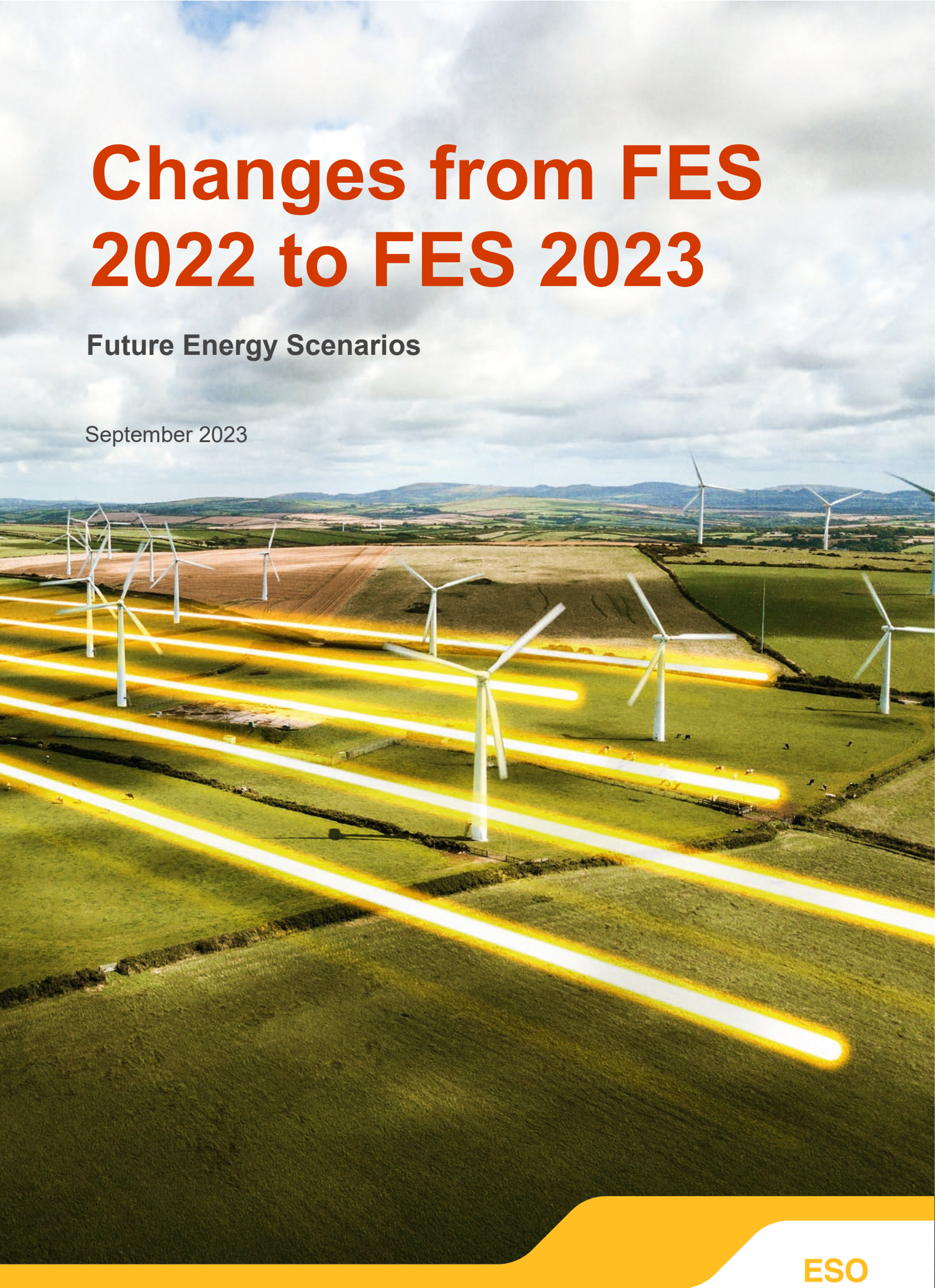
Changes from FES 2022 to FES 2023

Future Energy Scenarios

September 2023



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Document purpose

Every year we produce the Future Energy Scenarios (FES), which explore a range of credible scenarios for energy supply and demand. A key focus of FES is to consider how the 2050 net zero carbon emissions target can be met, based on what we believe could happen under the various scenarios. This document summarises the key differences between FES 2022 and FES 2023. We present a high-level summary of changes with more detail available in the main FES 23 report.

