprises **Editions 1** to **28** of Low Carbon Pulse. Click here and here for the sibling publications of Low Carbon Pulse, the ***Shift to Hydrogen*** (***S2H2***)***: Elemental Change*** series and here for the first feature in the ***Hydrogen for Industry*** (***H24I***) features.

On **October 19, 2021**, an **Anniversary Edition** of Low Carbon Pulse was published reflecting on the 12 months since the publication of Edition 1 on October 6, 2020, and looking forward to the next 12 months.

On **November 16, 2021**, normal service will be resumed with **Edition 30** of Low Carbon Pulse covering news in the period from Sunday October 31, 2021 to Sunday November 14, 2021. The Appendix to **Edition 30** will include the Reports on Reports for September and October. **Edition 31** of Low Carbon Pulse will be published in the usual two week cycle on November 30, 2021. **Edition 32** (*The Magic Johnson Edition*) will be published on Friday December 17, 2021 and **Edition 33** (*The Larry Bird Edition*) on Friday January 14, 2021, after the Christmas and western New Year holiday season.

Progress to COP-26:

- **Expectations – somewhere between heightened and sky high:**
  - **New York, Milan and Glasgow – Great Cities, Great Expectations:**

    After the weeks beginning September 20, 2021 (in New York), and September 27, 2021 (in Milan), the great and the good continued to prepare for the 26th session of the Conference of Parties (***COP-26***) of the United Nations Framework Convention on Climate Change opening this coming Sunday, October 31, in Glasgow, Scotland. The great and the good have been gathering in Glasgow for the last few days, and en route many of the great and good have been making announcements and caucusing.

    As US Special Climate Change Envoy, Mr John Kerry, said in Milan: "*The bottom line is, folks, as we stand here today, we believe we can make enormous progress in Glasgow, moving rapidly towards new goals that science is telling us we can achieve*".

    President of ***COP-26***, Mr Alok Sharma, set out the UK Government Goals for ***COP-26***, the fourth of those Goals including the finalisation of the ***Paris Rulebook***. Mr Sharma has been quoted as saying that reaching agreement of the ***Paris Rulebook*** will be more difficult that achieving agreement of the Paris Agreement.

    One senses that Mr Sharma is right, and yet just because something is difficult does not mean that it is not pursued. Third time lucky with the ***Paris Rulebook***!

- ***COP-26* Countdown:**

  During this week-beginning October 25, 2021, five Low Carbon Pulse – ***COP-26*** Countdown features were published covering the four key goals outlined for ***COP-26*** by the UK Government as the host of ***COP-26*** (the ***Four Pillars***).

  This Edition 29 of Low Carbon Pulse does not repeat the ***Four Pillars*** or the subject matter of them.

- **Top line to bottom line:**

  30 years and counting: It is a little over 30 years since the United Nations Intergovernmental Panel on Climate Change (***IPCC***) released its First Assessment Report in 1990. In a little over 30 years, the mass of ***GHGs*** present in the climate system has doubled. Among other things, this increase in ***GHG*** emissions reflects increasing population, prosperity and urbanisation.

  The bottom line is that by 2030, ***GHG*** emissions need to be reduced by 45% (at least) to ensure that average increases in global temperatures stay within the bottom end of the responsible range between the ***Stretch Goal*** and the ***Stabilisation Goal*** i.e., between ***1.5^{o}C*** to ***2°C*** (***Responsible Range***), and a reduction of 50% is required to achieve the ***Stretch Goal***. This analysis is drawn from the UNFCCC NDC Synthesis Report which synthesises information from the 164 latest nationally determined contributions (***NDCs***) communicated by the 191 Parties to the Paris Agreement as at July 30, 2021. While it is known that ***GHG*** emissions must be reduced, ***GHG*** emissions are projected to increase. It is the Synthesis Report that projects the ***Catastrophic Pathway***.

  In the week leading up to ***COP-26***, the **Commitment and Production Gap** has probably received more concerned coverage in news feeds and opinion pieces than any other matter.

  Commitment and Production Gap: The United Nations Environment Programme (***UNEP***) publishes a production gap report annually. On October 20, 2021, the ***UNEP*** published the ***2021 Production Gap Report*** (***PGR***). Each production gap report assesses the gap between ***NDCs*** and the planned and projected fossil fuel production. The authors of the ***PGR*** note that as countries have made ***NZE*** commitments and increased their ***NDCs***, they, "*… have not explicitly recognised or planned for the rapid reduction in fossil fuel production that these targets will require*".

  GHG* emission reduction gap:** The ***PGR notes that given current plans and projections, by 2030, the production of fossil fuels will exceed levels that are consistent with achieving the ***Stretch Goal***; by 240% more in the case of coal, by 57% more in the case of oil and by 71% more in the case of natural gas. The "policy setting hand" and the "practical, real world, hand" are not coordinated. As a result, there is a gap.

  If the gap is not bridged or narrowed, it is expected that the current bottom line (as projected) will result in at least a 16% increase in ***GHG*** emissions by 2030. This is not consistent with achieving the ***Stretch Goal***, rather it aligned with, what United Nations Secretary General, Mr Antonio Guterres has termed, a ***Catastrophic Pathway***.

  Tracking to 2.7^{o}C: United Nations Secretary General, Mr Antonio Guterres, pulled no punches in his address to the United Nations General Assembly in September. 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".

  The First Pillar (of the ***Four Pillars***) for ***COP-26*** contemplates staying within the ***Responsible Range***, while "keeping in touch" with the ***Stretch Goal***.

  "Faster, Higher, Stronger …. Together": Earlier in 2021, Mr Thomas Bach, President of the Olympic Committee, suggested the addition of the word "***Together***" to the Olympic motto, ***Faster***, ***Higher***, ***Stronger***. The rate of reduction in, and the rate of removal of, ***GHG*** emissions need to be faster and higher, and the commitments stronger.

  More than this, Article 2.2 of the Paris Agreement provides: "*This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances*".

- **Reducing the *GHG* emission reduction gap:**

  Functioning rule book required: Increased ***GHG*** reduction commitments (through increased ***NDCs***) will bridge or narrow the gap in concept, but equally important as ***NDCs*** is the use of an accepted and common monitoring and reporting framework in compliance with which reductions in ***GHG*** emissions will be monitored, and, through that monitoring, measurement, and those determinations, ***GHG***s emissions will be verified.

  This will be achieved by the bolstering of the ***2018 Paris Rulebook*** (developed but not finalised at COP-24 in Katowice, Poland, and COP-25 in Madrid, Spain) with the bolstered Rulebook being the ***Paris / Glasgow Rulebook***. The ***2018 Paris Rulebook*** was agreed in part in December 2018 at COP-24, and provides guidelines for countries to achieve the outcomes provided for under the Paris Agreement. Given that the ***2018 Paris Rulebook*** was agreed in part, it is incomplete, critically around key elements of accounting and accountability for ***NDCs***.

  As has been noted by many commentators, because the Paris Agreement is a bottom-up agreement, Parties to the Paris Agreement set their own targets (i.e., their ***NDCs***), set policies as the means of achieving those targets, set the standards used to account for them, and as such to monitor and to report on their achievement. Ideally, the ***Paris Rulebook*** will provided for standardisation.

  Trust and verify: For the author, while not headline grabbing, progress on the ***Paris Rulebook*** is the the most pressing outcome in achieving progress to ***NZE***, along with increased ***NDCs*** and commitments to development and deployment of renewable electrical energy, critically, to monitor achievement to respond to circumstances in which progress is not being made, and to verify what progress has been made.

At the moment, the ***2018 Paris Rulebook*** does not require countries to narrow or to bridge the gap between projected fossil fuel use and their ***NDC***s. It is possible to see some folk seeking to "paper over the gap" by use of ***International Market Mechanisms*** under Article 6 of the Paris Agreement. Papering over a crack is not advisable. Papering over a gap, even less so.

One of the most debated areas, if not the most debated area, is the use of carbon credits (and cross-border emissions trading), including to bridge or to narrow the gap. This debate appears set to take centre stage.

- **The *2021 Report*:** The point of reference for the author continues to be the ***IPCC Sixth Assessment Report – Climate Change, The Physical Science Basis*** (***2021 Report***). It is understood that the ***2021 Report*** is in the *Final Government Distribution phase*, a phase that is to end on November 26, 2021, being a date after ***COP-26*** finishes.

  During the weeks leading up to ***COP-26***, a number of news outlets reported on "leaks" of correspondence arising from the consultation process as part of the *Final Government Distribution phase*. While the author has not seen any of the correspondence, given the nature of the *Final Government Distribution phase*, the author does not read too much into the reported correspondence: the science will not change; how to achieve ***NZE*** is the subject of debate, validly so.

  By mid-February 2022, the Summary for Policymakers will be pretty much finalised. (The ***2021 Report*** comprised a Summary of Policymakers in draft – see Edition 24 of Low Carbon Pulse.)

  The ***2021 Report*** continues to be the oracle, providing the range of outcomes from which ***COP-26*** has to choose.

- **A reminder of the key provisions of the Paris Agreement:** While frequent readers of Low Carbon Pulse will be familiar with the key provisions of the Paris Agreement, for convenience they are set out below:

KEY PROVISIONS OF THE PARIS AGREEMENT FOR *COP-26*	
Article 2.1: This Agreement … aims to strengthen the global response to the threat of climate change … including by: (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; (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and (c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.	**Article 4:** 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* … . **Article 6:** 1. Parties recognise that some Parties choose to pursue voluntary cooperation in the implementation of their nationally determined contributions to allow for higher ambition in their mitigation and adaptation actions and to promote sustainable development and environmental integrity. 2. Parties shall, where engaging on a voluntary basis … promote sustainable development, and ensure … integrity and transparency … and shall apply *robust accounting* … to ensure .. *avoidance of double counting* consistent with guidance adopted by the Conference of Parties … .

Progress to COP-26 continued … :

- **Top Agenda Items:**

  Four Pillars*:** As noted above, during this week beginning October 25, 2021, Low Carbon Pulse – published five ***COP-26 Countdown features dealing with the four key goals outlined for ***COP-26*** by the UK Government as the host of ***COP-26*** (the ***Four Pillars***).

  The ***Four Pillars*** are as follows:

  1. Secure global net zero by mid-century and keep 1.5 degrees within reach;
  2. Adapt to protect communities and natural habitats;
  3. Mobilise finance; and
  4. Work together to deliver.

  From the ***Four Pillars***, and related matters, the agenda items at or towards the top of folks' lists are likely to be:

  - ***NDCs*** and ***Paris Rulebook***: Commitments to ***NDCs***, or commitments to increased ***NDCs***, accompanied by the ***Paris Rulebook*** to provide a clear, monitorable and verifiable pathway towards ***NZE***, are key to the success of ***COP-26***. Progress on these matters will be a clear indication of the success of ***COP-26***.

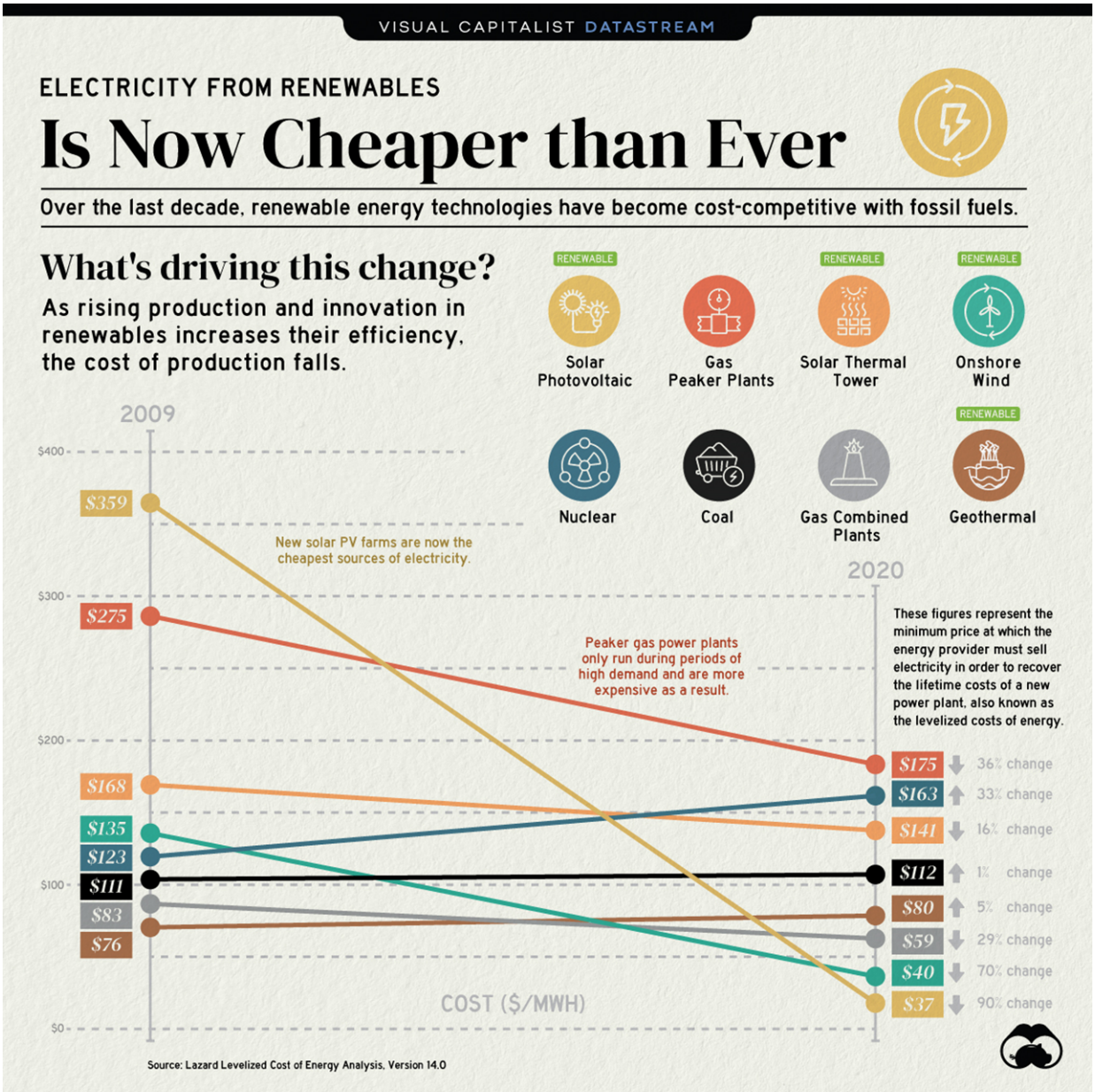
    Commitments to, or commitments to increased ***NDCs***, represent the first step for some countries, and longer strides for others. To avoid miscalculation of progress to achieving ***NDCs*** and ***NZE***, the ***Paris Rulebook*** is needed, both to monitor (and to provide the basis for measurement and determination) and to verify reductions in ***GHG*** emissions, and to achieve efficient deployment of technologies and initiatives on a basis that recognises and responds to any non-achievement of ***GHG*** emission reduction commitments.

    Also the ***Paris Rulebook*** is needed to provide a clear basis to monitor and to verify the use of carbon credits to offset compliance or mandatory obligations or to allow corporations to use carbon credits to manage their progress towards ***NZE***.

  - **Hydrogen, Here and Now**: Defined commitments to the development of: (**i**) Carbon Capture and Storage (**CCS**), and Carbon Capture Use and Storage (**CCUS**) including to allow the development of Blue Hydrogen production capacity are needed; and, (**ii**) renewable electrical energy capacity, solar and wind (off-shore and on-

shore), to develop sufficient renewable electrical energy to allow the production of Green Hydrogen as soon as practicable, is needed. (See Editions 26 and 27 of Low Carbon Pulse, including under ***Government needed to guide to achieve timely development***.)

- **Solar, Here, There and Everywhere**: The ever declining cost of photovoltaic solar electrical energy may be regarded as a function of markets working at their best, and critically, to lower the cost of producers of equipment, supplying domestic and international markets, allowing the deployment of photovoltaic solar at a scale that results in the lowest electrical energy costs in history, and the increasing development of battery electric storage systems (***BESSs***).



Electricity from Renewable Energy Sources is Now Cheaper than Ever. Visual Capitalist. https://www.visualcapitalist.com/electricity-from-renewable-energy-sources-is-now-cheaper-than-ever/

In some markets, these outcomes have been achieved before use of photovoltaic solar has been incentivized.

As a result of these dynamics, the Levelized Cost of Energy (***LCOE***) for photovoltaic solar electrical energy has become the lowest of any source of electrical energy in many markets.

From ***COP-26***, it is hoped that developing countries, including those in Africa, East Asia, South East Asia and the Pacific Islands, will emerge with funding support programs to maximise deployment of photovoltaic solar development, both roof-top and utility. Further, it is hoped that President Xi Jinping's proposal for a global high voltage direct current (***HVDC***) renewable energy network receives the "air-play" that it deserves.

- **Article 6 Agenda:** It is clear that a number of countries and organisations attending ***COP-26*** will seek to focus on carbon credits and trading in them, including to allow off-set against emission reduction commitments and liabilities, and the development of carbon credit trading. As noted above (and below), increased carbon credits, in theory, will narrow the gap between the projected increase in ***GHG*** emissions and the ***NDCs*** of some countries.

  It is critical to keep in mind that the use of carbon credits, while important, will not achieve the level of ***GHG*** emission reductions required to achieve ***NZE***. The effective use of carbon credits, and the development of trading

platforms for high-quality carbon credits, will "buy time" for the corporations purchasing them and for the rest of us by slowing the rate of increase in ***GHG*** emissions.

The slowing of the rate of increase in ***GHG*** emissions will slow the rate at which we deplete the global carbon budget, but ultimately decarbonisation of activities giving rise to ***GHGs*** is required.

- **A price on carbon:** A number of commentators have suggested that a global price on carbon should be on the ***COP-26*** agenda.

  While a global price on carbon would link directly to the market for carbon credits, the author does not consider that a price on carbon is an appropriate agenda item for ***COP-26*** or any Conference of Parties.

