Low Carbon Pulse –Report on Reports

EDITION 1 – JULY 2021

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 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	*H2zero 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:

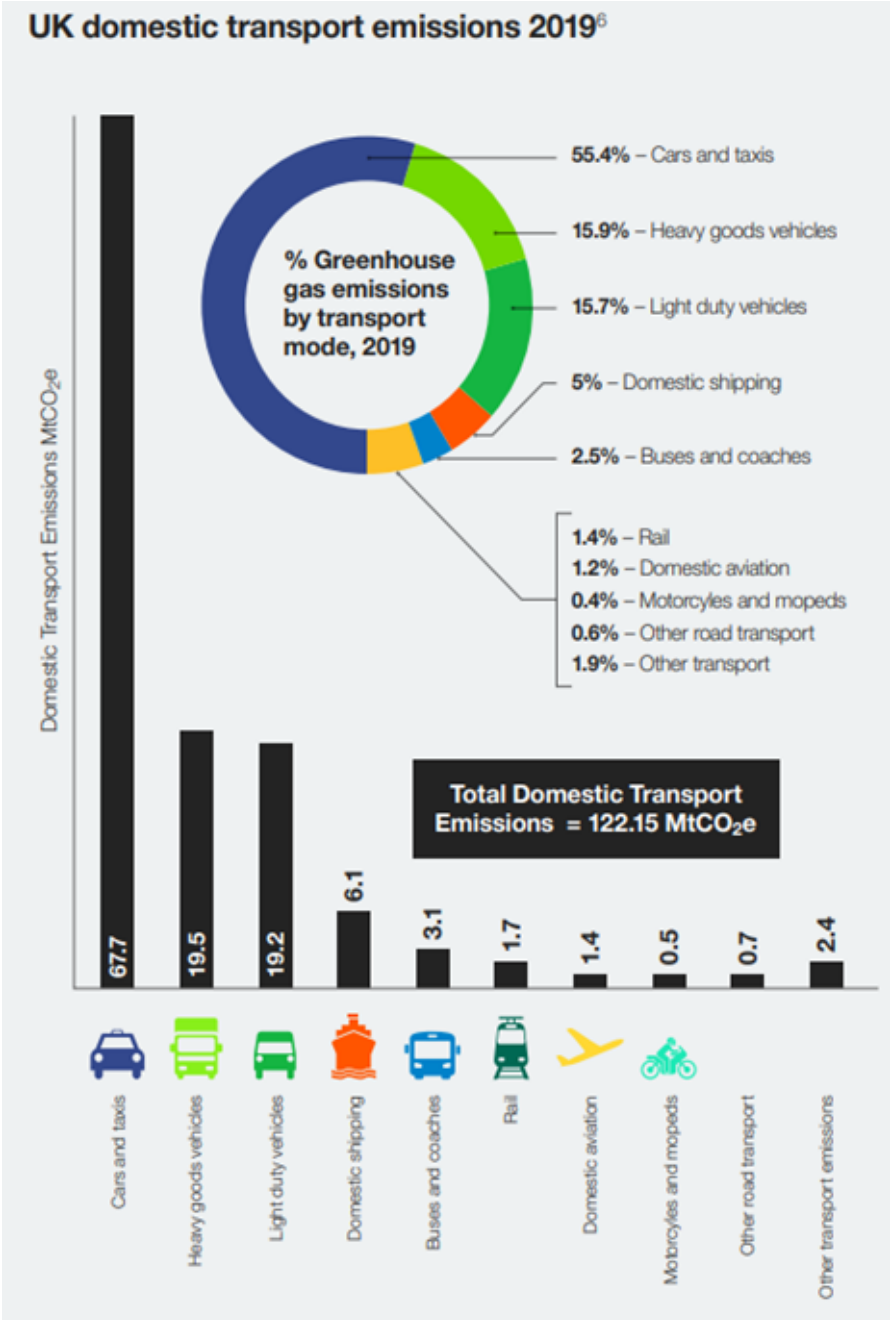
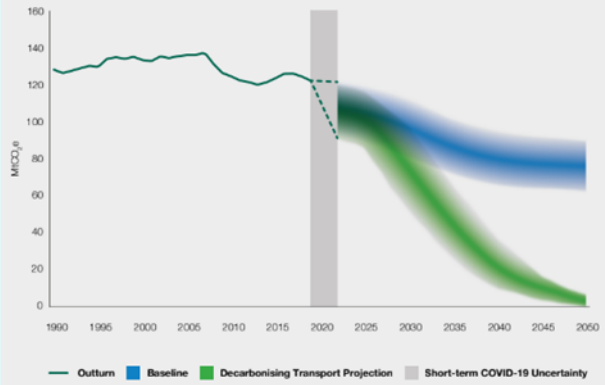
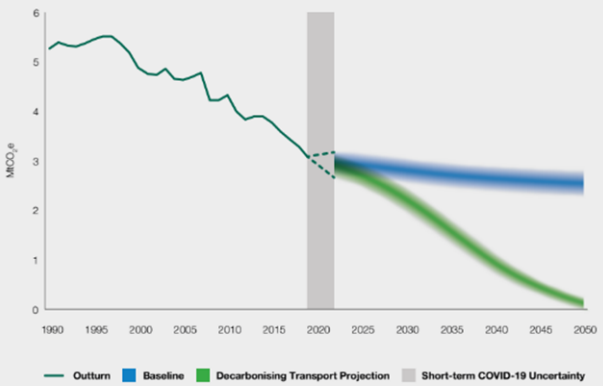


