FES 2019: Call for Evidence Consultation

Future Energy Scenarios I **National Grid**

September 2018

Welcome to the Future Energy Scenarios 2019: Call for Evidence Consultation.

Please note that this PDF is for information only to show the full list of questions.

Instructions:
Please read the below information to help you provide your submission.

Issued:
Monday 3 September 2018
Respond by: Friday 28 September 2018, midnight

How to Respond:
Where applicable and possible, it would be most helpful that your response is provided per organisation. We also ask that all responses are submitted through the Call for Evidence Online Consultation

To assist navigation through this consultation and for those specialising in particular topic fields, we have arranged the consultation into the following sections. You are of course welcome to submit responses to any part of the consultation or in its entirety. Please note: should you wish to complete the consultation in its entirety you may wish to allow up to an hour to do so.

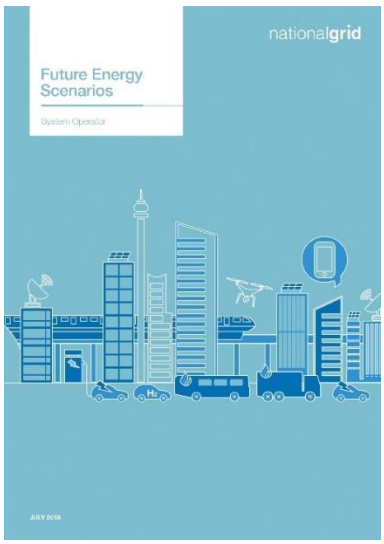
1. Future Energy Scenarios Document
2. Scenario Framework
3. Industrial and Commercial Energy Demand
4. Demand Side Response (DSR) & SMART
5. Energy Efficiency by 2030
6. Domestic Heat
7. Transport
8. Whole Energy System
9. Electricity Market Modelling
10. Gas Supply

Confidentiality and Data Protection:
All information provided as part of this call for evidence will be used for reasonable business purposes only. Your personal information will remain confidential and not published as a part of our findings. We will provide a summary of the feedback we receive and how we will take it forward as part of our annual Stakeholder Feedback Document publication in early 2019.

Evidence:
Where possible, please provide evidence to support your view(s). You can email this directly to us at FES@nationalgrid.com Please reference the section and question that you are supplying the evidence for in your email. The evidence could be your own analysis, reports or public studies for example.

Enquiries: Email the team at FES@nationalgrid.com

1. Future Energy Scenarios Document



1.1 What section or chapter of FES do you find the most useful?

- [ ] Key Messages
- [ ] Chapter 1 (Future Energy Scenarios Introduction)
- [ ] Chapter 2 (The scenarios)
- [ ] Chapter 3 (Decarbonisation and decentralisation)
- [ ] Chapter 4: Energy Demand
- [ ] Chapter 4: Industrial and commercial demand
- [ ] Chapter 4: Residential demand
- [ ] Chapter 4: Transport demand
- [ ] Chapter 4: Transformation demand
- [ ] Chapter 5: Energy Supply
- [ ] Chapter 5: Electricity Supply
- [ ] Chapter 5: Gas Supply
- [ ] Data Workbook
- [ ] Modelling Methods Document
- [ ] Spotlight: Hydrogen
- [ ] Spotlight: Autonomous Vehicles
- [ ] Spotlight: Changing Gas Flows
- [ ] Spotlight: Hybrid Heat Pumps
- [ ] Spotlight: Power Flows
- [ ] Spotlight: Energy Performance Certificates (EPC)
- [ ] Other (please specify)

1.2 Why did you find these sections helpful?

1.3 Are you able to quickly access the information that you need in the document?

- Yes
- No

1.4 If 'No' what could we do differently to improve this?

1.5 Was the new chapter on decarbonisation and decentralisation useful for you?

- Yes
- No

1.6 If 'No' what could we do differently to improve this?

1.7 Do you have any suggestions for the future content and structure of FES?

1.8 Are there particular areas you would like us to explore via spotlights in FES 2019, or in other Energy Insights publications?

2. Scenario Framework

Following extensive analysis and consultation, we created a new framework for FES 2018. The scenarios have been aligned to two new axes: 'speed of decarbonisation' and 'level of decentralisation'. In FES 2018 we have two out of four scenarios that meet the 2050 carbon reduction target.

2.1 We consider that the Scenario Framework addresses key issues for the energy industry which remain relevant. In order to ensure continuity and facilitate year-on-year comparison, we intend to keep this framework essentially unchanged for FES 2019. Do you agree with this proposal?

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

2.2 If you disagree, what changes would you suggest and why?

3. Industrial and Commercial Energy Demand

The European Parliament and European Commission have recently agreed to a binding 32.5% improvement in energy efficiency by 2030. BEIS have also recently published a call for evidence on measures which could improve energy efficiency in businesses by 20% by 2030.

3.1 In view of these policy developments and directions, are there particular sub-sectors of Industrial & Commercial energy demand, which you feel can improve energy efficiency more easily than others?

3.2 What reasoning and evidence do you have for your answer?

A high proportion of Industrial & Commercial energy demand is currently used for heating (space, water, cooking, high and low temperature processes); For instance, 75% of gas and more than 25% of electricity is used for heating.