  This is not because a price on carbon is not a good idea in the right setting, but because the imposition of a global price on carbon would have to take account of current policy settings (including current customs and excise duties and taxes on fossil fuels) in each country, and is "a third rail" that is best left untouched.

  A carbon price is a tool used to encourage participants in markets to move to lower, low or no carbon technologies. In some countries a carbon price makes sense, but it makes sense only if it is set at a level that encourages the development and deployment of lower, low or no carbon technologies (and those technologies are available or on the horizon) – this is the logic for any carbon price, whether set through an emissions trading scheme or as a carbon tax, or both.

  The "price on carbon versus technology" debate is one that the Federal Government of Australia has been sharing for a while: technology, not a carbon price (or, in Australian parlance, a carbon tax), will result in progress to achieving ***NZE***. The Federal Government of Australia is committing tax-payer money to support the development of technologies which the Government hopes will find a market.

  The debate that the Federal Government of Australia has shared is incomplete in that it ignores the rate at which reductions in ***GHG*** emissions need to be achieved, and that a price on carbon provides a benchmark for the cost of a lower, low or no carbon technology displacing carbon. This debate will no doubt continue.

- **Global energy demand and markets:** On ***October*** 6, 2021, S&P Global Platts reported on the assessment of the ***US EIA*** (the ***US Energy Information Administration***). The S&P Global Platts report notes that the projection of the ***US EIA*** in its ***International Energy Outlook*** (***IEO***) is that global energy demand will grow by 47% by 2050, and oil and natural gas will remain the largest source of energy.

  The assessment of the ***US EIA*** "*underscores the stark challenges ahead for transitioning away from fossil fuels and curbing global warming emissions*".

  The ***IEO*** is stark. It is the counterfactual to the aspirational ***NZE***, and emphasises the importance of the reduction of ***GHG*** emissions by 45% (or more) by 2030, if not sooner. As noted in previous editions of Low Carbon Pulse, leaving decarbonisation to markets will not result in ***NZE***.

  As noted above, there is a **Commitment and Production Gap**. ***COP-26*** will not resolve the **Commitment and Production Gap**, but this gap needs to be discussed, and the ***Paris Rulebook*** needs to address how Parties to the Paris Agreement will address this gap.

  As noted above, and to provide emphasis, in the week leading up to ***COP-26***, the **Commitment and Production Gap** has received more concerned coverage than any other matter.

- **Papers, Reports and Studies – Thick and Fast:**
  - **A good year for publications:** Throughout 2021 the mass of and the speed at which publications have been released has increased, in part in anticipation of ***COP-26***. This has been the case, in particular, since May 18, 2021.

    Since May 18, 2021, in addition to the ***2021 Report***, the following reports have been published, earliest first, most recent last (all summarised in Low Carbon Pulse):

    - **International Energy Agency** - ***Net Zero by 2050 – A Roadmap for Global Energy Sector*** (***IEA Roadmap***);
    - **International Renewable Energy Agency** - ***World Energy Transitions Outlook*** (***IRENA WETO***);
    - **Wood Mackenzie** – ***How to scale up carbon capture and storage***;
    - **BloombergyNEF** - ***New Energy Outlook, 2021***; and
    - **S&P Global Platts** - ***Platts Global Integrated Energy Model – Strategic Planning for a world in transition***.
  - **Paper, Paper everywhere – too much to drink in:** In the lead up to ***COP-26***, many papers, reports and studies have been published. In the context of ***COP-26*** the following seem the most relevant:
    - ***IEA GH2R***: On October 5, 2021, the International Energy Agency (***IEA***) continued its prolific year with the publication of its ***Global Hydrogen Review 2021*** (***IEA GH2R***).

      As always with ***IEA*** publications, the ***IEA GH2R*** is both helpful and informative, and as such well-worth a read, and continues the consistent engagement of the ***IEA*** in respect of hydrogen (see ***The Future of Hydrogen Report***). Of particular interest to the author is the ***Hydrogen Projects Database***.

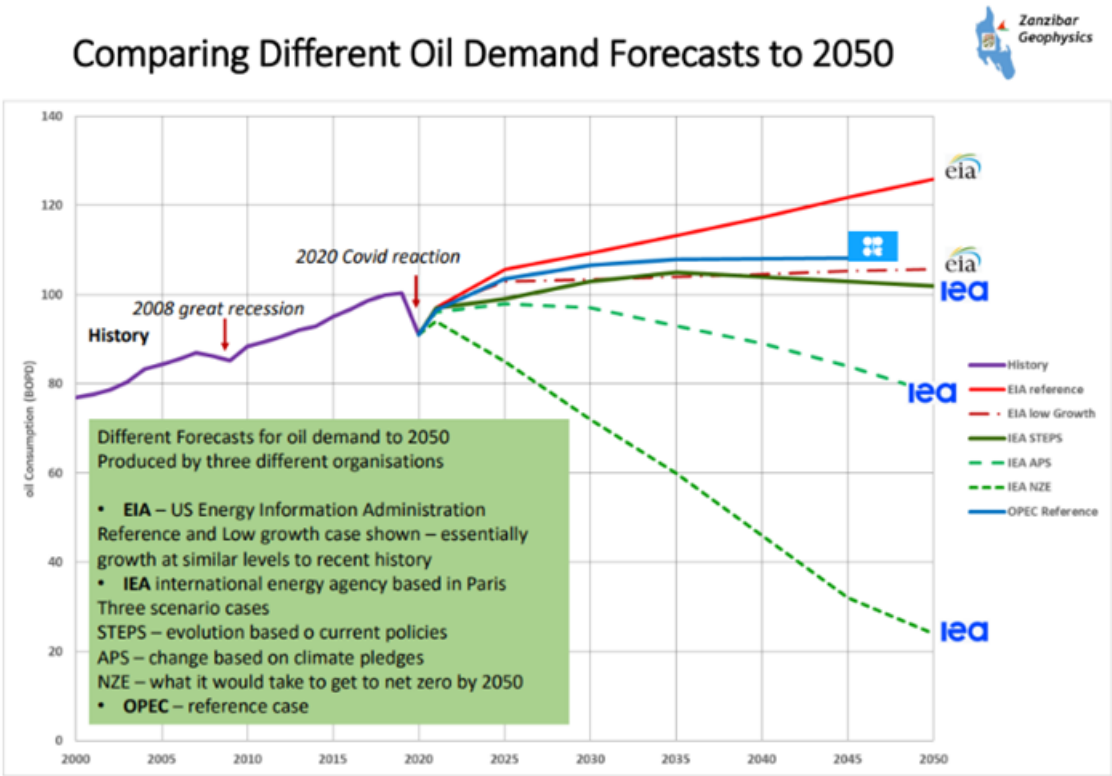
      The key message from the ***IEA GH2R***, in particular for the purposes of ***COP-26***, is one that will be familiar to readers of Low Carbon Pulse: the role of Government is central to the development of both the Blue Hydrogen and Green Hydrogen industries, and as such the associated development of hydrogen-based fuels.

      This key message is consistent with the messaging from the ***IEA*** since well before Edition 1 of Low Carbon Pulse. Edition 27 of Low Carbon Pulse (under ***A role for Government in the development of supply and demand for hydrogen***) referenced an opinion piece from Wood Mackenzie: "*… [COP-26] must go far beyond setting new emission targets. Ensuring that hydrogen is not just a "fuel of the future", but a fuel that needs to be … implemented into global society from today [and] should be top of the agenda*".

      The ***IEA GH2R*** will be considered in detail in the *October Report on Reports* (in the Appendix to Edition 30 of Low Carbon Pulse).

- ***US EIA - IEO*:** On October 6, 2021, the ***US EIA*** published its International Energy Outlook (***IEO***). As noted above, the ***IEO*** may be regarded as an assessment of what supply and demand will be given current policy settings, and as such without material and significant initiatives that change this direction of travel. (The *October Report on Reports* will consider the ***IEO*** in detail.)

  This ***IEO*** is a read for the positive realist, determined to press for progress on the basis of higher and faster ***GHG*** emissions, and stronger enforcement, together. This said, the positive realist needs to understand that the ***US IES*** may be regarded as plotting a demand / consumption curve above those plotted by others in the recent past:



- ***IEA* - *CCH4R*:** On October 7, 2021, the ***IEA*** published its ***Curtailing Methane Emissions from Fossil Fuel Operations*** (***CCH4R***). It will be no surprise to readers of Low Carbon Pulse that the headline from the ***CCH4R*** is that the reduction in methane (***CH_4***) emissions is "*among the most impactful ways to combat near-term climate change*".

  As noted in the **Anniversary Edition** of Low Carbon Pulse, one of the areas of progress since October 2020 has been the recognition of the need to address ***CH_4*** emissions, culminating in the ***Global Methane Pledge***, signed by the European Commission (***EC***) and the US on September 17, 2021. As at noon on October 29, 2021, 24 countries have committed since then, including Argentina, Indonesia, Italy, Mexico, and the UK, with New Zealand considering joining, and the Kingdom of Saudi Arabia has committed to joining.

  The ***IEA*** has been advocating consistently for a focus on ***CH_4*** emissions for some time, and will no doubt continue to do so.

  The ***CCH4R*** notes (as it has noted on a number of occasions) that: "*Methane has contributed around 30% of the global rise in temperature to date … Emissions from fossil fuel operations present a major opportunity [to limit global warming in the near term] since the pathways to reduction are both clear and cost-effective*".

  The ***CCH4R*** will be covered in detail in the *October Report on Reports* (in the Appendix to Edition 30 of Low Carbon Pulse).

  In passing, it is important to note that while the focus of the ***CCH4R*** is ***CH_4*** arising from the extraction, production and transportation of fossil fuels, ***CH_4*** arises from agriculture, forestry and other land use (***AFOLU***) and waste and waste water. At the same time as ***CH_4*** emissions from fossil fuel operations are being targeted, ***CH_4*** emissions from waste and waste water need to be addressed (see below **A role for Government in decarbonising *AFOLU*** and **A role for Government in the development of Bioenergy**).

  As noted in other editions of Low Carbon Pulse, ***AFOLU*** is challenging, but addressing waste, in particular landfill, and waste water, should be alongside addressing ***CH_4*** emissions from fossil fuel production. This requires policy settings and implementation from Government to align with the waste management system.
- ***IEA* - *IEA WEO*:** On October 13, 2021, the ***IEA*** published its ***World Energy Outlook 2021*** (***IEA WEO***). The key message from the ***IEA WEO*** is that the world is in energy transition but the rate of progress towards energy transition, and the achievement of progress towards **NZE**, needs to increase.

  The ***IEA WEO*** will be covered in the *October Report on Reports* (in the Appendix to Edition 30 of Low Carbon Pulse).

- ***IRENA*** - ***DESS Roadmap*:** On October 13, 2021, the International Renewable Energy Agency (***IRENA***) published its ***A Pathway to Decarbonize the Shipping Sector by 2050*** (***DESS Roadmap***).

  The ***DESS Roadmap*** notes that currently the shipping sector uses fossil fuels, and that it is necessary to displace fossil fuels so as to reduce CO_2 emissions. The ***DESS Roadmap*** provides a description of the ways and means to the displacement of fossil fuels so as to achieve an 80% reduction in CO_2 emissions by 2050.

  Director General of ***IRENA***, Mr Francesco La Camera provides a clear picture: "*[The DESS Roadmap] clearly shows that cutting CO_2 emissions in such a strategic, hard to abate sector, is technically feasible through [the use of] green hydrogen fuels.*"

  IRENA contemplates that up to 70% of the fuels used in the shipping sector by 2050 will be hydrogen-based fuels. Without necessarily wanting to pick winners, ***IRENA*** suggests that the use of e-ammonia could provide close to 45% of the energy demand from the shipping sector by 2050.

  In some ways, the ***DESS Roadmap*** may be regarded as conservative given the initiatives already "on the water", critically, the progress that the shipping industry is making in the use of hydrogen-based fuels (see Editions 26 and 27 of Low Carbon Pulse).

  The shipping sector is increasing, some might say intensifying, efforts to reduce the ***GHG*** emissions arising from the sector. By way of a reminder, the shipping sector gives rise to up to 3% of global ***GHG*** emissions (expressed in CO_2-e terms), with the International Maritime Organisation suggesting 2.9% and ***IRENA*** suggesting around the same. A recent article (entitled ***Enduring waves of climate change: Maritime Decarbonization, a tempest before the calm***) from the ever accurate S&P Global Platts provides a balanced perspective, noting the scale of the task, balanced with the achievability of the task.

  The *October Report on Reports* (contained in Appendix to Edition 30 of Low Carbon Pulse) will consider the ***DESS Roadmap*** in detail.

- ***IEA – UAC Paper*:** On October 19, 2021, the ***IEA*** published its paper Phasing Out Unabated Coal – Current status and three case studies (***UAC Paper***). The ***UAC Paper*** carries forward one of the key findings in the ***IEA WEO*** – critically, the need to end investment in new unabated coal-fired power plants, and to retrofit, and to repurpose, existing coal-fired capacity.

  As is typical in ***IEA*** publications, the ***UAC Paper*** contains a number of recommendations: **1**. Allow sufficient time for consultation and implementation of phase out plans; **2**. Provide support for affected communities, including workers; **3**. Ensure that security of electrical energy supply is maintained as "a cornerstone of phase-out policies"; **4**. Implement carbon pricing; **5**. Improve the climate for investment in clean electricity and the necessary infrastructure; and **6**. Consider conversion of coal generation assets.

  Recommendations **1** to **3**, and **5** and **6** will come as no surprise.

  The implementation of recommendation **4** (Implementing carbon pricing) may come as a surprise given the need to accelerate the retirement of coal-fired power generation is more about development of new renewable electrical energy capacity as soon as practicable, than use of a carbon price.

- ***IEA – NZE ES Report*:** On October 20, 2021, the ***IEA*** published its report Achieving Net-Zero Electricity Sectors in G7 Members (***NZE ES Report***).

  The ***NZE ES Report*** was requested by the UK (which holds the ***G7*** this year). As might be expected, the ***NZE ES Report*** builds on the finding from the ***IEA Roadmap*** published on May 18, 2021.

  The ***NZE ES Report*** will be considered in detail in the *October Report on Reports* (in the Appendix to Edition 30 of Low Carbon Pulse).

- **The Economist weighty reflection:**

  In the October 9, 2021 edition of The Economist, the venerable publication reflected on the size of the current hydrogen industry, at 90 million metric tonnes per annum (***mmtpa***) and USD 150 billion.

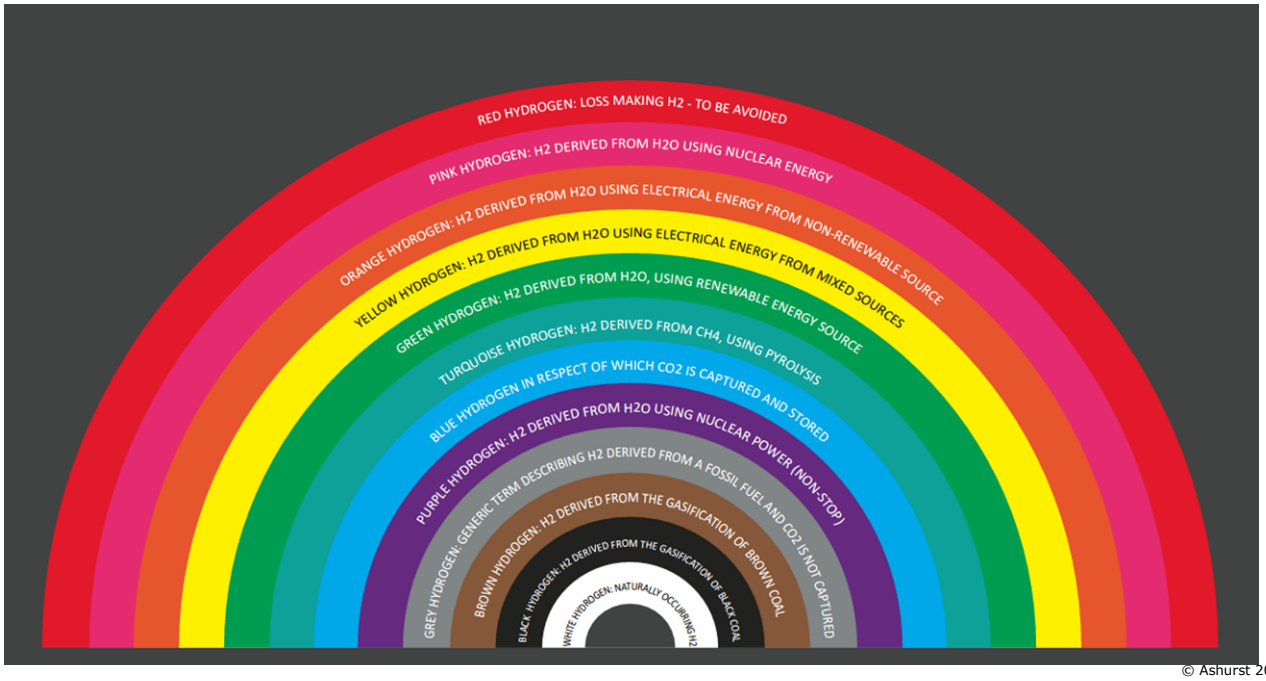
  Given current technologies (steam methane removing, grey hydrogen production and gasification, black or brown hydrogen production), around 6% of the natural gas and 2% of coal production is used each year to produce this 90 ***mmtpa*** of hydrogen.

  The production of the 90 ***mmtpa*** gives rise to between 850 and 900 ***mmtpa*** of ***GHG*** emissions, or around 1.8% of the 50 Giga-tonnes CO_2-e ***GHG*** emissions arising each year.

  As such, hydrogen produced using these technologies is not going decarbonise the production of energy carriers to displace hydrocarbons; rather CCS / CCUS to produce Blue Hydrogen and electrolysers and renewable electrical energy will do this.

