

Future Energy Scenarios 2018

FAQs

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Our **Frequently Asked Questions** (FAQs) publication is just one of a suite of documents we produce as part of our Future Energy Scenarios (FES) process. A huge amount of work – including modelling, analysis and interpretation – goes into the production of the main document. For ease of use we only highlight significant changes to our modelling methods in the main **FES** document. Alongside this publication, we have the **Scenario Framework** that details all the assumptions and levers that are used as input into our models. Our **Data Workbook** contains all the outputs from the numerous models: the detailed tables, graphs and charts. We also publish a summary document, **FES in 5**, and our **Modelling Methods**. For more information and to view each of these documents visit our website: www.fes.nationalgrid.com

Future Energy Scenarios document suite



This document seeks to answer the main questions we receive as we publish the **FES**. We will continue to update this document, ensuring the latest question and answers are shared. As with our other FES documents we welcome your feedback, please contact us at: fes@nationalgrid.com

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General questions

Q: How do I ask questions or seek further information about the Future Energy Scenarios (FES)?

A: Please send questions via email to fes@nationalgrid.com . We will answer your questions as soon as we can.

Q: FES looks different this year compared to last year. What has changed?

A: The main FES document is just one of a suite of documents we produce as part of our FES process. A huge amount of work, including modelling, analysis and interpretation, goes into the production of the main document. For ease of use we have not included all of that data in the main FES document.

Alongside it we have the **Scenario Framework** that details the assumptions and levers that are used as inputs into our models. Our **Data Workbook** contains the outputs from the numerous models: the detailed tables, graphs and charts. We also publish information on our **Modelling Methods**, a summary document **FES in 5** and these **FAQs**. For more information and to view each of these documents visit our website: <http://fes.nationalgrid.com/fes-document/>

Q: Where can I find further information about the modelling used for FES?

A: You can find this in our **Scenario Framework** and **Modelling Methods** documents which can be found on our website: <http://fes.nationalgrid.com/fes-document/>

Q: Where can I find the data published in the FES?

A: The FES charts and the associated data tables are available in the **Data Workbook**, which can be accessed on our website <http://fes.nationalgrid.com/fes-document/>. The charts are labelled as they are in the main document (e.g. Figure 3.1). We have also published additional datasets in the **Data Workbook**, containing data that supports the FES analysis. The **Data Workbook** uses the following abbreviations:

CP: Commodity Prices
GD: Gas Demand
ED: Electricity Demand
HT: Heating Technologies
RT: Road Transport Demand
ES: Electricity Supply
GS: Gas Supply

Q: What is the date format in the Data Workbook?

A: All Gas Demand and Gas Supply information is in calendar years, with the exception of Gas Peak Demand, which is in gas years. Gas Years run from 1 October to 30 September. All Electricity Demand and Electricity Supply information is in financial years, with the exception of Figure ED2 (Rollout of electricity smart meters, installations per year), which is in calendar years. Road Transport and Heating Technologies are in Calendar Years. Information on date formats is included in the notes on each relevant worksheet in the Data Workbook.

About the scenarios

Q: If you had to predict the future, which would be the most probable scenario?

A: FES is designed to provide a longer-term view of the range of potential energy landscapes, not to analyse where we are right now. We are not “in” any of the scenarios. The four scenarios we’ve outlined are based upon pathways beginning today.

Across our industry there is a great degree of uncertainty about the future, including the political, economic, social and technological landscapes. Scenarios are a powerful tool for understanding uncertainty. By providing a range of credible futures, we can be confident that the reality will be captured somewhere within that range. There is too much uncertainty in the future for a credible single view of the future in the timeframe that FES considers, i.e. out to 2050.

Q: Can the scenarios be translated to a regional level?

A: FES information is fed into National Grid's Electricity and Gas Ten Year Statements (ETYS & GTYS) processes which contain analysis at regional level. The ETYS and GTYS documents (with data tables) are published in November and will be available at: <https://www.nationalgrid.com/uk/publications>

Brexit and Europe

Q: How do you reflect / model Brexit in your scenarios?

A: The UK's decision to leave the European Union in 2016 has introduced some uncertainty around future energy trading. Given the uncertainty on future trading arrangements, our analysis assumes continued market harmonisation between GB and Europe once the UK has left the European Union. This includes for example that GB continues to participate in the Internal Energy Market, or similar future arrangements are developed. Should further information on future European energy trading arrangements become available, we will consider how any such changes impact our analysis.

Q: Do the FES scenarios take account of future energy scenarios for other countries?