Figure 2: Decarbonising Transport domestic transport GHG emission projections, versus the baseline*



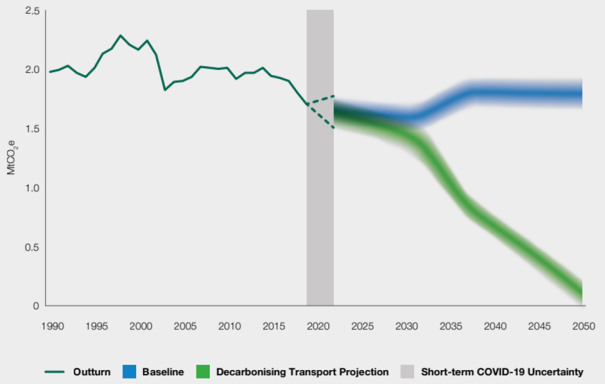
* Historic emissions are from published Her Majesty's Government (HMG) GHG statistics. Our projections are produced using a range of models, including the National Transport Model (road transport), and Traction Decarbonisation Network Strategy (rail), and Aviation model, adjusted for decarbonising transport 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*



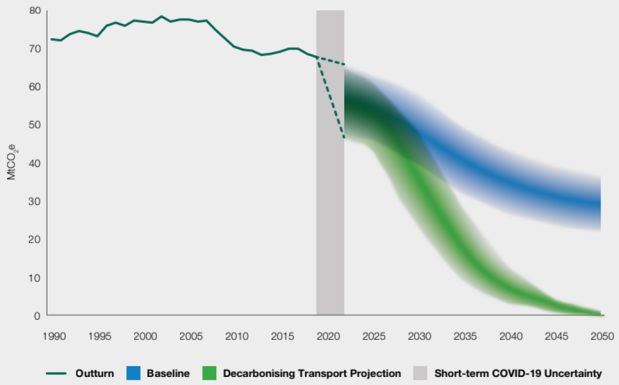
* Historic emissions are from published GHG statistics. Future bus and coach emissions are modelled using the National Transport model and adjusted for Decarbonising Transport measures. Bus and coach service levels in the central case are estimated based on 2015 levels. The uncertainty bands around projections 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