  The Economist notes the degree of difficulty and the scale of the endeavour. To remind the reader of the various colours of hydrogen, the Ashurst Hydrogen Rainbow is included on the following page.

Ashurst Hydrogen Rainbow:



The ***Ashurst Hydrogen Rainbow*** (a creation of the author of Low Carbon Pulse), is intended to provide an aide memoire to the reader. It is noted that the author of Low Carbon Pulse took liberties with both the colour coding of hydrogen and the spectrum: adding Red Hydrogen (at the top of the ***Rainbow***) to represent the difficulty of making a return on any early stage clean or low hydrogen project, and adding Grey, Brown, Black and White (at the bottom of the ***Rainbow***) for completeness of the colours that are used to describe hydrogen.

- **G20 activity and commitments in the lead up to *COP-26*:**
  - **UK All Green Electrons by 2035:** On October 4, 2021, UK Prime Minister, Mr Boris Johnson announced that by 2035 all electrical energy dispatched to satisfy load in the UK would be matched by renewable electrical energy. This is the perfect response to the impact of the shortage of natural gas on the electrical energy prices in the UK: the best cure for higher prices is higher prices, resulting in increased supply or in a switch to another technology or increased use of an existing technology.

    Stating the obvious, the switch to an existing technology is occurring, and needs to accelerate. Until the switch reaches a tipping point, the UK Government, like many countries around the world, needs an energy security policy (sufficient supply side to avoid sustained higher prices).

    While an inconvenient truth, the UK and ***EU*** countries may need more gas-fired power stations to provide required energy supply, and those gas-fired power stations will have to be developed with CCS / CCUS. As frequent readers of Low Carbon Pulse, and sister publications of Low Carbon Pulse, will know, this is a long-standing perspective of the author of Low Carbon Pulse.
  - **UAE comments to NZE by 2050:** On October 7, 2021, the United Arab Emirates (***UAE***) committed to reduce its ***GHG*** emissions to ***NZE*** by 2050 – see below (under ***GCC Countries update***) for more detail.
  - **Turkey ratifies the Paris Agreement:** Edition 28 of Low Carbon Pulse noted the good news arising from the United National General Assembly during the week beginning September 20, 2021, that Turkey had committed to ratify the Paris Agreement. The commitment had to be ratified by the parliament of Turkey. On October 8, 2021, the parliament of Turkey ratified the accession of Turkey to the Paris Agreement.
  - **ROK increases *NDC*:** On ***October 18, 2021***, the Republic of Korea (***ROK***) increased its ***NDC*** from 26.3% to 40% by 2030, compared to 2018. This is considered in more detail below under ***Republic of Korea (ROK) News***.
  - **Saudi Arabia commits to *NZE* by 2060:** On October 24, 2021, the Kingdom of Saudi Arabia (***KAS***) committed to reduce its ***GHG*** emissions to ***NZE*** by 2060. The commitment of the ***KAS***, and the associated steps to implementation (see below under ***GCC Countries update***) demonstrate in the clearest of terms the economic, environmental and social transformation that is upon us.
  - **Australia commits to its version of *NZE* by 2050**: As note in Edition 28 of Low Carbon Pulse, the Federal Government of Australia has been the subject of scrutiny by the international community and its own citizens because it had not committed to the achievement of ***NZE*** by 2050.

    On October 26, 2021, the Federal Government of Australia announced its commitment to ***NZE*** (see below under ***Australia – Weighted Progress*** for the reported perspectives on the commitment).
  - **UK Global investment Summit:** The UK Government hosted the UK Global Investment Summit (***GIS***), on October 19, 2021.

    Notable announcements from the ***GIS*** are captured in the following press release – click here – from the UK Government providing a high level overview of the outcomes and commitments from the ***GIS***.

During the week of ***GIS***, the UK Government announced two strategies: ***Net Zero Strategy: Build Back Greener*** and ***Heat and Building Strategy***. These strategies will be considered in detail in the *October Report on Reports*.

Roles to be played to reduce GHG emissions:

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

Edition 28 of Low Carbon Pulse contemplated that Edition 29 would cover the Role of Government in decarbonising Agriculture Forestry and other Land Use (***AFOLU***) and the development of bio-energy. It contemplated also that the Role of Carbon Credits and Coal would be considered. We have covered Carbon Credits, but not Coal (the ***LIAC Paper*** does this effectively).

- **A role for Government in decarbonising *AFOLU*:**
  - **Decarbonising *AFOLU*:**

    Edition 28 of Low Carbon Pulse noted that ***AFOLU*** is hard to decarbonise. 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 maintenance of the value of certain crops.

    Given these dynamics, the decarbonisation of the ***AFOLU*** sector is best regarded, and is best calibrated, on a country by country, area by area, basis.
  - **Do no harm, but do it quickly!**

    In this context, there is a role for Government in ensuring that it "does no harm" having regard to the areas within a country in which it seeks to set policies that will result in a reduction in ***GHG*** emissions. In the context of "doing no harm", there is a role for Government at a number of levels. In the collection of waste, rather than crop burning (over 3.5% of ***GHG*** emissions expressed in ***CO2*-e** terms), and providing value to landholders to avoid deforestation (close to 2.5% of ***GHG*** emissions). In these areas alone, there is close to 7% of the total mass of CO_2-**e** ***GHG*** emissions "in play".

    In addition, Governments can encourage afforestation and reforestation and wilding of land, and practices to reduce ***GHG*** emissions arising, including to provide value for these forms of land use, including by use of carbon credits. These activities have value in that they remove ***GHG*** emissions from the climate system. The removal of ***GHG*** emissions from the climate system means that the rate at which our global carbon budget is being depleted will slow. Governments are now acting on the ability of certain trees and crops to absorb CO_2.
  - **Giving value to *GHG* land use that removes *GHG*s:**

    The most potent ***GHG*** emission arising from agriculture is CH_4, including raising livestock (around 5.8% of ***GHG*** emissions expressed in CO_2-**e** terms) and growing certain crops (up to 2.2%). (CH_4 is more potent than CO_2 (see Edition 27 of Low Carbon Pulse).)

    As noted above, initiatives to collect waste, to change land use and to remove ***GHG*** emissions from the climate system will allow progress to decarbonising the ***AFOLU*** sector, but given the potency of CH_4, more needs to be done. What needs to be done in terms of CO_2 removal activities needs to be determined and planned by Governments. And countries that export products that have given rise to CH_4 need to do more still.
  - **Government to assess and to plan:**

    A key part of planning needs to consider the trees, and other vegetation (***green carbon***), that can achieve the highest levels of CO_2 absorption (***sequestration capacity***) on a sustainable basis within areas of countries. Governments are ideally placed to map and to monitor trees and other vegetation to assess the sequestration capacity of trees and vegetation, above and below ground.

    In addition, the use of coastlines and the nearshore in certain regions of the world offer potentially vast sequestration capacity (***blue carbon***). For example, mangrove forests and swamps, and areas with sea-grasses and tidal marshes, provide ecosystems that can absorb CO_2. For Government, the task is to assess how much of the coastline and the nearshore can be used to progress the development of ***blue carbon*** sequestration capacity.
  - **Blue carbon v. Green Carbon:**

    It is estimated that one mangrove tree will absorb 12.4 kg of CO_2 a year on average. Taking the benchmark of the Kingdom of Saudi Arabia to plant 50 billion trees (see Edition 13 of Low Carbon Pulse), 50 billion mangrove trees will absorb 620 million metric tonnes (***mmt***) per annum (***mmtpa***). It is possible to plant 5,000 mangrove trees per hectare, with each hectare absorbing 62 metric tonnes (***mt***) per annum (***mtpa***) of ***CO2***. 50 billion mangrove trees could be planted on 10,000,000 hectares.

    In contrast, a palm tree will absorb around 2.3 kg of CO_2 a year. On October 25, 2021, the US State of Florida announced plans to replace palm trees with native canopy trees, which absorb a greater mass of CO_2. Palm oil trees are different, and the data on their ability to absorb CO_2 has quite a spread. Taking the highest estimate of the spread at 57.6 ***mtpa*** per hectare, palm oil trees appear comparable with mangrove swamps. This is not to suggest deforestation and planting of palm oil trees (the broader challenges with palm oil are well known and beyond the scope of this Edition 29 of Low Carbon Pulse), rather it is to provide a point of comparison.

    By way of further comparison, a pine free will absorb around 10 kg of CO_2 a year. On the basis that there are approximately 1,000 trees per hectare, the pines trees in that hectare will absorb 10 ***mtpa*** of CO_2.
  - **Bamboo a super-absorber:**

    "Higher, Faster, Stronger" is a good description for bamboo: bamboo is a super-absorber of CO_2, storing CO_2 in its biomass, particularly its root system (its extensive root system being good for soil quality, preventing soil erosion and assisting in the restoration of soil-depleted areas). For these reasons, the planting of bamboo may be regarded as integral to long-term agricultural redevelopment and agroforestry.

As with the reporting on the capacity of palm oil to absorb ***CO_2***, the reporting on the capacity of bamboo to absorb ***CO_2*** varies somewhat. At the higher end, one hectare of bamboo is reported to be able to absorb between 17 and 20 ***mtpa*** of ***CO_2***. Bamboo is fast growing, and mature groves of bamboo can be established within two to three years. Bamboo is an effective above ground carbon and below ground carbon absorber.

For every 10 million hectares of land used to grow bamboo, between 170 and 200 ***mmtpa*** of ***CO_2*** will be absorbed each year. India is estimated to have around 12.4 million hectares of bamboo groves.

- **Assessment of *AFOLU*:**

  For each country, an immediate focus should be the assessment and analysis of the use of trees, other vegetation and 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). An assessment of this kind will yield an understanding of optimal land use, from both an economic and environmental perspective, and a means to realise value from carbon credits.

- **A role for Government in the development of Bioenergy:**
  - **Background:**

    The ***IEA Roadmap*** and the ***IRENA WETO*** both identified the development of bio-energy capacity as key to achieving ***NZE*** under the scenarios outlined in them. As noted in previous editions of Low Carbon Pulse, **bio-energy** is energy derived or produced from biomass, whether that energy is in gaseous, liquid or solid form. Bio-energy is derived from organic matter, but not fossilised organic matter.

    The sources of biomass for use as feedstock or fuel are many and varied, but in the context of ***GHG*** emissions, the organic waste stream arising from human activities provides a renewable resource that, if collected, processed and used, can reduce ***GHG*** emissions, avoiding or reducing ***CH_4*** (and ***CO_2***) on the decomposition of that organic matter, and the displacement of fossil fuels with that bio-energy.

    The 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).

  - **Bio-energy and carbon:**

    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 bio-energy production using ***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.

    This is where Government has a role to play. As has been noted in respect of CCS / CCUS in the context of carbon clusters (invariably located around ports and the hinterlands of ports), the storage of ***CO_2*** is likely to require Government funding support, and also Government risk support. It is no surprise that both the ***IEA Roadmap*** and the ***IRENA WETO*** contemplate tying the development of the bio-energy to CCS / CCUS to capture and to store the ***CO_2*** arising from the production of bio-energy.

  - **Waste management plans and systems required:**

    Progress towards achievement of ***NZE*** is not a zero sum game. More than that, it is to be expected that there will be increased scrutiny of the life-cycle and ***GHG*** emission footprint of asset and infrastructure life, and responsibility for recovery and recycling of organic matter giving rise to ***GHG*** emissions (in the same way as with metals and mineral and plastics, which is a topic for another edition of Low Carbon Pulse).

    Across all human activities, waste arises and ***GHG*** emissions arise. Globally, Government has a role to play in the development of waste management systems from the point of the waste arising to the point of recycling, re-use, or disposal, including in this context, the recycling and re-use of biomass, and the disposal into storage of ***CO_2***.

  - **Bio-energy and AFOLU sector:**

    The broader ***AFOLU***, 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. Organic matter in waste and waste water decomposes. The rate of decomposition varies. On decomposition, ***CH_4*** and ***CO_2*** arise.

    Capturing the life-cycle of carbon 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, the implementation of policy settings of this kind would 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.

  - **Interface with progress to *NZE* and progress to *Net-Zero Waste*:**

    While this piece is intended to identify the role of the Government in the development of bio-energy, the author thought that it may be helpful to outline the role of Government more broadly in the waste sector as progression is made towards the achievement of ***NZE***, and as such outline the policy settings that are emerging and likely will emerge.

    As progress towards ***NZE*** is made, the mass of waste arising on the extraction of metals and minerals, on the manufacture of equipment and infrastructure, on the transportation and installation of that equipment and infrastructure, and at the end of the life-cycle of that equipment and infrastructure, will increase. The most

prominent waste streams from progress towards the achievement of ***NZE*** are solar panels and wind-turbines, ***Net-Zero Waste*** if you will (not to be confused with the existing use of this phrase to describe another policy setting – Net-Zero Waste to landfill).

More broadly, the policy settings for the management of ***E-Waste*** and ***Net-Zero Waste*** are very much in the process of being re-based in the context of ***E-Waste*** and formulated in the context of ***Net-Zero Waste***. The phrase ***E-Waste*** is used to describe waste that arises from electronic equipment used for business, domestic, industrial or scientific use, including equipment needed for Information and Communications (***ICE***).

In a recent report, it is estimated that between 2.1 and 3.9% of global ***GHG*** emissions arise from equipment that becomes ***E-Waste***. In part, this reflects that the production of ***ICE*** gives rise to ***GHG*** emissions (including some of the more potent), housed in plastics that are not designed for recycling, using heavier metals, the life-cycle of which needs to be understood and captured. Ultimately, all residual material needs to be captured for safe and sustainable recycling or disposal.

Improved and new policy settings are needed if extraction and manufacturing is to be decarbonised in the case of ***ICE***, and if ***GHG*** emissions are to be avoided in the case of equipment and infrastructure manufactured and developed, for the purposes of achieving progress towards ***NZE***.

Policy settings for Recovery, recycling and disposal of materials arising at the end of life-cycle needs to be contemplated sooner rather than later, and the means of recovery, recycling and disposal developed by Government or with its support, and their use mandated.

Note: ***Net-Zero Waste*** is not yet a concept, but for present purposes it includes waste that arises from the extraction, manufacture, transportation and use of equipment and infrastructure developed for the purposes of reducing ***GHG*** emissions, including on the extraction of metals and minerals used in the manufacture of solar panels and wind towers and turbines, and energy storage systems (including ***BESSs***) on the manufacture of those panels, towers and turbines, and systems, and on recovery and recycling of resources from them at the end of their life-cycles, and the means of disposal of any material that cannot be recovered or recycled.

- **Role of carbon credits in progress to achieving *NZE*:**
  - **Background:**

    There has been considerable coverage around the role of carbon credits in achieving ***NZE***, not least because of the record high prices being paid for carbon credits in both compliance / mandatory markets (***Mandatory Markets***) and in voluntary markets (***Voluntary Markets***).

    In ***Mandatory Markets*** (typically, in the context of an emissions trading scheme structured as a-cap-and-trade), carbon credits have value if they can be used to acquit, i.e. can be used to offset, an obligation to match the ***GHG*** emissions arising from the activities of a corporation with emissions trading permits (***ETPs***) that organisation is required to acquire under that emissions trading scheme. In this context, the value of carbon credits will be a function of the operation of the ***Mandatory Market***, including the market price of ***ETPs*** and the consequences (including liability) under that emissions trading scheme for not acquitting or being able to offset.

    In ***Voluntary Markets***, carbon credits have value to corporations that have committed to achieving ***GHG*** emission reductions (and, in the longer term, ***NZE*** on the basis of carbon neutrality). Previous editions of Low Carbon Pulse have covered the uses of words and phrases in this context, but ultimately, decarbonisation takes time, and needs to be achieved across Scopes 1, 2 and 3 emissions. To buy the time, while still reducing ***GHG*** emissions on a net-basis, corporations buy carbon credits. In this context, the value of carbon credits is less well-defined than in a ***Mandatory Market*** and will tend to depend on the position of the corporation buying the carbon credits, and whether the carbon credits are going to underpin a transaction (for example, the sale of carbon neutral cargo of liquified natural gas or oil or an investment).
  - **Carbon credits and decarbonisation:**

    Acknowledging that some folk will debate this, the perspective of the author is that ultimately decarbonisation of activities is the only means of achieving ***NZE***, and as such the role of carbon credits is to place a value on activities that remove CO_2 from the climate system: the value is quantified in mass, with one metric tonne of CO_2 having a value. As ***NZE*** is achieved, the carbon sinks absorbing CO_2 the subject of the carbon credits should be used to remove CO_2 in the climate system on an absolute basis.
  - **The value of CO_2 removal:**

    The benefit of the removal of CO_2 from the climate system is that it reduces the rate at which the global carbon budget is depleted, and in the case of CO_2 that is removed from the climate system that is not subject to a carbon credit scheme, that removal of CO_2 gives rise to a net-reduction in the ***GHG*** emissions.
  - **The challenges with carbon credits:**

    Generally the challenge with carbon credits is the monitoring, measurement and determination, and auditing and verifying (***accounting and accountability***) the mass of CO_2 actually removed from the climate system and sequestered in a carbon sink.

    As noted in Edition 16 of Low Carbon Pulse, it is thought that the mass of ***GHG*** emissions assumed to being sequestered in carbon sinks is greater than the actual CO_2 that is actually sequestered, and is being sequestered, in those sinks. This is important, because they need to be the same. If they are not the same, the purpose of carbon credits is not being achieved.

    Specifically, the challenge with carbon credits issued in some countries (developed and developing) is that some carbon credits are issued in respect of activities that do not remove CO_2 emissions from the climate system. Further, the basis of ***accounting and accountability*** in some countries does not provide a level of assurance that CO_2 is being removed. For those purchasing carbon credits, this matters. The fact that there is an increasingly segmented market for carbon credits tends to reflect that this matters.
  - **Greater rigour around carbon credits:**

Carbon credits are issued by Governments, reflecting the policy settings of those Governments. It is hoped that at ***COP-26***, there is discussion and progress as to the basis upon which carbon credits should be issued so as to provide a level of consistency globally.