A: This year, we have enhanced our modelling of electricity interconnector flows. We have also modelled the impact of decarbonisation in connected countries. This is based on scenarios developed by other European Transmission System Operators and ENTSO-E – the European Network of Transmission System Operators for Electricity. We have published our sources in the Modelling Methods document. Where appropriate and available, we include energy scenarios developed by other Transmission System Operators, for example, those from Gas Networks Ireland and Gasunie.

Demand

Q: What are your economic growth scenarios?

A: We used Oxford Economics data to feed into our Industrial and Commercial demand model. In this year's FES we have used two economic conditions that have differing growth rates of Gross Domestic Product (GDP). We believe that these economic pathways provide enough flexibility to model the range of future outcomes. The average GDP growth rates over the FES period are shown in Table 4.1 of the main FES document (see below).

FES Table 4.1: GDP average annual growth rate for each scenario

	Two Degrees	Slow Progression	Steady State	Consumer Power
Growth	2.0%	2.0%	0.9%	0.9%

Q: What definition of electricity demand do you use in FES?

A: In FES we consider underlying demand. That is end-consumer demand, regardless of where (transmission, distribution or on site) that electricity is generated, plus network losses. Demand is weather corrected to seasonal normal for annual and average cold spell (ACS) for peak. For clarity, it does not include interconnector exports, station demand, pumping station demand or other forms of storage demand.

At peak, industrial and commercial "true demand reduction" is not deducted from the demand as the extent of response will vary depending on market conditions. Residential home appliance demand reduction is deducted as this is considered to be a behavioural response, rather than a significant response to real time signals. To differing degrees, electric vehicles are assumed to adopt smart charging in all scenarios.

Q: How does this definition of electricity demand differ from other National Grid publications?

A: Other National Grid publications (the Electricity Ten Year Statement (ETYS), the System Operability Framework (SOF) and the Network Options Assessment (NOA)) consider transmission demand, as they look at future development of the transmission system and year-ahead system security of supply. Our outlook documents are now moving to consider end consumer demand (like FES) in order to illustrate the total demand requirement, regardless of how the demand is met. You can find out more about our System Operator publications on our website at: <https://www.nationalgrid.com/uk/publications>

Q: Where can I find net transmission demand figures?

Historically these have been published with ETYS in November. Following feedback, we have included "National Demand" in the FES Data Workbook. This is demand on the transmission system but without the addition of demands from power stations, pumping, storage or interconnector exports (consumer demand on the GB transmission system).

Q: What definition of gas demand do you use in FES?

A: In FES we consider end-consumer demand, regardless of whether customers are connected to the distribution or transmission network. FES shows annual totals, so we do not include gas injected into

storage as gas flows into and out of storage will net to zero over a year. Demand is corrected to seasonal normal weather. In the demand and sensitivity chapters we include demand within GB; exports to Ireland and continental Europe are excluded. When matching gas supply to demand we include gas for export, losses on the distribution and transmission networks, and gas used in the operation of the system.

Q: What are your assumptions behind charging infrastructure for electric vehicles (EVs) and their charging profile?

A: Our assumptions around charging infrastructure are that all new EVs charged in a domestic location would utilise a 7kW charger rather than a 3kW charger. For the charging profile, we used the information from the Low Carbon Networks & Innovation (LCNI) project 'My electric avenue' to determine the diversification of charging at different times during the day and seasons. One of the major factors that influences peak domestic EV charging is how engaged the consumers are. Those most engaged consumers utilise smart charging to move their demand to an off-peak period.

We have also considered non-residential charging this year and used the assumption that this would be opportunistically and part of a journey rather than a journey specifically for charging. For this we have used the road survey data to determine the proportion of vehicles likely to be travelling at peak times; and proportioned the annual demand to determine how much energy would be required at peak time. Further information can be found in our Modelling Methods document at: <https://www.nationalgrid.com/uk/publications>

Q: Do you model electricity demand from rail transport?

A: We model electricity demand from rail transport at a high level only. In our fast decarbonisation scenarios (Community Renewables and Two Degrees) we assume 2.5% demand growth (aiming towards a long-term ambition of electrifying most rail transport, where economic, by 2050). We assume 1.5% growth (the historic rate of demand growth) in our slower decarbonisation scenarios (Steady Progression and Consumer Evolution).

Q: How much of a role does energy efficiency play in your modelling of heat demand?

A: Energy efficiency is a component of our modelling. Government intervention has played a major part in the last decade in reducing heating demand, through providing loft insulation and cavity wall insulation to millions of homes. We note there is significant debate as to how well insulated the GB housing stock should become by 2050 considering the current housing stock, which includes a significant number of low thermally efficient properties. In our highest insulation scenario (Two Degrees and Community Renewables), there is approximately a 48% reduction in space heating demand by 2050, reflecting strong government intervention. Within other scenarios the impact is less.

