# Low Carbon Pulse - Edition 23

## GLOBAL DEVELOPMENTS IN PROGRESS TOWARDS NET-ZERO EMISSIONS

Welcome to **Edition 23** of Low Carbon Pulse – sharing significant current news on progress towards net-zero emissions globally. This edition covers the period from Monday July 26, 2021 to Sunday August 8, 2021 (inclusive of each day).

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

The publication of the ***UK Hydrogen Strategy*** (***UKH2S***) was awaited so that Part 2 of the second article in the ***S2H2*** series (on Hydrogen Roadmaps and Strategies) would be current. Given the delayed release of ***UKH2S***, an article on carbon capture and storage and use will be published instead during August.

On August 4, 2021, members of the Global Ashurst Towards NZE team published an article entitled ***Realising Reserves and Realising Capital***. The article outlines the key dynamics for International Oil Companies (***IOCs***) and National Oil Companies (***NOCs***) in progress towards ***NZE***, and the importance of ***IOCs*** and ***NOCs*** to achieving ***NZE***.

Finally, this **Edition 23** includes, as an appendix, the July Report on Reports foreshadowed in recent editions of Low Carbon Pulse: this Report on Reports was planned as a standalone Report, but having tested the preferences of a number of readers, it has been included as an appendix.

**Edition 23** will be posted again on **August 13 2021** to pick-up those reading later in the week.

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## Progress towards COP 26:

- **IPCC 2021 Report published:** Edition 20 of Low Carbon Pulse reported on "smoke signals" (under ***"Worst is yet to come", unless greater and faster reductions***) that had emerged around messaging likely to be included in the Intergovernmental Panel on Climate Change (***IPCC***) Sixth Climate Report (***2021 Report***).

  On July 26, 2021, it was reported that the ***IPCC*** commenced final consultation ahead of the publication of the ***2021 Report*** being the first full-scale report from the ***IPCC*** since 2013 (***2013 Report***) captured in the ***Climate Change 2014, Synthesis Report***. The ***2013 Report*** provided the impetus for the Paris Agreement, with the ***IPCC*** ***special report on keeping global temperatures rise to under 1.5$^{o}$C*** being published in the interim.

  It is understood that the ***IPCC*** consulted with the representatives of 195 countries on a line-by-line basis in the weeks preceding publication. The ***2021 Report***, and a summary for policymakers, was published on August 9, 2021, the day after the end of the two week cycle for this edition of Low Carbon Pulse.

  The Ashurst Global Towards Net Zero team will publish Edition 24 of Low Carbon Pulse outside the usual two week cycle to report on the ***2021 Report***.

From a review of the ***2021 Report***, the themes are clear: there are five red alerts, all related: (**1**) Anthropogenic ***GHG*** emissions are responsible for climate change; (**2**). Average global temperatures will continue to increase; (**3**). It is highly unlikely that the *Stretch Goal* will be achieved, and this illustrates the need for immediate action; (**4**) Time is running short: it is likely that the *Stretch Goal* will be exceeded by 2030; **5**. Action is required to accelerate reductions in ***GHG*** emissions now.

Under the Paris Agreement, two of the principal objectives were to limit the increase in global average temperature to well below 2.0 $^{O}$C above pre-industrial levels (the *Stabilisation Goal*), and to limit the increase in global temperature of 1.5 $^{O}$C above pre-industrial levels (the *Stretch Goal*).

- **Enhanced emphasis:** In the count-down to COP-26, Low Carbon Pulse will emphasise the policy settings that work, and the policy settings that are needed (including by reference to the ***2021 Report***), to accelerate the reduction in ***GHG*** emissions as progress is made towards 2030. For the developed world, the need to accelerate ***GHG*** reductions to achieve ***NZE*** well-ahead of 2050 had emerged as a theme before the ***2021 Report***: there was recognition that policy settings need to accelerate reductions, the ***2021 Repor***t underlines the theme.

  In addition to the ***IPCC 2021 Report***, the International Energy Agency (***IEA***) has indicated that it will publish its ***World Energy Outlook 2021*** (***WEO21***) on October 13, 2021, ahead of COP-26.

  The pre-publication narrative from the ***IEA*** is that:

  > "With [the ***IEA***'**s**] **#NetZeroBy2050Roadmap** providing an integral part of the analysis, **#WEO21** is designed to serve as a handbook for **#COP26** at this vital moment for the clean energy transition & climate action".

  (The ***IEA*** has indicated that it will publish its ***Hydrogen in Latin America*** report, in mid-August 2021. This will be summarised in the August Report on Reports.)

- **The "five red alerts" already known globally:**
  - **UK aware of need for acceleration:** On August 1, 2021, Ms Allegra Stratton, Climate Spokesperson for No. 10 Downing Street, said that achieving ***NZE*** in the UK by 2050, is "too far away", "the science is clear", the UK must reduce its ***GHG*** emissions "right now". Ms Stratton encouraged people to "feel the fierce urgency of now". This may be regarded as one of the most telling and timely phrases of 2021: for the UK, leading the way to ***NZE***, and as such acting on the science, to consider that acceleration is needed, resonates.
  - **Finance Industry looking to accelerate coal-fired power station retirement:** On August 3, 2021, it was reported by BBC News, Business, that Prudential Insurance is developing an initiative to accelerate the retirement of coal-fired power plants in Asia.

    The initiative involves the acquisition of coal-fired power plants, and follows from the conclusion, reached by Prudential Insurance, that: "The world cannot possibly hit [the] Paris climate change targets unless we accelerate the retirement and replacement of existing coal-fired electricity, opening up much larger room in the near term for renewables and storage".

    As the statement from Prudential Insurance recognises, the acquisition of coal-fired plants, and their retirement, is part of a plan, but more important in any plan of this kind is the development of generation capacity to replace the coal-fired power plant capacity to be retired, ahead of its retirement.
  - **In facts and stats – the need for acceleration in *GHG* emission reductions:**
    - **Developing world not at peak *GHG* emissions:** On August 4, 2021, the World Economic Forum (***WER***) released a short video that conveys current key dynamics, projected increases in ***GHG*** emissions, and that the current rate of progress to ***NZE*** will not be sufficient: the majority of global ***GHG*** emissions arise from countries (with over 65% of global population) that have not yet reached peak ***GHG*** emissions. The ***GHG*** emissions from those countries are projected to increase by 5 gtpa (5 billion tonnes per annum) by 2040.
    - **Growing population, increased urbanisation:** As noted in Edition 22 of Low Carbon Pulse (under ***Empowering Cities for a Net Zero Future***), the decarbonisation of cities has to be front and centre of policy settings: every month globally an urban area the size of New York City will be developed for the next 40 years. In this context, if the countries that have reached peak emission are to work with countries that have not, to reduce, indeed to avoid, ***GHG*** emissions, there needs to be close coordination.
    - **What does this mean?** Even if the developed countries achieve ***NZE*** by 2040, this will not achieve ***NZE*** globally to achieve either Paris Agreement Goal. This is consistent with the analysis of BloombergNEF's recent report ***Net Energy Outlook***: unless the rate of ***GHG*** reductions increases, BloombergNEF's analysis is that the world carbon budget (which does not include 5 gtpa increase not above), will be exceeded by 2044: this will mean that neither the *Stretch Goal* nor the *Stabilisation Goal* under the Paris Agreement will be achieved. This outcome is consistent with the ***2021 Report***.
    - **Developed world needs to accelerate progress to *NZE*, home and abroad:** As noted in previous editions of Low Carbon Pulse, the rate of investment required to enable countries that have yet to reach peak ***GHG*** emissions to achieve ***NZE*** will not be achieved unless developed countries work with those countries to accelerate decarbonisation.

- **Develop world needs to adapt to changed environment: Article 2** of the Paris Agreement is best known for the *Stabilisation* and *Stretch Goals* (**Article 2.1(a)** of the Paris Agreement). It would appear that attention is turning towards **Articles 2.1(b)** and **(c)** (to many the forgotten objectives of the Paris Agreement): "Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emission development, in a manner that does not threaten food production" and "Making finance flows consistent with the pathway towards low greenhouse gas emissions and climate-resilient development". In the countdown to COP-26 it is to be expected that initiatives and policy settings will emerge in relation to each of these objectives. It is becoming increasingly clear that the science behind the Paris Agreement is incontrovertible.

## Big Bill - History Made to Make Infrastructure:

- **US Bipartisan Infrastructure Deal (nearly) Done:** In the last two weeks, it has been reported that the USD 1 trillion infrastructure investment package (***IIP***), as part of the Build Back Better agenda, has been close to finalisation: the ***IIP*** includes the previously approved USD 550 billion in new Federal Government funding for infrastructure.

  Colleagues in the US have penned a summary of the ***IIP***, and as such this outline looks at the ***NZE*** orientated elements of the ***IIP***. Depending on how one reads the ***IIP***, up to ***USD 114 billion*** of funding is to be made available for energy infrastructure and energy transition.

  On August 6, 2021, the US Senate voted to advance the ***IIP*** infrastructure bill (the Senate having addressed procedural issues), but is yet to finalise it. Once the ***IIP*** infrastructure bill is finalised, the Senate will develop a budget framework, "to pave the way" for the human infrastructure bill.

- **NZE initiatives:**
  - **Upgrading transmission grid (*UTG*):** For some time, the state of the US transmission grid has been expressed to be a concern; its integrity and stability, and the ability of the grid to allow connection of renewable electrical energy to the extent required to achieve US ***GHG*** emission reduction targets is at issue. A key element of the ***UTG*** is the allocation of USD 73 billion for infrastructure investment and a new grid deployment authority.

    As noted in previous editions of Low Carbon Pulse, the development and enhancement of grid networks ahead of connection of renewable electrical energy is critical, and given the scale of renewable electrical energy to be connected over the next 30 years, and beyond, the ***UTG*** is a "must have" policy setting.
  - **Recharging infrastructure:** develop a national network of electric recharge infrastructure (***RCI***), so as to deploy 500,000 chargers, including along highways and in rural and disadvantaged communities, to allow battery electric vehicles (***BEVs***) to recharge, and as such accelerate to the development of the ***BEV*** market. The development of the national recharging network is critical to achieving President Biden's desire for 50% of new vehicle sales to be ***BEVs*** by 2030.
  - **Renewable electrical energy and hydrogen:** In addition to the ***UTG***, the ***IIP*** provides funding support for:
    - **Electrification of school and transit buses:** As reported in previous editions of Low Carbon Pulse, electrification of school and transit buses will provide the scale and long term demand profile to encourage the private sector to develop ***BEVs*** for these (and other) functions; and
    - **Carbon capture and storage and hydrogen infrastructure:** the ***IIP*** is reported to provide support for carbon capture and storage, and carbon capture use and storage, with the likelihood of the development of $CO_2$ pipelines the preferred means of haulage to storage and to use and storage. This is consistent with the use of CCS / CCUS for the decarbonisation of the industrial sector (for example, cement, chemical and petrochemicals, and iron and steel), rather than the power sector (with the clear policy setting preference being to decarbonise the power sector, rather than allow it to use CCS / CCUS). It is understood that around USD 8.5 billion of funding is to be provided for CCS / CCUS.

  Further information will be provided in Low Carbon Pulse as the ***IIP*** proceeds.

- **The Inconvenient Truth is true:** It is coming up for 20 years since the author of Low Carbon Pulse attended a dinner hosted by former US Vice-President, Mr Al Gore.

  The dinner was memorable for Mr Gore's literacy on the science of climate change, and because Mr Gore was a great speaker, charismatic in a way that television could never capture. The subject matter of the dinner became a book and a film. On August 2, 2021, Journal Nature Communications reported that climate change is the result of anthropogenic ***GHG*** emissions, with less than a 1% chance that climate change has occurred naturally. This is consistent with the ***2021 Report***.

  The private sector, and a number of States of the US have acted on the science that has long informed Mr Gore. Hopefully in the next short while the legislature will finalise the ***IIP*** bill, "to play catch-up".

## Big Bill at the Gate:

- **Breakthrough at cost:** ***Breakthrough Energy*** founder, Mr Bill Gates, continues as a voice of reason, engaged with the size and shape of the task in hand:

  > "Every year, the world adds approximately 51 billion tons of greenhouse gases to the atmosphere trapping heat and driving up global temperatures. The only way to avoid the worst impacts of climate change is to stop adding greenhouse gases by 2050.
  >
  > We need to get from 51 billion tons to zero while still meeting the planet's basic needs. That means we need to transform the way we do almost everything".

  The starting point is clear, the end point is clear, it is the bit in the middle that is the challenge!

- ***Breakthrough Energy* - cost so far:** One of the key tenets of Mr Gates thesis is that clean technology must be deployed and improved, noting that the development and deployment of solar photovoltaic, wind and lithium-ion batteries will continue, but those technologies need to improve, and other clean technologies allowed to develop.

  For this purpose, ***Breakthrough Energy*** provides a platform to allow accelerated development and deployment. It has been reported that Direct Air Capture (DAC), Green Hydrogen, Long-Duration Energy Storage (LDES) and Sustainable Aviation Fuel (***SAF***) are four areas of focus.

- ***Breakthrough Energy* - connections:** Mission Innovation (***MI***) was announced at COP-21 by Mr Gates: it was established to provide a structure for the public and private sectors to come together to accelerate clean energy innovation to address climate change. ***MI*** has links to the private sector through the ***Breakthrough Energy***

***Coalition***, a group of private sector investors, of whom, one is Mr Gates. As reported in Edition 19 of Low Carbon Pulse members of ***MI*** reaffirmed their commitment with a second phase of ***MI***, **Mission Innovation 2.0**.

## Platting Progress:

On July 26, 2021, S&P Global Platts, published its ***Platts Global Integrated Energy Model – Strategic Planning for a world in transition*** (***IEM***). The ***IEM*** provides a 30 year look back (noting the "profound transformation" in total primary energy supply), and a 30 year look forward, with some particularly helpful graphics showing the forward looking transformation by source of energy to use of energy.

As with the reports published by the International Energy Agency or ***IEA*** (***Net Zero by 2050 – A Roadmap for Global Energy Sector***), the International Renewable Energy Agency or ***IRENA*** (***World Energy Transitions Outlook***), Wood Mackenzie publication, and BloombergyNEF (***New Energy Outlook, 2021***) (and reported on in Editions 20, 21 and 22 of Low Carbon Pulse), the ***IEM*** provides a rich data set, and a strong narrative, and is well-worth a read. (The ***IEM***, with ***NEO***, is long, and strong, on data.)

The August Report on Reports will summarise the ***IEM***.

## Don't do too little – says Deloitte:

On July 28 / 29, 2021, a Deloitte study, entitled ***Hydrogen4EU – Charting Pathways to Enable Net Zero*** was released (***DPS***). The ***DPS*** is excellent. Framed within the European Green Deal, the ***DPS*** goes down a number of layers to provide a clear line of sight as to how hydrogen may be used in the decarbonisation of activities across each sector and industry.

The August Report on Reports will summarise the ***DPS***.

## The Science Based Targets Initiative:

- **Substance has to be core of action:** In Edition 22 of Low Carbon Pulse, the carbon neutral versus net zero emissions debate was canvassed. In canvassing the debate, it was noted that while the debate may be interesting, ultimately substance counted: "the bigger issue is ensuring, whatever term is used, that the decarbonisation of activities occurs over time". What "over-time" means is becoming ever clearer: global ***GHG*** emissions must be halved by 2030 to avoid the worst effects of increases in average global temperatures.
- **The Science Based Targets initiative:** As such, rather than debate, each country and organisation should consider how best to halve its carbon footprint by 2030.
- **The Economist provides straight shooting:** During the week beginning the July 26, 2021, The Economist published an article outlining possible consequences of exceeding the Stabilisation Target under the Paris Agreement. The ***2021 Report*** provides a like narrative on the imperative to act, and to act promptly.

## CCS Support Framework in the Netherlands and Hydrogen import:

- **Policy setting, with an end in sight:** On July 26, 2021, a briefing (entitled ***The Industrial CCS Support Framework in the Netherlands***) was published that outlines the framework in the Netherlands to promote and to support ("carrot and stick" to some) the development of CCS / CCUS capacity, and its use.

  The ***SDE ++*** program provides support in the form of a 15 year "legal instrument" that compensates the user of CCS / CCUS for the increased costs of using CCS / CCUS compared to the counter-factual: counter-factual being, not using CCS / CCUS, and as a result incurring cost under the European Union (***EU***) Emissions Trading Scheme (see Editions 12, 19, 21 and 22 of Low Carbon Pulse) and being subject to the Carbon Tax regime in the Netherlands.

  Effectively, the ***SDE ++*** program provides a subsidy to address the negative externality of ***GHG*** emissions, the subsidy "pricing the benefit of capturing those ***GHG*** emissions". Also ***GHG*** emissions captured and stored are exempt from the Carbon Tax regime in the Netherlands.

  As currently configured, these policy settings will apply until 2035, with this support regarded as transitionary, allowing industry to move to lower, low and no carbon technologies over time.
- **Port of Rotterdam continues to lead the way:** Edition 20 of Low Carbon Pulse reported on leading roles of the Ports of Amsterdam and Rotterdam (under ***Getting ready for supply and distribution***). This leadership continues:
  - **Hydrogen storage facilities:** On July 28, 2021, it was reported that the 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.

    **See:** *Study for commercial-scale hydrogen imports*
  - **Ammonia import facilities:** On August 5, 2021, is was announced that ***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. A final investment decision on the ***BBP*** is anticipated towards the end of 2022. The ***BBP*** will have production capacity of 3,000 tpd of Blue Ammonia, or 1 mtpa.

    As noted in previous editions of Low Carbon Pulse, ports are critical to the export and import of hydrogen and hydrogen-based energy carriers. Blue Ammonia, a hydrogen-based energy carrier, is produced from the combination of Blue Hydrogen and Nitrogen. Currently, up to 15% of the energy carriers imported into western Europe enter Europe through the Port of Rotterdam.

    As things stand, ***PORA*** is reported as estimating that up 20 mtpa (or 100 mtpa) of hydrogen will transit through the Port of Rotterdam by 2050. These estimates may be regarded as conservative. (See ***Port of the Future: The Importance of Hydrogen*** to get the perspective of ***PORA*** and the role of hydrogen.)