Further, it is hoped that the basis of standards of ***accounting and accountability*** to be applied are developed, and that those standards are carried forward in the laws and regulations of each country issuing carbon credits, and compliance with those standards will be required so as to access the higher prices that are being paid for high-quality carbon credits.

- **Visual Capitalist background material:**
  - The Visual Capitalist provides a Voluntary Markets 101 outline, among other things, outlining the four key participants in the voluntary carbon credit markets, project developers, standards bodies, brokers and end buyers. The link is accessed with a click. The link has an accompanying descriptive narrative. In passing, it is noted that Governments are key, both as framers and as possible participants in voluntary carbon credit markets.
  - In addition to the Visual Capitalist, Shell has recently published ***Exploring the Future of the Voluntary Carbon Market***, developed by it in collaboration with BCG. The publication is well-worth a read, providing a balanced perspective. The *October Report and Reports* will consider the publication in more detail.

Climate change reported and explained and Visualisation and Listening Platforms and Tools, and useful materials:

At this point in recent Editions of Low Carbon Pulse, sections have been included on ***Climate change reported and explained*** and ***Visualisation and Listening Platforms and Tools, and useful materials***. To manage the length of this Edition 29 of Low Carbon Pulse, these sections are not included, but will return in future Editions.

GCC counties update:

- **United Arab Emirates commits to *NZE* by 2050:** On October 6, 2021, the United Arab Emirates (***UAE***) became the first Gulf Cooperation Council (***GCC***) country to commit to achieving ***NZE***. This is a materially significant commitment in a global context, and for the ***UAE*** it will spark a once in a generation, or possibly even, as some have noted, a one-of-a-kind shift in the economy of the ***UAE***, driven and effected by the level of investment required to effect the shift to what will be a photovoltaic solar and Blue Hydrogen and Green Hydrogen economy.

  The ***UAE*** is ahead of the curve in many ways, having already realised capital through its program selling interests in infrastructure assets and selling down interests in operating businesses, including on listing of them.
- **Engie firm perspective:** In Arab News on October 9, 2021, Chief Executive of Engie in the Kingdom of Saudi Arabia (***KAS***), Mr Turki Al-Shehri, expressed considerable enthusiasm around the development of Green Hydrogen, contrasted with caution around the development of Blue Hydrogen projects because these projects have become "*much more difficult*" to finance.

  While a number of commentators may have questioned the development of Green Hydrogen, those at the forefront of the development of Green Hydrogen projects are convinced of the need and that progress is occurring: " … *it's a global energy changer. Green hydrogen is coming. Even before it was a buzzword, [Engie has been spending roughly] €60 million a year on green hydrogen research around the world*".

  The ***KAS*** has some of the best renewable electrical energy resources globally, and as a result, some of the world's lowest cost electrical energy: ***KAS*** has reliable sunshine rates during the day, and reliable winds at night. This was proved up further on October 18, 2021 as the ***KAS*** announced the Round 3 of the ***NREP*** (see ***KAS* shortlists bidders on Round 3 of renewables** below).
- **Masdar in the news:**
  - **Republic of Turkmenistan closer ties**: On October 10, 2021, Masdar (Abu Dhabi Future Energy Company) announced that it had signed a strategic agreement to explore renewable energy opportunities in the Republic of Turkmenistan. This builds on the commitment that Masdar has demonstrated regionally. As noted previously in Low Carbon Pulse, Masdar is a member of the elite club of global "go to investors" in the renewable energy sector.
  - **Masdar credit rating**: Consistent with the role of Masdar as a member of the elite club of global "go to investors", Masdar has obtained a credit rating to assist in its facilitation of, and investment in, projects.
- **Egyptian Ammonia Plant:** On October 14, 2021, it was announced that Fertiglobe (a joint venture between ADNOC and OCI Chemical (world leading producer of soda ash)) and Scatec (a leading renewable electrical energy producing corporation) have entered into an agreement with the Sovereign Wealth Fund of Egypt (***SFE***) to develop a 50 – 100 MW electrolyser to produce Green Hydrogen as feedstock for the production on Green Ammonia.

  The Green Hydrogen production facility is to be located near Ain Sokhna, close to existing facilities of a subsidiary of Fertiglobe, EBIC. Under the agreement, Scatec is to build, operate and own (a majority interest) the Green Hydrogen facility, with the Green Hydrogen to be supplied to EBIC to produce Green Ammonia.

  See: *Scatec partners with Fertiglobe and the Sovereign Fund of Egypt to develop green hydrogen as feedstock for ammonia production in Egypt*; *Fertiglobe Partners with Scatec and the Sovereign Fund of Egypt to Develop Green Ammonia Project in Egypt*
- **New hydrogen production plant in *KAS*:** On October 11, 2021, the Saline Water Conversion Corporation and Cummins announced that they intend to develop a hydrogen production facility in the ***KAS***.

  See: Cummins website; Saline Water Conversion Corporation website
- ***KAS* home of the world's biggest *BESS*:** On October 16, 2021, Huawei Digital Power (***HDP***) and SEPCOIII (EPC contractor for the Red Sea Project as part of the development of NEOM (see ***Update on NEOM*** below)) signed a contract under which HDP is to supply a 400 MW / 1,300 MWh BESS.

  See: *Huawei to Power the World's Largest Energy Storage Project*

- **OQ signs JDA:** On October 17, 2021, it was reported widely that OQ (the Omani state-owned energy company) had signed a Joint Development Agreement with Dutco, Linde and Marubeni to undertake feasibility studies to assess the development of a 400 MW Green Hydrogen and Green Ammonia production facility (***SalalahH2 Project***) within the Salalah Free Zone in Oman. The ***SalalahH2 Project*** will make use of OQ's existing ammonia production plant at Salalah.

  As reported in previous editions of Low Carbon Pulse (see Editions 18, 20 and 26), OQ is progressing a Green Hydrogen within the Duqm Special Economic Zone with DEME (leading Belgian corporation).
- ***KAS* shortlists bidders on Round 3 of renewables:** Edition 14 of Low Carbon Pulse reported on the Round 2 of the National Renewable Energy Program (***NREP***). At the inauguration for the Sakaka IPP on April 8, 2021, Crown Prince Mohammad bin Salman bin Abdulaziz announced the results of the tenders for seven large-scale solar capacity projects under. The seven new projects are to be located in Jeddah, Madinah, Quarayyat, Rafha, Rebigh, Al Shuaiba and Sudair.

  The 600 MW Al Shuaiba photovoltaic solar project was awarded on the basis of a world record low bid price for electrical energy of USD 0.0104 kWh (a little over 1 cent per kWh, or USD 10.40 per MWh). The Sudair photovoltaic solar project was awarded with the second lowest bid price of USD 0.01239 (1.239 cents per KWh or USD 12.39 MWh). On development, the Sudair photovoltaic solar project will be the Kingdom's largest solar project, comprising around 1.5 GW of installed capacity. Approximately 3.6 GW of energy was contracted under Rounds 1 and 2 of the ***NREP***.

  On October 18, 2021, it was reported widely that ***KAS***' *Renewable Energy Project Development Office* (***Repdo***) had shortlisted bidders for Round 3 of the ***NREP***, with 1.2 GW to be contracted under Round 3. There two categories of project in Round 3, Category A and Category B.

  Category A projects are the 120 MW Wadi al-Dawasir PV IPP (***WADIPP***) and the 80 MW Layla PV IPP (***LIPP***). It is understood that TotalEnergies and Tamasuk Holding Company and the Acwa Power Consortium (comprising Acwa Power, SPIC (Huamghe Hydropower Development Company) and WEHC (Water and Electric Holding Company) ranked first and second on the ***WADIPP*** and Acwa Power Consortium and Alfanar ranked first and second on the ***LIPP***.

  Category B projects are the 700 MW Al-Rass PV IPP (***ARIPP***) and the 300 MW Saad PV IPP (***SIPP***). It is understood that the Acwa Power Consortium and Jinko Power ranked first and second on the ***ARIPP*** and that Jinko and Masdar ranked first and second on the ***SIPP***.

  As noted above, the Round 2 of the ***NREP*** resulted in a world record low bid price. Round 3 of the ***NREP*** has not quite resulted in the same outcome, but the pricing is nevertheless at a level that continues the narrative about low photovoltaic solar costs. It is reported that the levelized cost of electricity (***LCOE***) bids have tariffs at the following: ***WADIPP*** US cents 1.9 kWh, ***LIPP*** US cents 3 kWh, ***ARIPP*** US cents 1.5 kWh and ***SIPP*** US cents 1.5 kWh.
- **Qatar and Shell look to the UK:** On October 19, 2021, on the sidelines of the UK Global Investment Summit (see section entitled ***G20 activity and commitments in the lead up to COP-26*** above), Qatar Energy (formerly Qatar Petroleum, the state owned leading international energy corporation) and Shell (leading global international energy corporation) signed an agreement under which they will pursue jointly a Blue Hydrogen and Green Hydrogen project in the UK in which they can invest jointly.
- ***KAS* targets *NZE* by 2060:** On October 24, 2021, Crown Prince Bin Salman announced that the ***KAS*** would reduce its ***GHG*** emissions to ***NZE*** by 2060, with a reduction of 278 million metric tonnes per annum (***mmpta***) of ***GHG*** emissions by 2030. The financial capacity of the ***KAS*** makes the achievement of ***NZE*** by 2060 a high probability.

  For these purposes, the Crown Prince announced that the ***KAS*** would invest USD 186 billion, join the **Global Methane *Pledge*** (see Edition 27 of Low Carbon Pulse), plant 450 million trees by 2030 and rehabilitate 8 million hectares of land. It is estimated that the planting of trees and the rehabilitation of land will reduce the ***CO_2*** emissions by 200 ***mmtpa***. This initiative of itself will make a meaningful contribution to progress towards ***NZE***.
- **Saudi Aramco targets *NZE* by 2050:** On October 24, 2021, the world's largest corporation, Saudi Aramco, announced that it would target the reduction in ***GHG*** emissions to ***NZE*** by 2050.
- **Saudi Aramco Future Investment Initiative:** On October 27, 2021, Saudi Aramco announced that it had signed a memorandum of understanding with InterContinental Energy and Modern Industrial Investment Holding Group to develop Green Hydrogen and Green Ammonia production facilities in Saudi Arabia. As readers of Low Carbon Pulse will be aware, InterContinental Energy is involved in large scale renewable electrical energy and Green Hydrogen and Green Ammonia projects in Australia and in the ***UAE***.
- **Clean energy partnership between *ADNOC* and *EWEC*:** On October 27, 2021, Abu Dhabi National Oil Company (***ADNOC***) and Emirates Water & Electric Company (***EWEC***) formed a clean energy partnership under which ***ADNOC*** is to be supplied by ***EWEC*** with clean energy matching 100% of ***ADNOC*'s** electrical energy load.

  EWEC will supply clean energy from nuclear and photovoltaic solar sources to ***ADNOC*** under an off-take agreement. This establishment of the partnership, underpinned by the off-take agreement, is aligned to achieving ***NZE*** by 2050.
- **Update on NEOM:** The development of NEOM, the smart city, in Tabuk Province, on the coast bordering the Red Sea is progressing, and it is understood that visitors (including tourists) will be welcome from 2024. Key to the development of NEOM is that it is to be powered by 100% renewable electrical energy, including the use of Green Hydrogen. On October 30, 2021, fuelcellsworks.com provided a helpful update.

India moves to centre stage:

- **India PV solar scalable:** Recent editions of Low Carbon Pulse have outlined the policy settings and the private and public sector investment initiatives in India. On October 7, 2021, pv magazine, reported on a study from Lappeenranta-Lahti University (often mentioned in Low Carbon Pulse) and Wärtsilä.

  The headline from the study is that using an all renewable electrical energy system (with 76% photovoltaic solar), and appropriate levels and location of ***BESS***, the cost of electrical energy in India could be reduced by up to 50% by 2050, while at the same time making a major contribution to progress towards ***NZE***.

The study (and other publications) tends to feed confidence that, in respect of the development, the renewable electrical energy, progress is likely to be made to achieve ***NZE*** across the electrical energy sector. This should not be taken for granted, but it is possible for the optimist to conclude that we will get there. The electrical energy sector is however the easiest part of the global economy to decarbonise. The difficult to decarbonise sectors (including cement, chemical and petrochemical, glass and iron and steel) and the transport sector (aviation, road freight and shipping) remain.

On October 28, 2021, pv-magazine, noted that India is expected to install 14 GW of photovoltaic solar capacity in calendar year 2021, having installed 8.8 GW of capacity in the first nine months. As noted in previous editions of Low Carbon Pulse, the development and deployment of roof-top photovoltaic solar in India is highly prospective. It would appear that this assessment is being realised with 2 GW of the 8.8 GW installed in the first nine months of 2021 being roof-top photovoltaic solar.

On October 29, 2021, pv-magazine, noted that scientists at the KPR Institute of Engineering and Technology have developed a process to recycle silicon from solar panels at the end of their life-cycle. If the process is scalable, it seems to the author to be a significant shift in process technology.

On October 29, 2021, pv-magazine reported that tenders have been invited for the development of "advanced-chemistry battery cell manufacturing units in India". The tender is open to applications until December 31, 2021. It is reported that bidders must commit to setting up a minimum of 5 GWh of capacity to qualify for subsidies.

- **India and UK to strengthen Clean Hydrogen Partnership:** Edition 19 of Low Carbon Pulse reported that on June 1, 2021, India and the UK had enhanced their existing partnership to provide for cooperation in sharing thinking around policy settings, which in turn will respond to, and drive, technology development and investment as both countries progress to electrified and hydrogen economies, driven by the development of renewable electrical energy. More broadly, and in the context of specific outcomes, the provision and sourcing of sustainable finance will be a key part of electrification and the development of a hydrogen economy, in particular clean energy and clean transport technologies and solutions, and the shift to green and to greened businesses.

  On October 11, 2021, h2-view.com, reported that India and the UK intend to build on, or rather refine further, their collaboration, through a Government-to-Government agreement so as to contribute to the acceleration of progress towards the development clean energy capacity. The Government-to-Government agreement was formalised at a meeting of India's Minister for Power and New & Renewable Energy, Mr Raj Kumar Singh, and UK Energy Secretary, Mr Kwasi Kwarteng on October 8, 2021. It is understood that in the context of ***COP-26***, the ministers discussed the launch of the India and UK Government ***Global Green Grid – One Sun One World One Grid Initiative***.

  The Government-to-Government agreement with the UK follows the announcement from the meeting of the Quad countries (US, India, Japan and Australia) in late September as which it was agreed: **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.

Republic of Korea (*ROK*) News:

- ***ROK* increases *NDC*:** Edition 3 of Low Carbon Pulse reported on the commitment of ***ROK*** to achieving ***NZE*** by 2050. Since the commitment to ***NZE*** made on October 28, 2020, there has been expectation that ***ROK*** would increase its ***NDC*** from 26.3% by 2030 compared to 2018.

  On October 18, 2021, the ***ROK*** increased its ***NDC*** to 40% by 2030 compared to 2018. As with the increased ***NDC*** to which Japan committed in April 2021, this may be regarded as a challenging target for ***ROK***. Nevertheless, it is a target that ***ROK*** will able to achieve.
- **Doosan Fuel Cell (*DFC*) Hydrogen R&D project:** On October 22, 2021, ***DFC*** agreed with Korea West Power and KEPCO to develop a Pure Biogas (Hydrogen) fuel cell R&D project.
- **Blooming good news**: On October 25, 2021, it was announced that Bloom Energy and SK are to expand their blooming partnership to fortify their market leadership in the use of fuel cell technology to generate electrical energy and to establish leadership in the hydrogen economy. The budding and now growing nature of the relationship between Bloom Energy and SK has been covered in Low Carbon Pulse (see Editions 4, 17 and 22).

  Leaving the poor puns to one side, the expansion of the partnership is good for each corporation and more broadly – both organisations are at the forefront of early adoption of fuel cell technology and first movers in the development and deployment of it. The arrangements underpinning the expansion include SK contracting for equipment supply and service provision (estimated at USD 4.5 billion), and a further equity investment by SK in Bloom Energy.

  See: Bloom Energy's announcement
- **World's Largest Fuel Cell Power Plant opened:** On October 26, 2021, it was reported widely that Korean Southern Power (***KOSPO***) had opened the new Incheon Bitdream Fuel Cell Power Plant (***Bitdream FCPP***). The ***Bitdream FCPP*** uses fuel cell technology supplied by POSCO Energy and Doosan Fuel Cell. The ***Bitdream FCPP*** is reported to have capacity of 78.96 kWh, which output can be used to supply electrical energy to up to 250,000 households and hot water for up to 40,000 households. The opening of ***Bitdream FCPP*** is further realisation of the use of the power companies to use fuel cell technology (see Edition 2 of Low Carbon Pulse).

Australia – Weighted Progress:

Background: Edition 28 of Low Carbon Pulse included a piece entitled, ***Australia – A Curate's Egg***. This description appears unlikely to be revised any time soon.

- **International Monetary Fund (*IMF*) clear as to Lucky Country's Promise**:

  On October 13, 2021, the ***IMF*** released its Word Economic Outlook. In addition to the role of Australia as a key producer of iron ore, the ***IMF*** noted the importance of the cobalt, nickel and lithium resources of Australia for the purposes of the required expansion of resources to supply the global battery industry.

  The ***IMF*** notes that demand for the supply of these key metals will increase dramatically as the scale of the renewable electrical energy industry increases, and an associated increase for battery storage arises, principally for battery electric vehicles (***BEVs***) and battery electric storage systems (***BESSs***).

  By way of background, or as a reminder, the five key metals in the "battery age" (at least for the time being) are aluminium, copper, cobalt, nickel and lithium. It is anticipated that demand for: **1**. aluminium will increase to allow "light-weighting" to occur, particularly across the transport sector; **2**. copper will increase, with demand for ***BEVs*** and grids and infrastructure (distribution and transmission) and machinery generally; **3** cobalt is less certain, with its demand profile dependent on technology development; **4**. nickel will increase, with increased supply of nickel effectively responding to the new demand, and in the context of increased demand for (and therefore use of) nickel, stainless steel production will be the primary driver; and **5**. lithium will increase to satisfy demand for lithium-ion batteries, in particular in the stationary energy sector, critically for ***BESSs***.