Demand: Consumer engagement

Q: What are your assumptions regarding consumer engagement levels?

A: Our modelling of consumer engagement has been drawn in part from the work carried out by Ofgem, which involved direct market research to inform a current position of consumer engagement. The Ofgem consumer engagement survey has been conducted annually since 2014 to track engagement

in the domestic energy market following Ofgem's Retail Market Review (RMR). The 2017 research included a new attitude-based segmentation and was conducted with a nationally representative sample of 4,001 energy consumers in Britain.

In our modelling we do use Ofgem's split of consumer segments, however we do not use Ofgem's engagement numbers since these refer to a type of engagement which is different from what we model in FES. We applied engagement trends to each consumer group individually based upon the scenario framework and we assumed different speeds of engagement for each of the six consumer groups (Happy Shoppers, Savvy Searchers, Market Sceptics, Hassle Haters, Anxious Avoiders, Contented Conformers). We also took into consideration 'saturability ceilings' within the sectors for capping the maximum achievable level of engagement for each scenario.

In FES 2018 and following stakeholder feedback, the engagement levels are different for certain smart appliances groups, smart chargers and for consumer price flexibility and they change over time in response to both technology development and changes in attitude, reflecting the landscape of each scenario. Note that despite the adoption of smart appliances, the decrease in peak demand is delayed as it follows learning and adaptation curves i.e. the appliances once purchased are not utilised to their full potential straightaway.

Demand Technologies

Q: How have you selected low carbon technologies in your scenarios and not selected others?

A: We carefully assess all potential new technologies that are publicly available. We use a number of criteria to test whether any given technology should be included within FES. This includes technology maturity, supply chain potential, commercial readiness, and support required, together with consumer and political interest. Each year we reassess the technologies to ensure that we capture innovation and we test this through engagement with stakeholders.

Q: Do you consider vehicle-to-grid (V2G)?

A: We have included V2G in the FES scenarios for the first time this year. V2G could be significant source of future flexibility. There are about 38m million electric vehicles by 2050 in both Community Renewables and Two Degrees, and there are a large number of trials of this technology, offering commercial opportunities. We have assumed that the most engaged segments of society are those most likely to take part in V2G within the scenarios; reflecting both the uptake of electric vehicles and the engagement with smart technologies.

One of the major factors that influences peak domestic EV charging is how engaged consumers are. The most engaged consumers utilise smart charging to move their demand to an off-peak period. In Two Degrees, for example, we see high consumer engagement and a lower proportion of EV charging at peak. Both Smart charging and V2G have the potential to be very important in a mass EV world as it is likely to be a significant factor in the extent to which additional generation capacity and network reinforcements are required across the electricity system, to cater for demand caused by increased numbers of EV chargers.

Q: Do you have profiles for heat pump and EV usage?

A: Yes, our profiles are informed by data from 'Low Carbon Network' projects, which were funded by Ofgem. The 'Customer Led Network Revolution' project library contains a wealth of information on different innovation project trials: <http://www.networkrevolution.co.uk/resources/project-library/>

Searching for 'Electric Vehicles' or 'Heat Pump' will find the following datasets, as well as a number of reports and summaries on trial design and findings. Data is also available for residential solar panels, micro Combined Heat and Power (CHP), and DSR trials.

CLNR-L078 Dataset TC6: Enhanced Profiling of Domestic Customers with Electric Vehicles
CLNR-L075 Dataset TC3: Enhanced Profiling of Domestic Customers with Air Source Heat Pumps

Additional information is available from the 'My Electric Avenue', which trialled over 100 Nissan Leafs for 18 months: <http://myelectricavenue.info/>

Q: Do you include fuel cells in EV numbers?

A: Vehicles powered by hydrogen fuel cells are included in the road transport numbers in this year's FES for multiple different types of vehicle (Cars, Vans, Buses and HGVs).

Q: How do you account for DSR in FES?

A: In FES we look into total DSR (i.e. usage shift, micro generation and micro storage) and we also explicitly model pure load reduction DSR which is when consumer has shifted their usage. Only pure DSR is used to reduce FES peak demand and this happens because in FES we are interested in the underlying demand. We do not include cases where a consumer has switched to another power source – such as a generator or battery storage. This is not a demand shift as their demand is still the same; it is just being sourced differently. This figure would be captured in the supply side and, if we were to include on the demand side, we would end up double counting the true generation that is available. We only account for turn down demand DSR and we do not look into DSR in summer.

