REA Member Briefing: Future Energy Scenarios (FES) 2024: ESO Pathways to Net Zero

Introduction

This week, the National Grid ESO published their annual update of their Future Energy Scenarios (FES). *The Future Energy Scenarios 2024: ESO Pathways to Net Zero* lays out different credible ways to decarbonise Great Britain's energy system as we move closer towards the 2050 target.

The report stresses that decisive action is needed within the next two years to deliver the fundamental change required for a fair, affordable, sustainable and secure net zero energy system by 2050. Particularly when considering the long investment cycles needed for gas networks, electricity transmission lines and domestic heating systems.

This year's FES marks a considerable turning point, as later this year the National Grid ESO will transform to become the National Energy System Operator (NESO).

NESO will be involved in the strategic planning of gas and electricity networks, integrating them for the first time to develop a comprehensive whole system plan for future network development. NESO will develop a whole energy system view of future market direction so actions can be recommended to optimise markets across vectors and reduce costs for consumers. The Operator will also provide independent advice to Government and Ofgem on energy policy developments.

What's more, in recognition of the expansive industry transformation required, this year's Future Energy Scenarios (FES) framework has evolved from 'scenarios' to 'pathways' to explore narrower ranges and strategic, credible choices to propel us on the route to decarbonisation.

The three new net zero pathways are **Holistic Transition**, **Electric Engagement** and **Hydrogen Evolution**. The framework also features a Counterfactual pathway, which does not meet net zero.

This year's FES report includes 8 key actions. These can be seen in the image below:

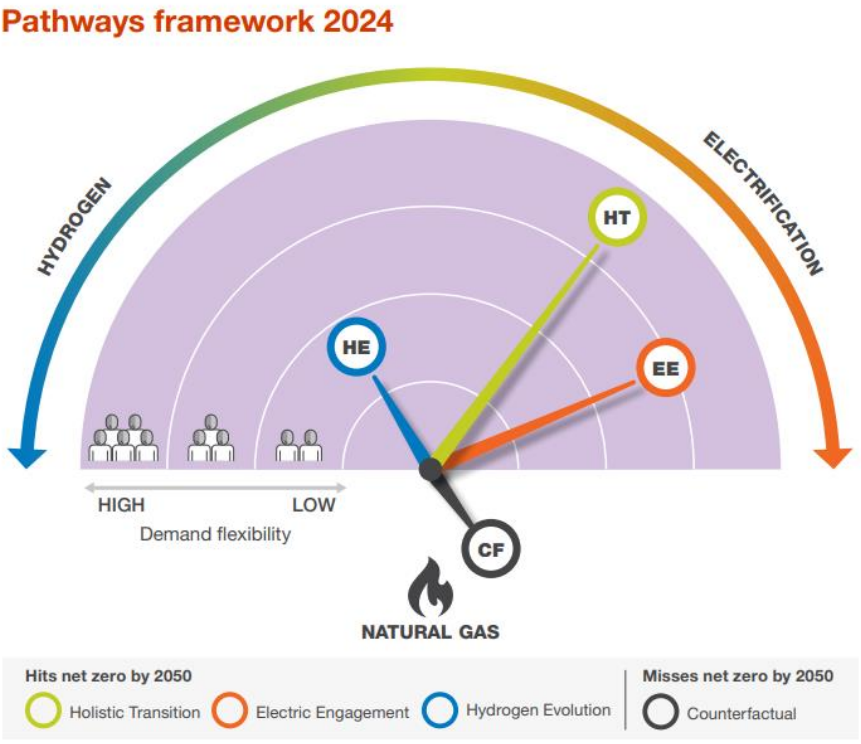
Actions:

1. Accelerate the delivery of whole system infrastructure through a strategic approach to network investment and introduction of planning reforms.
2. Deliver market reform, considering electricity, gas, hydrogen and CO_2, to ensure we have energy markets that provide for and work with a reliable and strategically planned energy system.
3. Prioritise the use of hydrogen for hard-to-electrify applications. Agree business models and kick-start delivery of the hydrogen and CO_2 transport and storage infrastructure needed for system flexibility.
4. Accelerate progress on low carbon heating including faster rollout of heat pumps irrespective of a decision on hydrogen for heat.
5. Deliver innovation and build consumer trust in affordable smart technology, enabling consumers to save on energy costs while helping with the management of Great Britain's electricity system.
6. Focus on energy efficiency improvements across all sectors to reduce overall energy demand.
7. Expedite the delivery of clean, low-cost and reliable new technologies and long-duration energy storage connected to the system by reforming the connections process.
8. Invest in supply chain and skills to deliver the low carbon technologies and infrastructure needed for net zero and enable the UK to become a world leader.

Future Energy Scenarios 2024 Framework

The new framework marks a move away from reactive scenarios to strategic network planning and seeks to identify credible, strategic routes to net zero. Through consultation, analysis and stakeholder engagement, the new framework:

- Replaces the four scenarios with three net zero 'pathways'
- Includes a 'Counterfactual' which does not meet the 2050 net zero target
- Retains our Five-Year Forecast (5YF) in our data workbook



The range presented in the pathways no longer represents the widest credible possible outcomes, but a narrower set of routes to net zero. It is important to note that there is still considerable uncertainty and there remains some variation across the pathways in some key areas, such as the level of consumer engagement and interactions between different fuels, as shown on the new framework diagram below.

The pathways are a subset of the envelope of possible outcomes. They are ambitious and will require decisive action if we are to move away from the Counterfactual and achieve net zero targets.

The Pathways in relation to our Power and Flexibility Pillar

Decarbonisation of the power sector will mark a critical milestone in our journey to become net zero by 2050. One of the crucial first steps towards this will be establishing the infrastructure needed across Great Britain for all low carbon fuels to work together, with strategic development of energy networks, markets and technologies. Reforms to planning, markets and connections must now continue at pace, and this will rely on investment in supply chains and skills.

An efficient and reliable system with increased levels of renewables will also need increased levels of flexibility. Our net zero pathways each demonstrate the importance of the interactions between low carbon fuels and technologies, alongside electricity storage, interconnectors and demand side flexibility to deliver a balanced system.

All net zero pathways achieve a decarbonised power sector by 2035 at the latest.

Holistic Transition and **Electric Engagement** achieve this in 2033 and 2034 respectively. This is driven by high levels of wind and solar uptake, reduced use of unabated gas and initial deployments of bioenergy with carbon capture and storage (BECCS).

At a glance:

- Across all net zero pathways, at least 94 GW of wind and solar is connected in 2030, with 121 GW connected in **Holistic Transition**.
- Between 40–51 GW of electricity storage is operating by 2050 in all our net zero pathways, with 26–35% of this connected at distribution level.
- There is over 33 GW of electrolyser capacity and 19 TWh of hydrogen storage needed in Holistic Transition in 2050.
- Imported gas volumes fall to between 15–56% of 2023 imports across the net zero pathways.

Electricity

Holistic Transition sees unabated fossil fuel generation reducing sharply to zero after 2035. Any remaining fossil fuel usage is abated through CCS. This pathway has the

highest renewable dispatch from wind and solar, reaching 581 TWh in 2050. Electricity storage generation, needed to enable the renewable transition in this pathway, is also the highest of the net zero pathways and reaches 17 TWh in 2050. Interconnectors start to export to the rest of Europe post-2030.

Electric Engagement has the highest total electricity generation in 2050. As with the other pathways, offshore wind generation makes up most of the generation output. Unabated fossil fuel generation output falls to zero by 2045. Interconnectors start to export to the rest of Europe post-2030.

Hydrogen Evolution sees some unabated gas remaining in the system in the later years for security of supply. This pathway has the highest gas CCS and hydrogen generation, reaching 66 TWh in 2050. As with all pathways, electricity generation from renewable sources increases out to 2050 with offshore wind accounting for the majority of this. Interconnectors start to export to the rest of Europe post-2030.