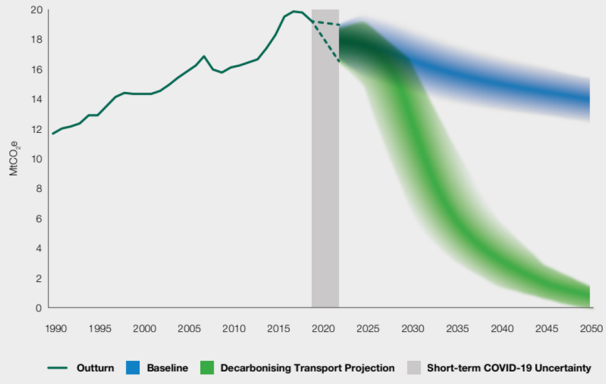
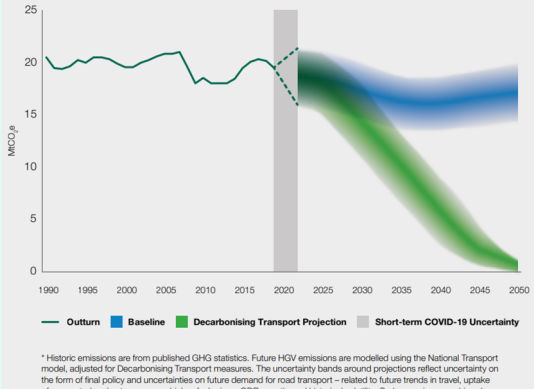


Figure 13: Decarbonising Transport HGV GHG projections, versus the baseline*



* 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.

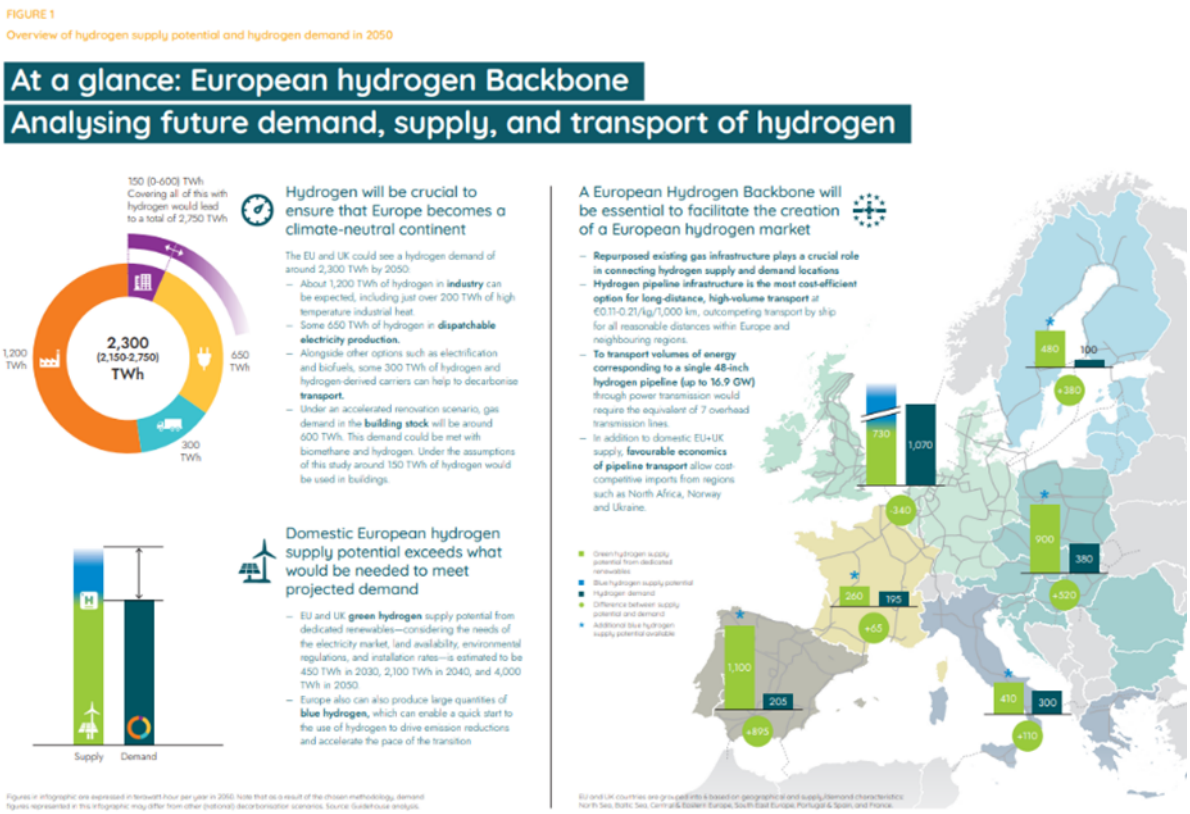
  (**Note:** For these purposes, **clean hydrogen** means renewable hydrogen, i.e., "hydrogen produced through electrolysis of water (in an electrolyser, powered by electricity), with electricity stemming from renewable resources. The full life-cycle of greenhouse gas emissions of the production of renewable 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.