In FES we do not include I&C DSR within our definition of peak (our definition is an 'unrestricted' one), but we do incorporate residential demand shift because of time of use tariffs. Residential demand shift is considered to be behavioural change and therefore less responsive to real time signals.

Q: Why could shared vehicles increase energy demand?

A: Currently privately owned cars, including EVs, are parked on average 95% of the time. Within the scenarios we have used shared autonomous vehicles, where an EV does not require a driver to move from place to place, and so can be easily utilised by multiple people. This increases the utilisation of the vehicle, and thus the miles and energy consumed per vehicle.

As an example, if person A uses the autonomous vehicle to travel to work, rather than leave the vehicle parked all day it is then sent to be used by person B. When person A needs the vehicle later in the day they would then call it to them.

Q: Have you considered hybrid heating in your scenarios?

A: Hybrid heating and its effects are considered within the scenarios. Hybrid gas boiler & heat pumps are among the low carbon heating technologies modelled. This year hybrids feature in all of our scenarios and are a prominent feature of Two Degrees and Community Renewables. They offer green heating throughout most of the year, running primarily on a heat pump, and then switch to gas for the cold peak times. Projects such as Project Freedom are furthering the industry's understanding of potential decarbonised heating solutions and we continue to monitor progress.

Q: What role could growth in peer-to-peer platforms play in better managing supply / demand?

A: In April 2018 the first UK physical trade of energy took place using blockchain and there is regulatory support for future development. Such trading arrangements will become particularly important for the development of such arrangements as vehicle-to-grid technology. We see such developments being particularly strong in the more decentralised scenarios of Consumer Evolution and Community Renewables. The development of localised trading will mean many more consumers will evolve into prosumers.

Supply

Q: Where can I find information on your projections for generation capacity?

A: In the Data Workbook downloadable with the main document:

- Tab ES1, contains capacity figures (MW) for transmission and non-transmission connected generation (contains micro-generation), as well as totals.
- Tab ES1, also contains annual output figures (GWh) by the categories described above, as well as totals.

Q: Are network constraints (such as thermal constraints, or fault current constraints) taken into consideration when calculating the amount of generation that is going to connect to either the transmission or distribution network?

A: Our modelling is built up from historic network performance, but we don't take into account current operational unavailability. One of the roles of the scenarios is to illustrate and highlight potential future need for change on the electricity system. The impact on networks is assessed in the other System Operator documents, including System Operability Framework (SOF), Electricity Ten Year Statement (ETYS) and Network Options Assessment (NOA), see <https://www.nationalgrid.com/uk/publications>

Q: Why do you use generic imports for gas supplies?

A: The background and our thinking on the UK's gas supply sources are described in chapter 5 in the main FES document. In summary, we build our gas supply scenarios by assessing the likelihood that various supply types come to GB. For example, UK Continental Shelf, shale or green gas (biogas or bio-substitute natural gas) are added to our supply sources first as they are indigenous. This is followed by Norwegian gas, as some fields are directly connected to import terminals in GB, and minimum levels of liquefied natural gas (LNG) are added as some LNG must flow due to boil-off requirements.

For some years our scenarios have included specific volumes of imported LNG and continental gas, as well as a volume of 'Generic Import', which could be LNG or continental gas, or a mixture. This approach effectively provides ranges for LNG and continental gas imports in each scenario. Predicting

LNG flows in the world market is challenging, and you have told us that our approach is a sensible way of dealing with the uncertainty.

Q: When you look at installed capacity do you use derated figures to reflect the load factor, e.g. different factors for solar PV and combined cycle gas turbine (CCGT)?

A: All capacities are de-rated when their contribution to meeting peak demand is modelled (noting that PV is negligible at this point in time). In terms of annual contributions, load factors are generated by our dispatch modelling. However, when 'installed capacity' is quoted this is Transmission Entry Capacity (TEC) (i.e. the contracted maximum capacity of the unit) and doesn't include any de-rating or load factor.

Network and System Impacts

Q: What are the grid development implications of each of these scenarios?

A: We publish a number of documents which illustrate the potential development of the gas and electricity transmission systems, including (see: <https://www.nationalgrid.com/uk/publications>):

- Gas Ten Year Statement (GTYS)
- System Operability Framework (SOF)
- System Needs and Products Strategy (SNAPS)
- Network Options Assessment (NOA)
- Electricity Ten Year Statement (ETYS)

Version control

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1.0	12/07/2018	First upload for FES 2018 launch on 12 July 2018

For any queries, please contact us at: fes@nationalgrid.com