**See:** *Horisont Energi and Port of Rotterdam sign memorandum of understanding regarding blue ammonia* and Port of Rotterdam website

## GCC countries continued activity:

- **UAE, another week, and another week of progress:** On July 29, 2021, it was reported that the United Arab Emirates (**UAE**) had signed a strategic partnership agreement (***SPA***) with Austria. UAE Crown Prince Mohammed bin Zayed Al Nahyan and Austrian Chancellor, Mr Sebastian Kurz, signed the ***SPA*** during meetings in Vienna, Austria. At the same time it is understood that a cooperation agreement was signed in respect of the development of links to develop a hydrogen and hydrogen-based fuel value chain.
- **ADNOC exports Blue Ammonia to Japan:** On August 3 and 4, 2021, it was widely reported that Abu Dhabi National Oil Company (***ADNOC***) and Fertiglobe (a joint venture between ***ADNOC*** and OCI chemical (world leading producer of soda ash)) exported the first cargo of Blue Ammonia from the UAE to Japan. The Blue Ammonia was produced at the fertiliser plant in Ruwais. The cargo is reported to have been sold to Itochu (leading Japanese trading house). It would seem that the Blue Ammonia has been produced using Blue Hydrogen, with $CO_2$ arising from the production of that Hydrogen being reinjected into the Bab and Rumaitha Fields to achieve enhanced oil recovery (see Edition 22 of Low Carbon Pulse under ***CCS can be a challenge***).

  It is reported that Fertiglobe is to combine in joint venture with ADNOC and ADQ (a key UEA holding company) to develop the Ta'ziz Blue Ammonia Project at Ruwais.

  **See:** *ADNOC and Fertiglobe Partner to Sell UAE's First Blue Ammonia to Japan's Itochu* and *Abu Dhabi's ADNOC sells its first 'blue ammonia' cargo to Japanese trading firm Itochu*

  The Oxford Institute for Energy Studies (***OIES***) has released a research paper (***ARP***) on the use of ammonia as an energy carrier and as a feedstock. The ***ARP*** is recommended. Also Renewable Energy News included an article on ammonia, entitled ***Ammonia – The Key to Unlocking Hydrogen's Potential As A Low Carbon Alternative to Fossil Fuels***. As with the ***ARP***, it is recommended.
- **PowerTap to deploy 100 hydrogen refuelling stations (*HRSs*):** On August 5, 2021, it was reported that PowerTap Hydrogen Capital is to deploy at least 100 hydrogen ***HRSs*** working with a number of governments in the Middle East. It is understood that ***HRSs*** may be co-located with existing refuelling stations.

  **See:** PowerTap website

## Germany feeling the push to accelerate off-shore wind:

While it has been reported that the development of off-shore wind capacity (as opposed to on-shore wind capacity) in the German sector of the North Sea may be fallow in 2021, it is clear that this state of affairs is not likely to continue, and more broadly Germany continues to be active in the deployment of renewable energy, but there is no doubt that more off-shore wind field capacity is needed.

- On July 27, 2021, it was reported that four green giants, Equinor, Gasunie, RWE and Shell are exploring the potential for the development of an off-shore hydrogen park in the German sector of the North Sea. While this project has been in concept for a while as the AquaSector as part of the integrated AquaVentus project (see Edition 17 of Low Carbon Pulse), this project would go beyond current thinking around AquaSector (as a pilot scheme), to encompass a 300 MW electrolyser development to produce up to 20,000 tonnes of Green Hydrogen a year. The Green Hydrogen would be transported to the mainland of northern Europe via the AquaDuctus.
- On July 27, 2021, Oil Price reported that despite a 62% increase in the installation in wind capacity across Germany in the first half of 2021, compared to 2020 (to 971 MW), this is not sufficient to achieve the national and ***EU*** wide targets for new installations. Under the Renewables Act in Germany, a little under 4 GW of wind capacity is to be installed each year.

## India – the beats up:

- **SECI in beat, not wasting time:** As reported in previous editions of Low Carbon Pulse, state-owned corporation, Solar Energy Corporation of India (***SECI***) is active in the development of solar photovoltaic capacity.

  On July 26, 2021, it was reported that ***SECI*** is planning the development of a 2 GW energy storage system comprising a number of projects developed on a build-own-operate basis (each an ***ES BOO*** contract).

  Each ***ES BOO*** contract will be for a term of 25 years. It is reported that ***SECI*** will come to market later in August 2021. It might be expected that the ***ES BOO*** contracts will be awarded in tranches, each tranche reflecting the expected roll-out of the ***SECI*'s** solar development.
- **Green Hydrogen Projects:** On July 29, 2021, it was widely reported that Fortescue Future Industries (***FFI***) had signed a framework agreement with JSW Future Energy (a leading Indian power company), under which the corporations will work together to identify and to develop opportunities to use Green Hydrogen for iron and steel production and for mobility, and the production and use of Green Ammonia.

  This continues to global initiatives if ***FFI*** in a number of countries that will benefit from the capital and markets that ***FFI*** is able to unlock.

  **See:** Fortescue Future Industries website
- **India a leading country:** On July 30, 2021, the Executive Director of the International Energy Agency (***IEA***), Mr Fitoh Birol, addressed India's role as a country leading in clean energy.

  Mr Birol is reported to have said that:

  > "India is a leading country in terms of renewable energy investments … the country has great plans to be a driver of clean energy transitions …".

## Israel to introduce carbon tax:

**To be phased in:** On August 2, 2021, The Times of Israel, reported that Israel is to introduce a carbon tax over a five year period, 2023 to 2028.

**Targeted Tax:** As reported the carbon tax:

- will apply:
  - to about 80% of the ***GHG*** emissions arising from the use of fossil fuels (coal, fuel oil, liquified petroleum gas, natural gas and petcoke) in Israel;
  - to ***GHG*** emissions arising from specified sources, including from cooling systems of all kinds, and landfill;
- will not apply to the use of diesel in the transport sector because, as reported, the excise duties on diesel in Israel are among the highest in the OECD.

**Israel's NDC:** As COP-26 approaches (in Glasgow, Scotland, in November), Israel has restated its national determined contribution (***NDC***) for the purposes of the Paris Agreement - 27% reduction in ***GHG*** emissions by 2030, and 85% reduction by 2050, compared to 2015. Modelling undertaken by the Environmental Protection Ministry indicates that the carbon tax will reduce ***GHG*** emissions by 67% by 2050, compared to 2015.

## Japan's draft 2030 energy mix:

Pausing to consider the implications, Edition 22 of Low Carbon Pulse reported on the draft plan for the 2030 energy mix for Japan. For some, there was an initial "cat among the pigeons" or "fox in the hen house" moment following the release of the draft Strategic Energy Plan, by the Ministry of Economy, Trade and Industry (***METI***).

While there has been much analysis, possibly the pithiest assessment the author has read is that provided by Wood Mackenzie on July 27, 2021. Leaving to one side what may be regarded as stretch targets for renewables and nuclear power in the draft Strategic Energy Plan, from a policy setting perspective the draft from ***METI*** is consistent with the reduction of ***GHG*** emissions to 46% compared to 2013 levels by 2030.

## ROK's energy mix dynamics:

- On July 31, 2021, The Korean Times published an article entitled ***LNG power generation poses dilemma for Korea's energy policy***. As with Japan, one of the "pause for thought" moments that has emerged in recent times in the Republic of South Korea (***ROK***) is the role of LNG, in particular the use of natural gas derived from the regasification of LNG as a fuel for power generation.

  For some time, the policy settings in ***ROK*** have been oriented towards phasing out coal-fired, and nuclear, electrical energy generation. To achieve this phasing out, LNG is critical: in April 2021, power generated from firing natural gas derived from re-gasified LNG became the largest source of fuel for electrical energy generation in ***ROK***. As noted on previous editions of Low Carbon Pulse, and other Ashurst publications, LNG is regarded as a key transition fuel source because it gives rise to lower levels of ***GHG*** emissions than the use of coal.

  The policy settings in ***ROK*** reflect this role for LNG: 59 GW of electrical energy capacity sourced from LNG by 2034 (an increase of 20 GW), representing 30.6% of projected load. It is increasingly likely that these policy settings will need to be revisited.

| CURRENT AND PROJECT ELECTRICAL ENERGY SOURCES IN ROK | | | |
|---|---|---|---|
| **2019 CAPACITY** (expressed as a percentage of load) | | **2034 CAPACITY** (expressed as percentage of load) | |
| Renewables | 6.5 | Renewables | 40.1 |
| LNG | 25.9 | LNG | 30.6 |
| Coal | 40.4 | Coal | 15.0 |
| Nuclear | 25.6 | Nuclear | 10.1 |
| Other | 1.4 | Other | 4.0 |

## UK in consultation mode:

On July 2, 2021, the UK Government (Department for Business, Energy and Industrial Strategy (***BEIS***)) opened consultation in respect of:

- ***Carbon capture, usage and storage (CCUS): offshore decommissioning regime for $CO_2$ transport and storage***: the key purpose of the consultation is stated to be to seek views on ***BEIS's*** proposals for a funded decommissioning regime of ***CCUS*** projects, that satisfies the "Polluter Pays Principle", and encourages investment in the sector.

  The ***BEIS*** notes that the consultation process will be of interest to certain participants and prospective participants, including the ***CCUS***-enabled industrial regions such as South Wales, Scotland, the North West, North East and Humberside (see ***Clustering and Hubbing around the UK*** below); and
- ***Carbon capture, usage and storage CCUS: duties and functions of the economic regulator for $CO_2$ transport and storage***.

## Policy Setting Updates:

On August 3, 2021, HyResource published ***International Hydrogen Policy Development An Update*** (***July 2021***) (***HySource Update***). The ***HyResource Update*** is a helpful publication, as was its March 2021 publication (***International Hydrogen Policies – Key Features***.

Both publications are great reference sources, and will be covered in the August Report on Reports.

## Bio-energy update:

As noted in previous editions of Low Carbon Pulse, it is anticipated that bio-energy is going to play a key role in progress to achieving ***NZE***. In recognition of this, Low Carbon Pulse will include details of bio-energy projects globally. These projects may not appear to be significant of themselves, but in combination they will reduce ***GHGs***, critically, they will reduce $CH_4$.

- **Biogas to RNT:** On July 27, 2021, it was reported that the City of Toronto (***CoT***) is to derive renewable natural gas (***RNG***) from organics collected from its green bin system. The ***CoT*** intends to work with the Enbridge Gas. The ***CoT*'s** Solid Waste Management Service Division has installed infrastructure designed and constructed by Enbridge Gas, at the ***CoT*'s** Dufferin Solid Waste Management Facility (which is an anaerobic digestion (***AD***) facility with capacity to take up to 55,000 tonnes of organics annually). The Enbridge Gas technology takes raw biogas arising from the anaerobic digestion of green organics, and processes that raw biogas further to scrub it, so to derive ***RNT*** or ***bio-methane*** that can then be used as pipeline gas.
- **Biogas to energy**: Towards the end of July 2021 the Santa Barbara ReSource Center is reported to have commenced operation of a materials resource recovery facility (***MRF***) and an anaerobic digester (***AD)***. As might be expected, the ***AD*** will process the organics collected from the waste stream to derive biogas, with the biogas to be processed further to derive bio-methane, with the bio-methane then used to provide renewable energy.
- **Whisky delivery trucks to run on "green biogas":** On July 27, 2021, it was announced that Glenfiddich, producer and purveyor of single malt whisky, is to derive biogas from the residual material arising from the distillation of whisky to derive green biogas. The green biogas is described as "ultra-low carbon fuel gas that produces minimal carbon dioxide and other harmful emissions". In hard statistics, it is reported that the use of the green biogas reduces $CO_2$ emissions by 95% compared to diesel. The development of the technology to produce the green biogas required parental guidance from William Grant and Sons.

  **See:** *Glenfiddich whisky lorries in Scotland to run on 'green biogas' made from distillery leftovers*

## Blue Carbon:

- **Background:** While the author has been following with interest the concept of Blue Carbon, the narrative around possible policy settings has not developed with a coherence, and the science remains to be firmed-up to be even close to proven. The exception to this proven science is the apparently strong science around mangrove swamps.

  A report published by the Environmental Justice Foundation (***EJFR***), outlines the role that oceans and waterways have in limiting the effect of climate change through the absorption and retention of Blue Carbon.
- **Facts and Stats:** The ***EJFR*** contains some facts and statistics that assist in framing thinking, and in confirming other information gleaned over time (mangroves store up to four times more carbon per hectare than tropical rain forests).

  The ***EJFR*** is well-worth a read. This said, with the exception of the restoration and planting of mangrove swamps and other flora close to oceans and waterways, as yet the science tends to support a Socratic approach – do no harm.

## BECCS and CCS and CCUS:

A number of news items in this edition of Low Carbon Pulse cover BECCS and CCS and CCUS (critically, ***Clustering and Hubbing around the UK*** below). The next edition of the ***Shift to Hydrogen (S2H2): Elemental Change*** will cover BECCS and CCS and CCUS in considerable detail, including in the light of the ***IPCC 2021 Report***.

## BESS:

- **Time for a "cold one": VBB registered with Australian Energy Market Operator (*AEMO*):** A previous edition of Low Carbon Pulse reported on the decision of Neoen (leading global renewable energy corporation) to develop the Victorian Big Battery (***VBB***): some may recall the lame joke from the author about Australia's favourite beer.

  Around July 28, 2021, it was announced the ***VBB*** had registered with ***AEMO***. As reported, from commencement of construction to registration has taken 205 days.

  This is testament to the project development acumen of the principal, Neoen, the timeliness of the supplier of batteries, Tesla, and the contractor, Downer UGL, and the role of ***AEMO*** and AusNet. To all, great outcome.

  **See:** Neoen website
- **Time for another "cold one":** In late July, 2021, it was announced that the Windoan Big Battery (***WBB***), owned by Vena Energy (leading global renewable energy corporation), had obtained its registration from ***AEMO***. The ***WBB*** is 100 MW / 150 MWh. The ***WBB*** was constructed by Doosan.

  **See:** Vena Energy website
- **UK Breaking Battery Limits:** On August 4, 2021, publication, Energy Storage, reported that there is an ever-increasing pipeline of submissions for the installation of utility-scale batteries: at the end for Q2 2021 it reported that the pipeline of submissions stands at 20 GW.

  This pipeline is expected to continue to fill, possibly not yet to its limits.

- **Big Batteries Filing In:** On August 5, 2021, it was widely reported that Maoneng (see Edition 21 of Low Carbon Pulse) has filed planning applications for the development of three new Big Batteries in Armidale (150 MW / 300 MWh), Lismore (100 MW / 200 MWh) and Tamworth (200 MW / 400 MWh) all in the New England region of New South Wales, Australia.

  **See:** Maoneng Group website

## E-Fuels / Future Fuels:

- **Korean Green Ammonia Alliance:** Edition 2 of Low Carbon Pulse reported on the establishment of the Korean Hydrogen Association.

  On July 20, 2021, it was widely reported that that:

  - **five public institutions:** Korea Institute of Energy Research, H2 Korea, Korea Research institute of Chemical Technology, and NETO; and
  - **thirteen private organisations:** Doosan Fuel Cell, Doosan Heavy Industries, Hanwa Solutions, Hyundai Glovis, Hyundai Heavy Industries, Hyundai Motor, Hyundai Oilbank, Hyundai Steel, Korean Shipbuilding & Offshore Engineering, Lotte Chemical (see Edition 22 of Low Carbon Pulse), Lotte Fine Chemical, POSCO and Samsung Engineering,

  combined to establish the ***Green Ammonia Alliance*** (***GAA***). Members of the ***GAA*** undertake activities in each link in the ammonia supply / value chain: production, transportation, cracking (i.e., extracting Green Hydrogen from Green Ammonia) and use.

  It is understood that the members intend to cooperate in the areas of ammonia production, transportation and use, including for marine use, and ammonia–coal co-fired power stations, Green Hydrogen as fuel for gas turbines, for high-temperature heat processes in the iron and steel industry, and as Green Hydrogen for ***FCT*** use, both mobility and stationary.

- **The nearer the destination, the more progress is made …:** On July 26, 2021, the World Economic Forum (***WER***) released a report, in collaboration with the Boston Consulting Group.

  Whether the credo or the conclusion (or possibly both), it is clear that: "Addressing supply-chain emissions [as a whole of supply chain] enables many customer facing companies to impact [a mass] of emissions several times higher than they could if they were to focus on decarbonisation their own operations and power consumption alone – and achieving a net-zero supply chain is possible with very limited costs".

  Of course this is a paradigm, but it is one that resonates across the freight sector (land or sea). The August Report on Reports, will provide further consideration of the ***WER*** report and the full range of fuel initiatives in the freight sector.

- **It is Scotland in Chile:** Edition 21 of Low Carbon Pulse reported on the development of the Haru Oni Methanol Plant close to Punta Arenas, Magallanes, in Southern Chile. The E-Fuels production project will use Green Hydrogen as feedstock to produce synthetic fuels; the Green Hydrogen will be combined with $CO_2$ captured / filtered from the air to produce Green Methanol. Edition 20 of Low Carbon Pulse reported on the engagement of Howden in respect of the supply of a high-pressure diaphragm compression system for ***HYBRIT***, the world's first fossil free steel plant at Svartoberget, in Lulea, Sweden. On July 27, 2021, it was widely reported that Howden is to supply hydrogen compression solutions for the Hari Oni Methanol Plant.

- **Russia has a key role to play:** On July 27, 2021, in a comprehensive article Oil Price (under ***Russia Ramps Up Its Hydrogen Energy Ambitions***), the various narrative strains that have emerged over the last month or so are pulled together. The article is well-worth a read.

- **Eggs and baskets**: **Bio** is used frequently, including biogas and biomethane, bio-ethanol, bio-methanol, bio-fertiliser, and bio-LNG. Bio (effectively short for biomass) indicates that the feedstock from which the energy carrier is produced is not a fossil fuel, but is produced in whole or in part from an organic compound, i.e., comprising carbon, that on oxidation will produce $CO_2$, and likely NOx and SOx.

  For any bio-energy carrier derived from a carbon intensive source to be carbon neutral, it needs to be produced from a renewable resource, with the electrical energy used to produce it, from a renewable source. This does not mean that on oxidation of an energy carrier that $CO_2$ will not arise, but rather, in theory, because the $CO_2$ that arises will be absorbed into another renewable resource on its growth, with the continued growth of that renewable resource providing a carbon neutral outcome. For any bio-energy carrier to be a blue energy carrier, all carbon arising on production of that energy carrier needs to be captured and stored.

  In this context the use of organic waste arising from agricultural and forestry activities and from waste collection and waste water collection is an ideal feedstock for the production of a bio-energy carrier.

