REA Members Brief:

NESO Future Energy Scenarios 2025 – REA Summary

NESO's Future Energy Scenarios 2025 (FES 25) is an annual release which models how UK energy systems could evolve by 2050. The report focuses on four main scenarios, three of which manage to decarbonise the energy system to meet the UK's legally binding net zero targets.

The four scenarios:

1. **Holistic transition**: Our 2050 net zero targets are met through a holistic approach using both electrification and hydrogen.
2. **Electric Engagement**: Net zero is mostly hit through electrified demand, with significant consumer engagement in technology that reduce energy demand, such as heat pumps and EV's.
3. **Hydrogen Evolution**: Net zero is met through fast adoption of hydrogen, in industry and heat, with widespread access to a national hydrogen network.
4. **Falling Behind**: The only scenario that fails to meet net-zero, reflecting partial progress but not at the scale to hit net-zero.

Flexibility:

The report is clear – NESO highlights that greater levels of flexibility, both on the supply and demand side, are essential to maximising the benefits of low-cost renewable energy and creating a system that works for consumers.

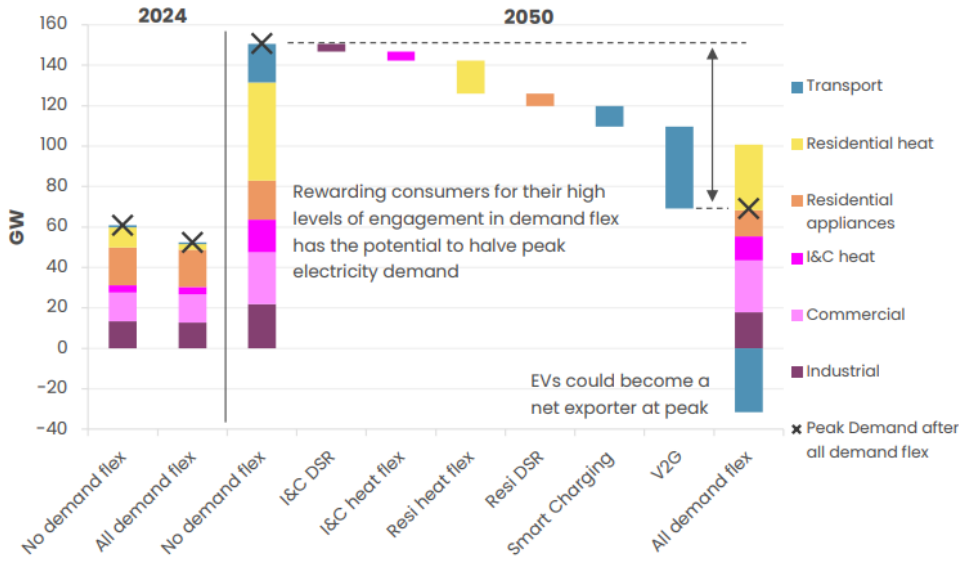
While today's flexibility is largely delivered by the supply side, NESO highlights the urgent need to scale up consumer flexibility in the years ahead which can lower system costs and allow households and businesses the ability to better manage energy usage.

Demand flexibility is framed not just as a system requirement, but as a consumer opportunity. By 2050, demand-side measures, with technologies such as EV smart charging and flexible heat pumps could cut peak demand by up to 54% by delivering significant shifts in peak energy use (83% and 36% respectively).

The report presents a clear progression pathway through three phases: Acceleration, Growth, and Horizon.

- **Acceleration** focuses on empowering consumers who are ready and willing to engage now. Smart tariffs, smart meters, and innovations like vehicle-to-grid are key tools in this phase. NESO identifies the Low Carbon Flexibility Roadmap as a first strategic step in identifying and targeting different sources of flexibility.
- **Growth** is characterised by the widespread rollout of smart energy solutions that integrate seamlessly with daily life. Consumers should be able to access flexibility services without the technical knowledge to do so. Innovations in heating, EVs, and automation will allow energy use to flex around lifestyles rather than the other way round. This phase also calls for increased participation from industrial and commercial sectors, including high-temperature processes and cooling for data centres.
- **Horizon** looks towards a fully developed, consumer-driven energy system by 2050. User-friendly technology will support informed, ongoing engagement. Tools and services will be embedded in daily routines, unlocking the full potential of low-cost renewable energy. Notably, vehicle-to-grid is projected to deliver up to **41 GW of peak flexibility** and EV's are touted as a net exporter at peak. This phase builds on innovation and trust developed in earlier stages, ensuring long-term consumer confidence and participation.
- NESO flags several uncertainties that will influence the cost and trajectory of the future system.From consumer engagement levels to global commodity prices, AI uptake, and demographic trends. However, the message is consistent: increasing flexibility, particularly on the demand side, is essential to a cost-effective transition.

