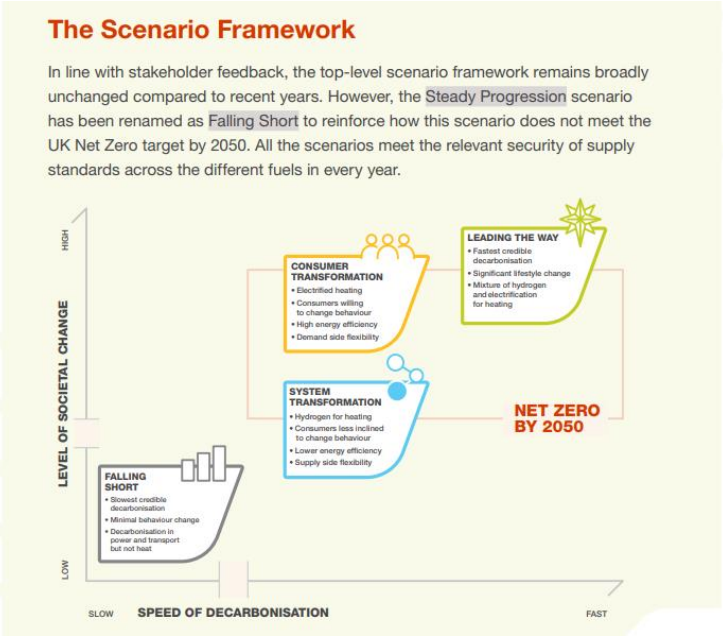
REA Members Brief:
National Grid ESO Future Energy Scenarios 2022

The National Grid ESO's Future Energy Scenarios 2022 (FES 22) is an annual release which models how UK energy systems are likely to change up to 2050. The report focuses on four main scenarios, three of which manage to decarbonise the energy system in line with the UK's net zero ambitions.



The four scenarios:

- **Falling Short (renamed from last year's Steady Progression):** The slowest decarbonisation with minimal behavioural change. Decarbonisation is achieved in power and transport but not heat. Net zero is not met.
- **System Transformation:** Energy system changes predominate with hydrogen being used for heating. There is some supply side flexibility and lower energy efficiency.
- **Consumer Transformation:** Heating is largely electrified, with willing consumer behavioural change. There is both high energy efficiency and demand side flexibility
- **Leading the Way:** The fastest decarbonisation which involves significant lifestyle change. A mixture of hydrogen and electrification is used to decarbonise heat.

On power, the report notes that:

- Electrification of existing fossil fuel energy demand, particularly for heat and transport, and growth in electricity demand in new sectors, will increase annual and peak electricity demands. This will require strategic investment in electricity generation and energy network infrastructure to meet this demand.
- Decarbonising electricity supply is a prerequisite for decarbonisation of other sectors like transport and heat by electrification. Load factors of gas-fired generation reduce significantly in all Net Zero scenarios and, in Leading the Way, there is no unabated natural gas capacity after 2035.
- Wind and solar made up 43% of domestic electricity generated in 2021 and, by 2030, they dominate accounting for 66% even in Falling Short. These levels of renewable output require the corresponding generation capacity to be much larger than previously due to the relatively lower load factor of wind and solar.
- Integrating large volumes of renewables, especially offshore wind, will require strategic whole system planning and coordination, as well as anticipatory investment, to avoid exacerbating existing network constraint
- In all of their Net Zero scenarios, offshore wind makes up the largest proportion of electricity supply capacity by 2030 (at least 50% of generation) and in 2050 wind, solar, nuclear and BECCS provide over 90% of generation output in all scenarios.

Solar

- The report expects continued price reductions, such as the recent removal of VAT on domestic energy efficiency measures, to increase the uptake of solar panels through the late 2020s.
- In each scenario, solar is predicted to make up 30GW (falling short), 50GW (leading the way), 80GW (system transformation) or 90GW (consumer transformation) respectively.

On flexibility, the report notes that:

- Significant levels of demand side flexibility are required to operate the electricity system without unabated natural gas after 2035. Suppliers must be further supported to increase the availability of flexible time-of-use-tariffs so that consumers can respond to market signals and benefit from low prices at times of high renewable output.
- Reforming energy markets to improve price signals will help unlock the flexible solutions needed to integrate renewables efficiently.
- Operating a future energy system with high levels of renewables and no unabated natural gas generation will require significantly more flexible capacity

than we have today. Current market signals mean that flexible assets cannot contribute their full value to the system and may at times exacerbate network constraints - the impact of this will only increase in the future if changes are not made now.

- Market reform is needed to provide the dynamic real-time locational signals required to optimise dispatch and siting decisions of flexible capacity on the whole energy system. Improving locational signals has the potential to deliver significant cost savings to consumers without any adverse impact on renewable targets.
- Consumer engagement with smart appliances and thermal storage will be important to help mitigate the increase in peak residential electricity demand from electrification of heat.