- **Swiss for Hydrogen:** On July 29, 2021, it was reported that Alpiq, EW Hofe, and SOCAR Energy Switzerland are to develop, at Freienbach, Switzerland, a 10 MW electrolyser to produce 1,200 tonnes of Green Hydrogen a year. It is understood that the Green Hydrogen plant is to source renewable electrical energy to power the facility, and that the Green Hydrogen produced will be used for mobility, principally to power and propel 200 ***FCT*** light commercial vehicles.

  **See:** *Green hydrogen: EW Höfe, Alpiq and SOCAR Energy Switzerland mark a new milestone*

- **Hungry for Hydrogen:** On July 30, 2021, it was reported that a hydrogen production plant is to be developed (***Project Aquamarine***) in the Kardoskut Underground Gas Storage facility. Project Aquamarine has the support of the Government of Hungary.

  **See**: *Burckhardt Compression to Deliver H2 Diaphragm Compressor Unit for Hungarian Green Hydrogen Project*

- **Green Hydrogen to deliver NZ *NZE*:** Edition 22 of Low Carbon Pulse reported on the outline plans for the development of renewable electrical energy, and the use of that energy at Tiwai Point, Southland (location of Tawai Point aluminium smelter).

  Contact Energy and Meridian Energy (two of New Zealand's electricity generation corporations) are testing the appetite for the development of a world-scale Green Hydrogen production facility (***Southern Green Hydrogen***).

  On August 1, 2021, the Otago Times provided an update on ***Southern Green Hydrogen***, noting that production of Green Hydrogen may commence as early as 2023. The update noted the likely involvement of Fortescue Future Industries or ***FFI*** (a subsidiary of Fortescue Metals Group, founded by Dr Andrew Forrest, AO).

  On August 3, 2021, The West Australian (Western Australia being the home state of Dr Forrest, AO, and ***FFI***), picked up on the ***FFI*** interest in ***Southern Green Hydrogen***.

  On August 4, 2021, FFI announced that it had signed a collaboration agreement with Murihiku Hapu of Ngai Tahu in respect of the potential development of a large scale, Green Hydrogen production project in Southland, New Zealand.

- **Mixed combustion testing in ROK:** Edition 18 reported on the plans to co-fire ammonia and natural gas in Japan. On August 3, 2021, Hanwha General Chemical and Korea Western Power Co agreed to work together to mix hydrogen and natural gas derived on the regasification of natural gas form LNG to allow co-firing of those fuels to generate electrical energy. As note previously, the higher the proportion of hydrogen in the co-fired mix, the lower the $CO_2$ arising on combustion, but the lower the energy density of the mixed $H_2$ / $CH_4$ stream.

  **See:** *Hanwha, Korea Western Power to test mixed hydrogen combustion*

- **Hydrogen power plant for Texas:** On August 3, 2021, it was widely reported that Entergy, Texas, intends to seek approval for a hydrogen and natural gas fired combined cycle gas turbine power station, to be located in Orange County, Texas (***Orange County Advanced Power Station*** or ***OCAPS***) . While the details have yet to emerge from the filings for approval, it is understood that the ***OCAPS*** will be using 30% hydrogen and 70% natural gas as its fuel, converting to 100% hydrogen in the future.

  **See:** *Entergy Texas Plans New Generation Facility To Power Southeast Texas*

- **Spanish Hydrogen Value Chain:** On August 4, 2021, it was widely reported that Bosch, Petronor and Repsol have signed a letter of intent to work together to assess development of, and to develop, a hydrogen value chain in Spain. Each corporation regarded hydrogen as a key energy carrier for the future, in particular for the purposes of mobility (cars, buses, trains and shipping).

  **See:** Bosch website; Petronor website; Repsol website

- **Raven SR selects designers for waste to hydrogen project:** Edition 16 of Low Carbon Pulse and the first feature in the Ashurst hydrogen for industry (***H24I***) series outlined plans by Hyzon Motors Inc and Raven SR to develop up to 100 waste to hydrogen facilities to derive hydrogen from waste delivered to landfill sites across the US.

  On August 4, 2021, it was announced that Raven SR has appointed Power Engineers and Steller J Corporation to complete the final design of the first two waste to hydrogen facilities.

  **See:** Raven SR website

- **Green Hydrogen under water:** On August 5, 2021, it was widely reported that Fincantieri SpA (global leading ship building corporation) and Enel Green Power Italia (part of the global leading renewable energy corporation) agreed to explore the use of Green Hydrogen for vessels, including submarines.

  Head of Business Development for Enel Green Power, Mr Carlo Zorzoli said:"The signing of this agreement represents a further step forward in Enel Green Power's commitment to collaborating with operators interested in developing solutions for the use of Green Hydrogen in sectors where electrification is not possible, this contributing to the energy transition process through the decarbonisation of industrial activities".

  **See:** Enel website

- **BP inks-in Blue:** On August 5, 2021, it was widely reported that BP (global leading international energy corporation) had inked a number of agreements for the sale of Blue Hydrogen. As noted below, BP plans to develop a 1 GW Blue Hydrogen production facility on Teesside, in the North East of England, and to proceed with the development it is contracting with off-takes of Blue Hydrogen. It is reported that CF Fertilisers, Mitsubishi Chemical Corporation and Sembcorp Energy UK have each signed memorandums of understanding with BP for the supply of Blue Hydrogen, and that Alfanar Company and BP have signed another memorandum of understanding for the supply of Blue Hydrogen to Alfanar at its waste to ***SAF*** facility.

  **See:** BP website

- **Deutsche Bahn and Statkraft:** On August 6, 2021, it was reported in publication, Clean Energy Pipeline, that German rail corporation Deutsche Bahn signed a 10 year power purchase agreement with Norway's Statkraft for the supply of 190 GWh pa of renewable electrical energy.

  **See:** Deutsche Bahn website; Statkraft website

- **Iceland and UK killer combination:** On August 6, 2021, it was widely reported that Icelandic utility corporation HS Orka and, the UK based corporation, Hydrogen Ventures Limited are to develop a methanol production plant using Green Hydrogen as the feedstock.

  The Green Hydrogen will be produced using renewable electrical energy from HS Orka's geothermal power plant at Reykjanes.

  It is reported that the methanol produced will be used as mobility (for cars, vans and trucks) and as shipping fuel.

  **See:** HS Orka website; Hydrogen Ventures website

## Green Metals and Minerals, the Mining Industry and Difficult to Decarbonise industries:

- **ArcelorMittal Green Bases:** Edition 22 of Low Carbon Pulse reported on ArcelorMittal's plans to develop its Sestao steel mill in Spain as a zero carbon emissions steel plant following the development of a direct reduced iron (***DRI***) plant and an electric arc furnace (***EAF***). The ***DRI*** and ***EAF*** projects are to proceed following the signing of a memorandum of understanding (***MOU***) by ArcelorMittal and the Spanish Government, with the development of the projects scheduled for completion in 2025, with up to 1.6 mpta of zero carbon emission steel to be produced annually.

  On July 29, 2021, AcerlorMittal and the Government of Canada announced a similar investment "to green" AcerlorMittal's Hamilton, Ontario steel plant. The investment means that the Hamilton plant will transition from the use of blast furnace technology to the use, and operation of, ***DRI*** and ***EAF*** technology.

  **See:** *ArcelorMittal and the Government of Canada announce investment of CAD$1.765 billion in decarbonisation technologies in Canada*

- **Comment on CO2MENT:** In late July 2021, the Journal of Commerce, reported on a "first-of-its-kind" carbon capture, and use, pilot project at the Lafrarge Canada (part of LafargeHolcin, global leader in cement products), cement plant in Richmond, British Columbia (***CO2MENT Project***).

  The ***CO2MENT Project*** is using technology developed by Svante, Inc: as reported, the technology captures $CO_2$ arising on the production of clinker and reuses $CO_2$ (and as such stores that $CO_2$) in cured concrete – thereby achieving the troika of "capture, use and storage".

  As outlined in ***Shift to Hydrogen (S2H2): Elemental Change***, cement production gives rise to a significant mass of ***GHG*** emissions, which when added to the ***GHG*** emissions arising on transportation of limestone as feedstock, transportation of cement for concrete production, and transport of concreate to point of use, leaves a significant carbon footprint.

- **BHP Nickel West and TransAlta – global first:** Both BHP (world leading mining corporation) and TransAlta (Canadian headquartered global leading energy solutions corporation) have announced that they have contracted to transform the energy supply arrangements at BHP's Nickel West operations in Western Australia. BHP has contracted with TransAlta to effect the evolution of energy supply so as to achieve ***NZE*** over time, consistent with BHP's global commitments to achieving ***NZE***.

  As noted in previous editions of Low Carbon Pulse, the mining industry is a quiet achiever in making progress toward ***NZE***, and the BHP and TransAlta arrangements provide a blue print that may be expected to be rolled-out globally to decarbonise electrical and heat energy supply over time.

  **See:** *TransAlta Renewables Announces Agreement to Build a Hybrid Solar – Battery Project for BHP Nickel West in Western Australia*; *Two new solar farms and battery to help power mines at BHPs Nickel West*

- **Komatsu Greenhous Gas Alliance:** On July 2, 2021, it was widely reported that Komatsu (world leading manufacturer of yellow gear and other mining equipment), has set up an alliance with global mining giants, BHP and Rio, and Boliden and Codelco (***KGHGA***).

  It is reported that through ***KGHGA***, Komatsu will work on product development and deployment to accelerate the development and deployment of ***NZE*** mining equipment and infrastructure. It is reported that an early development prospect is the development of "power-agnostic" truck and can be powered by a range of power sources, including battery and fuel cell.

  At the risk of beating a drum too long and too loudly, the ***KGHGA*** illustrates the willingness of mining corporations to engage so as to accelerate progress towards ***NZE***.

- **UAE developing green steel production capacity:** On August 3, 2021, it was reported that the Abu Dhabi National Energy Company (***TAQA***) and Emirates Steel have combined in a partnership to develop a large-scale Green Hydrogen green steel production mill.

  As reported in Editions 13 and 21 of Low Carbon Pulse, ***TAQA*** is a key participant in the development of green utility solutions within the UEA, and the broader MENA region.

  CEO and Managing Director of ***TAQA*** Group, Mr Jasim Husain Thabet said:

  > "TAQA is setting out to become a recognised champion of low carbon power and water, and this partnership with Emirates Steel leverages our combined expertise to lower the overall cost of production as well as reducing carbon emissions".

  **See:** *TAQA Group, Emirates Steel to Enable the Region's First Green Steel Manufacturing* and Emirates Steel website

- **Anglo American and Salzgitter partner on the greening of iron and steel:** As covered in Editions 13 and 18 of Low Carbon Pulse, Anglo American (global leading diversified mining corporation) and Salzgitter (global leading rolled and tube steel producer) are both active in making progress to achieving ***NZE*** in their respective core businesses.

  On August 4, 2021, Anglo American and Salzgitter, announced that they had entered into a memorandum of understanding (***MOU***) to develop shared understanding of the greening of steelmaking and the use of natural gas and hydrogen as energy carriers to displace fossil fuels and other carbon intensive fuels for high-heat temperature processes to produce iron ore pellets and lump iron ores for ***DRI***.

  This is noteworthy because it illustrates that Anglo American is positioning to address its Scope 3 emissions.

  **See:** *Anglo American partners with Salzgitter Flachstahl to advance green steelmaking*; *Salzgitter AG and Anglo American cooperate in optimizing iron ore supplies for low $CO_2$ steel production*

## Clustering and hubbing around the UK:

- Edition 22 of Low Carbon Pulse promised a deeper consideration of the industrial clusters and hubs around the UK which are in the process of developing, and a number of them awaiting the outcome of applications for government support in Track 1 of the CCUS Programme (see second bullet point below). The CCUS Programme is consistent with key outcomes in the Ten Point Plan for a Green Industrial Revolution (***10 Point Plan***).

  Each cluster or hub is located in an area that is, or has been, dominated by industry (in some instances since the industrial revolution). Each cluster or hub hosts activities within its hinterland that contemplate a role for CCS / CCUS, with proximate storage (depleted fields) and, in the case of a number of them, the production, and likely proximate storage (salt caverns) and use, of hydrogen.

  Given the various editions of Low Carbon Pulse have touched on the development of most if not all of the clusters and hubs, it seemed timely to summarise each cluster and hub. Some clusters and hubs are more developed than others, but all are developed beyond concept.

| UK CLUSTERS AND HUBS | | |
|---|---|---|
| **Name / location of cluster / hub:** | **Participants:** | **Range of activity / production:** |
| **Bacton Gas Terminal (*BGT*):** Oil and Gas Authority (OGA) has identified ***BGT*** as an ideal location for a low carbon hub | The concept continues to develop, noting the huge potential for Blue and Green Hydrogen production | CCS / CCUS given proximity to southern North Sea Gas fields, and 5 GW of Blue and Green Hydrogen production capacity |
| **Isle of Grain (*IOG*)**: The Isle of Grain, Kent, cluster / hub to comprise natural gas reforming facilities to produce Blue Hydrogen (with $CO_2$ captured and stored off-shore), including to blend with $CH_4$ | Arup, Cadent, National Grid, Royal Dutch Shell, SSE Thermal, SGN, Uniper and VPI National Grid sees the benefit of blending Blue Hydrogen with natural gas across its entire national network | 700 MW pa (2026) and 1.75 GW pa (2030) of Blue Hydrogen to be used for power generation.<br>1.2 mpta (2026) and 3 mtpa (2030) of $CO_2$ captured and stored |
| **East Coast Cluster:** Comprises Northern Endurance Partnership, Zero Carbon Humber and Net Zero Teesside | | |
| **Zero Carbon Humber (*ZCH*)**:<br>The anchor project is the Blue Hydrogen (**H2H**) Saltend project at PX's Saltend Chemicals Park, and use at Power Plant<br>BECCS at Drax will capture $CO_2$, CCS at SSE Thermal 's Keadby 3 will capture $CO_2$, and CCS at Uniper's Immingham Blue Hydrogen production facility<br>Captured $CO_2$ compressed in Centrica's Easington facility | ***ZCH* participants:** Associated British Ports, British Steel, Centrica, Drax, Equinor, Mitsubishi Power, National Grid, PX, SEE Thermal, Triton, Uniper, and AMRC.<br>**Equinor across the clusters:** Equinor is a member of part of the Net Zero Teesside and Northern Endurance Partnership (***NEP***), and leads the ***ZCH***<br>National Grid is a partner in the ***NEP*** | Humber and Teesside regions account for around 50% of UK industrial emissions. The ***ZCH*** and ***NZT*** projects are intend to capture $CO_2$ from industrial activities along the Humber and Tees Valley, with 17 capture projects identified, both to reduce current $CO_2$ arising currently, and to allow the development of new facilities and plants (including to allow the production of Blue Hydrogen). |
| **Net-Zero Teesside (*NZT*) project:** The intention is to capture up to 10 mtpa of $CO_2$ | BP, Eni, Equinor, Shell and TotalEnergies, with BP leading ***NZT*** | In addition, four clean hydrogen / low carbon hydrogen production plants are contemplated across ***ZCH*** and ***NZT***. |
| **Northern Endurance project:** pipeline and storage infrastructure to take CO2 captured by ***NZT*** and ***ZCH***, it being 145 km and 85 km from each respectively | BP, Eni, Equinor, National Grid, Shell and TotalEnergies, with BP as the corporation operating the project. There is potential to expand the carbon storage capacity | There is up to 27 mtpa of $CO_2$ storage capacity in the Endurance aquifer (located in the southern North Sea), with capacity to be operational by 2030 |
| **HyNet North West:** | | |
| **HyNet North West:** carbon capture (industrial, bioenergy and waste to energy) and storage in Liverpool Bay, Blue Hydrogen production (of up to 3.8 GW) and sustainable aviation fuel (***SAF***) production | Eni, Essar, Cadent, Intergen, CF Fertilisers, Hanson (Heidelberg Cement Group), and INOVYN (an Ineos company).<br>***HyNet North West*** is led by Progressive Energy (***PE***) | For the purposes of $CO_2$ haulage, a $CO_2$ pipeline is to be developed to allow $CO_2$ to be delivered into storage in Liverpool Bay.<br>PE and Essar plan to phase in hydrogen production, 3.8 GW by 2030 |
| **Scottish Cluster** comprising $CO_2$ source projects at Grangemouth (INEOS and Petroineos), Peterhead (Equinor and SSE Thermal CCS Power Plant), St Fergus Gas Complex (ExxonMobil and Shell, and North Stream Midstream Partners (***NSMP***)), contracting with the Acorn CCS Project and Acorn Hydrogen | | |
| **Scottish Cluster** carbon capture, and haulage of $CO_2$ to the Acorn CCS project that will store $CO_2$ from up to nine different sources, including a DAC facility | Harbour Energy, INEOS, Petroineos, ExxonMobil and Shell, ***NSMP***, Equinor and SSE Thermal, Petrofac and Storegga, with Storegga key | Acorn CCS Project, with storage of 25.5 mt by 2030, at a rate of 6.7 mtpa, and 500 mt of total storage to 2050<br>Acorn Hydrogen Project |
| **South Wales Industrial Cluster** (**SWIC**): carbon capture across a number of industries and Blue Hydrogen production | RWE, Tata Steel, Tarmac, and Valero. | CCS / CCUS is key to this area of the UK, and its use will contribute to decarbonisation of difficult to decarbonise industries |

- 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:** the Acorn CCS Project is key, as are the number of sources of $CO_2$, nine, with eight anticipated to have capture capacity in place by 2027; and
  - **VNZ Cluster:** Harbour Energy is 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).

  If all five eligible projects were to proceed they would provide 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***. The UK is well on the way.
- On October 25, 2021, as part of the Track 1 CCUS Programme, two successful clusters will be announced, as will one individual project connected to each cluster. At the same time, the process for the Track 2 CCUS Programme will be announced.

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

- **First Solar, another first:** On July 30, 2021, it was widely reported that First Solar (Arizona, US, based global leading solar corporation) intends to develop a USD 680 million, 3.3 GWdc solar photovoltaic thin film solar factory in the state of Tamil Nadu, India (***TNF***). On completion of the ***TNF***, in combination, the global manufacturing capacity of First Solar will be a little over 16 GWdc during 2024. It might be expected that this capacity will increase as further capacity is added to respond to increased demand.

  As noted across previous editions of Low Carbon Pulse, the progress to ***NZE*** is layered. Electrification is core to progress to ***NZE***. Electrification is dependent on increased manufacturing capacity, including to realise the benefits of scale and the resulting reduction in unit costs of production. Increased manufacturing capacity is dependent of the extraction and processing of metals and minerals (and production of other materials) as the raw materials for manufacturing. Increased extraction and processing of metals and minerals requires expansion and new mine development. Each requiring the deployment of capital, either from free cash flows or from borrowing, or both. Like dynamics arise in respect of the development of the Green Hydrogen supply chain.