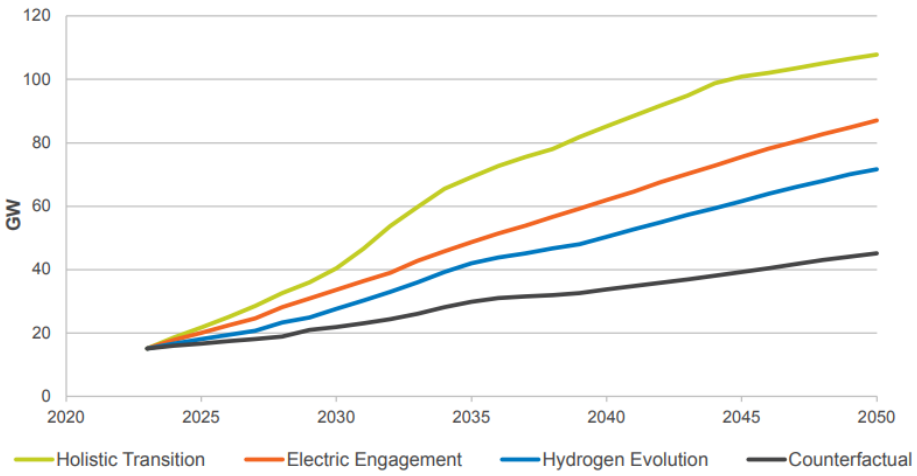
Solar

Holistic Transition sees the Government's ambition of 70 GW installed capacity by 2035 met in 2036. This pathway assumes higher consumer engagement, leading to a greater volume of micro-solar (less than 1 MW) generation. Solar generation is co-located with flexible technologies at different connection voltages to optimise grid connection, such as electrolysis to produce hydrogen or grid-scale battery storage for solar farms.

Electric Engagement assumes lower consumer engagement, leading to lower deployment of micro-solar generation in the residential sector. This pathway sees less colocation between solar and other flexible assets compared to Holistic Transition. The 70 GW Government 2035 ambition is met in 2043.

Solar

Figure ES.14: Solar capacity



Bioenergy with Carbon Capture and Storage

This year's FES calls for clear and robust sustainability criteria for biomass feedstocks. Future deployment of BECCS will rely on both scaling up domestically grown biomass feedstock and increasing imported biomass feedstock. The supply of sustainable domestic biomass resources needs to be scaled up rapidly. Availability of domestic and international feedstocks should be assessed regularly

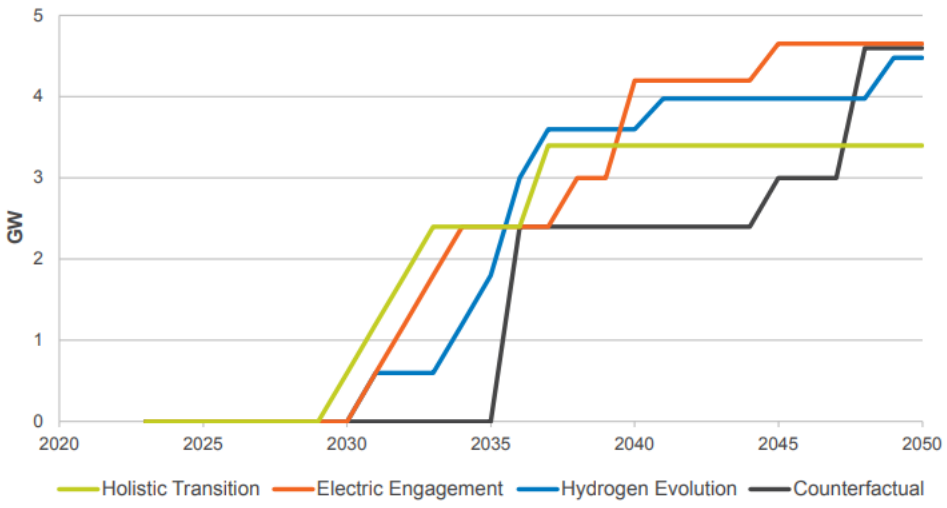
All net zero pathways see levels of BECCS grow. This growth is driven by requirements for baseload generation and conversion of existing unabated biomass plants to BECCS but is limited by sustainable biomass fuel availability.