  As noted in Edition 22 of Low Carbon Pulse (in a feature on Form Energy), iron (using iron-air technology) could soon be joining these five metals as key metals in the "battery age". If this potential is realised, Australia will continue its role, and even enhance its role, as a key source of metals and minerals as raw materials to support progress towards the achievement of ***NZE***.

- **Scrutiny of Australia:**

  In Edition 28 of Low Carbon Pulse, it was reported that the Federal Government of Australia had 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.

  On October 26, 2021, the Federal Government of Australia committed to achieving ***NZE*** by 2050. This commitment was not accompanied by meaningful ***GHG*** emissions targets on route to ***NZE***. The approach manifest in the commitment to ***NZE*** by 2050 is consistent with the "technology versus carbon tax" debate that the Federal Government of Australia has been sharing in support of the approach that it has been taking (see the section above entitled ***A price on carbon***).

  The commitment to ***NZE*** has been criticised from all sides. For those in favour of the commitment to ***NZE***, the means of achieving ***NZE*** has been described as more "prayer than policy" due a lack of meaningful commitments to ***GHG*** emission reductions before 2030, and an absence of a staged pathway to achieving ***NZE*** by 2050. For those not in favour the commitment to ***NZE***, the criticism is best described as variable, and none of it capable of withstanding reasoned scrutiny.

- **States and Territories continue to make progress:**

  Queensland:

  On October 13, 2021, Premier Annastacia Palaszczuk committed her State of Queensland to progressing to ***NZE*** by 2050. This commitment followed a vote the Queensland Parliament on October 12, 2021. This commitment came in a week packed full of announcements about the development of the Green Hydrogen industry across Queensland.

  South Australia:

  During the week beginning October 25, 2021, the State of South Australia, continued its progress towards becoming a 100% renewable electrical energy State. The State Government of South Australia is committed to achieving net 100% renewables by 2030. The events of the last week tend to indicate that the State of South Australia will achieve this target as early as 2025 at the current rate of progress.

  On October 25, 2021, ElectraNet announced the installation of four synchronous condensers (in effect acting as spinning reserve). The installation of the synchronous condensers means that the restrictions on the dispatch of renewable electrical energy across the ElectraNet grid are not as stringent as previously under certain conditions: the restrictions providing a limit to the dispatch of variable renewable electrical energy sources to the grid so as to be assured of continued integrity and stability.

  As reported in previous editions of Low Carbon Pulse, the State of South Australia has been a stellar performer, but during the last week it has eclipsed previous achievements with photovoltaic solar and wind reaching 81% at the start of the week, and 85% over three days of the last part of the week.

  Victoria:

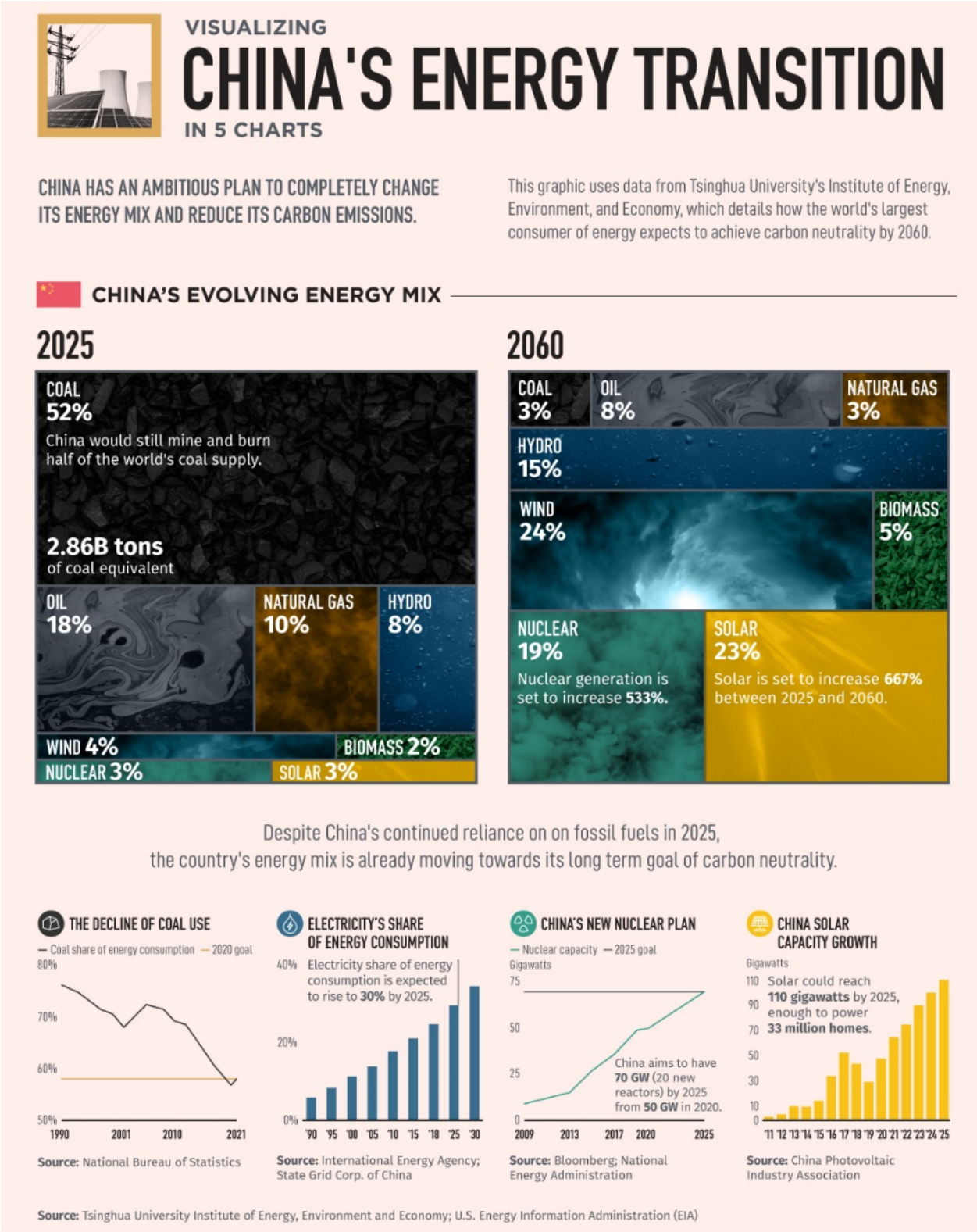
  On October 29, 2021, the State of Victoria reported that it achieved a 25% reduction in ***GHG*** emissions compared to 2005, between 2005 and 2019. The State Government of Victoria has delivered on its pledge to reduce ***GHG*** emissions by 20% by 2020 (in fact it is has exceeded it), and is well on the way to delivering on its pledges to reduce ***GHG*** emissions by between 28% to 33% by 2025, and to between 45% to 50% by 2030.

  As has been noted previously in Low Carbon Pulse, the eight States and Territories of Australia are both ambitious and progressive in reducing ***GHG*** emissions and progress towards achieving ***NZE***. The ambition and that progressiveness are not static.

- **Australia's hydrogen opportunity:** Edition 28 reported on the publication by the Australian Hydrogen Council of its ***Unlocking Australia's hydrogen opportunity***. On October 29, 2021, a Wood Mackenzie publication outlined further the scale of the opportunity for Australia.

PRC continues to lead the way:

- ***PRC* energy mix visualised:** Previous editions of Low Carbon Pulse have covered the policy settings for energy transition in ***PRC***. On October 10, 2021, the visualcapitalist.com, published five graphics that allow the viewer to visualise the transition from now to 2060 (the year by which the ***PRC*** has committed to achieve ***NZE***).



- **President Xi at the helm**: On October 12, 2021, President Xi Jinping made a speech to the fifteenth conference of the parties to the Convention of Biological Diversity. President Xi confirmed the commitment of the ***PRC*** to achieve peaking of ***GHG*** emissions by 2030, and ***NZE*** by 2060. (Edition 30 of Low Carbon Pulse will include a one page summary of the outcomes from COP-15 to the Convention of Biological Diversity.)

To deliver on these commitments, President Xi said that it would be necessary to introduce policy settings (named "***I+n***") to achieve peaking of ***GHG*** emissions and then ***NZE***. For these purposes, President Xi noted the need to increase the installation of photovoltaic solar and wind in desert areas of the ***PRC***.

This is not new (having been noted in Edition 21 of Low Carbon Pulse, and confirmed in the next piece), but it may be regarded as further demonstration of the commitment of the ***PRC*** to mobilise sufficient renewable energy resources to achieve peaking and ***NZE***, and consistent with the prospect of use of High Voltage Direct Current (***HVDC***) cables to deliver renewable electrical energy.

- ***PRC* continues development of renewables:** On October 29, 2021, it was reported widely that the ***PRC's*** National Development and Reform Commission (***NDRC***) confirmed that the development of a number of renewable electrical energy projects was proceeding across a number of provinces in the north and north-west of the ***PRC*** – Gansu (12.85 GW), Inner Mongolia (2 GW of photovoltaic solar), Ningxia, Qinghai (10.9 GW), Shaanxi (2 GW), and Xinjiang (GW). Once completed, the projects will have combined installed capacity in the region of 30 GW. It is understood that ultra-high voltage connection will be used for the purposes of transmission from generation to load, with some projects to deploy hydrogen energy storage systems (***HESS***).

Bio-energy (including BECCS and BECCUS) update:

- **Background:** As noted in previous editions of Low Carbon Pulse (and touched on above, under ***A role for Government in the development of Bioenergy***), **bio-energy** is energy derived or produced from biomass, whether that energy is in gaseous, liquid or solid form. Bio-energy is derived from organic matter, but not fossilised organic matter.

  Note: For the production of bio-energy to be carbon-neutral, it must be combined with ***BECCS*** or ***BECCUS***. For ***BECCS*** / ***BECCUS*** 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.
- ***CCUS Development Pathway for the EfW Sector*:** On October 5, 2021, a report entitled ***CCUS Development Pathway for the EfW Sector***, produced by Eunomia Research & Consulting, commissioned by waste company, Viridor, notes the ability of the EfW sector to help underpin the continued development of the CCS / CCUS sector in the UK, effectively ***BECCS*** and ***BECCUS***.
- **Repsol, Blue and Green Initiatives:** On October 7, 2021, rechargenews.com, Repsol (world leading oil and gas corporation, head-quartered in Spain) announced plans to develop 200 MW of biogas / biomethane steam reforming capacity (to derive hydrogen from biomass itself derived from biomass) to produce Blue Hydrogen, and 350 MW of electrolyser capacity, powered by renewable electrical energy from 1.8 GW of photovoltaic solar and wind, to produce Green Hydrogen. It is anticipates that this clean hydrogen capacity will be developed by 2025, with around USD 1.5 billion earmarked for these initiatives alone.

  On October 18, 2021, the-eic.com, reported that this was part of broader initiatives involving the development of 20 GW of renewable electrical energy by 2030, and an investment of €2.5 billion to develop a hydrogen chain by 2030, as part of its renewable hydrogen strategy, with 550 MW to be developed and deployed by 2025 (200 MW of Blue Hydrogen and 350 of Green Hydrogen capacity, as noted above).

  See: *Repsol will invest €2.549 billion to boost renewable hydrogen*
- **Bio-energy projects**:
  - **Haldor Topsoe demonstration plant:** On October 17, 2021, biofueldigest.com, reported that Haldor Topsoe (leading technology provider, including electrolysers and its eSMR technology) has commenced operation of a demonstration plant that derives methanol from biogas (a combination of CO_2 and CH_4 for the most part, derived from biomass). It is stated that the plant produces sustainable methanol, and has the capacity to produce 10,000 litres of CO_2 neutral methanol.
  - **Yosemite Clean Energy – Dawn:** On October 29, 2021, it was reported widely, that a site had been secured by CHBC (a member of Yosemite Clean Energy) to develop a carbon-negative renewable hydrogen and renewable natural gas (***RNG***) production facilities in Oroville, California. As reported, 31,000 kgs (31 metric tonnes) a day of ***RNG*** and 12,200 kgs (12 metric tonnes) a day of renewable hydrogen will be produced.
- **Carbon neutrality - – complete picture:** A rechargenews.com article notes that: "*Because biomethane is produced from plant matter that absorbed CO_2 from the air as it grew, the gas which is produced in large tanks known as anaerobic digesters – it is said to be carbon neutral when burned or cracked*". As readers of Low Carbon Pulse will know, this is not incorrect, but it is important to add that CO_2 and CH_4 arises from the production of biogas / biomethane, and from the production of hydrogen from it, and that CO_2 and CH_4 needs to be captured. Of course, the hydrogen gives rise to no ***GHG*** emissions at the point of use other than water vapour which, while is a ***GHG*** emission, does not remain in the atmosphere in the same way that CO_2 and CH_4 (and other ***GHGs***) do.

  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 of which are carbon intensive), the capture and storage of CO_2 arising from the production of those feedstocks, 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.

Blue Carbon

- **Back to the future:** Continuing a narrative and a theme (commenced in previous editions of Low Carbon Pulse, added to above under ***A role for Government in decarbonising AFOLU***), one of the means of achieving negative ***GHG*** emissions is through the development of new growth, or the regeneration / restoration, of mangrove swamps and the restoration of wetlands generally (being a generic phrase that includes mangrove swamps, estuaries, and mud-flats), in particular in the tropical areas of the world.

Certain countries have the ideal climates and coastlines to develop carbon sinks to sequester carbon. It is estimated that, since 1900, a little over 50% of the global coasted wetlands have been removed.

In addition to the negative ***GHG*** emission benefits, the restoration of wetlands will provide protection against storm damage as noted in a recent report from James Cook University, which considers land use in 71 countries that had wetlands in the path of storms.

As such, there are two benefits of the new growth and regeneration / restoration: the absorption of ***CO_2*** and the absorption of the impact of storms (and as such, adaptation to climate change, aligned with Article 2.1(b) of the Paris Agreement).

- **Increasing awareness to be matched by action:** In the context of the development of markets for carbon credits (in particular ***voluntary carbon markets*** or ***VCMs***), discussion around Article 6 of the Paris Agreement has become more pressing. There is a great opportunity for certain countries, in particular those in the tropical regions of the world, to add to the global carbon budget by the development of new growth and the regeneration / restoration carbon sinks. While this discussion relates to both Blue Carbon and Green Carbon, it is included here for convenience.

  To do this effectively, i.e., in a manner that results in the issue of high-quality carbon credits from the sale of which those countries realise appropriate value, the focus of the discussion around Article 6 and the ***Paris Rulebook*** needs to be on the assessment of existing carbon sinks and new growth or regeneration / restoration carbon sinks, and accounting and accountability, and the funding of the three A's (assessment, accounting and accountability) by developed countries and policy banks.

  As noted above, in respect of the UNFCCC NDC Synthesis Report, a ***Catastrophic Pathway*** awaits unless ***GHG*** emission reductions are slowed, reduced and balanced. A key means to slowing, reducing and balancing is the use of carbon credits and allowing their use to off-set ***GHG*** emission obligations.

  In an article published in October 29, 2021, the Independent Commodity Intelligence Services (***ICIS***) outline the current dynamics surrounding Article 6 of the Paris Agreement and the ***VCM***. The article is well-worth a read – it is balanced and clear.

  Deep Blue Thinking: On October 27, 2021, SciTech Daily , reported (under ***Marine Carbon Sequestration: New Research Delves Into Fate of Ocean Carbon***), on new research undertaken by the oft mentioned Lawrence Livermore National Laboratory (***LLNL***), with the work published in the Proceedings of the National Academy of Sciences. Edition 27 of Low Carbon Pulse reported on a study from ***CSIRO*** (Commonwealth [of Australia] Scientific and Industrial Research Organisation) which found that up to 80% of the 715 million tonnes of ***CO_2*** released to the climate system from Australian bush fires over the southern hemisphere summer 2019/2020 has been absorbed by ocean algal blooms in the Pacific Ocean.

  The ***LLNL*** research builds on concepts arising from ***CSIRO*** findings. Both studies recognise that algae and plankton are one of the many natural carbon sinks in the blue carbon setting, and that understanding them is critical.

BESS and *HESS* -Scale of BESS by 2030:

As renewable electrical energy is developed and deployed, ***BESS*** (and ***HESS***) will be required to ensure that renewable electrical energy is stored to allow dispatch of electrical energy from storage to maintain grid integrity and stability, and to provide electrical energy as the variable nature of renewable electrical energy dispatch necessitates dispatch from ***BESS*** to match load.

As the scale of development and deployment of renewable electrical energy becomes clearer, so does the scale of the development and deployment of ***BESS*** (and ***HESS***). The analysts as Wood Mackenzie have been assessing and quantifying how much ***BESS*** may be required.

In Wood Mackenzie's ***Global Energy Storage Outlook*** (published on October 7, 2021), it is estimated that up to 1 TWh of storage may be required. This assessment is underpinned by reasonably consistent assessments that during 2021, around 12 GW of ***BESS*** will be installed globally, and an anticipated acceleration of development and deployment of ***BESS***, including, in the near term, acceleration in the ***PRC***. The question that is yet to be firmed is the extent to which ***BESS*** will be utility, sometimes referred to as in-front of the meter, and off-grid (including to store from roof-top photovoltaic solar), more often than not referred to as behind the meter.

CCS / CCUS and difficult to decarbonize round-up:

- **Norway CCS Potential**: On October 5, 2021, the Director General of the Petroleum Directorate, Ms Ingrid Solvberg, indicated that the continental shelf of Norway had the capacity (in theory at least) to store 1,000 years of ***GHG*** emissions arising from Norway. As part of the operation of natural gas fields, the two largest two CCS projects, at Sleipner and Snovhit, are operated in Norway.