Comparison of Approach

This section addresses the differences in scenario framework, scenarios, and modelling between the two years.

What are the key changes in the framework and approach when comparing FES 2022 and FES 2023?

In line with stakeholder feedback, FES 2023 uses the same scenario framework as FES 2022 and FES 2021. The 'societal change' axis combines changes in innovation, consumer understanding and behaviour to examine the ways in which our economy can decarbonise, while the 'speed of decarbonisation' axis demonstrates how quickly this can be done. These have featured in the framework since FES 2018.

In addition to the scenario framework remaining the same for FES 2023, we have used the same four scenarios, since according to stakeholder engagement during 2022 and 2023, these remain fit for purpose. The scenarios are **Consumer Transformation**, **System Transformation, Leading the Way and Falling Short.**

How do the scenarios from FES 2023 compare with the scenarios from FES 2022?

In FES 2023, the scenario visions remain the same with respect to where they sit within the framework. Three scenarios (**Consumer Transformation, System Transformation** and **Leading the Way**) reach net zero by 2050, just like FES 2022, and we call them our net zero scenarios. Due to changes in the way that emissions are calculated, we see a drop in emissions from the sectors not directly modelled in FES such as agriculture and land use which means that there is further scope to meet net zero by 2050.One difference is that **Leading the Way** reaches net zero by 2046, which is a year earlier than FES 2022.

As in previous years, **Falling Short** does not meet net zero. However, annual emissions have reduced from FES 2022. Last year's **Falling Short** scenario emits 186 $MtCO_2e$ annually by 2050, while in FES 2023 179 $MtCO_2e$ is emitted annually by 2050. The improvement on the FES 2022 levels due in the main to the removal of climate feedback in our emissions calculations to align with international standards (see below).

What changes have been made to the modelling approach/data?

We have kept the overall modelling approach same as last year, but we have made changes to the way we compute emissions and hydrogen demand and changed the underlying data for distributed solar generation. In addition, following stakeholder feedback, we have added regional spotlights and areas of new analysis at the end of each chapter.

Changes to the international emissions calculation methodology led to a reduction in forecast emissions compared to those from FES 2022. For example, in FES 2023, climate feedback was removed from the emissions analysis to align with international standards. This change resulted in lower scenario emissions compared to 2022. More detail around changes to the emissions methodology can be found in the Net Zero chapter of FES 23 (p. 49)[1].

For FES 2023, in the period up to 2030, hydrogen demand modelling became 'supply led' due to the way that low carbon hydrogen is being developed. This is because the initial low carbon hydrogen projects are being

[1] https://www.nationalgrideso.com/document/283101/download

developed close to the end consumers and, in the absence of a larger hydrogen transport network, additional consumers will not be able to convert to hydrogen if there is no funded project in the vicinity.

We have also changed the data used to set the solar capacity in our distribution connected generation backgrounds for FES 23. To ensure we are aligned with our internal short-term forecasting process, we utilised data from Sheffield Solar (a research group at The University of Sheffield) who partnered with Solar Energy UK and Department for Energy Security and Net Zero (DESNZ) statisticians to improve the methodology for modelling solar generation.

Based on stakeholder feedback, we added regional spotlights to all chapters. Focus was given to consumer archetypes, distributed generation, electrolyser locations and regional participation in the Demand Flexibility Service (DFS), that ESO launched during November 2022. Next, in each of the main chapters of FES 2023, we included new sections of analysis. Specifically, we explored different heat decarbonisation options in the energy consumer chapter, nuclear trade-offs in the energy system chapter and extreme weather event analysis in the flexibility chapter, where the focus was on the flexibility contribution from both the demand and supply sides during periods of system stress.

How has the view of sectors, vectors and technologies changed?

Electricity demand overall

Compared to FES 2022, the electricity peak and annual demands for FES 2023 are marginally lower in some scenarios in the short-term timescales. This is due to the impact of higher energy prices and slower economic growth, as can be seen from the Average Cold Spell (ACS)[2] demand graph in Fig. 1.