Holistic Transition has the lowest levels of BECCS. This pathway prioritises emissions reductions through demand side reduction and has the highest levels of DACCS, an alternative negative emissions technology.

Electric Engagement and **Hydrogen Evolution** have higher levels of power BECCS, reaching around 4.5 GW by 2050 due to reduced levels of DACCS.

The Counterfactual sees the first increase in BECCS in 2035, with lower growth until 2045. After this point, BECCS capacity increases to serve as baseload.

Figure ES.24: Bioenergy with carbon capture and storage capacity



Managing the Energy System: Grids and Network

Strategic and timely investment across the whole energy system is critical to achieving decarbonisation targets and minimising constraints. Coordinated planning and delivery of strategic, whole system investment through the SSEP, CSNP and Regional Energy System Planner (RESP) need continued collaboration with UK Government, Ofgem, local communities, industry and the supply chain.

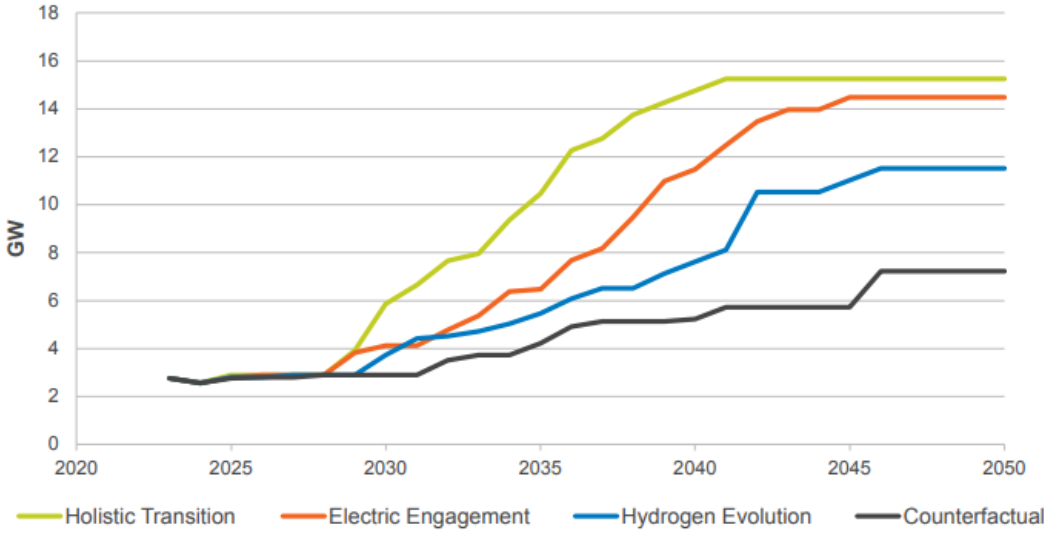
Connections reform is required to facilitate quicker, more coordinated and efficient connection to Great Britain's energy system. The process must be future proofed to facilitate potential prioritisation of connections for delivery of whole system benefits and net zero, in line with strategic network planning.

Managing the Energy System: Flexibility

Increased levels of renewables will also need increased levels of flexibility. The pathways demonstrate the importance of the interactions between low carbon fuels and technologies, alongside hydrogen and electricity storage, including LDES, interconnectors and demand side flexibility to deliver a balanced system.

Policy support for energy storage is essential to help bring forward the investment needed for long-duration energy storage. With the retirement or conversion of unabated gas plants post-2030, delivering the levels of energy storage and low carbon dispatchable power needed for security of supply will be essential.

Figure ES.17: Long-duration energy storage installed capacity (excluding vehicle-to-grid and hydrogen)



The Pathways in relation to our Heat Pillar

This year's FES report recognises that decarbonising heat remains one of our biggest challenges in reaching net zero.