  Edition 27 of Low Carbon Pulse reported on the applications process currently underway for two CCS sites on the continental shelf of Norway. The deadline for the submission of applications is December 9, 2021. As noted in previous editions of Low Carbon Pulse, the Norway continental shelf is the location of the Equinor, Shell and TotalEnergies ***Northern Lights*** project (as part of the Longship Project), and the proposed location of CCU for the ***CO_2*** arising from the ***Barents Blue*** (Blue Ammonia) project (see Edition 27 of Low Carbon Pulse).

- **Another Oak to Acorn:** Previous editions of Low Carbon Pulse have covered the progress being made by the ***Acorn Project***, and its importance to the Scottish Cluster (see Editions 14, 16, 17, 21 and 22).

  Edition 21 of Low Carbon Pulse noted that the ***Acorn Project*** was contracting with a number of corporations for the provision of carbon storage services. Edition 21 of Low Carbon Pulse reported ExxonMobil, Royal Dutch Shell and North Stream Midstream Partners (***NSMP***, owned jointly by the Kuwait Investment Authority and JPMorgan Infrastructure Fund) had signed provisional deals (under memorandums of understanding) with the ***Acorn Project***. The underlying business case for the ***Acorn Project*** is that ***CO_2*** captured from natural gas processing terminals at St Fergus, Peterhead (and Grangemouth) will be stored by it. The provisional deals with ExxonMobil and Shell are in respect of their terminal and in respect of the ***NSMP*** owned terminal (with ***NSMP*** also the owner of the main feeder lines to it).

On October 6, 2021, ExxonMobil announced that it had signed an expression of interest to study the storage of ***CO_2*** from its Fife Ethylene Plant. The progression to expression of interest in respect of the Fife Ethylene Plant may be regarded as further stride for the ***Acorn Project***.

On October 12, 2021, it was reported widely that the ***Acorn Project*** had agreed to provide carbon storage services in respect of ***CO_2*** captured at a new Blue Hydrogen facility in the Thames Estuary (***Project Cavendish***), and then transported, using a ***CO_2*** carrier from the Thomas Estuary to Peterhead Port (owned and operated by the Peterhead Port Authority), and then on to the ***Acorn Project***.

As noted in previous editions of Low Carbon Pulse, the ***Acorn Project*** is the key element of the Scottish Cluster – see Edition 23 of Low Carbon Pulse. ***Project Cavendish*** is likewise covered in Edition 23 of Low Carbon Pulse.

For Storegga Geotechnologies, this is another step in progress towards the realisation of its landmark, market defining, CCS project. CEO of Storegga, Mr Nick Cooper, noted that the signing of a memorandum of agreement with Project Cavendish and the Peterhead Port Authority, "*demonstrates how the Scottish Cluster can decarbonise not only Scottish emitters but those throughout the UK and Europe*".

As noted below, the UK Government selected the **East Coast Cluster** (comprising Net Zero Teesside and Zero Carbon Humber) and **HyNet North West** as the two CCS projects that were to receive government support in the ***Track 1 CCS Programme*** (see Edition 23 of Low Carbon Pulse): the policy setting provided for the selection of two CCS projects (as outlined in Edition 23).

Notwithstanding the decision of the UK Government in respect of the CCS projects is receive Track 1 government support, it is understood that the Scottish Cluster, with the ***Acorn Project*** at its core, will continue to progress.

- **Woodmac on CCS:** In Edition 28 of Low Carbon Pulse, it was reported that 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. Having re-read the Wood Mackenzie piece for the *September Report on Reports*, the author commends the piece to all readers again. 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. For the potential of CCS / CCUS to be realised, it is important to realise its potential! Up to 30% of the required reduction in ***GHG*** emissions could be achieved by effective CCS / CCUS.
- **Equinor plans to invest USD 12 billion:** On October 10, 2021, it was reported widely that Equinor (global leading international energy company) intends to invest up to USD 12 billion in the production of Blue Hydrogen using CCS technology. Equinor intends to use natural gas as the feedstock for the production of Blue Hydrogen.

  As noted in previous editions of Low Carbon Pulse (and as noted in this Edition 29), natural gas gives rise to fugitive ***GHG*** emissions, and on its use to produce Blue Hydrogen, gives rise to ***CO_2*** which needs to be captured and stored. As noted above, if ***CO_2*** is not captured, the production of hydrogen using natural gas as the feedstock gives rise to around 10 metric tonnes of ***CO_2*** for each 1 metric tonne of hydrogen produced. While this is a rule of thumb, it is a helpful rule of thumb. Given that Equinor is aiming to have a 10% share of the global hydrogen market by 2030, this is going to equate to avoidance of ***CH_4*** fugitive emissions and capture and storage of significant mass of ***CO_2***.
- **Carbon Storage Licence granted to Harbour Energy:** On October 10, 2021, the Oil and Gas Authority in the UK granted a carbon storage licence (***CSL***) to Harbour Energy (***HE***). The ***CSL*** will cover an area in the Southern North Sea 140 km off the coast of Immingham, Lincolnshire. ***HE*** proposes to store ***CO_2*** in the depleted Rotliegend gas fields, Victor and Viking (the ***V Net Zero Project***).

  The geological formations in which the ***CO_2*** will be stored are around 2743 metres (9000 ft) below the sea-bed of the North Sea. ***CO_2*** to be injected into the ***V Net Project*** will be transported using the existing pipeline to the Victor / Viking fields. A new pipeline will transport ***CO_2*** from the point source of capture to the on-shore connection point on the existing pipeline, for transportation into storage.
- **Repsol outlines the Sakakemang CCS project:** On October 13, 2021, Repsol outlined its plan to develop a CCS project as part of the Sakakemang natural gas development project, off the coast of Sumatra, Indonesia. It is understood that the CCS project will store up to 2 million metric tonnes per annum (**mmtpa**).

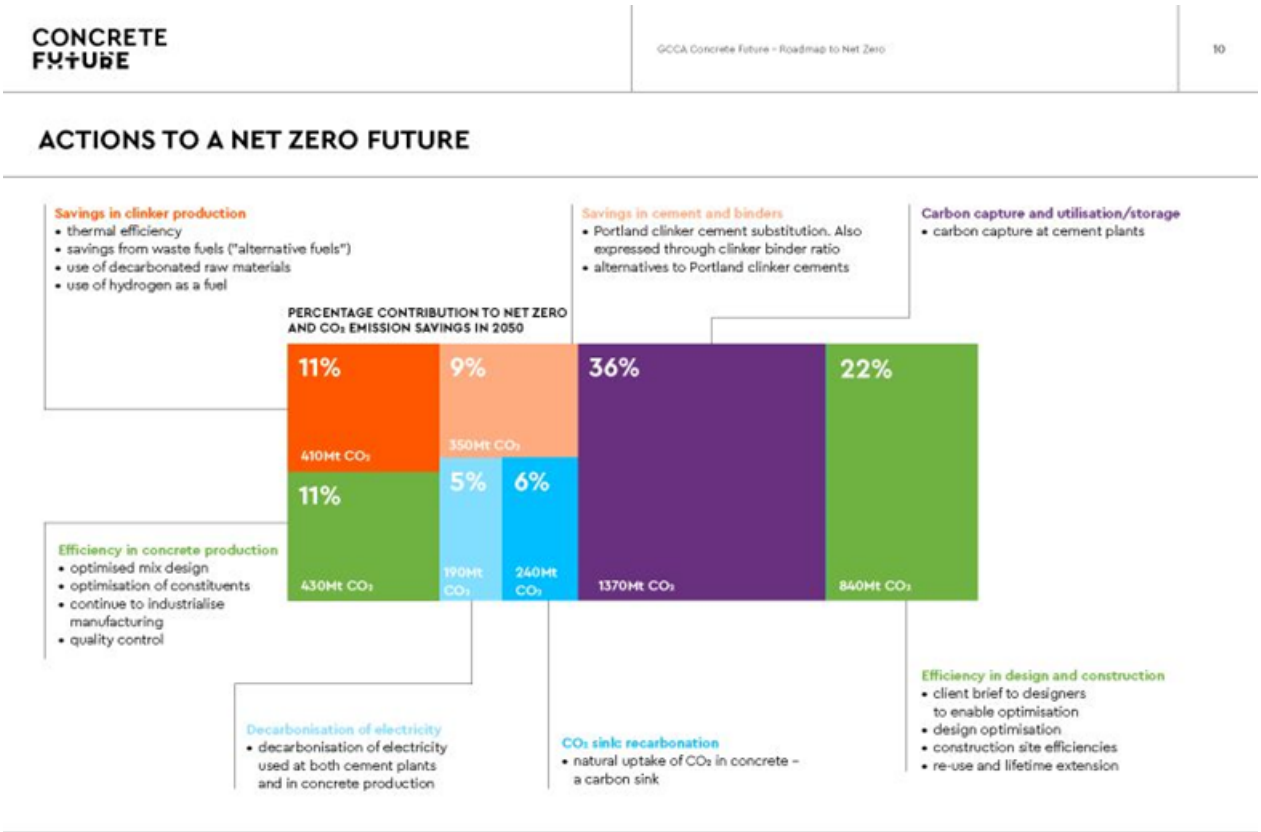
  As understood, the CCS project will involve the use of the depleted Gelam and Dayung natural gas fields to effect enhanced gas recovery from the Sakakemang project.
- **Decarbonisation of cement and concrete production globally:**
  - **More progress towards NZE:** Edition 28 of Low Carbon Pulse reported that Hansen Cement had produced clinker using a 100% net zero mix of heat-temperature fuels in its cement kiln. Also Edition 28 of Low Carbon Pulse reported that 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, the California Air Resources Board is to develop a ***NZE*** strategy to decarbonise the production of cement completely by 2050.

    On October 12, 2021, global cement and concrete makers outlined steps to reduce ***CO_2*** emissions by "an additional 25%" by 2030, and to progress to NZE by 2050; conservatively a reduction of this magnitude would result in a 5 Giga tonne reduction in ***CO_2*** emissions assuming a linear rate of reduction. It is reported that the cement and concrete industry will transition to carbon-free technologies for the high-heat temperatures required to produce clinker, carbon capture to capture the ***CO_2*** arising on the use of limestone to produce clinker, and new chemistry and manufacturing technology.
  - **Background to the need to achieve NZE:** 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. Edition 28 of Low Carbon Pulse noted that the cement production industry needed 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.
  - **Further background:** ***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***. Stated another way, for each metric tonne of cement produced, one tonne of ***CO_2*** emissions arise.

- **Concrete Future:** The graphic below is the best summary that the author has seen of explaining the anatomy of what is required to achieve ***NZE*** across the cement and concrete industry.
- **Concrete Present:** The Global Cement and Concrete Association estimates that around 14 billion m3 of concrete is poured to cast each year (1 m^3 of concrete has a mass of approximately 2.41 metric tonnes). The mass of cement produced and concrete poured to case is going to increase as urbanisation increases globally.

  The production of cement alone give rise to between 7% and 8% of ***GHG*** emissions. As noted above, one metric tonne of cement gives rise to one metric tonne of ***CO_2*** .



- **Track 1 outcomes announced:** Edition 23 of Low Carbon Pulse outlined the industrial carbon clusters and hydrogen hubs around the UK which are in the process of being developed, and a number of them awaiting the outcome of applications for government support in ***Track 1*** of the ***CCUS Programme***. The ***CCUS Programme*** is consistent with key outcomes in the Ten Point Plan for a Green Industrial Revolution (***10 Point Plan***).

  On July 30, 2021, the UK Government announced five eligible projects for its ***CCUS*** (cluster sequencing) ***Programme***, detailed below:

  - **DelpHYnus Project:** a combined development from Neptune Energy to capture, haul and store ***CO_2*** from the South Humber Industrial area and the production of Blue Hydrogen at the site of the former Theddlethorpe Gas Terminal, with ***CO_2*** arising on production of Blue Hydrogen being captured, hauled and stored;
  - **East Coast Cluster:** a combination of the Equinor led ***Zero Carbon Humber***, the BP led ***Net Zero Teesside*** projects, and the Northern Endurance Partnership (***NEP***). The ***NEP*** founding members comprise BP, Eni, Equinor, National Grid, Shell and TotalEnergies;
  - **HyNet North West**: a combination of clean hydrogen production (up to 3.8 GW by 2030, or 80% of the 5 GW target in the ***10 Point Plan***), and CCS, with storage in the Eni UK depleted gas field in Liverpool Bay. The clean hydrogen production would be phased in as follows: 350 MW 2025, 1 GW 2026, and 3.8 GW 2030;
  - **ScottishCluster:** while the ***Acorn Project*** is key, the sources of ***CO_2***, being ten (including from Grangemouth, Peterhead and, latterly, the Isle of Grain), with eight anticipated to have capture capacity in place by 2027; and
  - **VNZ Cluster:** Harbour Energy is the sole developer of the Viking Net Zero (***VNZ***) concept, developing the depleted Viking Field sourcing ***CO_2*** from the Immingham (including from EPUKI, Phillips 66, PRAX, and VPI) – see section entitled ***CCS / CCUS and difficult to decarbonize round-up*** above.

  On October 19, 2021, the UK Government announced the results of applications for government support in ***Track 1*** of the ***CCUS Programme***. The **East Coast Cluster** and the **HyNet North West** projects were selected for government support. It is clear that the quality of each of the five eligible projects was very high. Had all five eligible projects proceeded, they would have provided production capacity for up to 9.7 GW of low-carbon hydrogen by 2030, 4.7 GW more than the 5 GW contemplated in the ***Ten Point Plan***.

  (From earlier communications, the announcement had been expected on October 25, 2021.)

Shortly after announcing the outcome of ***Track 1*** of the ***CCUS Programme***, the UK Department for Business, Energy and Industrial Strategy announced new investment in the Net Zero Strategy, noting in the period since the announcement of the ***Ten Point Plan*** (see Edition 4 of Low Carbon Pulse), the UK Government has "*mobilised GBP 26 billion of government capital investment for the green industrial revolution*".

- **ExxonMobil CCS Hub in WY:** On October 21, 2021, Natural Gas World reported the Exxon Mobil Corporation (leading global international energy corporation) is to expand its CCS capacity at the LaBarge natural gas field in Wyoming. It is understood that the expansion will increase CCS capacity by 1 million metric tonnes per annum (***mmtpa***) of ***CO_2*** .The LaBarge field is known for its high level of ***CO_2*** at about 65%, with 21% ***CH_4***, 7% **N** and 5% **H_2S** and 0.6% **He**.
- **ExxonMobil CCS Hubs in SEA:** On October 25, 2021, Channel News Asia, reported that ExxonMobil Corporation (leading global international energy corporation) is considering the development of CCS Hubs in South East Asia (***SEA***). Edition 27 of Low Carbon Pulse reported on the plans of ExxonMobil Corporation to develop a CCS Hub in the Gulf of Mexico to store up to 50 million metric tonnes per annum (***mmtpa***) of ***CO_2***.

  It is understood that ExxonMobil is "*studying the concept of placing **CO_2** capture hubs in some of Asia's heavy industrial areas such here in Singapore and then connecting them to **CO_2** storage locations elsewhere in the region*". While this concept is not new, the fact that ExxonMobil is considering the concept is encouraging: there is no organisation as expert at assessing the capacity of depleted fields.

  Editions 20 and 21 of Low Carbon Pulse reported that Singapore does not have suitable sub-surface structures (under land or sea) suitable to allow use for CCS, and as such the ExxonMobil study is aligned with these findings.
- **From Greening Smelters to formation of carbonates:** Editions 20, 21 and 26 of Low Carbon Pulse have reported on initiatives of Rio Tinto to green its smelters. On October 20, 2021, Rio Tinto announced plans to invest in the development and deployment of up to 5 GW of photovoltaic solar and wind capacity to provide renewable electrical energy for its Boyne Island and Tomago smelters.

  In addition, Rio Tinto has announced that it will develop and deploy a further 1 GW of renewable capacity to provide electrical energy for its iron ore mines in the Pilbara region of Western Australia. The development and deployment of renewable energy is part of the commitment of Rio Tinto to reduce its ***GHG*** emissions by 15% by 2025, and 50% by 2030. The accompanying price tag of achieving this reduction is estimated to be AUD 7.5 billion, and is stated to focus on the decarbonisation of its aluminium and iron ore divisions.

  On October 27, 2021, Rio Tinto announced that it had signed a memorandum of understanding with Carbix, under which Carbix is to use land surrounding Rio Tinto's ISAL smelter in Straumsvik, Iceland to store carbon captured from industrial facilities and plants around Europe.

  The carbon captured will be liquified at the point source of capture, and transported by vessel to the Coda Terminal, Iceland, with the ***CO_2*** to be re-gasified at the Coda Terminal, and dissolved into water (creating carbonated water). The carbonated water is to be injected into rocks underground. On injection into the rocks, the rocks will release cations (being an ion (atom or atoms) with a positive charge), including calcium, iron and magnesium. These elements combine with the ***CO_2*** dissolved in the carbonated water to produce carbonates that are stored within the rocks. The carbonates are stable, and this process can be regarded as storing ***CO_2*** permanently.

CO2 use and transportation:

- ***CO_2* liquefaction:** On October 8, 2021, Hz-Inova (***HZI***) announced that it has contracted with **CO2 Energie AG** to develop a plant to separate and to liquefy ***CO_2*** from an existing biogas facility. The biogas (and biomethane) is derived from biomass processed at a digestion facility (presumably using anaerobic digestion technology). The capture and the liquefaction of the ***CO_2*** will allow the ***CO_2*** to be transported and used or possibly stored.
- ***CO_2* carriers:** On October 10, 2021, it was announced that the Northern Lights Joint Venture has awarded contracts for the construction of two dedicated ***CO_2*** carriers. The construction contract has been awarded to Dalian Shipbuilding Industry Co., Ltd (located in Dalian, Liaoning province, the ***PRC***.)

  Each ***CO_2*** carrier has 7,500 m^3 of containment capacity (to carry liquefied ***CO_2*** under pressure), with delivery scheduled for mid-2024. The ***CO_2*** carriers are to be Norwegian flagged, and classified by leading international classification society, DNV.