- **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:

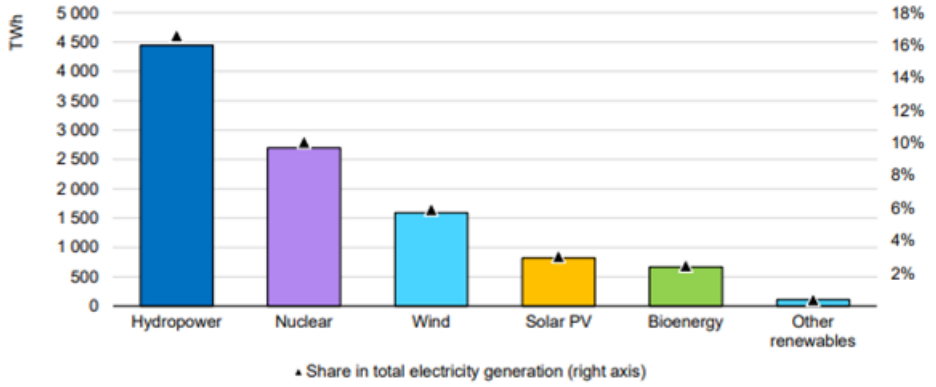
The International Energy Agency (***IEA***) was established in 1974 as a response to the oil price crises during that year. The ***IEA*** now comprises 30 member countries, and 8 association countries.

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.

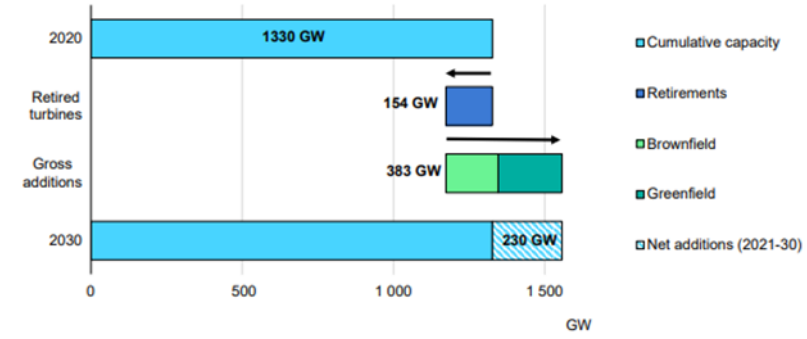
- ***Hydropower Report***:
  - **Purpose:** It is recognised that hydropower (pumped storage, reservoir and run-of-river) capacity has grown significantly since 2000, and that the growth of the sector needs to continue as part of progress towards ***NZE***. In this context, the ***IEA*** presents forecasts 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

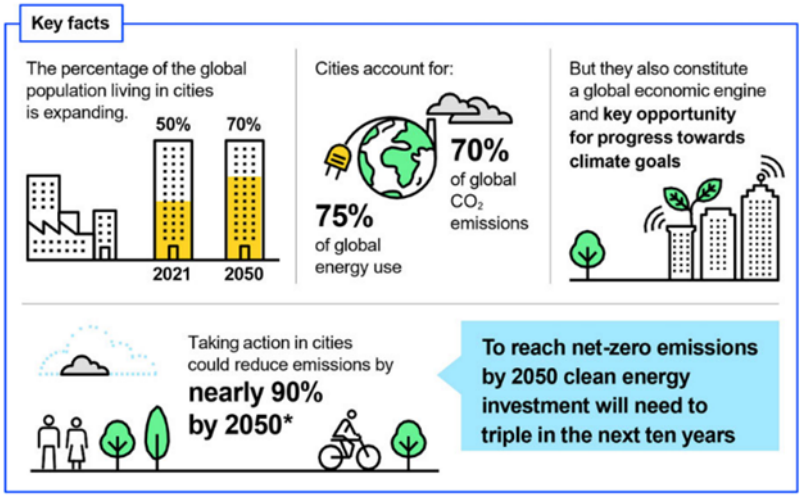


While this represents a 17% increase 2021 to 2030, it is a slower rate of increase than occurred 2010-2020. The ***IEA*** considers that this slower rate of increase will be a missed opportunity. In this context, the ***IEA*** identifies seven priority areas for governments so as to avoid missing the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