Residential Level

All net zero pathways follow similar electricity demand in the short term from similar heat pump uptakes. The range in electricity demand up to 2035 is influenced by the range in heat pump efficiency projections.

A phase-out on the installation of new gas boilers in 2035 is required to make sure Sixth Carbon Budget targets are met. This also prevents the decommissioning of any gas boilers installed after this point and potentially before the unit's end of life, to achieve the 2050 net zero target.

Holistic Transition and **Electric Engagement** see fast decarbonisation of heat compared to historic trends. These are only slightly faster than **Hydrogen Evolution**, which has the slowest rate while still achieving emissions targets.

All pathways see a range of low carbon heating technologies but have varied access to hydrogen. To ensure a sufficient pace of heat decarbonisation, all pathways to net zero require supportive policies for all technologies

The report outlines that heat pumps will be suitable everywhere and encourage the development of heat networks particularly in dense areas. They highlight that the government needs to rapidly come to a decision on the use of hydrogen for heating.

Figure EC.14: Residential annual electricity demand for heat

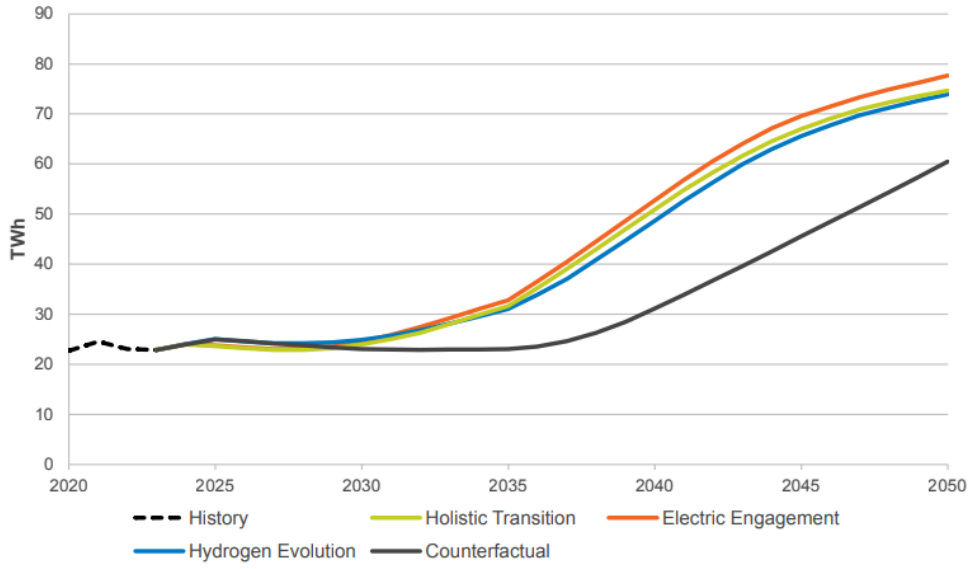
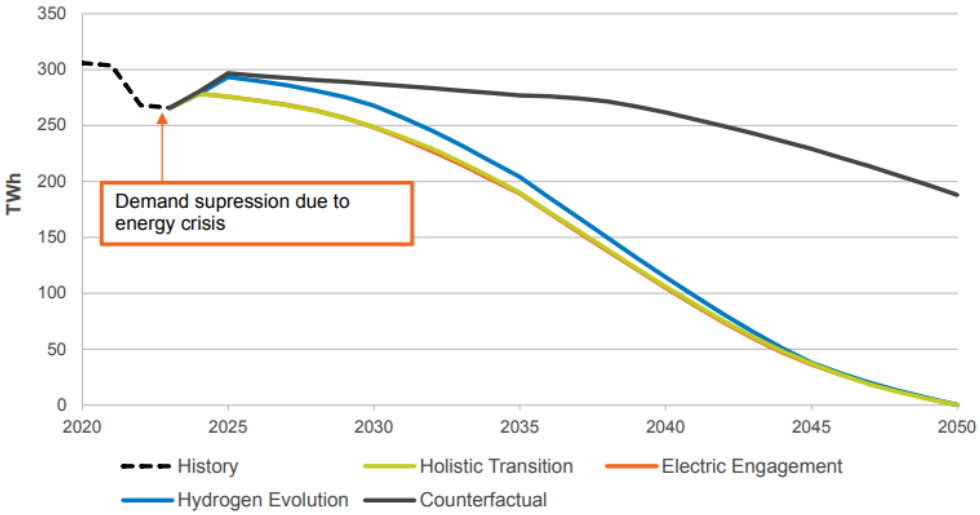