  Decisions by the private sector to invest, involve decisions around assumption of risk, and once investment decisions are taken, development,. This takes time. As noted of late, the global carbon budget does not afford the luxury of time. As COP-26 approaches (it is less than 100 days to the commencement of COP-26), the clock is ticking: the need for government policy settings and direct investment is becoming ever more pressing. What is needed, is known.
- **Battery recharging infrastructure - Australia:** Continuing the theme of infrastructure development required to achieve ***NZE***, downstream of renewable electrical energy generation (and hydrogen production) is the development of recharging infrastructure (and refuelling infrastructure). As noted in previous editions of Low Carbon Pulse, there is a role for government in the development of this infrastructure.

  On July 29, 2021, the Australian Federal Government, through the Australian Renewable Energy Agency (***ARENA***) agreed to provide support in the development of 400 fast recharging stations, from the ***ARENA*** managed, Fuel Fund and the private sector, Ampol Australia, Engie and Evie Networks. Co-funding of this kind may be regarded as ideal: the private sector is best placed to assess risk, with investment risk shared, so as to provide supply to the market for ***BEV*** to allow it to develop at a greater rate, with the attendant ***GHG*** emission reduction benefits.
- **BEVs to use recharging infrastructure – UK:** On the same day that Australia announced the development of 400 fast recharging stations working with government, seven UK corporations combined to provide a blue print to accelerate the adoption of electric vehicles across the UK. BP, BT, Direct Line Group, Royal Mail, Scottish Power, Severn Trent and Tesco, as the Electric Vehicle Fleet Accelerator (***EVFA***). The blue print is intended to accelerate progress to deliver on ***GHG*** emission reduction targets, critically in the area of road transport. The August Report on Reports will summarise the proposals.

  As noted in Edition 22 of Low Carbon Pulse, road transport in the UK accounts for nearly 90% of total ***GHG*** emission arising from the transport sector.

## Wind round-up:

- **North to South:** On July 27, 2021, it was widely reported that the first Green Hydrogen scale production plant is to be developed in Hokkaido (***HGHP***) towards the end of Q1 2024. It is reported the ***HGHP*** will produce up to 550 tonnes of Green Hydrogen a year, modelled to be sufficient to fuel 10,000 ***FCEVs***. The electrical energy to power the ***HGHP*** will be sourced from an on-shore farm in the first instance, and off-shore wind fields in future to allow expansion of the capacity to 2,500 tonnes per year. It is understood that Green Power Investment, Hokkaido Electric Power, Nippon Steel Engineering and Air Water (industrial gas supplier) are participating in ***HGHP***.

  By way of a reminder, the policy settings (***Green Growth Strategy***) contemplate that by 2030 the use of hydrogen in Japan will be around 3 mpta, increasing to up to 20 mtpa by 2050.

- **West Coast, US:** Edition 22 of Low Carbon Pulse reported on the prospective development of off-shore wind capacity off Northern California. On July 29, 2021, it was reported in, renews.BIZ, that the US Department of the Interior's Bureau of Ocean Energy Management (***BOEM***) has called for information and nominations, by September 13, 2021, to determine interest in developing off-shore wind fields in two new areas, the Morro Bay Call Area, East and West Extensions (adjacent to the Morro Bay Call Area, which ***BOEM*** identified in 2018).

  ***BOEM*** Director, Ms Amanda Lefton said: "Today's announcement builds on the earlier agreement between the White House, the Department of the Interior, the Department of Defense, and the State of California to advance areas for off-shore wind off the northern and central coasts of California. If approved for off-shore wind … development, these areas could bring us close to reaching this administration's goal of deploying 30 GW of off-shore wind by 2030".
- **Orsted US:** On 4 August, 2021, it was widely reported that Orsted had completed the development of its 367 MW on-shore wind project, its largest in the US.

  **See:** Orsted website
- **Masdar winding up:**: It has been a busy couple of weeks for Masdar with the development of the floating solar photovoltaic ***Cirata Project*** in Indonesia (see below) and the connection to the grid of the 400 MW Dumat Al Jandal (***DAJ Project***) on-shore wind farm in Saudi Arabia.

  On August 8, 2021, The National News, reported that the ***DAJ Project***, developed in joint venture between Masdar (the Abu Dhabi Future Energy Company) and EDF (global leading French electrical energy company), had produced its "first carbon-free megawatt-hours … of energy [that] will help bolster Saudi Arabia's network during the hot summer months when electricity consumption is at its peak".

  The electrical energy generated by the ***DAJ Project*** is to be supplied under a 20 year power purchase agreement to the Saudi Power Procurement Company (as subsidiary of the Saudi Electricity Company). The ***DAJ Project*** comprises 99 wind turbines, each with 4.2 MW of output. The turbines were supplied by Vestas (world leading renewable energy supplier and contractor), which also acted as the EPC contractor.

## Solar round up:

- **Pertamina to develop solar photovoltaic plants:** On August 2, 2021, it was widely reported that PT Pertamina New Renewable Energy (***PNRE***), a wholly-owned subsidiary of PT Pertamina (***Persero***), is to develop 500 MW solar photovoltaic plants to be co-located with facilities that are part of the ***Persero*** Group. It is understood that ***PNRE*** has completed solar photovoltaic plants at Badak LNG Terminal, Cilicap and Dumai Refineries. The continued development of solar photovoltaic capacity is consistent with ***Persero*** Group's objective of reducing GHG emissions by 30% by 2030.

  **See:** Pertamina website
- **Masdar floating solar commences build:** On August 4, 2021, Masdar (the Abu Dhabi Future Energy Company) announced that financial close has been achieved in respect of the 145 MW Cirata Floating Photovoltaic Power Plant Project (see Edition 18 of Low Carbon Pulse).

  The ***Cirata Project*** is the first floating photovoltaic power plant in Indonesia. It is being developed by PT Pembandkitan Jawa Bali Masdar Solar Energi (PMSE), a joint venture between Masdar and PT JJBI. The ***Cirata Project*** is expected to be commence operation in 2022.

  **See:** *Masdar joint venture reaches financial close and starts construction on Indonesia's first utility-scale floating solar power plant*

## Sustainable energy round-up:

- ***WEF* report on US Renewables:** In another short video, the ***WEF*** reports on progress on renewable electrical energy development in the US during 2020. In 2021, 21% of electrical energy in the US was derived from renewable energy sources, second to gas fired generation capacity, and ahead of coal (in 2020, falling 20% to 20% of electrical energy generation) and nuclear. As is the case with Australia, the US has achieved this progress on the basis of State, rather than Federal, policy settings, intended to support the development of renewable electrical energy.
- **West to East, and back again:** Previous editions of Low Carbon Pulse have reported in the proposed development of the 2 GW EuroAsia Interconnector connecting Attica, Greece, Crete, Greece, Cyprus, and Israel so as to create a means of achieving electrical energy security through access to renewable electrical energy sourced from different countries.

  It was noted that the EuroAsia Interconnector had been designated as a Project of Common Interest (PCI13,10), which allows access to ***EU*** funding and support.

  On July 27, 2021, it was reported that the Council of the ***EU*** had allocated €100 million in grant funding. It is expected that the development of the first phase of the EuroAsia Interconnector will be completed, so as to allow commissioning, by the end of 2025.

## Land Transport:

Edition 21 of Low Carbon Pulse name checked "first movers" and "early movers", including Cummins Inc (***CMI***). There are of course three major corporations "that are key" to progress to development of hydrogen power and propulsion, and those corporations are Air Liquide, Air Products and Linde: all three corporations are long-standing industrial gas producers, and technology providers, key to decarbonisation across a number of sectors.

- **Global Market Leaders in complementary combination:** On July 27, 2021, it was widely reported that ***CMI*** and Air Products are to work together to accelerate the development and integration of fuel cell technology for heavy goods vehicles / trucks in the Americas, Asia and Europe. It is reported that the focus for the corporations in working together includes ***CMI*** providing ***FCT*** powertrains for use to transport Air Products industrial gases.

As with the working relationships underway among Hyzon Motors Inc and TotalEnergies (see Edition 22 of Low Carbon Pulse), the ***CMI*** and Air Products arrangements allow each corporation to play to its global leading strengths, while at the same time ensuring that its core business benefits in a complementary way from working with the other.

- **Air Liquide ROK solid:** On July 27, 2021, it was widely reported that Air Liquide had continued its run of success in South Korea, with arrangements progressing with:
  - Lotte Chemical (see Edition 22 of Low Carbon Pulse) to develop high pressure hydrogen refilling and refuelling infrastructure (***HRI***) and refuelling stations (***HRS***);
  - SK Energy (see Edition 20 of Low Carbon Pulse) to develop a scale hydrogen liquefaction plant to liquid hydrogen (***LH2***), with that ***LH2*** to be used in mobility markets; and
  - Yeosu City and Jeollanam-do province to undertake studies relating to the development of hydrogen liquefaction facilities on the south coast of South Korea, in the heartland of refining and petrochemical industry.
- **On the high road and on the road overhead:**
  - **Hyzon Motors Inc keeps trucking to deliver:**
    - **Hyzon Motors Inc and RenewH2 align:** Edition 22 of Low Carbon Pulse reported that Hyzon Motors had signed a memorandum of understanding with TotalEnergies' Marketing and Services division to work together to develop hydrogen refuelling infrastructure (***HRI***) across Europe, and to continue to develop long-haul transport solutions for customers for those services across Europe.

      On August 3, 2021, it was reported widely that Hyzon Motors had signed a memorandum of understanding with RenewH2 (a hydrogen production, liquefaction, distribution and delivery system corporation) to develop liquid hydrogen refuelling stations (***HRS***). It is understood that a number of ***HRS*** are to be developed and that they will be used to deliver hydrogen derived from biogenic methane, produced using gas reforming technology. The first feature in the Hydrogen for Industry (***H24I***) series featured similar plans of Hyzon Motors in the context of locating hydrogen production facility and ***HRS*** at landfills.

      As has been the case with many other news items reported stories in Low Carbon Pulse, this is another instance of the private sector positioning to be able to match supply to demand, and positioning for purchasing decisions made by other participants in the private sector.

      **See:** *Hyzon Motors partners with liquid hydrogen production company RenewH2 to develop fueling stations* and RenewH2 website
    - **First Hyzon Motor waste collection vehicle:** On August 2, 2021, it was reported that the City of Rotterdam has commenced use of its first Hyzon Motors ***FCT*** waste collection vehicle. As noted above, Hyzon and Raven SR are in joint venture in the US to develop up to 100 hydrogen from waste facilities located across the US, with the intention to use the hydrogen derived to power and to propel waste collection vehicles.

      **See:** Hyzon Motors website
  - **Hyundai Motor Co invests in H2 Mobility:** As may be expected by one of the world's leading ***FCT*** proponents, Hyundai Motor Co has invested in H2 Mobility (a German ***HRS*** operator). It is understood that Hyundai joins Air Liquide, Daimler, OMV, Royal Dutch Shell and TotalEnergies as an investor in H2 Mobility.

    **See:** *Hyundai becomes shareholder in H2 Mobility*
- **Scaling up first movement:** Previous editions of Low Carbon Pulse have reported on the progress that Hyundai has made in the development and deployment of fuel cell technology (***FCT***) heavy goods vehicles / trucks (***FCEVTs***) (see Editions 1, 17 and 18 of Low Carbon Pulse). Likewise, the pace-setting of Macquarie Group has been covered, including through Green Investment Group. On July 27, 2021, Macquarie Group announced that it had entered a consortium with Hyundai Motor Company to complete the deployment of 20 Class 8 ***FCEVTs*** in North America. Macquarie will own the ***FCEVTs***, and lease them to the freight transportation sector.
- **E-Highway in UK:** Edition 21 of Low Carbon Pulse reported on the first overhead electrical cable freight system (under ***On the high road and overhead***) (***E-Highway***). On July 27, 2021, it was reported that the Department for Transport, through Innovate UK, is conducting a study into the development of the UK's first ***E-Highway***. It is reported that Costain is leading a consortium to undertake the study, initially over a nine month period. If the ***E-Highway*** study proves up viability, ***E-Highways*** may be adopted in the UK during the 2030's.
- **Midlands – all change to hydrogen:**
  - **Birmingham City Council (*BCC*) takes delivery of 20 hydrogen buses:** Edition 22 of Low Carbon Pulse reported on the delivery of the first London Buses to be powered and propelled by hydrogen.

    On July 28, 2021, it was reported that ***BCC*** took delivery of its first fleet of hydrogen buses.

    **See:** *Birmingham gets first hydrogen bus*
  - **H2GVMids funded:** Also on July 28, 2021, it was reported that the Department for Transport is to provide funding under the Zero Emission Road Freight program to deploy heavy goods vehicles / trucks (***HGVTs***) across the Midlands in the UK for the purposes of demonstrating their use for freight transportation.
- **Miles and miles:** Edition 21 of Low Carbon Pulse reported on the approach of the first anniversary of the commencement of use of the Hyundai Xcient truck in Switzerland (August 2020), and the intention of Hyundai to extend its horizons to the US.

  On July 30, 2021, it was announced that tests are to commence in California of the Hydrogen Xcient truck, based the ***FCT*** technology used in Switzerland, with the range of the Californian FCT truck to be 500 miles (or 805 kilometres) (the ***Class 8 500-mile***).

As reported in Hydrogen Fuel News (under ***500-mile range Hyundai hydrogen fuel cell semi-trucks undergo testing***), the testing program is to take place under the **NorCal ZERO project**, with grant funding from the California Air Resources Board (***CARB***) and California Energy Commission (***CEC***), together providing funding of USD 20 million, and the Alameda County Transportation Commission (***ACTC***) and the Bay Area Air Quality Management District (***BAAQMCD***), together providing funding of USD 7 million.

As the project progresses, it is reported that Hyundai intends to develop hydrogen refuelling infrastructure (***HRI***), starting with an hydrogen refuelling station in Oakland, California.

**See:** *Hyundai's XCIENT Fuel Cell Hitting the Road in California*

- **NorCal ZERO Project:** The NorCal ZERO project is intended to, and will, deploy the hydrogen fuel cell trucks. The Center for Transportation and the Environment (***CTE***) is working on the project, with the support of ***CARB***. In addition to ***CTE***, ***CARB***, ***ACTC*** and ***BAAQMCD***, Air Liquide, EBMUD, FE Fuel, Fielder Group, Macquarie, NorCal Kenworth, Port of Oakland, West Oakland Environmental Indicators Project, and two Berkeley based policy and research organisations, are involved in the project.
- **A Vision for Freight Movement in California – and Beyond**: On August 3, 2021, the California Fuel Cell Partnership (***CaFCP***) released its vision for the use of HD class 8 fuel cell electric trucks (***FCETs***) entitled "***Fuel Cell Electric Trucks: A Vision for Freight Movement in California and Beyond***" (***Foundational Document***).

  The ***Foundational Document*** contemplates the deployment of 70,000 ***FCETs*** and 200 hydrogen refuelling stations (***HRS***) by 2035. While trucks represent 2% by number of vehicles on California roads, they give rise to 9% of the ***GHG*** emissions, 32% of its NOx emissions and 3% of its particulate emissions. The stated intention is accelerate private sector investment in ***FCT*** as progress is made toward ***NZE*** (whether in 2045 or sooner).

  The release of the ***Foundational Document*** follows ***CARB's Advanced Clean Truck*** rule: a world first in that it requires truck manufactures to transition from diesel powered and propelled trucks and vans to electric-zero emission vehicles.

## Shipping News and Forecast:

- **Best laid plans of Norled – first ferry delivered:** Edition 12 of Low Carbon Pulse reported on the liquid hydrogen supply arrangements for the world's first hydrogen powered and propelled ferry (with Linde to supply hydrogen from its Leuna Chemical Complex in Germany, using a proton exchange membrane (PEM) electrolyser technology).

  In late July 2021, it was reported that the first ferry had been delivered. The ferry is named ***MF Hydra***. As reported previously, the ***MF Hydra*** is 82.4 metres in length, with capacity for 300 passengers and 80 motor cars.
- **BP joins Maersk Mc-Kinney Moller Center for Zero Carbon Shipping:** Low Carbon Pulse has reported on the establishment (see Edition 16 of Low Carbon Pulse) and progress of the Maersk McKinney Moller Center (***MMMC***) (see Editions 19 and 22 of Low Carbon Pulse).

  On July 27, 2021, it was reported that BP and ***MMMC*** signed a partnership agreement, with each committing to work together over the longer-term to develop and to deploy new fuels and lower or low carbon solutions for the shipping industry.

  The partnership agreement and the resourcing and cooperation that it is intended to engender, is another illustration of the private sector combining consistently to navigate a route to ***NZE***.

  **See:** *bp joins the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping as a strategic partner*

## EU Forest Strategy:

- **Wood for the trees and woods with more trees:** As part of the ***European Green Deal*** (see Edition 22 of Low Carbon Pulse), during the week beginning July 21, 2021, the ***EC*** released its Forest Strategy. The Forest Strategy contemplates that between now and 2030, at least 3 billion additional trees are to be planted across Europe: it is estimated that the additional trees will provide the ***EU*** with a verified carbon sink of 310 mt of $CO_2$.
- **Woods and well-being:** While the preservation of forests (and more generally the preservation and rehabilitation of land), is regarded as contributing to ***NZE***, it is not, and should not be, regarded as a central policy setting to decarbonisation.

  Yes, carbon credits, and their use to offset ***GHG*** emissions, are important to transition, and will be critically important as a tool to bridge (the hoped for) ever narrowing gap between decarbonised activities and activities remaining to be decarbonised (using negative ***GHG*** emission initiatives), and yet woods are linked to the well-being of fauna and flora, and humans.
- **Trees bare in the woods:** The Forest Strategy, should be viewed as, and the ***EC*** views it as, one of a number of policy settings that in combination go to the environmental and sustainability outcomes generally: the purpose of the Forest Strategy is: (**1**) for carbon storage; (**2)** Improving our health and well-being; (**3)** halting the loss of habitats and species, which in turn form part of a broad set of Sustainable Development Goals (***SDGs***).
- **Soil science = sinking feeling:** Edition 20 of Low Carbon Pulse reported on recent reporting on findings as to the percentage of flora that is underground. These findings are allowing a reassessment of the mass of $CO_2$ stored in flora, and the mass of $CO_2$ that can be stored in new growth flora.