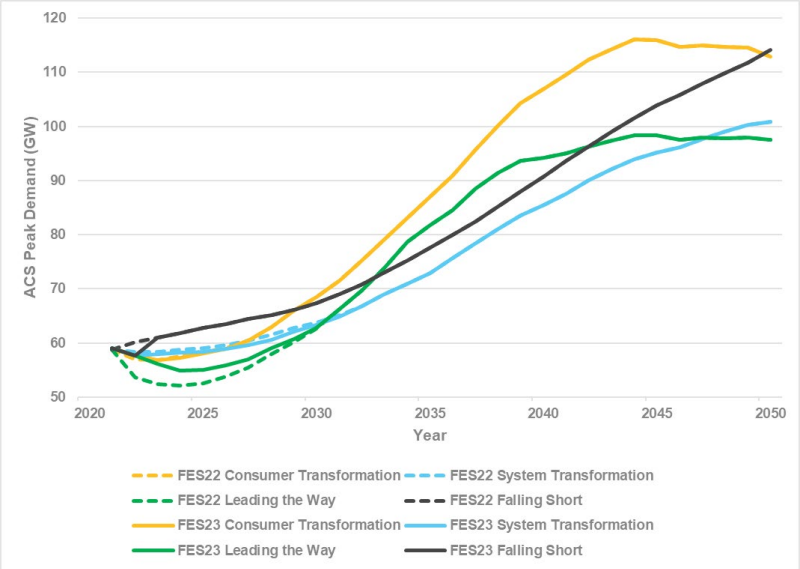

Fig. 1: Comparison of ACS demand for FES 2022 and FES 2023

For longer-term timescales, demand changes as explained below for all the scenarios:

[2] ACS Peak Demand: The estimated unrestricted winter peak demand (MW and MVar) on the national electricity transmission system for the average cold spell (ACS) condition. This represents the demand to be met by large power stations (directly connected or embedded), medium power stations and small power stations which are directly connected to the national electricity transmission system and by electricity imported into the onshore transmission system from external systems across external interconnections (and which is not adjusted to take into account demand management or other techniques that could modify demand). For more information, please see here: https://www.nationalgrideso.com/document/215581/download.

- Post-2030, peak demand in **System Transformation** rises at a similar rate to FES 2022.

- For the other net zero scenarios, electricity peak and annual demands from the early 2030s up to 2050 are higher than FES 2022, reflecting stakeholder feedback and policy announcements. The changes to electricity peak and annual demands are primarily due to a combination of increased fuel switching away from natural gas in the Industrial & Commercial (I&C) sectors, reflecting the Industrial Decarbonisation Strategy and the increased electrification of Heavy Goods Vehicles (HGVs).

- In **Falling Short**, an increased level of electrification is seen compared to FES 2022, though this is without the efficiency measures seen in some of the net zero scenarios.

Large electrical demands

New large electricity demands are expected in all our net zero scenarios in FES 2023. This includes electrolysers, data centres and Direct Air Carbon Capture and Storage (DACCS). These types of demand have significant potential to deliver whole energy system flexibility and reduced network constraints alongside decarbonisation.

Transport sector

In FES 2023, the growth in Battery Electric Vehicles (BEV) sales has been significant. The actual 2022 sales (new EV registrations) reached 267,203 vehicles, which sits towards the top of the FES 2022 scenario range. The FES 22 range of BEV vehicles on the road remains credible with updates only made to historic figures. For transport Demand Side Response (DSR) please see the Demand Side Response section below.

Heat sector

As the heat sector decarbonises with greater use of heat pumps, district heating schemes, energy efficiency measures and hydrogen boilers, the peak demand for natural gas will reduce across the net zero scenarios. **Falling Short** shows similar progress in decarbonising heat by 2050 as FES 2022, with 147 TWh of natural gas being used for residential heating in this year's results compared to 142 TWh last year. In **Consumer Transformation** and **Leading the Way**, natural gas peak demand declines to nearly zero by 2050 as unabated gas is phased out completely, with only limited residual uses in the energy system, like FES 2022. In **System Transformation** natural gas is still used to produce hydrogen via methane reformation with CCUS, as in FES 2022.

We note that in FES 2023, hydrogen for heating has only a marginal presence in short-term, and very little of the demand for this purpose is domestic. The government is expected to provide a decision in 2026 on the direction of domestic heating.