6. Demand flexibility reduces both peak electricity demand and the need for supply side infrastructure.



As shown by the graph above, this report reinforces the centrality of flexibility to the UK's energy future and highlights the growing role of consumers – domestic, commercial and industrial – in delivering it. REA members should take note of three key points:

- **Consumer participation is not optional** – it is now a central design feature of the system. Technologies and services that make participation simple and beneficial will be prioritised.
- **System value will increasingly flow to those who can provide or enable flexible behaviour** – either directly or through automation.
- **There is a strategic policy and market opening around smart tariffs, automation, and behind-the-meter flexibility** – especially in heat, EVs, and data centre demand.

The REA will continue to track how this vision develops and support members in navigating the policy, regulatory and market implications. If you are developing, enabling or depending on demand flexibility, please get in touch – rmaschietto@r-e-a.net

Electricity Storage:

- On the Holistic Transition Pathway, the supply side flexibility would be high, delivered through electricity storage (along with interconnectors). This is true when following theElectric Engagement pathway as well.
- Total storage capacity today (2024) is currently around 10GW (2.8GW of Long Duration Energy Storage and 6.8 GW of Batteries).
- By 2030, Long Duration Energy Storage (LDES) should be totalling 3-5.3GW, by 2040 it should be 9.2-14GW and by 2050 it should be 13.2-16.6GW.
- By 2030 Battery Energy Storage Systems (BESS) should have a total capacity of 20.5-25.2GW;by 2040 this should increase to 28.3-35.6GW and by 2050 there should be 31.2-40.4GW of BESS capacity in the UK energy mix.
- LDES, along with low carbon dispatchable power will be crucial for decarbonising the remaining demand from 2040-2050 as we get closer to Net Zero, and where fossil fuels are purely used for security of supply.
- The Holistic Transition Pathway offers the most utilisation of storage capacity by 2050 followed by the Electric Engagement Pathway and then the Hydrogen Evolution Pathway.
- 4.7- 4.8% of homes should be using electricity storage by 2035, 4.8% if the Holistic Transition Pathway is followed, and by 2050, this should increase to 5.8% if the Holistic Transition Pathway is followed, 11.8% if the Electric Engagement Pathway is followed and 9.1% if the Hydrogen Evolution Pathway is followed.
- In all pathways NESO may very well look to utilise Demand Side Response more often instead of using electricity storage as a source of flexibility, to save costs and reduce the build out of grid-scale electricity storage assets.

Carbon Capture and Storage and negative emissions:

- The FES highlights that engineered carbon removals are necessary from the 2030s, together with carbon removals from the land sector, to offset residual emissions in hard-to-decarbonise sectors such as agriculture and aviation.
- While not directly in scope, the report does note the role of nature-based carbon removals enabled by Land Use/Land Use Change and Forestry. These kinds of interventions, including tree planting and peat bog restoration can deliver roughly half the net carbon removals required by

2050 (30 MtCO2e), yet cannot deliver all the scale and speed of required removals and do not always result in permanent removals. Therefore, the report notes these must be supplemented by engineered removals which can offset the remaining need for carbon removals and are expected to yield more permanent removals.