  On July 27, 2021, Quanta Magazine published an article entitled ***A Soil Science Revolution Upends Plans to Fight Climate Change***. There has been an orthodoxy, actual or perceived, that soil, in particular that humus, has within it carbon-rich molecules that capture and retain carbon for hundreds of years (if not thousands).

  The challenge is that carbon-rich molecules are consumed by abundant micro-organisms: there is no carbon that cannot be broken down / consumed by micro-organisms, and this results in $CH_4$ emissions.

One of the consequences of these findings is that models used to predict temperature are probably underestimating the mass of ***GHG*** emissions that will be released from soil as temperatures increase. (This leaves to one side the estimate 2,000 trillion tonnes of $CH_4$ estimated to be contained in the permafrost.)

While soil science continues to develop, there is one takeaway: decarbonisation is the only fail safe means of achieving ***NZE***.

## EU progress in respect of the 17 SDGs:

**Sustainable Development Goals, globally relevant:** The ***European Green Deal*** goes to achieving some, but not all of the United Nations 17 ***SDGs***. (***UN SDGs***). Of late, there has been reporting on the ***UN SDGs***, and progress towards them. As part of this reporting round, the ***EC*** has published a helpful graphic indicating progress of the EU in respect of each of the UN ***SDGs***.

While the subject matter of UN ***SDGs*** goes beyond the usual scope of Low Carbon Pulse, it is an area that is going to get more scrutiny, critically in the context of the Paris Agreement as countries seek to adapt to the consequences of increased average global temperatures. In the context, it is to be expected that policy settings take an increasingly holistic perspective.

## As Temperature Changes, policy needs to do likewise:

- **Snap shots of long term temperature change:** Edition 19 and 20 of Low Carbon Pulse included some interesting and informative arcs and circles reporting on emissions and temperatures.

  During the week-beginning July 26, 2021, another graphic (this time a time lapse graphic) came to the attention of the author showing the ***Temperature Change 1880 to 2020*** linked to over a 100 countries. The graphic conveys a compelling message in a little over 35 seconds.

- **Policy forged in heat:** On July 31, 2021, The San Francisco Chronicle (***SFC***) published an article entitled ***Carbon neutral is not good enough. California needs to be carbon negative by 2030***. The headline grabs the attention of the reader.

  The ***SFC*** notes that the mass of ***GHG*** emissions projected to be emitted in 2021 from the production, transportation and use of energy and resources is going to be in the region of 37 giga tonnes (37 billion tonnes).

  **This will be a record.**

  This record will follow a record decline in ***GHG*** emissions during 2020 (***2020 Dip***). (Previous editions of Low Carbon Pulse have reported on the ***2020 Dip***.) Reporting and analysis of the ***2020 Dip*** continues, including in the highly respected and influential ***BP Statistical Review of World Energy 2021*** (***BPER***). The ***BPER***, with the benefit of more time and analysis, estimates a 6% decline in $CO_2$ emissions from 2019 to 2020 (compared to earlier estimates of around 7%).

  - **Impact and Politics local:** California is drier and hotter than it was in 1990. In this context, Governor, Mr Gavin Newsom is seeking acceleration of progress on clean energy, and as such climate protection and environmental justice objectives.
  - **California has long led:** As noted in Edition 9 of Low Carbon Pulse, California (under ***Negative GHG emissions … not new, but hight profile likely***) has been ahead of the curve on policy settings, including the need to develop and to deploy negative GHG emissions initiatives. Among other things, Edition 9 of Low Carbon Pulse notes the policy setting of achieving net-zero GHG emissions by 2045.

    There are now calls for California to:

    - Reduce ***GHG*** emissions to below 80% of 1990 levels by 2030; and
    - Commence negative ***GHG*** emission initiatives to remove ***GHG*** from the atmosphere by 2030,

    in combination to achieve carbon neutrality by 2030.

    In addition, on July 28, 2021, it was reported that a bipartisan group in the Californian legislature seeking USD 300 million for the development of hydrogen refuelling infrastructure (***HRI***).

    It is no coincidence that a State experiencing the effects of climate change is responding to them.
  - **Policy settings need to be global:** As noted in previous editions of Low Carbon Pulse (and above), and as illustrated by the ***Temperature Change 1880 to 2020***, developed countries need to do more, and to do more at an accelerated pace, than countries that are not as developed.

    The calls for acceleration in California as timely: as noted above, the elephant in the room is that development countries aiming to achieve ***NZE*** by 2050 is not going to be enough to stay safely, if at all, within ***GHG*** carbon budget. The developed world needs to accelerate, thereby taking responsibility for both past emissions and because developed countries are able better to afford acceleration.

    While all politics is local, responsibility is global. Taking responsibility is manifested and delivered through policy settings, and the effective funding and implementation of them.

- **Drier and hotter = drought:** The following link provides a real time US Drought Monitor. As noted previously in Low Carbon Pulse, and in this edition, an objective of the Paris Agreement that has been forgotten is **Article 2.1(b):** Adapting to climate damage.

  The extreme weather conditions in Europe and the US appear to be forcing governments (Federal, State / Provincial, City and Local) to turn their minds to the need to adapt to climate change, including, the recognition of new weather patterns, and the economic, environmental and social impact of them.

  It has to be said that those familiar with the thought processes to crafting and drafting of **Article 2.1(b)** have been surprised by the lack of thinking at country by country level, other than those countries at threat because of rising sea-levels.

## Carbon credits and Carbon offsets, Insurance, Investors, Negative Emissions Initiatives and Sustainability:

- **Walk the Talk: the how as well as the what:** Previous editions of Low Carbon Pulse have mentioned the Institutional Investors Group on Climate Change (***IIGCC***), and the roles of key members of ***IIGCC*** in driving ***NZE*** outcomes at a corporate level (see Edition 19 of Low Carbon Pulse). The ***IIGCC*** has recently increased the definition around what is required from corporations.

  Critically, investors are going to require corporations to disclose target reduction plans, i.e., how the particular corporation intends to achieve any announced reduction target, appoint a director or directors responsible to implement the plan, and the requirement that investors vote on progress of implementation against plan.

  Set out is the ***IIGCC's Paris Aligned Investment Initiative*** and ***Net Zero Investment Framework Implementation Guide***.

- **NASA surveys for Vital Signs of the Planet:** Edition 22 of Low Carbon Pulse reported in the NASA study, undertaken by its Jet Propulsion Laboratory (***JPL***) in Southern California.

  One of the headline grabbing by-lines from reporting of the study has been that the Amazon Basin is both a carbon source and a carbon sink, and that across the entire Amazon Basin it is close to becoming neutral. The reasons for this are many and varied, but are reported as arising as a result of deforestation, and the degradation that results, the impact of increased average temperatures, including drought and its affects.

  Edition 25 of Low Carbon Pulse will take a closer look at the findings and the implications of the NASA study, including in the light of the ***2021 Report***, and how the findings and the implications of the NASA study are core to the basis of policy setting for carbon credits, and ability to use them to off-set ***GHG*** emissions: planting trees is not sufficient.

## Airports and Aviation:

Edition 25 of Low Carbon Pulse will update include an update on Airports and Aviation.

## NZE News and Facts and Statistics:

- **Amazon and TotalEnergies firmly planted:** On July 29, 2021, TotalEnergies announced a strategic collaboration with Amazon under which TotalEnergies will contribute to Amazon's 100% renewable electrical energy commitment (474 MW of renewable electrical energy in Europe and the US under a single power purchase agreement (***SPPA***)) and Amazon will work with TotalEnergies to accelerate its digital transformation. It is expected that in time the ***SPPA*** will cover load in the Middle East and Asia Pacific.

  On its face, this may appear to be just another business to business deal, and to some extent it is, and yet it goes beyond the transactional to the transformational: President, Gas, Renewables & Power, TotalEnergies, Ms Stephane Michel stated: "… we are proud to enter into this key collaboration with Amazon and to accompany them on their journey to carbon neutrality. We are also counting on Amazon and AWS [Amazon Web Services] to help use advance our exponential shift in the speed, scale and advancement of digitalization'.

  **See:** *TotalEnergies and Amazon announce strategic collaboration*

- **Sunniest Cities on Earth:** In previous editions of Low Carbon Pulse, graphics have been included from the Visual Capitalist. In another great graphic, the Visual Capitalist has provided a graphic representing World Cities Ranked by Average Annual Sunshine Hours.

  For ease of reference, the Visual Capitalist graphics are included as links below:

  - Race to Net Zero: Carbon Neutral Goals by Country and
  - Visualizing the Climate Targets of Fortune 500 Companies.

## *NZE* reports:

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

| ORGANISATION | TITLE / SUBJECT MATTER |
|---|---|
| European Union Agency for the Corporation of Energy Regulators (ACER) | *Transporting Pure Hydrogen by Repurposing Existing Gas Infrastructure: Overview of existing studies and reflections on the conditions for repurposing* |
| Hydrogen Counsel and McKinsey & Company | *Hydrogen Insights: An updated perspective on hydrogen investment, market development and momentum in China* |
| National Nuclear Laboratory | *Unlocking the UK's Nuclear Hydrogen Economy to Support Net Zero* |
| International Energy Agency | *Empowering Cities for a Net Zero Future- Unlocking resilient, smart, sustainable urban energy systems* |
| Jet Propulsion Laboratory | *Changes in global terrestrial live biomass over the 21st century* |
| International Energy Agency | *Sustainable Recovery Tracker* |
| All-Party Parliamentary Group | *The role of hydrogen in powering industry* |

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# Appendix

## EDITION 1 - JULY REPORT ON REPORTS

Welcome to **Edition 1** of **Report on Reports** – sharing summaries of papers, reports and studies published in respect of net-zero emissions (***NZE***), and related matters. This edition covers paper, reports and studies published during July 2021, and some from June (noting that the Report on Reports idea arose in July 2021). As noted in recent editions of Low Carbon Pulse, each Report on Reports is intended to provide a summary of key findings.

All reports and studies in this **Edition 1** of **Report on Reports**, were covered in the editions of Low Carbon Pulse published during July 2021: Edition 21, click here, and Edition 22, click here.

The table following table details each paper, report and study covered in this July Report on Reports, and has a link to it:

| REPORTS AND STUDIES COVERED IN DETAIL JULY REPORT ON REPORTS | | | |
|---|---|---|---|
| **REPORT / STUDY** | **LINK** | **REPORT / STUDY** | **LINK** |
| ***APPG Report*** | *The role of hydrogen in powering industry* | ***IEA – CCS / CCUS SEA Report*** | *Carbon capture, utilisation and storage: the opportunity in Southeast Asia* |
| ***DB Plan*** | *Decarbonising Transport – A Better, Greener Britain* | ***IEA Hydropower Report*** | *Hydropower Special Market Report* |
| ***ETC Report*** | *Bioresources within a Net-Zero Emissions Economy: Making a Sustainable Approach Possible* | ***IEA Smart Cities*** | *Empowering Cities for a Net Zero Future- Unlocking resilient, smart, sustainable urban energy systems* |
| ***EHB Report*** | *Analysing future demand, supply, and transport of hydrogen* | ***IRENA – WETO*** | *World Energy Transitions Outlook* |
| ***H2E GO Paper*** | *H2ero Net Zero: different energy carriers require separate systems of guarantees of origin* | ***IRENA – RP Report*** | *Renewable Power Generation Costs in 2020*. |
| ***H2E Maritime Paper*** | *How hydrogen can help decarbonise the maritime sector* | ***OIES ET Report*** | *Energy Transition: Modelling the Impact of Natural Gas*. |

## *APPG* - Hydrogen report:

- **Title, and provenance, of report:** ***The role of hydrogen in powering industry*** (***APPG Report***)**:** The All Party Parliamentary Group (***APPG***) in the UK published the ***APPG Report***. The ***APPG Report*** was researched by Connect, and was funded by Baxi, Bosch, Cadent, EDF Energy, Energy and Utilities Alliance, Equinor, Johnson Matthey, National Grid, Northern Gas Networks, SGN and Shell (all key players in UK energy markets).

  Neither ***APPG*** nor the ***APPG Report*** have formal standing in the UK Parliamentary context, including in a policy setting context, but the members of ***APPG***, and the organisations funding the ***APPG Report***, make the publication, and the contents, of the ***APPG Report*** significant.

- **Purpose of *APPG Report*:** To identify "*measures that can be taken to support the overall delivery of decarbonising industry through hydrogen, and establishing the UK as a global leader in hydrogen technology*". (The concept of establishing the UK as a global leader in hydrogen technology, informs at least one of the recommendation contained in the ***APPG Report*** (i.e., the third recommendation).

- **Findings: Ten recommendations:**

  **1**. The UK Government must continue to expand beyond its existing commitments to 5 GW of low-carbon hydrogen production capacity by 2030;

  **2**. Any forthcoming policies must be complementary of the wider UK low-carbon commitments.
  **Comment:** This may be read as a "motherhood statement", it is not if read with the detail that sits beneath it: which detail notes that it is critical to co-ordinate and to streamline policy settings and implementation;

  **3**. The UK Government must commit to incentivising hydrogen production within the UK as opposed to importing hydrogen.
  **Comment:** This recommendation is consistent with the purpose of the ***APPG Report***, but overtime it is likely to succumb to lower cost imports of hydrogen, in particular Green Hydrogen;

  **4**. The UK Government must align hydrogen production pathways with nuclear technology to enhance hydrogen production.
  **Comment:** The UK Government's *Ten point plan for a green industrial revolution* (***Ten Point Plan***), provides for the development of the nuclear power sector (Point 3 of ***Ten Point Plan***), a low-carbon source of electrical energy, that may be used to produce hydrogen. In this context, the recommendation is a good one;

  **5**. A UK wide hydrogen network to support the transport sector is required, include a larger-scale implementation of hydrogen refuelling stations.
  **Comment:** ***Decarbonising Transport – A Better, Greener Britain*** states that close to 90% of GHG emissions arising from the transport sector in the UK arise from road transport, and as such development of refuelling stations, and recharging stations, is key;

  **6**. Industrial clusters will be key catalysts for driving forward the UK's decarbonisation of industry using CCS / CCUS and hydrogen and should be an immediate priority for the UK Government.
  **Comment:** This recommendation is a good one, and in many ways reflects what is already happening, with six clusters (some may say seven) identified and being developed by the private sector (including some of the organisations funding the ***APPG Report***), with five clusters and hubs identified on July 30, 2021 (see Edition 23 of Low Carbon Pulse) as eligible for the Track 1 CCS Programme;

  **7**. Changes in regulation by the UK Government are required to support hydrogen's role in powering industry.
  **Comment:** This recommendation is a good one, and like Recommendations 5 and 6, it is a recommendation "at home" in any jurisdiction globally: each country and economic bloc needs to develop laws and regulations that provide safety and certainty;

  **8**. For hydrogen to expand in the UK, a technology neutral approach is required for all types of energy systems.
  **Comment:** This recommendation goes to the core of Blue Hydrogen versus Green Hydrogen, and one being preferred over the other. The recommendation is a good one, not least by Blue Hydrogen, using subsidised CCS / CCUS, is needed to develop the supply side for hydrogen, with Green Hydrogen likely to displace Blue Hydrogen;

  **9**. Significant and long-term financial support is required for the development, deployment and operation of hydrogen technologies:
  **Comment:** Like Recommendations 5, 6, 7 and 8, this is a recommendation that is at home in any country, with support required for CCS / CCUS to produce Blue Hydrogen, and a likely role for Government to allow the deployment of Green Hydrogen production and storage technologies; and

  **10**. Ofgem must ensure that the hydrogen market is subject to effective competition to drive down prices for consumers.
  **Comment**: This is a laudable recommendation, but it is likely "to care of itself" as choices will exist for consumers in respect of many consumer choices, critically, the price of energy for the daily drive.

## Department for Transport: Decarbonising Transport – A Better, Greener Britain:

- **Title, and provenance, of report:** ***Decarbonising Transport – A Better, Greener Britain*** (***DB Plan***)**:** The Department for Transport in the UK released the ***DB Plan*** on July 14, 2021 (the same day as the European Commission released its **Fit for 55** package (see Edition 22 of Low Carbon Pulse)). The ***DB Plan*** may be regarded as a consolidation of initiatives and plans already developed to provide the policy setting framework for the decarbonisation of the UK's transport sector.

- **Purpose of *DB Plan*:** To act as a point of consolidation for decarbonisation commitments across the transport sector, and more importantly, to outline the key enablers to decarbonisation. Edition 22 of Low Carbon Pulse outlined the key enablers, and they are considered in more detail below. Rather than report further on the ***DB Plan***, the key facts and statistics are the focus.

- **Scale of Decarbonisation required:**

  **Total GHG emissions:** In Q1 of 2021, the UK passed the half way mark to achieving ***NZE***: the reporting in the ***DB Plan*** has yet to catch up with this achievement. So as to provide a like-for-like comparison with the facts and statistics it is necessary to use the 2019 statistics in the ***DB Plan***. In 2019, human activities in the UK gave rise to 414.1 million tonnes $CO_2$ equivalent ***GHG*** emissions (414.1 $MtCO_2$-e): at that point, a 48.8% reduction in the mass of GHG emissions arising was required compared to 1990. By any measure, a first rank performance. But a performance that is likely to be accelerated.

  **Total Transport sector GHG emissions:** On the basis of the same source data, in 2019 the UK domestic transport emissions were 122.15 MtCO2-e, a little short of 30% of all ***GHG*** emissions. It is likely that the absolute mass of ***GHG*** emissions arising in 2020 was lower because of the impacts of Covid-19, but it may be that the percentage of ***GHG*** emissions arising from the transport sector has increased slightly. The transport sector in the UK may be regarded as more difficult to decarbonise than other sectors of the economy. The UK is not the only country in which this the case, but it is eminently achievable in the case of the UK.

  **UK domestic transport emissions 2019:** The following graphics outline the 2019 level of ***GHG*** emissions arising from each segment of the transport sector, and the profile of reductions in ***GHG*** emissions to achieve ***NZE***. To achieve ***NZE***, policy settings need to be finalised, funded and implemented.