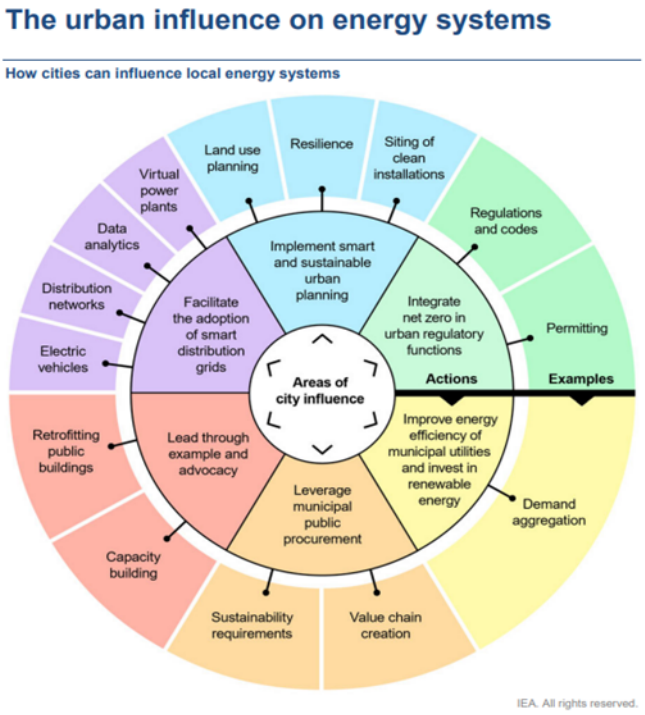
- Move hydropower up the energy and climate policy agenda;
- Enforce robust sustainability standards for all hydropower development with streamlined rules and regulations;
- Recognise the critical role of hydropower for electricity security and reflect value through remuneration mechanisms;
- Maximise 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.

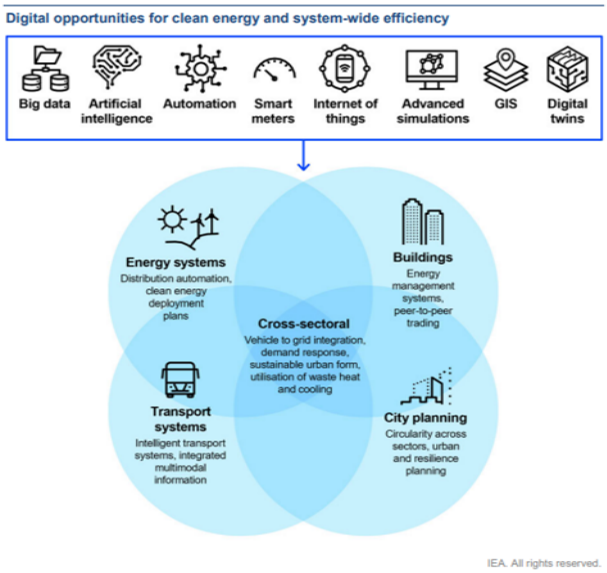
- ***Smart Cities Report*:**
  - **Purpose:** It is recognised more than 50% of the world's population lives in cities, and that this concentration will increase as the pace of urbanisation increases, and the standards of living increase, overtime in countries whose populations are continuing to grow, 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:

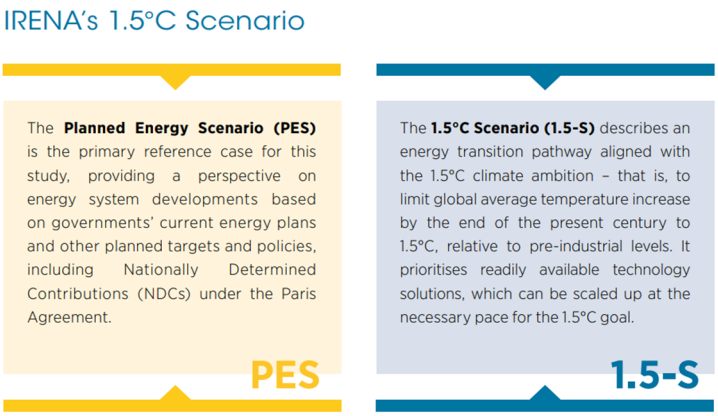
- Design inclusive policies and programmes with people at their core;
- Build capacity across digitalisation and energy;
- Ensure timely, robust, transparent access to data;
- Ensure the availability of finance and promote financial innovation;
- Promote the development and uptake of international standards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

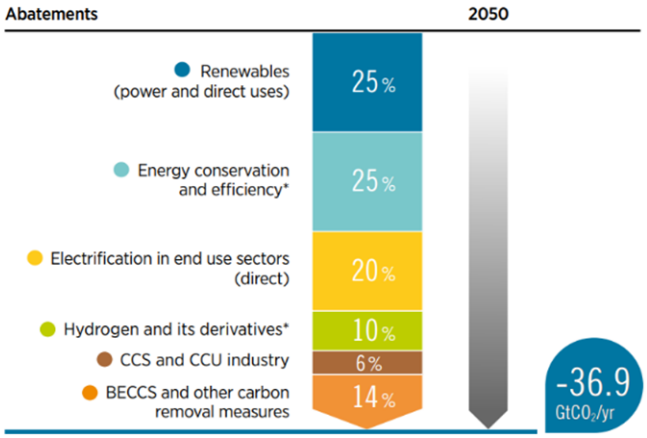
- ***IRENA* Reports during July, 2021 (and late June)**
  - *World Energy Transition Outlook: 1.5°C Pathway* (***WETO***); and
  - *Renewable Power Generation Costs in 2020* (***RP Report***).
- ***WETO***: The ***WETO*** was long-awaited, not least because it was previewed in Q1 of 2021 (***Preview 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***).

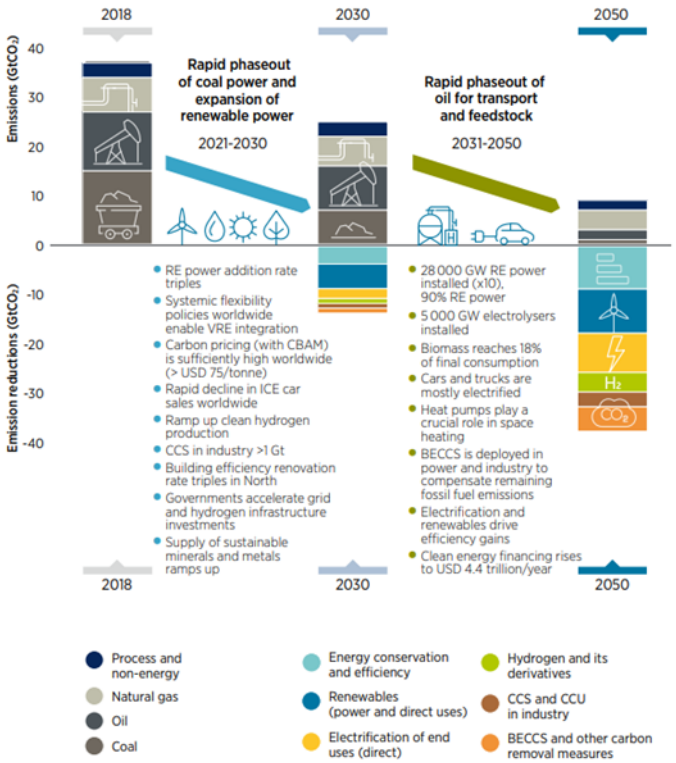
- **Findings:** The findings of ***WETO*** are many and varied, and the findings are best summarised in the following graphic that identifies ***IRENA's*** assessment of the sources of abatement of ***GHG*** emissions to achieve ***NZE*** across the energy sector.
  - Abatement as modelled:

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

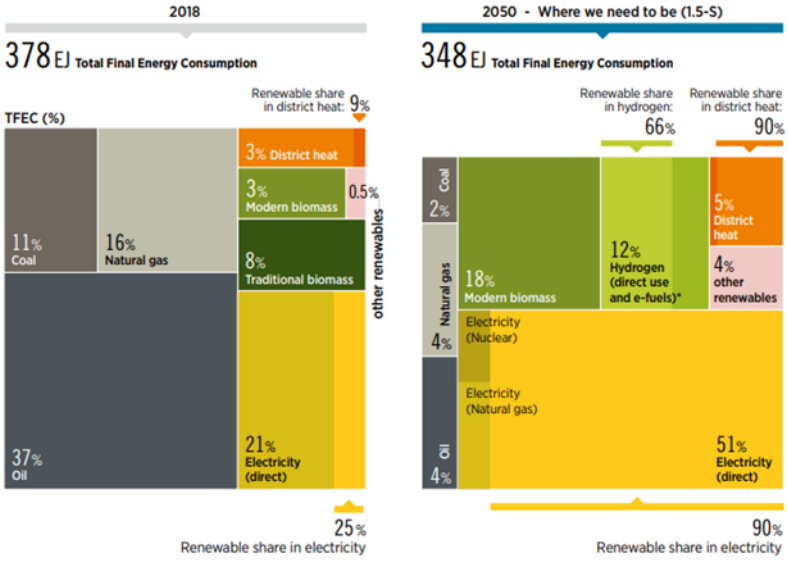


Note: RE = renewable energy; VRE = variable renewable energy; CBAM = carbon border adjustment mechanism; ICE = internal combustion engine; GW = gigawatt; Gt = gigatonne; CCS = carbon capture and storage; BECCS = bioenergy combined with carbon capture and storage; CCU = carbon capture and utilisation.

- **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



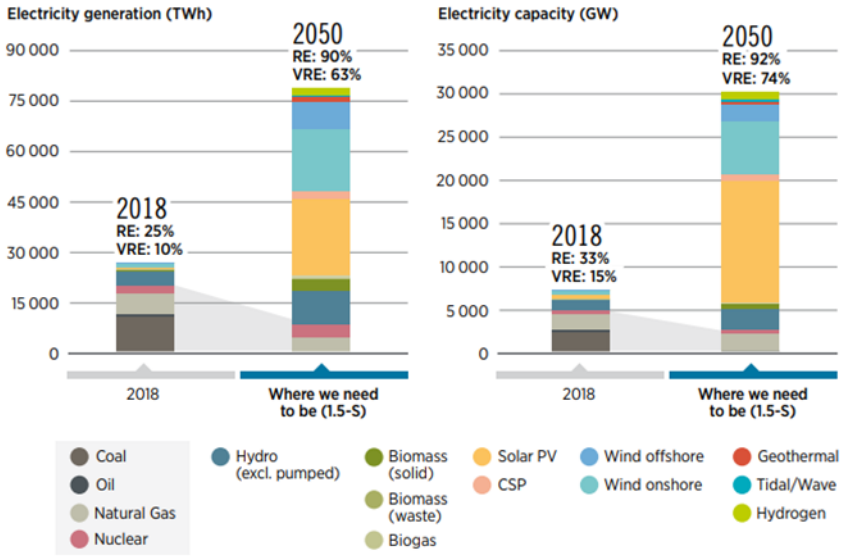
Note: The figures above include only energy consumption, excluding non-energy uses. For electricity use, 25% in 2018 and 90% in 2050 are sourced from renewable sources; for district heating, these shares are 9% and 90%, respectively; for hydrogen (direct use and e-fuels), the renewable energy shares (*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.

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***)	*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 Transition Outlook: 1.5^{O}C Pathway: Preview*
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.

Key Contacts

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

Michael Harrison
Senior Partner, Energy, Resources and Infrastructure

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

Richard Guit
Global Co-Head, International Projects

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

Daniel Reinbott
Partner

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

Peter Vaughan
Partner

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

Dan Brown
Partner

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

Paul Curnow
Partner

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

Michael Burns
Partner

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

Anna-Marie Slot
Global Environmental, Social and Governance Partner

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

Antony Skinner
Partner

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

David Wadham
Office Managing Partner, Tokyo

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

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