Demand Side Response (DSR)

According to stakeholder feedback, for FES 2023 we grouped all the sectors (residential, industrial and commercial) together under what we called 'consumer DSR. Similar grouping was done for the heat flexibility. The effect on peak demand reduction from the aggregated response of Air Source Heat Pumps (ASHPs) and Ground Source Heat Pumps (GSHPs) was also explored this year. More granularity on DSR for FES 2023 can be found in our data workbook. For transport DSR, to deliver our modelling, we take a separate look at smart charging and vehicle-to-grid operation for all our scenarios. Vehicle-to-Grid engagement is expected to remain very low in the short-term, where an increased take-up will require both technology deployment (such as bi-directional charging) and electricity market change to reward consumers for participating in the energy system.

Electricity generation and storage

In Fig. 2, we show the difference in the installed generation capacities between FES 2022 and FES 2023 for the years of 2022, 2030 and 2050. This is followed by Table 1 where the focus is on the year of 2050. Positive values in Fig. 2 (and Table 1) indicate an increase in the installed generation capacities in FES 2023, whereas negative values represent decrease in total installed generation capacities in FES 2023.

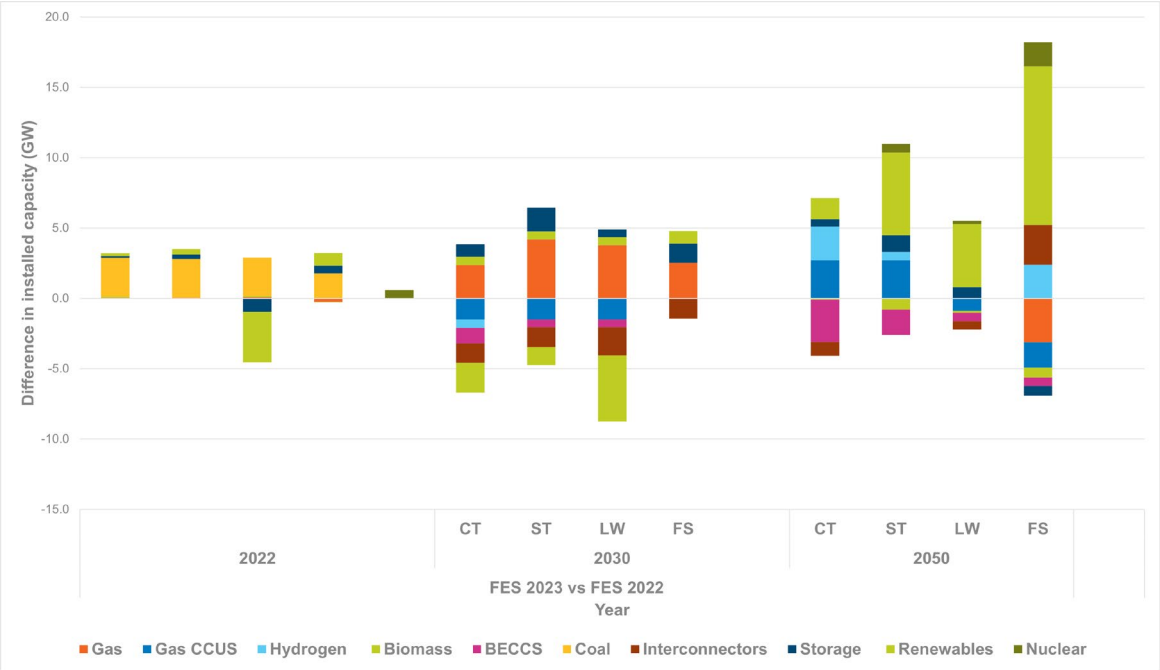

Fig. 2: Comparison of installed generation capacities between FES 2022 and FES 2023, for the years of 2022, 2030 and 2050.