**Decarbonising Transport domestic transport GHG emission projects, versus the baseline:**

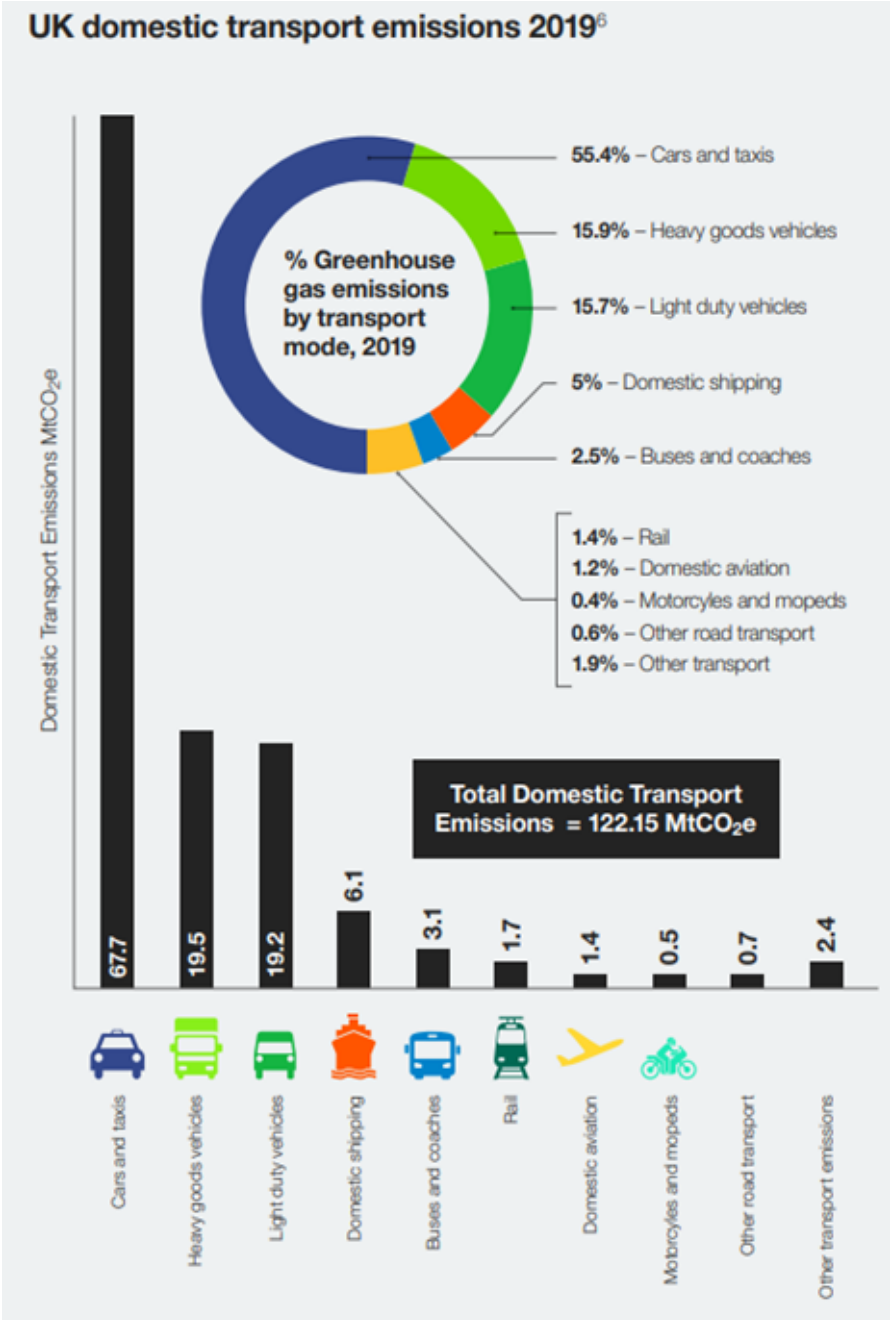
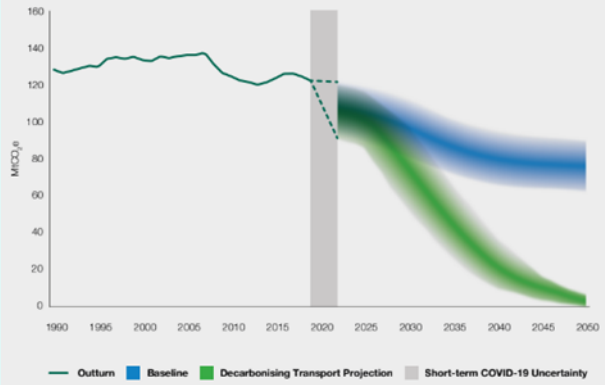
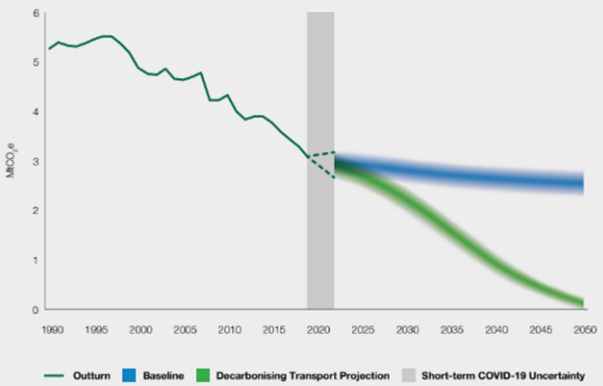


**Figure 2: Decarbonising Transport domestic transport GHG emission projections, versus the baseline***



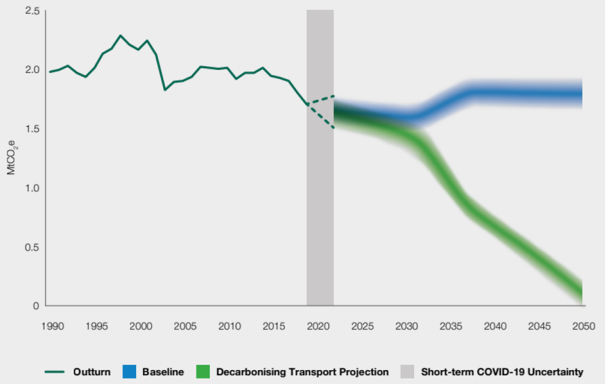

* Historic emissions are from published Her Majesty's Government (HMG) GHG statistics. Our projections are produced using a range of models, including the National Transport Model (road transport), and Traction Decarbonisation Network Strategy (rail), and Aviation model, adjusted for decarbonising transport measures. The shipping baseline and projections are based on the latest analysis by the CCC (https://www.theccc.org.uk/publication/sixth-carbon-budget/), which drew on research commissioned by DfT. Given the emerging nature of zero emission shipping fuels, the projections should be interpreted as possible scenarios for meeting the net zero goal that the government has announced for the UK maritime sector rather than estimates of the impact of specific policies. Baseline forecasts are not consistent with the 2019 BEIS Energy and Emission Projections (EEP), as these use different methodologies. Where feasible, uncertainty in projections reflects uncertainty on policy design, GDP, fuel prices, trip rates, and historic volatility in emissions. The range in the policy line declines as we move out to 2050, due to a higher proportion of zero emission vehicles. Transport emission projections exclude military aircraft and shipping.

**Figure 5: Decarbonising Transport bus and coach GHG projections, versus the baseline***



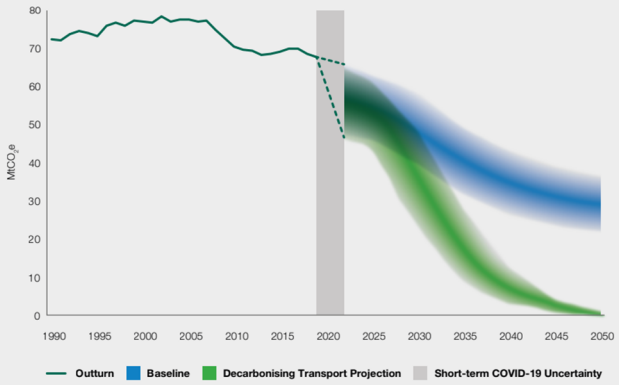

* Historic emissions are from published GHG statistics. Future bus and coach emissions are modelled using the National Transport model and adjusted for Decarbonising Transport measures. Bus and coach service levels in the central case are estimated based on 2015 levels. The uncertainty bands around projections reflect uncertainty on the form of final policy and uncertainties on future demand for road transport – related to future trends in travel, uptake of connected and autonomous vehicles, fuel prices, GDP growth, and historical volatility. Carbon savings are driven by Decarbonising Transport policies and ambitions. Modelling assumes zero emission technology is available for all buses and coaches. There is significant uncertainty about future business models for the bus and coach fleet (e.g. mobility as a service), which are not factored in these projections.

**Figure 7: Decarbonising Transport rail GHG projections, versus the baseline***




* Historic emissions are from published GHG statistics. Carbon savings have been estimated using TDNS analysis. The uncertainty bands around projections reflect uncertainty on the form of final policy, and on historic volatility in rail. Emission reductions are primarily driven by rail electrification, but also from the deployment of battery electric and hydrogen trains on difficult to electrify sections of the rail network. Modelling assumes successful implementation of battery or electric trains.

**Figure 9: Decarbonising Transport car GHG projections, versus the baseline***




* Historic emissions are from published GHG statistics. Future car and van emissions are modelled the using the National Transport model and adjusted for Decarbonising Transport measures. Uncertainty bands around projections reflect uncertainty on the form of final policy and uncertainties on future demand for road transport – related to future trends in travel, uptake of connected and autonomous vehicles, fuel prices, GDP growth, and historical volatility. Carbon savings are driven by Decarbonising Transport policies and ambitions. The range of uncertainty in emissions projections falls in the policy line as the proportion of miles by zero emission vehicles increases. From 2040 the lower end of policy projections includes emission reductions from speculative scenarios to get emissions to zero.

**Figure 10: Decarbonising Transport van GHG projections, versus the baseline**

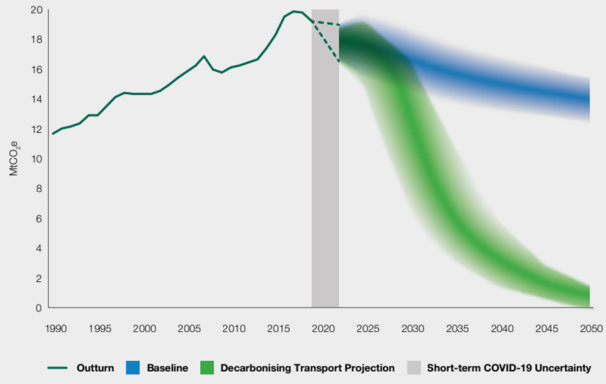
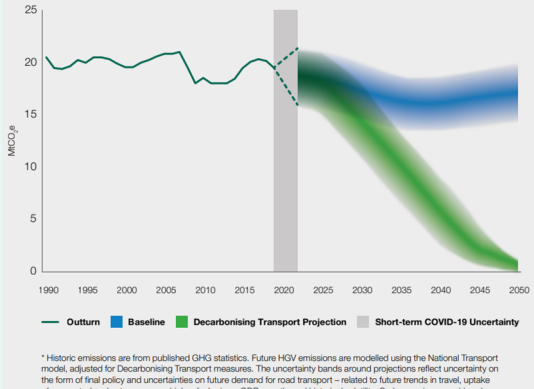



**Figure 13: Decarbonising Transport HGV GHG projections, versus the baseline***




* Historic emissions are from published GHG statistics. Future HGV emissions are modelled using the National Transport model, adjusted for Decarbonising Transport measures. The uncertainty bands around projections reflect uncertainty on the form of final policy and uncertainties on future demand for road transport – related to future trends in travel, uptake of connected and autonomous vehicles, fuel prices, GDP growth, and historical volatility. Carbon savings are driven by Decarbonising Transport policies and ambitions. The range of uncertainty in emissions projections falls in the policy line as the proportion of vkms by zero emission vehicles increases – this modelling assumes successful implementation of zero emission HGVs for all categories of HGV.

## ETC on Bioresources within a Net-Zero Economy report:

- **Title, and provenance, of report:** ***Bioresources within a Net-Zero Economy : Making a Sustainable Approach Possible*** (***ETC Report***)**:** The Energy Transitions Commission (***ETC***) is a global coalition of leaders from across the energy sector (producers and users). The ***ETC*** publishes reports from time to time. (In addition to the ***ETC Report***, in April 2021 the ***ETC*** published the excellent, *Making Clean Electrification Possible: 30 Years to Electrify the Global Economy* and *Reaching climate objectives: the role of carbon dioxide removals*).
- **Purpose of *ETC Report*:** To assess the extent of the role of the use of bio-resources to provide energy carriers on a sustainable basis. This is in the context of increased interest on bio-energy sector, with most if not all reports on studies on pathways to achievement of net-zero emissions (***NZE***) contemplating a material role of bioenergy in the mix by 2050, for example, each of the International Energy Agency (***IEA***) and the International Renewable Energy Agency (***IRENA***), contemplate that bio-energy is a pillar to decarbonisation.
- **Findings:**

  **1**. "**Not all biomass is good biomass**": There is a working assumption that any bio-resource (i.e., biomass) is a renewable resource, and that the use of any renewable resource to derive or to produce energy (electrical or heat) or an energy carrier (gaseous, liquid or solid) is a good thing. All bio-resources contain carbon. Decomposition of carbon gives rise to $CH_4$ and oxidation (partial or complete) of carbon gives rise to $CO_2$ (and NOx and SOx: each a ***GHG***).

  If ***GHG*** emissions arising during production of energy or an energy carrier are captured and stored, and renewable electrical energy is the source of all electrical and heat energy to produce an energy carrier, on use, ***GHGs*** will arise. The theory is that the ***GHGs*** produced on use will be absorbed because bio-resources will be grown to absorb those ***GHGs***. As a matter of theory, this is a little rough-and-ready, and by no means sound in all instances. As a matter of practice, this is rougher-and-readier, and not sound in many instances.

  **2**. **Bioresources should have low lifecycle emissions and growth must comply with three rules:** For the theory to be firmer, production of bio-resources should take into account the "opportunity cost" related to carbon that should be absorbed without intervention. Critically, there are three rules, growth of any bio-resource, must not: (**a**) compete with use of land for food production; (**b**) trigger any land use change (direct or indirect) that could release absorbed carbon into the atmosphere; and (**c**) impact biodiversity negatively.

  **3**. **Use of bioresources for bioenergy:** On the basis of compliance with the three rules on a strict basis, the ***ETC Report*** estimates that by 2050 on a sustainable basis it will be possible to derive up between 40 and 60 EJ pa from bio-energy. (The ***ETC Report*** outlines the conditions to deriving more than 60 EJ from bio-resources as bio-energy.)

## Report Card on *EC* - A hydrogen strategy for a climate neutral Europe:

- **Title and provenance:** July 8, 2021, was the first anniversary of the publication of the ***Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – A hydrogen strategy for a climate-neutral Europe*** (***EU Hydrogen Strategy***). In Edition 21 of Low Carbon Pulse, it was noted that the July Report on Reports would include a piece assessing progress.

  Given that many of the actions in the ***EU Hydrogen Strategy*** contemplate achievement in 2021, the thought is to assess progress at the end of 2021, likely as part of the fourth article in the ***Shift to Hydrogen (S2H2): Elemental Change*** series on ***Hydrogen Plans, Roadmaps and Strategies*** (publication of which has been deferred until the UK Hydrogen Strategy is published).
- **Purpose of *EU Hydrogen Strategy*:** To set out a vision of how the European Union (***EU***) can turn clean hydrogen into a viable solution to decarbonise different sectors of the economy over time, including installing at least 6 GW of renewable hydrogen electrolysers in the ***EU*** by 2024 and 40 GW by 2030. The production of Green Hydrogen is the subject to specific targets, the reference to clean hydrogen (see the note below) does not limit the ***EU Hydrogen Strategy*** to Green Hydrogen.

  The use of hydrogen to decarbonise is an integral part of the European Green Deal.

  (**Note:** For these purposes, **clean hydrogen** means renewable hydrogen, i.e., "hydrogen produced through electrolysis of water (in an electrolyser, powered by electricity), with electricity stemming from renewable resources. The full life-cycle of greenhouse gas emissions of the production of renewable hydrogen are close to zero. Renewable hydrogen may [also] be produced through the reforming of biogas (instead of natural gas) or biochemical conversion of biomass, if in compliance with sustainability requirements".)

## European Hydrogen Backbone – Analysing future demand, supply, and transport of hydrogen:

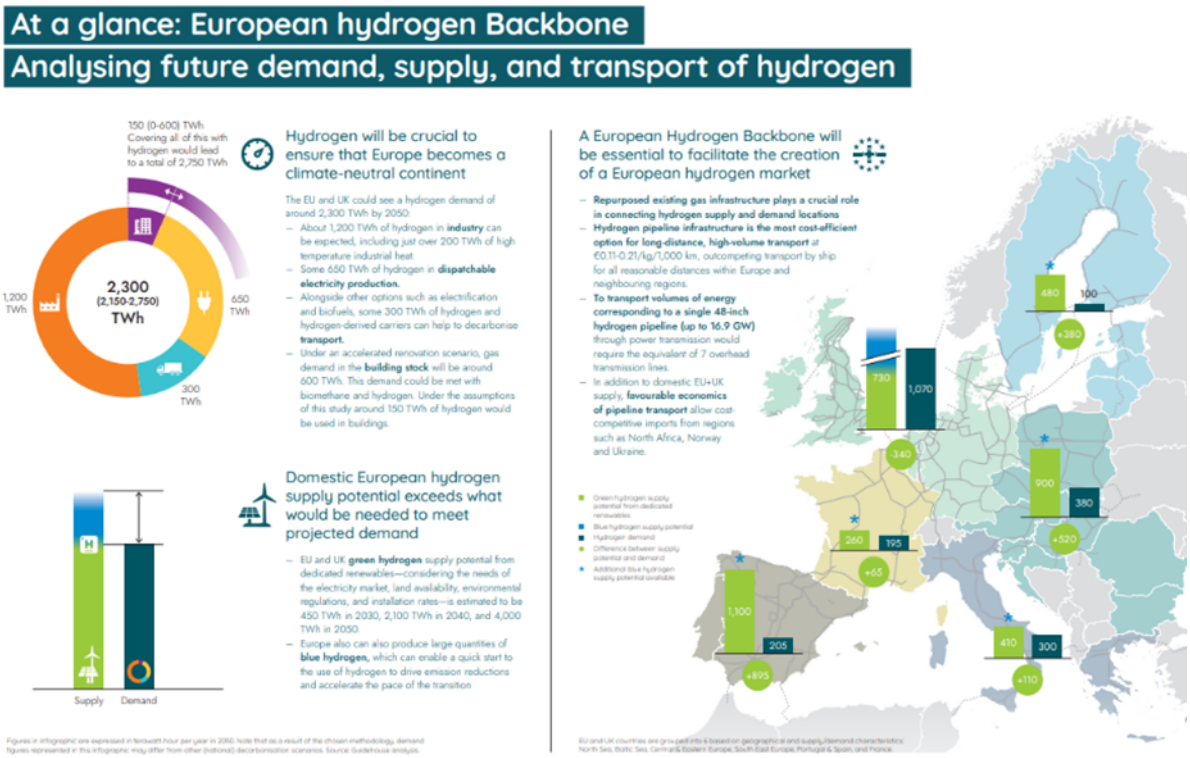
- **Title and provenance:** The European Hydrogen Backbone (***EHB***) is an initiative of European Gas Transmission System Operators (***TSOs***) (the ***Initiative***): it covers 23 ***TSOs***, with gas networks across 19 EU member states.