  The procurement of the two ***CO_2*** carriers represents further progress in the realisation of the Northern Lights Project (as part of the Longship Project) reported on in previous editions of Low Carbon Pulse (see Editions 2, 3, 11, 16, 17, 19 and 20).
- **Captured *CO_2* as feedstock for methanol:** The use of captured ***CO_2*** to produce methanol (***CH_3OH***) is being undertaken. The use of ***CO_2*** to produce ***CH_3OH*** will give rise to clean or e-methanol if renewable electrical energy is used to provide the required electrical energy. The production of methanol using ***CO_2*** involves the use of electrical energy to combine ***CO_2*** with ***H_2*** to produce ***CH_3OH***.

  As noted in previous editions of Low Carbon Pulse, the combustion of methanol will give rise to ***CO_2***, and as such it is not a no / non carbon fuel. If however the ***CO_2*** is captured from the processing of biomass (for example on bio-fuel production, using ***BECCS*** or ***BECCUS***), in theory at least, if biomass is grown that will absorb and equivalent mass of ***CO_2***, that bio-methanol may be characterised as carbon neutral.

E-Fuels / Future / Now Fuels:

- **JERA continues to make progress:**
  - **JERA and Yara joined by Idemitsu Kosan:** Edition 17 of Low Carbon Pulse (under ***Yara and JERA leading the way from WA to Tokyo Bay***) reported on the signature of a memorandum of understanding between JERA Co, Inc (the largest power generation company in Japan, being a joint venture between Tokyo Electric Power and Chubo Electric Power) and Yara International ASA (world leader in ammonia production) to work together in the production and delivery of, and supply chain development, for Blue Hydrogen and Green Hydrogen.

On October 5, 2021, it was reported widely that JERA, Yara and Idemitsu Kosan have signed a memorandum of understanding (***MOU***) to explore the establishment of a domestic distribution network for ammonia from Idemitsu Kosan's Tokuyama Complex, the establishment of a bunkering business at the Tokuyama Complex and the optimisation of the use of ammonia. Given the parties to the ***MOU***, it may be expected that it will result in the development of discussion around the production and use of fertiliser for the agriculture and power sectors, using the refining capacity and existing infrastructure and refining capacity of Idemitsu.

As has been reported in earlier editions of Low Carbon Pulse, JERA is at the forefront of the use of ammonia to transition to "zero-emission thermal power plants".

- **IHI and JERA co-firing:** In addition to the Yara / JERA news, Edition 18 of Low Carbon Pulse reported (under ***IHI and JERA granted means to commence co-firing***) that IHI Corporation (***IHI***) and ***JERA*** had received notice of acceptance of their joint grant application to undertake a demonstration project to co-fire ammonia in the generation of thermal power using Units 4 and 5 of ***JERA*'s** 1 GW Hekinan Thermal Power Station.

  On October 6, 2021, it was reported widely that ***IHI*** and ***JERA*** had commenced co-firing of coal and ammonia at the Hekinan Thermal Power Station. The commencement of co-firing is part of a program (scheduled to complete in March 2025), with the objective of co-firing ammonia (20%) and coal (80%). As noted in Edition 17 of Low Carbon Pulse, Unit 5 is being used to develop the co-firing burner, with Unit 4 to be used as the co-firing burner is scaled up.
- ***JERA* opens office in *UAE*:** Reflecting on activity in ***GCC*** countries, ***JERA*** is opening an office in the ***UAE***. This is significant because ***JERA*** is the largest electrical energy generator in Japan, and it is an early adopter of hydrogen-based fuels, including in its blending of ammonia for use in thermal power stations. It is to be expected that ***JERA*** will procure Blue Hydrogen and Blue Ammonia in the near term, and Green Hydrogen and Green Ammonia in the medium to longer term.
- **See:** ***JERA*** announcements here, here and here.

- **Austria production and storage = HESS:** On October 5, 2021, it was reported widely that ADX Energy and Windkraft Simonsfeld have agreed to develop Green Hydrogen production and storage facilities to be located in the Northern Vienna basin. The Green Hydrogen will be produced using a PEM electrolyser, with the renewable electrical energy from wind power and with the Green Hydrogen to be stored underground to act as a ***HESS*** to be used to maintain grid integrity and stability.

  See: ADX Energy website; Windfraft Simonsfeld website
- **Plug Power, keeps plugging away:**

  As readers of Low Carbon Pulse will know, the activities of Plug Power, Inc., are reported reasonably consistently, which is a function of the activity of Plug Power. For example, Edition 28 of Low Carbon Pulse reported 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**)*".

  Within the news cycle for this Edition 29 of Low Carbon Pulse, even by the standards of Plug Power, it has been busy:

  - **Plug Power and SK Group progress:**

    Edition 5 of Low Carbon Pulse reported that on January 7, 2021, Plug Power Inc. and SK Group intended to form a strategic alliance with the objective of accelerating the development of the hydrogen economy in the Republic of Korea, and Asian markets more broadly. In January 2021, Low Carbon Pulse described, "Plug *Power, Inc. is a clear leader in fuel cell technology, Green Hydrogen production and distribution*", and that "*the SK Group is active in the fuel cell technology, fixed and mobile uses of fuel cell technology, including working with Bloom Energy on a number of fixed fuel cell technology projects.*"

    On October 6, 2021, it was reported widely that Plug Power and SK Group (leading Republic of Korea chaebol, and leader in progress towards ***NZE***) had entered into a joint venture to develop and deploy technology so as to accelerate the development of the hydrogen economy across Asian markets. Given the expertise Plug Power and SK Group, it is to be expected that they will work together to develop electrolysers, fuel cell systems and technologies, and hydrogen refuelling infrastructure. It is understood that Plug Power and SK Group intend to develop a giga-factory so as to allow the production of electrolysers and fuel cell systems and technologies at scale.

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

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

    See: FFI website; Plug Power website
  - **Airbus and Plug Power Inc:** On October 12, 2021, Plug Power Inc announced a collaboration with Airbus SE, under which they would work together to mobilise the use of Green Hydrogen across the airport and aviation sector, with Airbus providing insight in respect on the use of Green Hydrogen to power and to propel aircraft, and Plug Power to design, develop and deploy hydrogen infrastructure at airports.

    See: Airbus website; Plug Power website
  - **Phillips 66 and Plug Power Inc mobilise:** On October 12, 2021, Plug Power announced that it had signed a memorandum of understanding with Phillips 66 to advance Green Hydrogen across the mobility / transport sector. Phillips 66 and Plug Power are going to work together to develop low carbon hydrogen technology to be designed, developed and deployed across the operations of Phillips 66.

See: Phillips 66 website; Plug Power website

- **Renault and Plug Power mobilise:** On October 14, 2021, Plug Power and Renault unveiled the first HYVIA hydrogen Renault Mast Van in North America.

  See: Renault Group website; Plug Power website

- **STAMPED for approval - Empire State Building:** On October, 26, it was reported widely that Plug Power had commenced construction of its Green Hydrogen production facility in the Town of Alabama, Genesee County, New York, as part of the Science, Technology and Advanced Manufacturing Park (***STAMP***).

  Previous editions of Low Carbon Pulse have noted on ***STAMP*** (see Editions 11, 13, and 26).

- **Lhyfe and Plug Power:** On October 27, 2021, it was reported widely that Plug Power and Lhyfe has agreed to pursue jointly the development of Green Hydrogen facilities across Europe, with the intention to develop and to deploy 300 MW Green Hydrogen facilities by 2025, and to develop a 1 GW production site.

- **Sunfire Gmbh** (***Sunfire***) **responding to demand:** On October 7, 2021, Sunfire announced plans to develop and deploy a 500 MW alkaline electrolyser by 2023 to allow it to respond to projected increased demand for Green Hydrogen. This represents continued progress by Sunfire, with the announcement accompanied by news of further fund raising.

  See: Sunfire website

- **Air Products liquefying to satisfy demand:** On October 7, 2021, Air Products (one of the big three industrial gas producers globally, with Air Liquide and Linde) announced that it had started to liquefy 30 metric tonnes of hydrogen a day at its La Porte facility, with the hydrogen being liquefied sourced from the existing Gulf Coast Hydrogen Pipeline, with the liquified hydrogen (***LH_2***) gas. The ***LH_2*** gas will be delivered from the La Porte facility to industrial customers using tanker-trailers.

  See: Air Products website

- **Horisont Energi and Koole Terminal B.V combine:** Edition 23 of Low Carbon Pulse reported that:

  1. Port of Rotterdam Authority (***PORA***), Chiyoda Corporation, Koole Terminals, and Mitsubishi Corporation signed an agreement to undertake a study jointly to assess the feasibility of the import of hydrogen to a Koole terminal, using proven hydrogen storage and transportation technology developed by Chiyoda; and

  2. ***PORA*** and Horisont Energi signed a memorandum of understanding (***MOU***) to import Blue Ammonia (produced in northern Norway, at the Barents Blue project (***BBP***)) and to store it at the Port of Rotterdam, pending distribution throughout North Western Europe.

  On October 8, 2021, it came as no surprise to read that Horisont Energi and Koole Terminals intend to combine to develop an ammonia terminal and storage facility within the Port of Rotterdam.

  At the risk of banging the private sector drum too loud and too long, this is another instance of the private sector combining to develop infrastructure ahead of the supply and demand for hydrogen and hydrogen based fuels.

  See: Horisont energi website; Koole Terminal BV website

- **Itochu Corporation and NEL ASA partner:** On October 10, 2021, it was reported widely that Itochu Corporation (leading Japanese trading house) and NEL ASA (leading electrolyser technology supplier) had entered into a strategic partnership in the hydrogen sector. NEL is a manufacturer of both alkaline and proton exchange membrane (***PEM***) electrolysers, each used in the production of Green Hydrogen. The purpose of the strategic partnership is to identify hydrogen businesses that Itochu and NEL may develop, including production, transportation and distribution.

  See: Itochu website; NEL ASA website

- **CS Energy and IHI Corporation progress Kogan Hydrogen Demonstration Plant:** On October 12, 2021, it was reported widely that CS Energy (Queensland government owned generation company) and IHI Corporation (***IHI***) are to proceed with the development of the Kogan Hydrogen Demonstration Plant (***KH2DP***) located at CS Energy's Kogan Creek Power Station. The ***KH2DP*** electrolyser is to be powered by renewable electrical energy at a co-located solar farm with the solar farm utilising ***BESS***, and is to deploy a hydrogen fuel cell.

  See: CS Energy website; IHI Corporation website

- **CleanCo and Sumitomo:** On October 13, 2021, it was announced that CleanCo Queensland (Queensland Government owned renewable energy corporation) had signed an agreement with Sumitomo Corporation to join in the development of Green Hydrogen production capacity in Queensland.

- **France set-fair:** On October 12, 2021, French President Emmanuel Macron outlined plans to invest €30 billion (USD 35 billion) in the development and support of French corporations to become champions and lead in innovation. To President Macron it is necessary to "*… wage the battle of innovation and industrialisation at the same time … to re-industrialise*" France.

  In addition to the development of the hydrogen industry in France, the package will allow the development of smaller scale nuclear reactors, providing renewable electrical energy, and the means to the production of hydrogen from that energy or steam from that energy, or both.

  As will be apparent from the **Ashurst Hydrogen Rainbow** (see above) the use of nuclear electrical energy to electrolyse water to produce hydrogen is said to give rise to Pink Hydrogen, and the use of steam arising from cooling in the context of nuclear energy gives rise to Purple Hydrogen.

  See: French Government website

- **The Netherlands ports calling:** On October 12, 2021, VoltH2 announced that it is to commence construction of a 25 MW Green Hydrogen production facility. The Green Hydrogen production facility is to be located in the North Sea Port of Vlissingen, is capable of producing 3,500 metric tonnes per annum (***mtpa***) of Green Hydrogen, and is scalable on modular basis up to 100 MW and 14,000 ***mtpa***.

  As is the case with many other Green Hydrogen production facilities (and Blue Hydrogen production facilities for that matter), the facility is located in an industrial area / carbon cluster, in proximity to high-voltage power and gas transmission and distribution infrastructure, and adjacent to the European Hydrogen Backbone.

See: VoltH2 website

- **A Sunday in Queensland, A Wednesday in New South Wales:** Edition 28 of Low Carbon Pulse reported that New South Wales (***NSW***), Australia's most populous State, has released a report entitled ***Development of a hydrogen industry in New South Wales*** on September 30, 2021.

  On October 13, 2021, the recently appointed Premier of ***NSW***, Mr Dominic Perrottet, outlined a AUD 3 billion hydrogen strategy for the State of New South Wales. (The *September Report on Reports* will consider the report and the hydrogen strategy for NSW.)

- **Air Projects chooses Eastern Louisiana as the home for Blue Hydrogen Clean Energy Complex:** On October 14, 2021, it was reported widely that Air Products is to develop a USD 4.5 billion Blue Hydrogen Clean Energy Complex (***BH2CEP***).

  The ***BH2CEP*** was announced jointly by Governor of Louisiana, Mr Jon Bel Edwards, and Air Products Chair, Chief Executive Officer and President, Mr Seifi Ghasemi.

  Air Products is to build, own and operate ***BH2CEP*** that will produce Blue Hydrogen, with the Blue Hydrogen to be supplied to customers across Air Products' Gulf Coast hydrogen pipeline network. Key to the ***BH2CEP*** will be the CCS of ***CO_2*** arising from the use of technology provided by Haldor Topsoe. Air Products and Haldor Topsoes are working together on the NEOM project in ***KAS***, and Haldor Topsoe is providing technology for Air Products Blue Ammonia facility in Texas City (producing 3,600 metric tonnes a day of Blue Ammonia).

  As reported in previous edition of Low Carbon Pulse, Air Products is one of the Big Three industrial gas corporations, with Air Liquide and Linde.

- **Premium sized Green Hydrogen project on Teesside:** On October 14, 2021, Protium announced the development of a 40 MW Green Hydrogen production facility, with the facility to include ***HESS***. The development of the Protium Green Hydrogen production facility adds further to the hydrogen hub forming part of Net-Zero Teesside (See Edition 23 of Low Carbon Pulse).

- **Green Hydrogen development across the UK:** On October 14, 2021, Octopus Energy and RES announced plans to invest GBP 3 billion by 2030 to develop and deploy Green Hydrogen production capacity across the UK.

- **INEOS continues progress to *NZE*:** Previous editions of Low Carbon Pulse (see Editions 22 and 23 and Edition 28 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.

  As noted in Edition 28 of Low Carbon Pulse, 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.

  On October 18, 2021, ***INEOS*** announced plans to invest €2 billion (USD 2.3 billion) in the development of Green Hydrogen production facilities across Europe. ***INEOS*** announced plans to develop and deploy electrolyser plants across Europe, Belgium, Germany and Norway within the next 10 years, with plants in France and the UK also planned. The first of the electrolyser plants will be a 20 MW electrolyser plant be co-located at ***INEOS***' petrochemical complex at Rafnes, Norway, followed by a 100 MW electrolyser plant at ***INEOS***' existing facilities in Cologne, Germany.

- **Mississippi Clean Hydrogen Hub (*MCH2H*):** On October 19, 2021, it was reported that Hy Stor Energy has plans to develop a Clean Hydrogen Hub, working with Connor, Clark & Lunn Infrastructure. It is proposed that the ***MCH2H*** produce 110,000 metric tonnes (***mt***) per annum (***mtpa***) of hydrogen (or 110,000,000 kilograms). It is understood that up to 70,000 ***mt*** of hydrogen will be stored in salt caverns. As noted in previous editions of Low Carbon Pulse, the storage of hydrogen will be key to its use.

- **Air Liquide accelerates the development of Normandy Green Hydrogen Project:** On October 20, 2021, Air Liquide increased its stake in H2V Normandy, renaming it ***Air Liquide Normand'Hy***, so as to accelerate the 200 MW Green Hydrogen production facility at Port-Jerome, using a proton-exchange membrane (***PEM***) electrolyser. The Green Hydrogen production facility is located within the Normandy carbon cluster / industrial basin, with Air Liquide intending to supply Green Hydrogen to industrial customers and to the mobility / transport sector. The Green Hydrogen production facility will connect to Air Liquide's existing hydrogen pipeline network in Normandy.

- **WEL done – plans to develop clean-ammonia export facility:** On October 25, 2021, it was reported widely that the Woodside Energy Limited (leading energy corporation) intends to develop a clean-ammonia production facility (***H2 Perth project***). The ***H2 Perth project*** is to be located in a carbon cluster in an industrial precinct in the southern metropolitan region of Perth, and will produce up to 15,000 metric tonnes of clean-hydrogen a day, with the clean-hydrogen to be used to produce clean-ammonia and hydrogen for export. A final investment decision in respect of the project may be expected in 2024.

- **PowerChina International and Oracle Power Green Flag:** On October 25, 2021, H2-view.com, reported that PowerChina International and Oracle Power had signed a co-operation agreement to develop a 400 MW Green Hydrogen production facility in Pakistan. It is understood that the electrolysers at the production facility will source renewable electrical energy from photovoltaic solar and wind sources.

- **Aberdeen City Council and BP Green Flag:** On October 25, 2021, it was reported widely that Aberdeen City Council (***ACC***) had selected BP as its preferred bidder on its procurement of a Green Hydrogen Hub in Aberdeen, Scotland. It is understood that the first stage of the development of the Green Hydrogen Hub is the development of a Green Hydrogen production facility. ***ACC*** has demand for the supply of Green Hydrogen produced at the production facility to enable it to fuel its fleet of Fuel Cell Electric Vehicle technology buses.

- ***ENEOS* and FFI combined study**: On October 29, 2021, ***ENEOS*** (leading hydrocarbon importer into, and refiner in, Japan) announced that it is undertaking a study jointly with Fortescue Future Industries to assess the development of a Japan-Australia CO_2 free Hydrogen Supply Chain, sourcing CO_2 free hydrogen from Western Australia.