Electricity Storage

- Electricity storage capacity increases in all scenarios to ensure peak demand can be met reliably as an increasing proportion of our electricity is generated from weather dependent renewables.
- The ESO are significantly increasing the amount of storage they expect to see by 2050 and how early it is deployed in all scenarios.
- Large amounts of flexibility with duration of a few hours will be needed to match supply and demand within day. This includes up to 35 GW of electricity storage with an average discharge duration of less than 4 hours by 2050.
- Pumped hydro storage provides almost all our 25 GWh electricity storage volume today and continues to grow in all scenarios. By 2050, it is joined by V2G, Liquid Air Energy Storage (LAES), Compressed Air Energy Storage (CAES) and battery storage. We expect battery storage to make up the largest share of storage power capacity in all scenarios by 2050 to help with shifting demand within the day and managing network constraints as battery costs fall.

Heat

- The report argues a 'one-size fits all' approach to decarbonisation of residential heat is not optimal. This is due to differences in consumer preferences, availability of resources and infrastructure.
    - However, biomass for heat has been left out, having a small role in all scenarios.

- Hydrogen heating take-up develops primarily across the Midlands, East England and the South East, in some areas from as early as 2028 under LW scenario, with air source and ground source heat pumps more dominant in other areas.
- In scenarios where hydrogen is used for commercial heating, this is likely to grow first around dedicated hydrogen clusters in the early 2030s

- Within a national strategy, delivery of targeted solutions and investment should take place at a more regional level. This will leverage local knowledge and improve affordability.
- 23 million homes will have heat pumps by 2050 in the "Consumer Transformation" scenario.
  - Approximately 60,000 heat pumps installed in 2021, well below 600,000 target - could take until 2045 to meet target at this rate
  - 1.1m heat pumps per year is the best case scenario
- Flexibility solutions reduce peak electricity demand from electric residential heating by 38% in the best case "Lead the Way" Scenario in 2050.
- On track foR 4 in 5 homes not using natural gas boiler as primary heat source by 2050 under all scenarios
- Use of oil-based fuels in residential heating largely replaced by electric heat pumps in all scenarios
- Storage and seasonable relationships are likely to play a large role in hydrogen heating
- System Transformation has the greatest inter-seasonal variation, with stored hydrogen peaking in mid-autumn, and declining through the winter as hydrogen heat demands increase. Stored energy reaches a minimum in early spring, before increasing.
  - In Leading the Way the inter-seasonal relationship is still present but much weaker due to lower heating requirements
  - In Consumer Transformation with no heating requirement there is almost no seasonal relationship.
- Industrial heat is significantly harder to decarbonise than other sector

On transport, the report notes that:

- Energy demand for road and rail transport represented 31% of total end consumer energy demand in 2021, and 24% of emissions. This was

overwhelmingly met by oil in the form of petrol and diesel; this oil demand is higher than the total demand on the electricity system today.

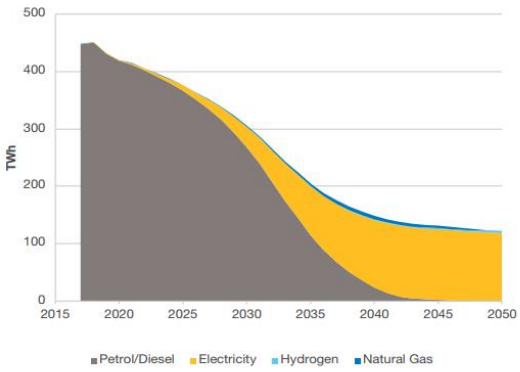
The route to 2050

- In the mid-2020s, higher levels of consumer engagement result in more people opting to use public transport where feasible.
- The 2030 petrol and diesel ban for cars and vans is met, followed by Plug-In Hybrid Vehicles (PHEV) from 2035.
- In the 2030s, uptake of battery electric lorries begins to increase and the 2040 target for all new HGVs to be zero emission is met. Some small growth in hydrogen HGVs post-2040.
- Smart charging of BEVs is widespread, and plays an increasingly important role as road transport is electrified.
- All buses sold are zero emission by 2030, and by 2035 for minibuses and coaches.

What does 2050 look like?

- Total demand for road transport in 2050 is 121 TWh. Most forms of road transport use electricity, with only small amounts of hydrogen.
- Hydrogen use in this scenario is limited, with some use for HGVs. These rely on regional refuelling infrastructure, since there is no national hydrogen network in this scenario.
- Most privately owned BEVs are used to support the grid with 68% of EV charging demand shifted away from peak and over 5m private EVs provide flexibility via Vehicle-to-Grid services.

Figure EC.T.06: Annual energy demand for road transport in Consumer Transformation



- Adoption of Battery Electric Vehicles (BEVs) will be the most common way to decarbonise cars and vans, with the role of hydrogen being less certain and varying across scenarios.
- Overall transport demand is lowest in scenarios with the most electrification of transport. Electrification of transport leads to increased annual electricity demands in all scenarios, but lower overall energy demand as electricity displaces petrol and diesel.
- Further action is needed to meet the Government's target for no new sales of petrol and diesel cars by 2030, noting up-front costs and the availability of charging infrastructure as key barriers.
- Rapid uptake of zero carbon HGVs in the 2030s in line with government targets is needed to significantly reduce energy demand for freight and lower emissions. All new Heavy Goods Vehicles are zero emission by 2040 in the Net Zero scenarios.
- Enabling consumer engagement in smart charging and Vehicle-to-Grid technology, both for passenger electric cars and larger vehicles, will be crucial to minimise increases in peak demand and requirements for network reinforcement.

REA, July 2022