  In June 2021, the ***EHB*** launched a paper entitled *Analysing future demand, supply, and transport of hydrogen* (***EHB Study***).

  In June 2020, the ***Initiative*** published a paper outlined an initial vision of the ***EHB***. An updated report was published in April 2021. These papers outline the physical assets and infrastructure that are available for use to haul hydrogen across Europe, anticipating assets and infrastructure across 21 EU members states will comprise the ***EHB*** as currently contemplated.
- **Purpose of the *EHB Study***: The ***EHB Study*** (intended to complement the existing papers from the ***Initiative***) considers the development of supply and demand of hydrogen across the continent, as part of progress to achieved "a climate-neutral continent". The ***EHB Study*** considers both Blue and Green Hydrogen.

FIGURE 1

Overview of hydrogen supply potential and hydrogen demand in 2050




- **Findings:** Key findings of the ***EHB Study*** were reported in Edition 20 of Low Carbon Pulse, in terms of demand and supply.

## Hydrogen Europe (*H2E*)– Different energy carriers required separate systems of guarantees of origin:

- **Title, and provenance, of paper:** ***Different energy carriers require separate systems of guarantees of origin*** (***H2E GO Paper***)**:** Hydrogen Europe (***H2E***) is an organisation drawing its membership from across the private and the public sector, providing thought leadership and direction for the hydrogen industry in Europe, viewing hydrogen as "the other leg of the energy transition – alongside renewable electricity". ***H2E*** represents the interests of the European Hydrogen industry, and it publishes papers, reports and studies from time to time.
- **Purpose of *H2E Paper*:** To assess the current Guarantees of Origin (***GO***) system under the Renewable Energy Directive (***RED***), including to assess any shortcomings in its design.
- **Findings: Four recommendations** as follows, each of which feeds into the design and architecture of the ***RED*** as it relates to ***GOs***:
  1. Create a distinct hydrogen ***GO***, separate from electricity and gas.
  2. Encourage the use of ***GOs*** to prove the renewable character, and $CO_2$ intensity, of electricity procured for the production of renewable hydrogen.
  3. Initiate the development of a global system of Hydrogen Guarantees of Origin (***H2GOs***), with track-and-trace and auditing functionality.
  4. Set clear ground rules that avoid false or misleading claims. Enable the cancellation of ***H2GOs***, and the issuance of a natural gas ***GO*** when physical volumes are blended.

  These recommendations are carried forward through detailed recommendations on four ***T's***: Traceability and Trackability, Tradability, and Transparency.

## *H2E* – How Hydrogen Can Help Decarbonise The Maritime Sector:

- **Title, and provenance, of paper:** ***How Hydrogen Can Help Decarbonize The Maritime Sector*** (***H2E Maritime Paper***). As noted above, ***H2E*** represents the interests of the European Hydrogen industry. As might be expected, ***H2E*** is seeking to promote the development of the hydrogen industry, critically, in each area that may be regarded as difficult to decarbonise. In the area of shipping, ***H2E*** has been advocating that the ***EU*** takes the lead in the absence of the International Maritime Organisation (***IMO***) doing so. The ***H2E Maritime Paper*** provides helpful background on ***GHG*** emissions arising from the shipping industry, and ***IMO*** initiatives.
- **Purpose of *H2E Maritime Paper*:** To assess the potential of hydrogen and hydrogen-based fuels to contribute to the decarbonisation of the maritime sector, noting there are challenges, and, in the context of those challenges, to identify what the ***EU*** can do to address them. In this context, ***H2E*** notes the importance of the ***EU*** taking the lead, for example, the inclusion of "the maritime sector in the European Union Emission Trading Scheme [***EU ETS***]". As reported in Edition 22 of the Low Carbon Pulse, the shipping has been included in the ***EU ETS***.

- **Findings:** The key points that arise from the ***H2E Maritime Paper*** are as follows:
  - the choice of the fuel of the future for the shipping industry is uncertain. Factors that need to be balanced are:
    - cost and ease of storage on board, including volume, noting that energy density is a key factor;
    - for smaller vessels and short distance vessels, pure hydrogen is convenient, and cheaper than other future fuels, for larger vessels and longer distance vessels, ammonia is the cheapest future fuel; and
    - a considerable amount of clean hydrogen will be required, which goes to assurance, cost and quantity, and timing, of supply development;
  - the choice of Green Hydrogen as the future fuel enables a 100% reduction of Well-to-Wake (***WTW***) GHG emissions;
  - the choice is not simple, and certainly not a Green Hydrogen only choice: there is a range of choices:
    - Green Hydrogen or Green Ammonia (combination / synthesis of $H_2$ and N);
    - E-Fuels (or Bio-fuels): e-diesel, e-kerosene, e-LNG and e-methanol; and
    - Blue Hydrogen and Blue Ammonia.

    The ***H2E Maritime Paper*** considers each possible future fuel for the shipping industry, and each facet that arises.

## *IEA* Reports:

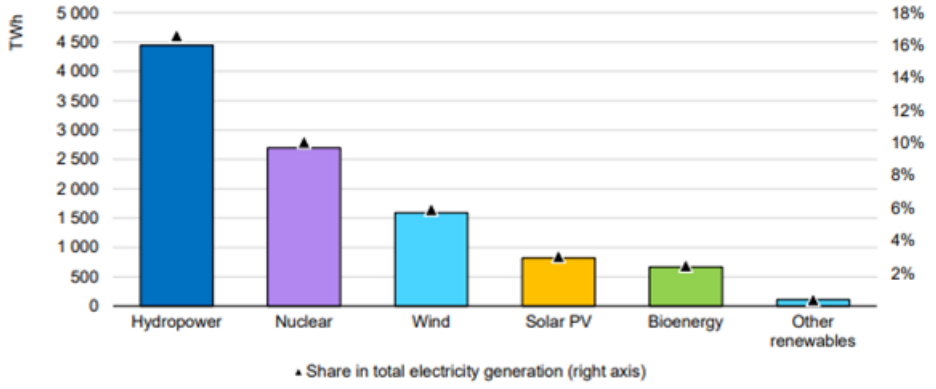
The International Energy Agency (***IEA***) was established in 1974 as a response to the oil price crises during that year. The ***IEA*** now comprises 30 member countries, and 8 association countries.

The ***IEA*** has become one of the leading energy data collection and analysis organisations, and from this key to information provision and to research globally.

- ***IEA* Reports during July, 2021** (and late June)**:**
  - Energy Prices: Overview;
  - Carbon Capture, Utilisation and Storage: The Opportunity in Southeast Asia (***CCS / CCUS SEA Report***);
  - Hydropower Special Market Report – Analysis and Forecast to 2030 (***Hydropower Report***);
  - Trends and developments in electric vehicle markets;
  - Empowering Cities for a Net Zero Future: Unlocking resilient, smart, sustainable urban energy systems (***Smart Cities Report***); and
  - Sustainability Tracker: Monitoring Progress towards sustainable recovery from Covid-19 crisis.
- For the purposes of this July 2021, Report on Reports, the ***CCS / CCUS SEA Report***, the ***Hydropower Report*** the ***Smart Cities Report*** are reported upon in more detail, with headlines only included in respect of the other reports, first those headlines:
  - **Energy Prices**: ***Overview***: Rightly the ***IEA*** regards monitoring end-use energy prices as critical for the purposes of understanding markets, and framing policy settings, and as end-use energy prices increasingly cease to be regulated, this monitoring becomes ever more important, and relevant. The ***Overview*** is commended because it looks at energy prices and energy taxes;
  - **Trends and development in electric vehicle markets**: The ***IEA*** notes that in 2020 "the global electric car stock hit the 10 million mark": this is 1% of total global car stock, but in 2020, 3 million new battery electric vehicles (***BEVs***) joined the global stock. Low Carbon Pulse will continue to cover developments in ***BEVs***.
  - **Sustainability Tracker: *Monitoring Progress towards sustainable recovery from Covid-19 crisis***: The Sustainability Tracker provides a report card against the *IEA Sustainable Recovery Plan* (***IEA SRP***) from 2020. The high level summary is that governments, globally, have committed to spend an additional USD 350 billion a year between 2021 and 2023, but this is 35% of the amount envisaged as required by the ***IEA SRP***, which is the amount that the ***IEA*** considers necessary to put the world on track to achieve ***NZE*** by 2050.
- ***CCS / CCUS SEA Report*:**
  - **Purpose**: It is recognised that CCS / CCUS has a key role to play in clean energy transition in Southeast Asia: CCS / CCUS may capture emissions from existing chemical, petrochemical and power production, and other industrial activities, including cement, glass, and iron and steel. Regional cooperation to store $CO_2$ captured will accelerate capture and storage, and transportation, development.
  - **Findings and strategic priorities:** To facilitate the development of CCS / CCUS regional co-operation is required as is the development of legal and regulatory frameworks consistent with policy settings, including incentives under those policies. The key findings from the ***CCS / CCUS SEA Report*** are the strategic priorities for CCUS in Southeast Asia as follows:
    - **Increase regional cooperation and collaboration:** to identify and to develop opportunities for shared infrastructure development, and to develop CCS / CCUS capabilities;
    - **Identify and develop on-shore and off-shore CO2 storage resources** in parallel with the development of robust legal and regulatory frameworks for safe and secure storage of CO2, and in this context to leverage support available from policy banks;
    - **Encourage early investment in CCUS projects**, critically, pilot projects to demonstrate feasibility and scalability, and to make use of industrial hubs as hubs for carbon capture; and
    - **Build International support and financing for CCUS in Southeast Asia**, critically, to access grant and loan support, noting that on-going subsidy support (of the kind that is provided in Europe) is less likely to be feasible, and as such upfront grant and loan support is to key.

- ***Hydropower Report*:**
  - **Purpose:** It is recognised that hydropower (pumped storage, reservoir and run-of-river) capacity has grown significantly since 2000, and that the growth of the sector needs to continue as part of progress towards ***NZE***. In this context, the ***IEA*** presents forecasts for the potential for growth. The ***IEA*** reminds the reader that hydropower is the backbone of existing low-carbon electricity generation, providing almost half of the low-carbon electricity generation.

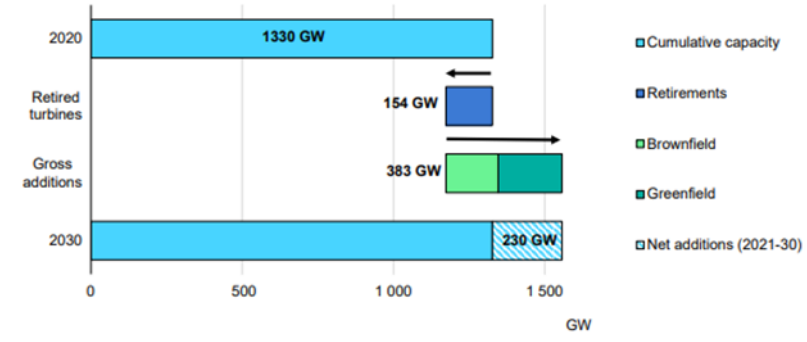
**Figure 1.1 Low-carbon electricity generation by technology and shares in global electricity supply, 2020**






  - **Findings and priority areas:** It is recognised that hydropower has a key role to play, and a greater role to play in progress towards ***NZE***. Looking forward to 2030, the bar chart below indicates that headline hydropower capacity is projected to increase by 230 GW (net, taking account of retirement of existing capacity).

**Figure 3.1 Global hydropower capacity forecast, retirements, and gross and net additions, 2020 and 2030**



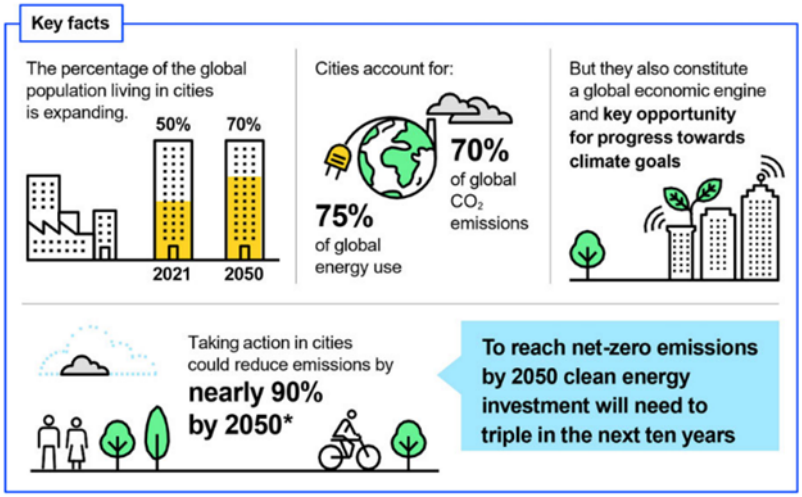



While this represents a 17% increase 2021 to 2030, it is a slower rate of increase than occurred 2010-2020. The ***IEA*** considers that this slower rate of increase will be a missed opportunity. In this context, the ***IEA*** identifies seven priority areas for governments so as to avoid missing the opportunity:

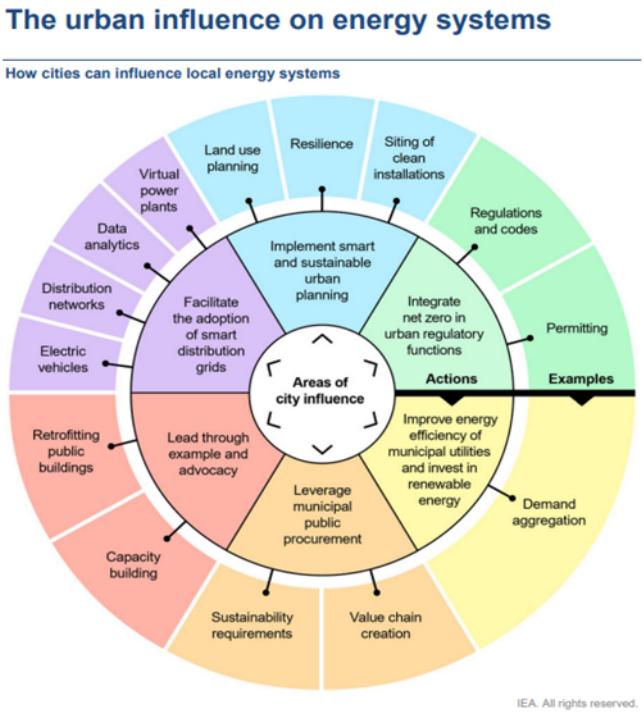
- Move hydropower up the energy and climate policy agenda;
- Enforce robust sustainability standards for all hydropower development with streamlined rules and regulations;
- Recognise the critical role of hydropower for electricity security and reflect value through remuneration mechanisms;
- Maximise the flexibility capabilities of existing hydropower plants through measure to incentivise their modernisation;
- Support the expansion of pumped storage hydropower;
- Mobilise affordable financing for sustainable hydropower development in developing economies; and
- Take steps to ensure to price in the value of multiple public benefits provided by hydropower plants.

The ***Hydropower Report*** is well-rounded, and it considers the challenges of hydropower, including cost.

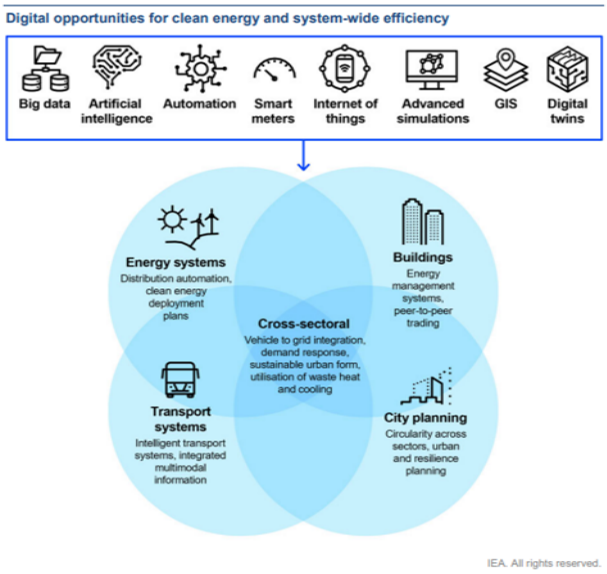
- ***Smart Cities Report***:
  - **Purpose:** It is recognised more than 50% of the world's population lives in cities, and that this concentration will increase as the pace of urbanisation increases, and the standards of living increase, overtime in countries whose populations are continuing to grow, with 70% of the world's population expected to live in cities by 2050. Currently, 70% of $CO_2$ emissions arise from activities undertaken in cities, and as the number of cities increases, and the populations of them increases, the reduction of ***GHG*** emissions arising from cities will be critical to the reduction of over 80% of the ***GHG*** emissions arising globally so as to achieve ***NZE***. In this context, energy production, transportation and use is central to policy settings in the urban setting.




  - **Findings and recommendations:** It is recognised that improved efficiency of energy use is critical in the built environment as is the reduction in ***GHG*** emissions arising from urban transport, and of course the increased electrification and the use of low-carbon or no carbon energy carriers, including hydrogen and hydrogen-based fuels.



Digitisation is seen as a key means of improving efficiency of energy use across all sectors and industries.




The ***IEA*** makes six recommendations:

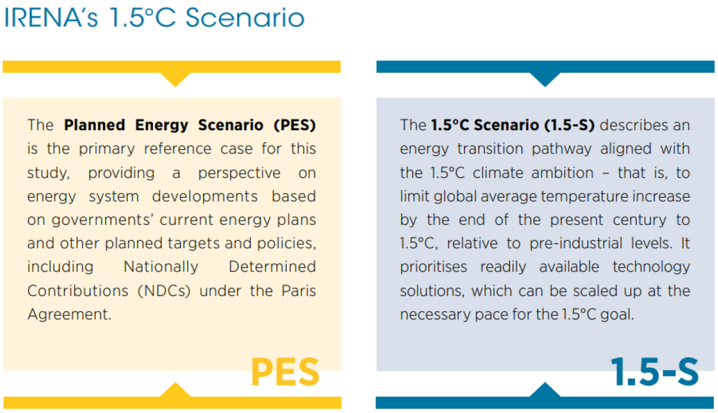
- Design inclusive policies and programmes with people at their core;
- Build capacity across digitalisation and energy;
- Ensure timely, robust, transparent access to data;
- Ensure the availability of finance and promote financial innovation;
- Promote the development and uptake of international standards and benchmarks; and
- Create opportunities for sharing and learning.