  As readers of Low Carbon Pulse will recall, ***ENEOS*** is active in the development of hydrogen and hydrogen-based fuel supply chains: Edition 27 of Low Carbon Pulse reported that ***ENEOS*** and Petronas (the national oil company of Malaysia) signed a memorandum of understanding for the development, jointly, of a clean hydrogen supply chain between Malaysia and Japan; Edition 26 of Low Carbon Pulse reported on the study of a hydrogen and hydrogen-based energy carrier supply chain starting at the Origin Energy Green Hydrogen facility at Gladstone, Queensland, Australia, and terminating at the ***ENEOS*** refineries in Japan (with ***ENEOS*** considering the use of Green Hydrogen to produce methylcyclohexane (***MCH***)); and Edition 10 of Low Carbon Pulse reporting on the ground-breaking Hydrogen Energy Supply Chain Project in the Latrobe Valley, Victoria, Australia, in which ***ENEOS*** participates with Kawasaki Heavy Industries, Electric Power Development Co., Ltd (J-Power), Iwatani Corporation, Marubeni Corporation, Sumitomo Corporation, AGL Energy Limited, Shell, and Kawasaki Kisen Kaisha, Ltd (K-Line).
- **Linde hopping in Brazil:** On October 29, 2021, it was reported widely that Linde had signed a memorandum of understanding for the development of a Green Hydrogen production facility as part of the Pecem Industrial and Port Complex (***CIPP***). As readers of Low Carbon Pulse will recall, up to 12 memorandums of understanding have been signed in respect of the development of infrastructure at ***CIPP***.

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

- **Forging Means to Green:** Earlier in 2021, ***FMG*** (driven on by the force of nature that is its founder, Dr Andrew Forrest, AO), committed to achieving ***NZE*** across its Scope 1 and 2 ***GHG*** emissions by 2030, if not earlier.

  On October 5, 2021, ***FMG*** announced its intention to achieve ***NZE*** across its Scope 3 ***GHG*** emissions by 2040. For those who have worked with Dr Forrest, the apparently impossible becomes the everyday. It has to be said that the world needs a few more folk like Dr Forrest; folk who believe in the need for acceleration, and who have the energy and will to achieve that acceleration.

  The Australian Broadcasting Corporation (funded the Federal Government of Australia and its own commercial revenue), reported that ***FMG*'s** Scope 1 and 2 emissions in 2019/2020 were around 2.2 million metric tonnes (***mmt***) of ***GHG*** emissions. It is estimated that the Scope 3 ***GHG*** emissions to June 30, 2021, were 252 ***mmt***, with 246 ***mmt*** arising from the production of iron and steel.

SCOPE OF *GHG* EMISSIONS	
Scope 1	***GHG*** emissions arising directly from activities and assets controlled or owned by the corporation.
Scope 2	***GHG*** emissions arising indirectly from supply of energy to the corporation, including electrical energy and heat by the corporation.
Scope 3	***GHG*** emissions arising indirectly in the supply chain of the corporation, including use of energy.

- **BlueScope to Green Hydrogen:** On October 29, 2021, it was reported widely, that BlueScope Steel Limited (***BSL***) and Rio Tinto are to explore the various pathways to low-carbon iron and steel production, focussing on the use of high quality Pilbara iron ore and clean-hydrogen so as to displace the use of metallurgical coal at BlueScope Steel's Port Kembla Steelworks. It is understood that the use of Green Hydrogen (as a clean hydrogen) will be prioritised.

  Edition 25 of Low Carbon Pulse reported on ***BSL***'s commitment to achieve ***NZE*** in respect of its Scope 1 and Scope 2 emissions. ***BSL*** was to achieve this ***NZE*** commitment using renewable electrical energy, and Green Hydrogen, rather natural gas (***CH_4***), whether alone or blended with hydrogen.

  Edition 21 of Low Carbon Pulse reported that Rio Tinto and POSCO had entered into a memorandum of understanding (***MoU***) to develop, explore, demonstrate and deploy technologies to accelerate the transition of the iron and steel sector to lower, low and no carbon. At that time, Rio Tinto's Chief Commercial Officer, Mr Alf Barros, noted that "*The [**MoU**] … complements Rio Tinto's partnerships with other customers as the industry focus*" on Scope 3 emissions. For Rio Tinto, the ***MoU*** is a clear demonstration of its commitment to ***NZE*** (including in respect of Scope 3 emissions).

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

- **Hyundai Plans Big:** On October 7, 2021, Hyundai Mobis announced plans to develop two new fuel cell plants in ***ROK***. It is understood that the two new plants (one west of Seoul towards Incheon, and one at Ulsan), costing USD 1.1 billion to develop, will be operational during 2023. The increased fuel cell production capacity, will provide the means to accelerate the development of the hydrogen economy in ***ROK*** and globally.
- **Hyundai Motor Company (*HMC*) and Shell Hydrogen (*SH_2*) combine:** On National Hydrogen and Fuel Cell Day (October 8, 2021), ***HMC*** North America and ***SH_2*** announced plans to develop and deploy 48 new hydrogen refuelling stations, and to upgrade 2 more, across the US State of California (***Project Neptune***). As is becoming increasingly typical, the private sector ***HMC*** North America and ***SH_2*** is developing ***Project Neptune*** with the funding support from Government, in this case the California Energy Commission.

  This initiative, combining the means to supply and demand, and allowing efficient development, has become a model globally. (See Editions 17, 23 and 27 of Low Carbon Pulse.)

  See: Hyundai Motor Company website; Shell website
- **Alignment around a hydrogen valley:** On October 8, 2021, h2-view.com reported that global mining giant, Anglo American, the Department of Science and Innovation (***DSI***), South Africa, the South African National Development Institute (***SANEDI***), Engie (leading global energy corporation) and Bambili Energy (manufacturer of fuel cell stacks),

released the findings from a feasibility study into the development of a hydrogen valley. The feasibility study finds that there is potential for the development of a hydrogen valley along the commercial and industrial corridor between Durban and Johannesburg. The hydrogen valley would have three hubs, Joburg to Pretoria, Durban and Richards Bay, and the Limpopo province centred around the Anglo American Mogalakwena platinum Group metals mine.

- **Fortescue Future Industries (*FFI*) and Queensland Government produce:** One of the dynamics in Australia (noted in previous editions of Low Carbon Pulse) is the forward looking perspective of the Australian private sector and Australian State and Territory Governments.

  On October 10, 2021, this was again in evidence. Queensland Government Premier Annastacia Palaszcuk and Dr Andrew Forrest, AO (founder of ***FMG***, parent company of ***FFI***, and chair of ***FFI***) announced the development of an electrolyser manufacturing facility at Aldoga within the Gladstone State Development Area (***GEM***). As noted above, Plug Power is joint venturing with FMG / FFI, and it appears likely that ***FFI*** and projects in which ***FMG*** and ***FFI*** invest will be one of the cornerstone customers of the joint venture.

  See: Queensland Government website; FFI website
- **thyssenskrupp scale up to 5 GW a year:** On October 10, 2021 it was reported that thyssenkrupp is to scale up electrolyser production to 5 GW a year, from the current 1 GW a year. For all manufacturers of electrolysers these are momentous times, and for thyssenkrupp, leading the H2Giga Flagship, it is as well-placed as any.

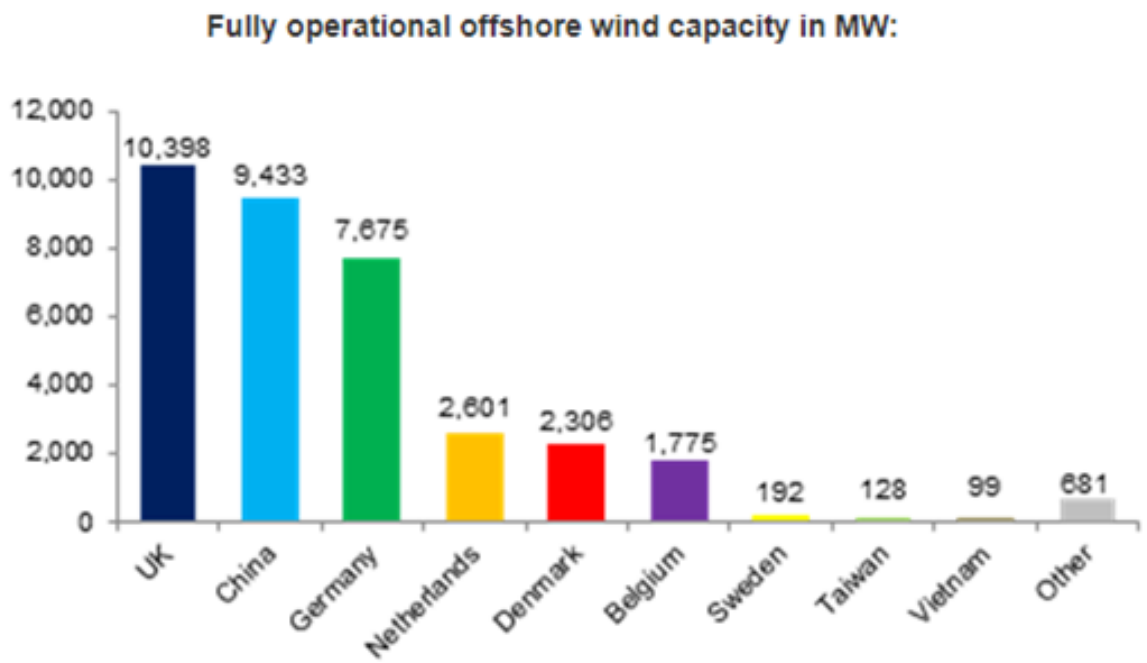
  See: thyssenkrupp website
- **Koch Strategic Platforms and FREYR Battery:** On October 12, 2021, energy-storage.news, reported that Koch Strategic Platforms and FREYR Battery have established a joint venture (***KFJV***) to develop 50 GWh battery cell factories in the US. The ***KFJV*** is stated to be considering the use of 24M Technologies' SemiSolid battery technology to achieve higher-energy density. The intention is to progress to development by 2030 to produce batteries for electric vehicles and for energy storage systems.
- **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 28 of Low Carbon Pulse 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:

- **World Bank Winds-up:** On October 5, 2021, it was reported widely that the World Bank had released ***Key Factors For Successful Development of Offshore Wind in Emerging Markets*** (***WB OWF***).

  The ***WB-OWF*** is the work of the Energy Sector Management Assistance Program (***ESMAP***) of the World Bank, and is intended to provide guidelines for Governments in emerging countries as to how best to develop their resources.

  The headline from the ***WB OWF*** is that there is up to 16,000 GW of off-shore wind field capacity capable of development globally in emerging markets, with this capacity seemingly located in 48 countries. The split between fixed-bottom and floating is 5,500 GW and 10,100 GW.
- **World Wind-up:** On October 6, 2021, it was reported widely that **RenewableUk's Project Intelligence** team had released a report (***OWF Report***) outlining the global off-shore wind field project profile. The ***OWF Report*** identifies 413 GW of off-shore wind field projects.



[**Note:** *The author of Low Carbon Pulse has not verified the basis for the reported GW of off-shore wind field capacity the subject of the* ***OWF Report****, but it appears consistent with the information that the author has read*.]

- **Dutch Wind-up:** On October 6, 2021, it was reported that the Netherland Enterprise Agency (***RVO***) is procuring the undertaking of metocean campaigns in respect of two off-shore areas (Lots 1 and 2) in the Dutch sector of the North Sea, within the Ijmuiden Ver Investigation Area (***IVIA***). The ***IVIA*** is one of three off-shore areas identified in the

Dutch Offshore Wind Energy Roadmap 2030. The ***IVIA*** is 62 kms off the west coast of the Netherlands, having an area of 400 km^2. The ***IVIA*** has four lots in all, with IVOA I and II to be tendered in to 2023, and IVOA III and IV to be tendered in to 2025.

- **Australia winds getting-up:** As noted consistently in Low Carbon Pulse (most recently in Edition 28 of Low Carbon Pulse), Australia has world class off-shore wind resources. As has become typical in the news cycle of each edition of Low Carbon Pulse, another major off-shore wind field project is announced off Australia. On October 8 2021, Alinta (one of Australia's largest integrated energy corporations) announced plans to develop a 1 GW off-shore wind field off the East Coast of Australia and a 300 MW on-shore wind farm in the Pilbara Region of Western Australia.

  An article in The Guardian (Australian Edition), entitled "***Good seas, good grids and good wind***": *Australia's tentative first steps towards an offshore wind industry* provides a snap shot of the current state of play.

  See: Alinta Energy website
- **Uruguay unveils united undertaking:** On October 7, 2021, ANCAP (the national oil company of Uruguay) and the Ministries of Environment and Industry for Uruguay unveiled a plan for the development of Green Hydrogen production facilities using renewable electrical energy from off-shore wind fields – the ***H2U Offshore*** program. It is understood that the current thinking is to schedule a tender by the end of 2023.

  See: ANCAP website
- **Energy Islands in the UK Sector of the North Sea:** Both Denmark and Germany are developing green power islands in their sectors of the North Sea. On October 8, 2021, the New Scientist reported that the UK's National Grid company, the owner and operator of the high-voltage transmission network across the UK, is discussing the development of an energy island. The discussions are said to be three-way, with the National Grid not revealing the other two parties as yet. If the energy island discussions progress, the suggestion is that the renewable electrical energy dispatched from the energy island will match load in the north west region of Europe.
- **Polish Off-shore wind field tender approaching:** Editions 14, 18 and 21 of Low Carbon Pulse have reported on the off-shore wind field development plans for the Polish sector of the Baltic Sea. Ahead of the commencement of the auction process for the off-shore sea-bed leases, consortiums are starting to come together. On October 14, 2021, Ørsted announced that it was partnering with ZE PAK in respect of the upcoming auction.

  See: Ørsted website; ZE PAK website
- **US looks to off-shore wind:** On October 14, 2021, the Biden Administration announced plans to allow the development of seven off-shore wind fields along the East, Gulf and West Coasts of the US: Gulf of Maine, New York Bight (between Long Island and New Jersey), Central Atlantic, the Carolinas, the Gulf of Mexico, California and Oregon.
- **Lithuania progressing to first off-shore wind field:** On October 18, 2021, offshorewind.biz reported that Lithuania had completed the environment impact assessment in respect of its proposed first off-shore wind field in its sector of the Baltic Sea. Adopting tried and tested project structures, Lithuania intends to develop the proposed off-shore wind field project using contracts for difference, with the obligation to connect resting with the transmission system operator.
- **BlueFloat Energy and Falck Renewables continue developments:** Edition 28 of Low Carbon Pulse reported that Falck Renewables (leading Italian renewable energy developer) and BlueFloat Energy (leading off-shore wind developer) had announced that they have entered into a 50:50 joint venture for the purposes developing off-shore wind field (***OWF***) projects off the coast of Italy.

  The first project was the 1.2 GW ***OWF*** project off Brindisi (***Kailia Energia Project***), with projected annual generation dispatch of up to 3.5 TWh.

  On October 26, 2021, it was reported widely that the joint venturers are not seeking a permit in respect of a further 1.3 GW of ***OWF*** projects off the southern coast of the province of Lecce. For the projects to proceed, authorisations will have to be obtained from the Ministero per la Transizione Ecologica and maritime concessions granted by the Ministero delle Infrastructurre and the Port Authority of the Southern Adriatic Sea.

Solar and Sustainable Energy Round-up:

In addition to other news items covered above in respect of solar and sustainable energy, the following news items may be regarded as noteworthy within the news cycle of this Edition 29 of Low Carbon Pulse.

- **South Africa Renewable Energy Procurement:** On October 29, 2021, pv-magazine, reported on the outcome of the fifth round of the Renewable Independent Power Producer Procurement Program (***REIPPP***).

  It is reported that the Department of Mineral Resources and Energy awarded concessions in respect of 25 projects having a combined installed capacity of 2.583 GW, with the projects being within a range of 75 MW to 140 MW. Given the size of the projects, the bids may be regarded as highly competitive, with the lowest bid reported for a 124 MW wind-farm of US cents 2.279 per kWh.

To manage the length of this Edition 29 of Low Carbon Pulse, the usual features on **Land Transport (automobiles, buses, trains and trucks) round-up, Ports and Shipping Forecast and Aviation and Airports** will be the subject of a standalone special feature for October 2021.

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***
BloombergNEF	***New Energy Outlook, 2021***
Euromia Research & Consulting	***CCUS Development Pathway for the EfW Sector***
IEA	***Global Hydrogen Review 2021***
IEA	***Curtailing Methane Emissions from Fossil Fuel Operations***
IEA	***World Energy Outlook 2021***
IEA	***Net Zero by 2050 – A Roadmap for Global Energy Sector***
IEA	***Achieving Net-Zero Electricity Sectors in G7 Members***
IEA	**Phasing Out Unabated Coal – Current status and three case studies**
IMF	**Word Economic Outlook**
IRENA	***A Pathway to Decarbonize the Shipping Sector by 2050***
IRENA	***World Energy Transitions Outlook***
James Cook University	***The global value of coastal wetlands for storm protection***
Lancaster University and Small World Consulting	***The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations***
New South Wales Legislative Council	***Development of a hydrogen industry in New South Wales***
S&P Global Platts	***Platts Global Integrated Energy Model – Strategic Planning for a world in transition*.**
Shell	***Exploring the Future of the Voluntary Carbon Market***
Shell and Deloitte	***Decarbonising Aviation: Cleared for Take-off, Industry Perspectives***
United Nations	***UNFCCC NDC Synthesis Report***
United Nations	**2021 Production Gap Report**
US EIA	***International Energy Outlook***
World Bank	***Key Factors For Successful Development of Offshore Wind in Emerging Markets***
Wood Mackenzie	***How to scale up carbon capture and storage***
Wood Mackenzie	***Global Energy Storage Outlook***

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Low Carbon Pulse – Edition 29 – October 29, 2021. The author of (and researcher for) each edition of Low Carbon Pulse is Michael Harrison.