Figure EC.15: Residential annual gas demand for heat



Commercial Level

At a commercial level, **all net zero pathways** feature a phase-out of gas and oil boilers for heating new commercial buildings from 2025, followed by a phase-out of new installations in existing commercial buildings in 2035. These pathways also feature varying degrees of hydrogen for commercial use where it can be made available.

Industrial Level

At an industrial level, **all net zero pathways** see fuel switching from gas to electricity in the 2030s at varying rates. In pathways with lower levels of access to hydrogen, large facilities located further away from industrial hydrogen clusters will see higher levels of electrification, to decarbonise alongside the use of abated gas or biofuels to a lesser extent. A limited amount of industrial gas usage remains out to 2050 for gaseous processes which cannot be electrified, with associated emissions abated with CCS.

The FES report does recognise that bioenergy, including biomass for heating, can play a role in the net zero transition providing the value chain is sustainable. However, it did not specify how much of a role it could play for heating domestic or non-domestic buildings, or in industrial processes.

Shared ground loop heat pumps are highlighted as a potential novel solution for heating buildings. Furthermore, deep geothermal (or Enhanced Geothermal Systems) are recognised as an emerging technology in the latter part of the report.

The Pathways in relation to our Transport Pillar

Across all net zero pathways, we will see low levels of hydrogen buses and coaches on the roads, with BEVs dominating due to their lower operational costs.

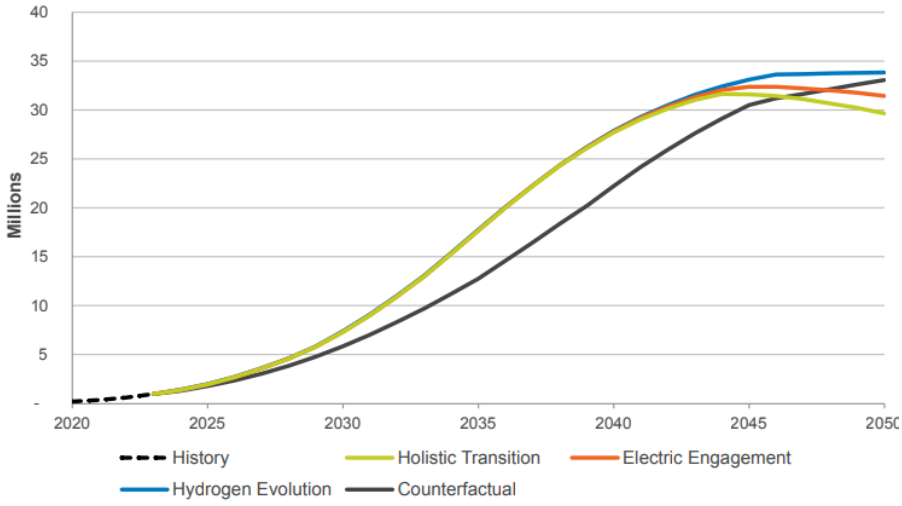
Battery Electric Cars (BEVs)

All net zero pathways follow the targets of the ZEV mandate, as BEV cars provide potential to accelerate the decarbonisation of the industry. Deviation from the mandate would require increased action in other sectors to make hitting targets within the Sixth Carbon Budget feasible.