Biomass and Energy from Waste:

- As mentioned above, **Carbon Capture and Storage (CCS)** features heavily in the report and is seen as essential to broader decarbonisation efforts, noting a "targeted and strategic need for CCS."
- While recent government funding for CCS is positive, the report notes that there "remains a significant gap between this [funding] and what is required" for medium- and long-term ambitions.
- **This report should be seen as a continued endorsement of the role of CCS and justification for further government support.**
- Within this report's work on CCS, Biomass features heavily (and to lesser degree Energy from Waste). **BECCS is emphasised as a "cornerstone of the required engineered carbon removals"** and has a crucial role in all future scenario planning. For example, the Electric Engagement pathway suggests BECCS capacity climbing from 0.6 GW capacity in 2030 to as much as 4.2 GW by 2050.
- The report projects most forms of biomass power generation shifting towards BECCS with the role of **some unabated facilities acting as dispatchable** solutions to short-term solar and wind output issues. BECCS facilities should take high priority for connection to CO2 networks.
- The **volume of biomass power** is predicted to decline in two scenarios and remain the same in another scenario. However, the assumptions behind these will require further analysis. The report predicts an increasing role for biomass in **biomethane production** and **sustainable aviation fuels**, alongside BECCS carbon removals.
- Regular reference is made to the government's 2023 Biomass Strategy – indicating that the strategy continues to inform working assumptions. In particular, **biomass supply** and the need for a **common framework for biomass sustainability** is emphasised. The report highlights the need for a "clear pathway to having the right kind of domestic feedstock, in the right location, at the right time" – and pathways assume that by 2050, that

feedstock will come from a diverse mix of forest residues, energy crops, agri-residues and biogenic wastes.

- According to the Committee of Public Accounts report earlier this year, timing on the **Common Biomass Sustainability Framework Consultation** remains unclear, noting that it will occur "at some point in 2025", The REA is keeping a close eye on this.
- It is also worth noting that stakeholders **felt that the biomass needs greater policy and economic support for CCS from government,** further emphasising the need for coordinated cross-sector advocacy.
- The report mentions the importance of enabling capital investment through policy design, and that "government consultations have confirmed that a dual CfD approach for both electricity generation and carbon removal is preferred and economic incentives for BECCS are provided to encourage widescale deployment."
- **Energy from Waste** features in future planning scenarios, particularly with CSS, but remains a niche contributor. There is brief reference to the ETS inclusion, with no mention of potential complexities ahead of any UK and EU ETS linkages. Further analysis is needed to understand the assumptions behind predictions.

What does this mean for members?

The report could be seen as a **tacit endorsement of existing industry efforts** to pursue CCS and the need for **further government support** albeit offering nothing substantively new. **Members and the REA can use this report's findings to further make the case for this support.**

Gaseous fuels:

Natural Gas:

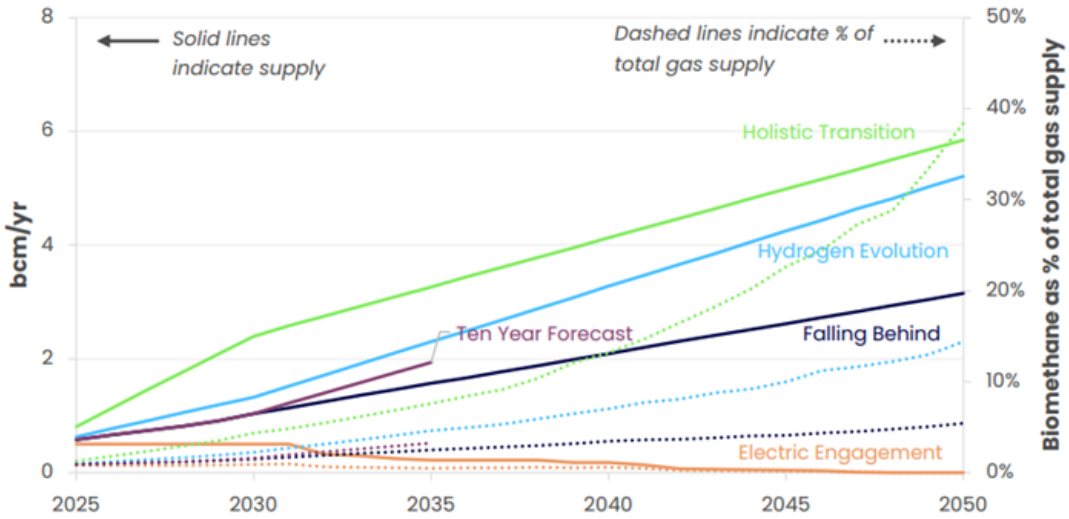
- Across the 4 scenarios, there is a significant use of natural gas: for dispatchable electricity production, hydrogen production and in heavy industry - where it can be paired with CCS.
- Unabated natural gas for electricity production accounts for capacity of 45 GW in Falling Behind, but only 11GW, 6GW or 0GW in the Hydrogen, Electric and Holistic pathways respectfully up to 2050. These have load factors of around 12-13%.