Table 1: Difference in installed generation capacities (GW) between FES 2022 and FES 2023

	2050			
	Consumer Transformation	System Transformation	Leading the Way	Falling Short
Gas	0.0	0.0	0.0	-3.1
Gas CCUS	2.7	2.7	-0.9	-1.8
Nuclear	0.6	0.2	1.7	0.0
Hydrogen	2.4	0.6	0.0	2.4
Biomass	-0.1	-0.8	-0.1	-0.7
BECCS	-3.0	-1.8	-0.6	-0.6
Coal	0.0	0.0	0.0	0.0
Interconnectors	-1.0	0.0	-0.6	2.8
Storage	0.5	1.2	0.8	-0.7
Renewables	1.5	5.9	4.5	11.3

The short-term (up to 2030) gas supply for FES 2023 is higher than that in FES 2022. This reflects the recent high volume of exports to Europe. In 2022, a total of 89 billion cubic meters was supplied to the UK via the pipeline from Norway, shipped LNG, and green gas from UK sources, such as anaerobic digestors. This is an increase in supply of 10 bcm against 2021. This was primarily due to increased export demand as the UK was used as a transit market to get gas into Europe via the gas interconnectors to Belgium and the Netherlands.

Natural gas peak demand is expected to decline in line with the reduced use of natural gas in the net zero scenarios. In 2050, gas supply was reduced in **Falling Short** so that the scenario comes closer to net zero and was partly replaced by hydrogen.

For unabated gas and gas CCUS (Carbon Capture Usage and Storage), installed capacities increased for both **Consumer Transformation** and **System Transformation**, resulting from the reduction in BECCS and marginal increase in the installed capacity of hydrogen. This was the desire to rebalance the dispatch to produce less curtailment of renewables, by removing baseload generation (BECCS) and replacing it with dispatchable generation (gas CCUS and/or hydrogen).

With regards to storage, we expect significant deployment of transmission connected storage in Scotland towards 2050. Our stakeholder engagement, research and analysis predict that 35% of total battery storage deployment (~3.9 GW) will be sited in Scotland versus a combined capacity of 7.1 GW in England and Wales. This is a significant increase compared to FES 2022 data. This increase also complies with the recent capacity market auction results for electricity storage. This increase in battery storage connected projects in Scotland is driven by recent pathfinder contracts for management of the electricity network, greater land availability for new projects in Scotland, and shorter connection times.

For nuclear technology, the installed capacity across all scenarios increased in 2050. This was to better align with the current government target for that technology. The first uptake of Small Modular Reactors (SMR) takes place in 2033 rather than 2031, as presented in FES 2022. This is based primarily on engagement with industry. There are some differences in large nuclear uptake according to our stakeholder engagement; mainly due to certain capacity no longer considered. Very minor short-term changes to the existing plant closures also led to slight differences between capacities presented in FES 2023 compared with FES 2022.

Offshore wind locations have been revised to align with the Holistic Network Design (HND) 1 and 2 updates[3]. According to stakeholder feedback and the HND, renewable capacity increased across all scenarios.

Following the announcement of successful projects within the first industrial clusters, we do not expect large scale BECCS to be delivered before 2030 and have revised our scenarios to reflect this. As result, BECCS has lower installed capacities for FES 2023 across all four scenarios. Instead, gas CCUS and hydrogen have increased to account for that reduction in BECCS and to also reduce the curtailment of renewable energy.

In FES 23, bioenergy supplies are lower across all scenarios by 2050 than presented in FES 22 since these are moved to BECCS to achieve lower emissions.

In FES 22, the hydrogen export seen in **System Transformation** was driven by an excess of hydrogen production from electrolysis seen within our electricity dispatch modelling, where more hydrogen was produced than needed to meet demand. These was from both Steam Methane Reformation, and electrolysis primarily from renewable generation that would otherwise have been curtailed. For FES 23, there is no hydrogen export, as we have changed some of our underlying assumptions on growth of hydrogen production such that production meets demand without excess. This is an area with a high level of uncertainty and the growth of a hydrogen export market is something we will continue to keep under review. Current stakeholder feedback suggests that Great Britain is viewed as more likely to import than export hydrogen.

Lastly, according to stakeholder feedback, interconnectors have reduced capacity in FES 2023 across all net zero scenarios.

[3] https://www.nationalgrideso.com/future-energy/pathway-2030-holistic-network-design/holistic-network-design-offshore-wind

Further information

More detail of all areas and technologies can be found in the FES 2023 Data Workbook. A high-level summary of key statistics can also be found in FES in Five. These documents can be found on the FES section of the ESO website - https://www.nationalgrideso.com/future-energy/future-energy-scenarios.

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