While the findings and the recommendations of in the ***Smart Cities Report*** are not surprising, the ***Report*** is helpful in collating research, and outlining what needs to be done.

## *IRENA* Reports:

The Intentional Renewable Energy Agency (***IRENA***) is an intergovernmental organisation supporting countries in the transition to renewable / sustainable energy, and is reported to be actively engaged with more than 180 countries in this endeavour.

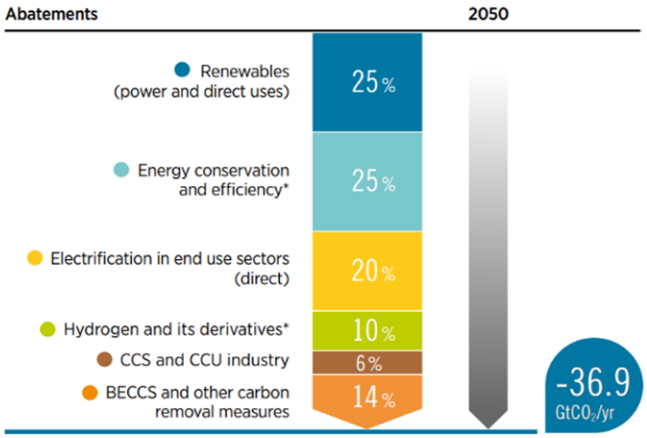
- ***IRENA* Reports during July, 2021 (and late June)**
  - *World Energy Transition Outlook: 1.5°C Pathway* (***WETO***); and
  - *Renewable Power Generation Costs in 2020* (***RP Report***).
- ***WETO***: The ***WETO*** was long-awaited, not least because it was previewed in Q1 of 2021 (***Preview to World Energy Transition Outlook***, and reported on in Edition 13 of Low Carbon Pulse). Editions 21 and 22 provide high level summary of the key elements of ***WETO*** (and comparison with the ***IEA Net Zero by 2050 – A Roadmap for Global Energy Sector***, the ***IEA Roadmap***). In this report on report, the key facts and statistics are extracted, and presented:
  - **Purpose of *WETO***: The purpose of ***WETO*** is to provide "an energy transition pathway aligned with the 1.5°C climate ambition" (i.e., to limit global average temperatures increase to 1.5°C above pre-industrial levels), and in so doing to provide a tool-kit for those developing and implementing policy settings in countries and economic blocs globally.



Throughout ***WETO*** the Planned Energy Scenario (***PES Scenario***) and the 1.5$^{O}$C Scenario (***1.5-S***) models are considered side by side. This is different from the ***IEA Roadmap***, which uses the specific policy setting model (***STEPS***) and the announced pledges model (***APC***).

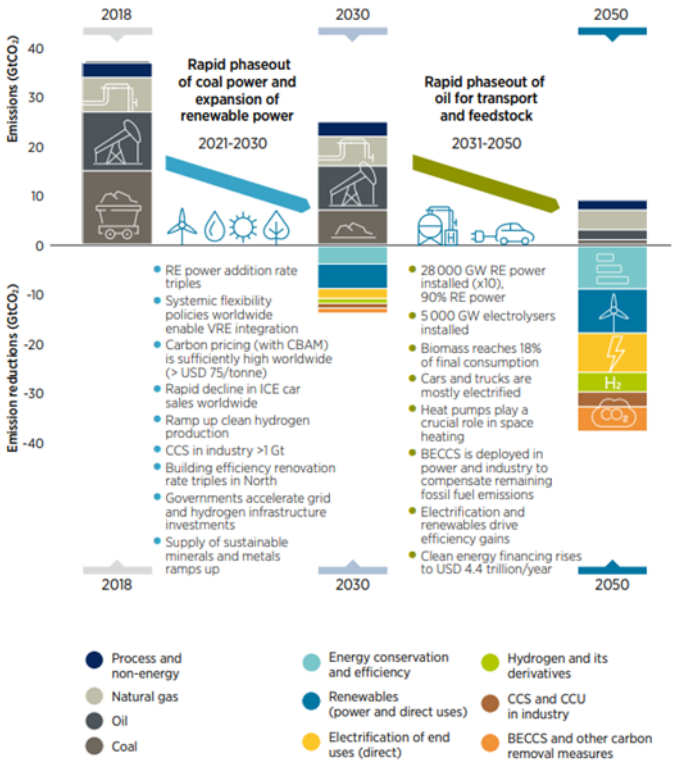
- **Findings:** The findings of ***WETO*** are many and varied, and the findings are best summarised in the following graphic that identifies ***IRENA's*** assessment of the sources of abatement of ***GHG*** emissions to achieve ***NZE*** across the energy sector.
  - Abatement as modelled:

**FIGURE S.4 Carbon emissions abatements under the 1.5°C Scenario (%)**




The graphic needs to be read with the next graphic, which outlines the progress required to reduce ***GHG*** emissions arising from the use of the current mix of technologies, with abatement of ***GHGs*** from the use of other the technologies (and other means).

**FIGURE S.5 Evolution of emissions with phaseouts of coal and oil, 2021-2050**

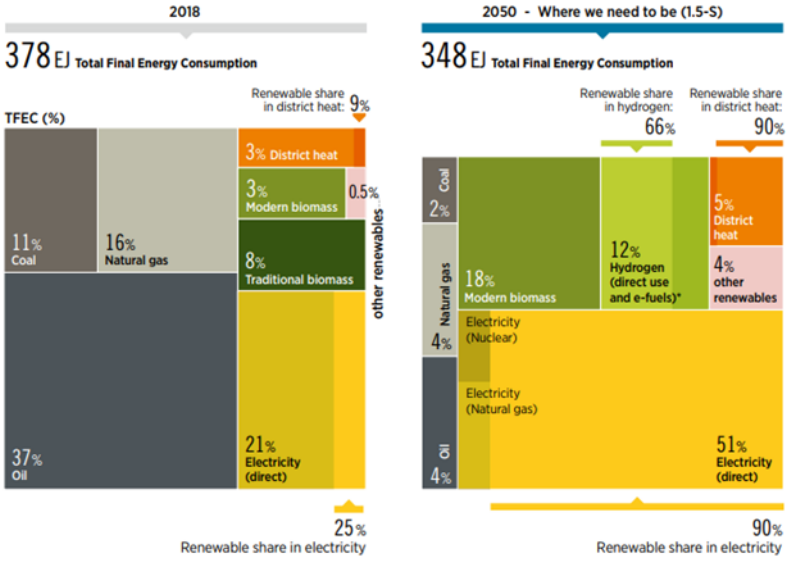



Note: RE = renewable energy; VRE = variable renewable energy; CBAM = carbon border adjustment mechanism; ICE = internal combustion engine; GW = gigawatt; Gt = gigatonne; CCS = carbon capture and storage; BECCS = bioenergy combined with carbon capture and storage; CCU = carbon capture and utilisation.

- **How much energy now and then?**

  The concepts that arise from the above graphics, are explained equally plainly by reference to total final energy consumption as follows:

**FIGURE 2.4 Breakdown of total final energy consumption (TFEC) by energy carrier in 2018 and 2050 (EJ) in the 1.5°C Scenario**



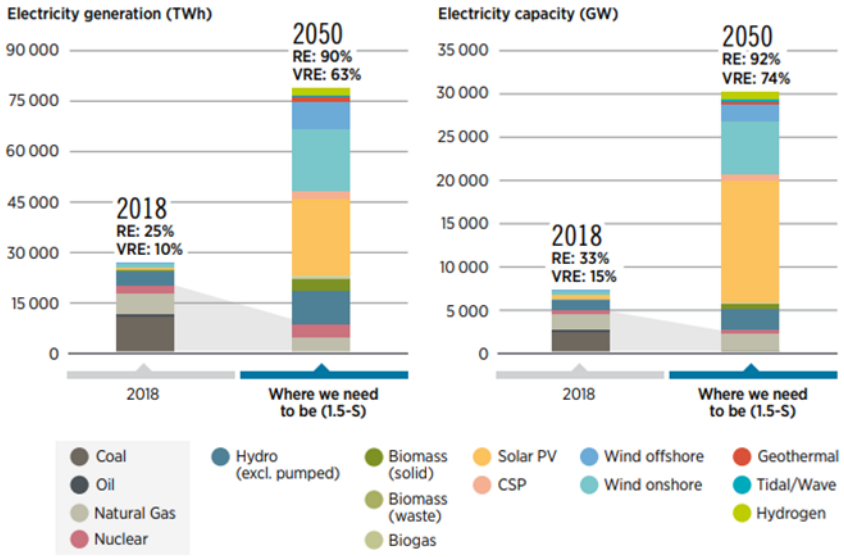

Note: The figures above include only energy consumption, excluding non-energy uses. For electricity use, 25% in 2018 and 90% in 2050 are sourced from renewable sources; for district heating, these shares are 9% and 90%, respectively; for hydrogen (direct use and e-fuels), the renewable energy shares (*i.e.*, green hydrogen) would reach 66% by 2050. The category "Hydrogen (direct use and e-fuels)" accounts for total hydrogen consumption (green and blue) and other e-fuels (e-ammonia and e-methanol). Electricity (direct) includes all sources of generation: renewable, nuclear and fossil fuel based. 1.5-S = 1.5°C Scenario; EJ = exajoule.

- **How much electrical energy now and then?**

  The core of energy transition under any model is the need to increase electrical energy from renewable sources, both for direct supply and for the derivation and production of energy carriers (including hydrogen, and hydrogen-based fuels).

  The following graphic explains this graphically!

**FIGURE 2.5 Electricity generation and capacity by source, 2018 and 2050 (TWh/yr and GW) in the 1.5°C Scenario**




Note: 1.5-S = 1.5°C Scenario; CSP = concentrating solar power; GW = gigawatts; PES = Planned Energy Scenario; PV = photovoltaic; RE = renewable energy; TWh/yr = terawatt hours per year; VRE = variable renewable energy.

**If there is one graphic in all the papers, reports and studies published in recent times that conveys the magnitude of the level of electrification required, it is this.**

**While other papers, reports and studies may have provided statements that are different (invariably higher) as to the electricity generation and capacity required, this graphic speaks loudly to the scale of what needs to occur in electrical energy generation capacity and electrical energy generated.**

**The hard numbers, reflect how hard the task is going to be**.

- **How?**

  **Six Pillars: *WETO*** provides six pillars to frame thinking and development policy setting and its implementation: (**1**)**.**. Energy Conservation and efficiency; (**2**) Renewables (power and direct uses); (**3**) Electrification of end use (direct); (**4**) Hydrogen and its derivatives; (**5**) CCS and CCUS in industry; and (**6**) BECCS and other carbon removal measures.

  While the **IEA *Roadmap*** has seven pillars, whether six or seven, pillars cover the activities that needed to achieve ***NZE***. In some ways, the pillars are more helpful than the detailed modelling, because they allow the framing of thinking and policy setting and implementation while at the same time showing that certain activities will require more government support than others, because there is differing execution risk.

  **Government role:** In addition to government policy settings, governments need to take an active role, critically in respect of the right policy settings to encourage the development of renewable electrical energy and grids, ahead of load, the development of CCS / CCUS projects to achieve scale use as quickly as possible, both to capture ***GHGs*** and to allow the development of Blue Hydrogen production capacity, to fund or co-fund the development of infrastructure, including recharging and refuelling infrastructure, and critically to consider whether it becomes a "forward-buyer" of hydrogen and hydrogen-based fuels to allow government to provide the right supply and demand side mix, and as such the right price point.

  (As is the case with the ***IEA Roadmap*** *and* ***BloombergNEF's New Energy Outlook***, ***WETO*** assesses the pathway through energy transition to ***NZE*** across the energy sector. As such, not all activities giving rise to anthropogenic ***GHGs*** emissions are covered: in short, abatement of ***GHG*** emissions arising from Agriculture, Forestry and other Land Use (***AFOLU***) and from waste and waste water is not covered in ***WETO***).

- ***RP Report***: In what has become an annual event, in July 2021, ***IRENA*** released its ***Renewable Power Generation Costs in 2020***. Edition 20 of Low Carbon Pulse reported on the headlines from the ***RP Report***. Those reading the ***RP Report*** tend to focus on the comparative cost of renewable energy versus fossil fuel.

  The ***RP Report*** provides a consistent lens through which to consider and to analyse the development of the renewable energy sector, critically, the scale of development from 2000 to 2020, from 754 GW to 2,799 GW. The accurate and consistent reporting provides confidence in the broader analysis undertaken by ***IRENA***, critically ***WETO***.

  At the risk of labouring the point made above as to the scale of development of renewable electrical energy required on the road to achieving ***NZE***, for those who have followed the ***IRENA Renewable Power Generation Costs*** reports, the scale of development required has been visible for a while.

## *OIES* – Energy Transition: Modelling the Impact on Natural Gas

- **Title, and provenance, of paper:** The ***Energy Transition: Modelling the Impact on Natural Gas*** (***OIES Report***) was prepared by The Oxford Institute For Energy Studies (***OIES***), a non-governmental organisation that operates as a research organisation and think tank.
- **Purpose of *OIES Report*:** To share two scenarios on the possible role of natural gas, both stated to have been developed and modelled to be consistent with the sustainable development model of the ***IEA***, which is fully aligned with the Paris Agreement to hold the rise in global average temperature to "well below 2$^{O}$C … and pursuing efforts to limit [it] to 1.5$^{O}$C". Each of the two scenarios is compared to business as usual. The ***OIES Report*** is helpful as a counter-point to other reports, critically, those that may be regarded as understating the role of natural gas as progress towards ***NZE*** is made. Further, the report takes a regional perspective, which may be regarded as critical because the use of natural gas will differ by region.
- **Findings:** The key finding is that in Asian markets the use of natural gas will continue to grow as part of energy transition.

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| ALL PAPERS, REPORTS AND STUDIES COVERED IN LOW CARBON PULSE DURING JULY 2021 | |
|---|---|
| **Organisation** | **Title / subject Matter** |
| All-Party Parliamentary Group (APPG) | *The role of hydrogen in powering industry* |
| Commonwealth Government of Australia, Advisian and the Clean Energy Finance Corporation (***CEFC***) | *Australian hydrogen market study – Sector analysis study* |
| Dii & Roland Berger | The Potential for Green Hydrogen in the GCC Region |
| Electric Power Research Institute | *Impact of carbon dioxide removal technologies on deep decarbonization of the electric power sector* |
| Energy Transition Commission | *Bioresources within a Net-Zero Emissions Economy: Making a Sustainable Approach Possible* |

| | |
|---|---|
| European Commission | *A hydrogen strategy for a climate neutral Europe* |
| European Hydrogen Backbone | *Analysing future demand, supply, and transport of hydrogen* |
| European Union Agency for the Corporation of Energy Regulators (ACER) | *Transporting Pure Hydrogen by Repurposing Existing Gas Infrastructure: Overview of existing studies and reflections on the conditions for repurposing* |
| Hydrogen Counsel and McKinsey & Company | *Hydrogen Insights: An updated perspective on hydrogen investment, market development and momentum in China* |
| Hydrogen Europe | *Hydrogen Europe's How Hydrogen Can Help Decarbonise the Maritime Sector* |
| Hydrogen Europe | *H2zero Net Zero – Different energy carriers required separate systems of guarantees of origin* |
| Hydrogen Valley Platform | *Hydrogen Valleys: Insights into the emerging hydrogen economies around the world* |
| Hysource | *Net Zero Emissions by 2050 and the Role of Hydrogen* |
| International Energy Agency (***IEA***) | *Unlocking the Economic Potential of Rooftop Solar PV in India* |
| International Energy Agency (***IEA***) | *Net Zero by 2050: A Roadmap for the Global Energy Sector (IEA Roadmap).* |
| International Energy Agency (***IEA***) | *Energy Prices: Overview – High-Quality data on end-use energy prices*. |
| International Energy Agency (***IEA***) | *Carbon capture, utilisation and storage: the opportunity in Southeast Asia* |
| International Energy Agency (***IEA***) | *Energy Prices: Overview – High-Quality data on end-use energy prices* |
| International Energy Agency (***IEA***) | *Hydropower Special Market Report* |
| International Energy Agency (***IEA***) | *Trends and Developments in Electric Vehicle Markets*. |
| International Energy Agency (***IEA***) | *Empowering Cities for a Net Zero Future- Unlocking resilient, smart, sustainable urban energy systems* |
| International Energy Agency (***IEA***) | *Sustainable Recovery Tracker* |
| International Renewable Energy Agency (***IRENA***) | *World Energy Transitions Outlook* |
| International Renewable Energy Agency (***IRENA***) | *World Energy Transition Outlook: 1.5$^{O}$C Pathway: Preview* |
| International Renewable Energy Agency (***IRENA***) | *Renewable Power Generation Costs in 2020* |
| International Renewable Energy Agency (IRENA) | *Renewable Power Generation Costs in 2020*. |
| Jet Propulsion Laboratory | *Changes in global terrestrial live biomass over the 21st century* |
| KBR | *Study of Hydrogen Imports and Downstream Applications for Singapore* |
| McKinsey & Company | *Creating the -zero carbon mine* |
| McKinsey & Company | *How negative emissions can help organizations meet their climate goals* |
| NASA and NOAA | *Satellite and Ocean Data Reveal Marked Increase in Earth's Heating Rate* |
| National Nuclear Laboratory | *Unlocking the UK's Nuclear Hydrogen Economy to Support Net Zero* |
| Navigant | *Carbon Capture, Utilisation and Storage, (CCUS): Decarbonisation Pathways for Singapore's Energy and ChemicalsSectors* |
| Regulatory Horizons Council | Regulatory Horizons Council Report of Fusion Energy |
| Swiss Re Group | *The Insurance Rationale for Carbon Removal Solutions* |
| The Oxford Institute for Energy Studies | *Energy Transition: Modelling the Impact of Natural Gas*). |
| University of Houston and the Center for Houston's Future | *Houston: The Low Carbon Energy Capital* |
| Zickfeld, K., Azevedo, D., Mathesius, S. et al. | *Asymmetry in climate – carbon cycle response to positive and negative $CO_2$ emissions* |

***The author of the July Report on Reports is Michael Harrison.***

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