- Low carbon dispatchable capacity (natural gas with CCS) have an installed capacity of around 50GW for the three scenarios aside from the Falling Behind scenario where there is only 17GW of capacity.
- These figures are in line with previous assumption that natural gas will still be used in 2050. However, given the Governments recent pledges for the industrial clusters that will include CCS and H2 from SMR there is now an actual pathway to how Net Zero 2050 can be achieved while continuing to use natural gas.

Biomethane:

- Following the disappointing role for biomethane in the CCC's 7th Carbon Budget the role for biomethane in FES2025 is far more encouraging, recognising the role biomethane can play and the potential volumes.
- Figure 70 extracted from the report gives the clear indication that there is a significant role for biomethane both in terms of the total volumes and in the percentage of total gas supply.

70. Biomethane supply



- The Electric Engagement projects that biomethane will pay almost no contribution by 2050. Instead, this scenario relies heavily on natural gas (either unabated or with carbon capture and storage), which is expected to provide nearly 60 GW of electricity generation capacity. However, even in a highly electrified energy system, there remains a critical need for sustainable organic waste treatment—a need that anaerobic digestion

(AD) is well-suited to meet, whether for biomethane production or renewable electricity generation.

- This Electric Engagement scenario assumes the absence of gas infrastructure to support biomethane transport through the gas grid. This contrasts with the Holistic Transition pathway which assumes around 280TWh of gases (including biomethane, natural gas and hydrogen) will be transported through the gas networks in 2050.

Table 36: A list of key outputs from our FES 2025 models covering supply from biomethane.

Modelling assumptions	Holistic Transition	Electric Engagement	Hydrogen Evolution	10 Year Forecast	Falling Behind
Biomethane supply by 2035	36 TWh	2 TWh	25 TWh	21 TWh	17 TWh
Biomethane supply by 2050	64 TWh	0 TWh	57 TWh	N/A	35 TWh

- By contrast, it is encouraging to see the significant role biomethane plays in the medium (2035) and longer term. Indeed, it will require significant ramping up of biomethane production to meet the 2035 scenarios in addition to the 2050 scenarios. Even when the Holistic Transition of 64TWh of biomethane is only half of the 120TWh potential identified by Alder BioInsights for the Green Gas Taskforce report, our current rates of deployment are not going to achieve any of the assumptions, other than Electric Engagement. This highlights the importance of the Future Support Framework for Biomethane beyond 2028 to support increasing biomethane production volumes to meet future requirements.

Hydrogen:

- Hydrogen development is a complex picture of electrolytic green hydrogen and SMR with CCS blue hydrogen in addition to the transport and storage of H2.
- No Hydrogen projects in the UK have reached final investment decision which includes HAR1 and HAR2 or any of the large hydrogen clusters.
- The Holistic and Electric scenarios have modest amounts of production capacity at 22GW and 19 GW respectfully but much greater amount in the Hydrogen Evolution of 58GW. Interesting point is that they estimate 7.1GW of capacity in their 10-year forecast (2035) when currently there is only 448 MW under construction and 764MW with planning approval. These figures indicate a ramp up of development in the near future to meet the capacity deployment and 19TWh of production.

Table 37: A list of key inputs and outputs from our FES 2025 models covering supply from hydrogen.