The pathways begin to diverge in the 2040s, accounting for an increase in shared autonomous vehicle (AV) usage which reduces car ownership at varying levels across the three net zero pathways. **Holistic Transition** features the most AV usage, reducing the number of BEV cars on the road by 2m from 2044 to 2050.

The **Counterfactual** has a slower BEV car uptake than the UK Government's ZEV mandate, with BEVs only reaching 100% of new car sales by 2040 (five years after the net zero pathways) and fails to meet the Sixth Carbon Budget.

Figure EC.06: Battery electric cars on the road



Other Battery Electric Vehicles

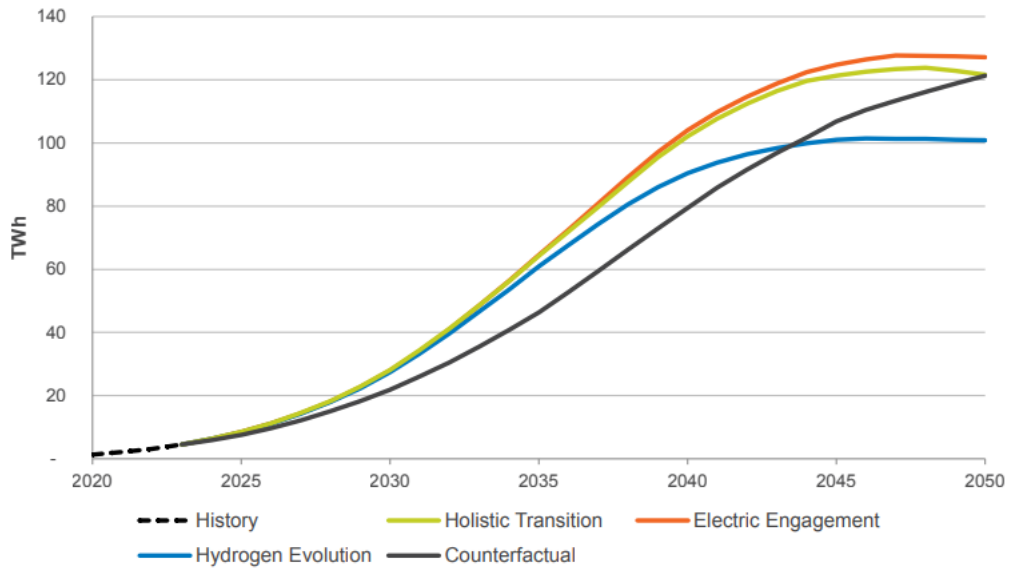
All net zero pathways follow the ZEV mandate for vans. Buses and coaches are predominately electrified in all net zero pathways by 2050, with hydrogen vehicles still in use for longer journeys.

Motorcycles are heavily electrified in all net zero pathways and meet an ICE ban date in 2030 for small motorcycles and scooters and 2035 for larger motorcycles.

Holistic Transition and **Electric Engagement** see high levels of electric HGV uptake, starting with lighter vehicles as the technology develops and gradually becoming more competitive in the heavier HGV market. The electrification of road transport sees a 122 TWh increase in electricity demands in 2050 in Holistic Transition, and 127 TWh increase in 2050 in Electric Engagement.

Hydrogen Evolution mainly sees the electrification of lighter HGVs, with the requirement for larger vehicles (approximately half of all HGVs) forecast to be met by fuel cell electric vehicles (FCEVs).

Figure EC.07: Electricity demand for road transport



Charging and Vehicle to Grid

The report calls for an increased need for consumer trust in smart chargers. Additionally, more investment is needed in on-route rapid charging infrastructure. Greater emphasis needs to be placed on improving competitive off-peak charging for consumers without home chargers.

The maximum capacity of Vehicle to Grid (V2G) is expected to be around 2GW in the Holistic Transition in 2030, with this rising to 18GW in 2035, and 65GW in 2050.

Meanwhile, as peak demand is expected to reach 109GW in 2050, V2G will be able to offer 32GW (accounting for vehicles likely to be on the road during this window).