Modelling assumptions	Holistic Transition	Electric Engagement	Hydrogen Evolution	10 Year Forecast	Falling Behind
Hydrogen supply in 2035	33 TWh HHV	15 TWh HHV	91 TWh HHV	19 TWh HHV	2 TWh HHV
Total hydrogen production capacity in 2050	22 GW	19 GW	58 GW	7.1 GW (in 2035)	4.8 GW

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- Hydrogen production is prioritised for sectors with few alternatives and to provide specific roles such as reduction in renewable electricity curtailment for electrolytic production and then use in flexible electricity production.
- These will require the development of transmission networks, particularly to transport hydrogen from the North of Scotland where most wind curtailment is experienced today, and significant storage at suitable sites, such as Cheshire where there are sites suitable for salt cavern developments.
- Overall, there will be a requirement for at least 250TWh of gases in 2050 and it's great see recognition that biomethane can make a significant contribution of at least 65TWh. This is up from the 30-40TWh of potential identified in the Biomass Energy Strategy published in 2023 but short of the 120TWh identified by Alder BioInsights. Hydrogen is predicted to make a significant contribution of 33TWh by 2050 but even though a strategy on how this will be achieved is developing the details are not clear yet. HAR3 and HAR4 along with the details of hydrogen transmission and storage are pivotal to achieving hydrogen potential at the scales predicted.
- Overall, a great news for renewable gases following the disappointing figures published by the CCC in the 7th Carbon Budget just six months ago.

Electric Vehicles:

- The report makes projections on the numbers and %'s of electric vehicles on the road across various milestones. This now also includes fleet vehicles.
- For cars, it confirms the ZEV mandate is hugely successful and by 2050 estimates there will be between 31.5-36.1 million electric cars on the road. Estimates vary but there are around 29 million petrol and diesel cars on the road today.

NESO say these numbers are achieved through:

- A deployment of chargers that meet consumer requirements without access to home charging, alongside growth in rapid enroute chargers across all regions of Great Britain.
- Reductions in the cost of public charging through the lowering of VAT and reduction in standing and capacity costs.
- Growth in enroute charging infrastructure which lowers the need for long range batteries as well as increase in demand and effectiveness of smaller electric vehicles.
- Clear, updated information on charger locations, myth dispelling, and clear communication that rapid chargepoints are not the normal way for most consumers to regularly charge.

For Vans, Buses and HGVs the modelling is also encouraging:

Table 9: A list of key outputs from our FES 2025 models covering energy demand from other electric vehicles.

Modelling assumptions	Holistic Transition	Electric Engagement	Hydrogen Evolution	10 Year Forecast	Falling Behind
Vans on the road in 2035 that are EVs	56%	56%	56%	46%	33%
Buses on the road in 2035 that are EVs	52%	52%	53%	40%	27%
Share of HGVs on the road that are electric and hydrogen in 2050	93%, 7%	98%, 2%	65%, 35%	N/A	71%, 0%

- Across all scenarios, electric van adoption is expected to accelerate rapidly, driven by the Zero Emission Vehicle (ZEV) mandate, with coaches also seeing significant progress.
- For HGVs and coaches, NESO assumes the deployment of an equivalent ZEV mandate to support uptake. FES now recognises as the CCC (Committee on Climate Change) did earlier this year that hydrogen trucks are simply not a viable long-term solution in most cases.
- This growth is supported by targeted infrastructure developments, particularly using faster grid connections for en-route charging hubs for large and commercial vehicles

Flexibility - EVs

- In the Holistic Transition Scenario, smart charging is expected to become the default for domestic EV charging by 2030, enabled by implementation of a Market Wide Hour Hourly Settlement as soon as feasible.

- By 2030, V2G capacity is projected to reach **1.2 GW**, equivalent to that of a power station.
- In the Holistic Transition scenario, EV's through smart charging and V2G are the largest contributor to flexibility, providing **51GW** at peak time in 2050.
- Crucially the V2G success is underpinned by car manufacturers including V2G in warranty terms.
- We are pleased to say that after conversations with the FES advisory board, we have successfully had commercial vehicles included within the V2G modelling for the first time.
- The report also acknowledges the impact on public CPOs. It states that CPOs in locations with high chargepoint availability may encourage customers to charge outside of the evening peak, rather than in a smaller window off peak window which may have the consequence of lower utilisation. As CPO's start to bring such options to the market, this will be vital to consider.