3.3 In addition to thermal efficiency improvements, which technologies do you think are most suitable and likely to be successful in decarbonising Industrial & Commercial heating?

- ☐ Electrification of heating: Air Source Heat Pumps
- ☐ Electrification of heating: Ground Source Heat Pumps
- ☐ Biomass boilers
- ☐ Biomass CHPs
- ☐ Biogas CHPs
- ☐ Onsite renewable generation with coupling technologies (e.g. thermal storage, electrification of heating)
- ☐ Maintaining existing heating technologies, but coupling with CCUS
- ☐ Conversion to hydrogen as the fuel source
- ☐ Other (please specify)

3.4 Why have you chosen these?

3.5 Are there particular sub-sectors of I&C where you feel certain technologies would work well for decarbonising heating (please include reasoning and evidence is possible)?

3.6 Do you think there will be any significant new gas or electricity demand in the I&C sector and what evidence do you have to support this view?

4. Demand Side Response (DSR) and SMART

For reference to the content of this section please see:

- FES 2018 Document pages 58, 69 and 79-82
- FES 2018 Modelling Methods document sections “Industrial and commercial demand side response” and “Residential electricity DSR and Smart Meters Roll-Out”
- FES 2018 Data Workbook Tabs 4.8, ED8, ED9, ED10

Demand Side Response (DSR) – Load reduction: Our analysis in FES 2018 showed that ~50% of total DSR comes from load reduction only, with the rest met by on-site generation and storage.

4.1 Do you agree with the ~50% figure output?

- ○ Yes
- ○ No
- ○ Don't know

4.2 If not, how much do you consider will be the contribution of load reduction to DSR and what evidence do you have to support this view?

4.3 How do you see trends (load reduction vs storage vs on-site generation) changing in the future and what evidence do you have to support this view?

4.4 If you consider that the levels are not appropriate, what levels would you suggest and what is the evidence to support this view?

DSR in FES Scenario Framework: We believe that DSR in all sectors (domestic, industrial and commercial), is driven by decarbonisation and decentralisation. In FES 2018, Community Renewables has the highest levels of DSR, followed by Two Degrees, Consumer Evolution and Steady Progression.

4.5 Do you agree with this approach?

- ☐ Yes
- ☐ No
- ☐ Don't know

4.6 If you don’t agree, what is your view and what is the evidence to support it?

Smart Domestic Appliances:

Definition 1: We define smart appliance as energy-related products that are communications-enabled and able to respond automatically to price and/or other signals by modulating their electricity consumption. These changes to consumption patterns are what we call the ‘flexibility’ of the smart appliance.

Definition 2: We define consumer engagement with smart appliances as people's willingness to buy a smart appliance and use it in a “smart” way which will enable them reduce or change their consumption patterns automatically.

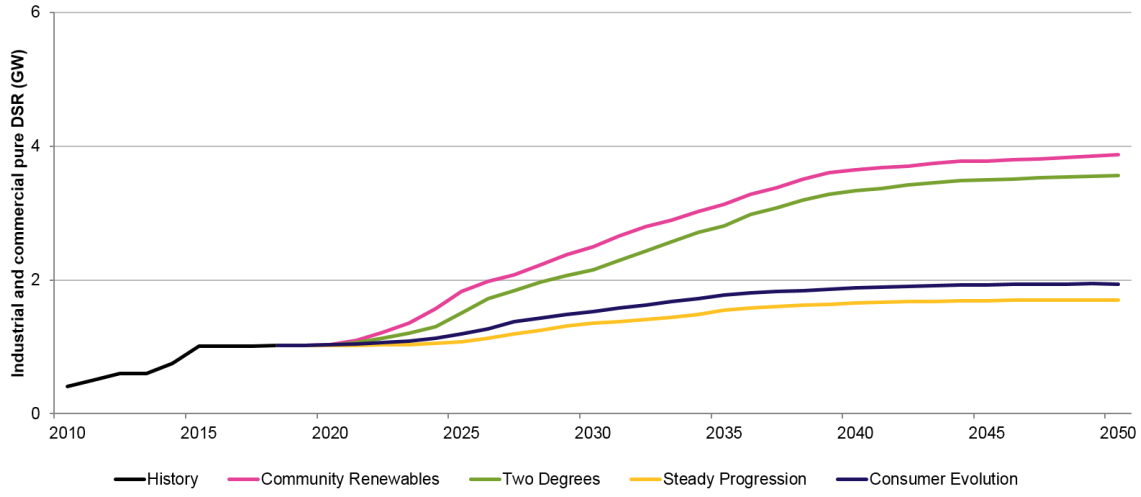
Considering the above two definitions this year, we looked into the consumer engagement with smart cold and wet appliances. In FES 2018, we assumed that by 2030 the maximum engagement with smart wet (such as washing machines) and cold appliances (such as fridges) will be 27% and 25% respectively. We assumed that by 2050 the engagement levels will increase to 68% and 85% for wet and cold appliances respectively. For reference see tab ED8 in the Data Workbook.

4.7 Do you consider these levels to be appropriate?

- About right
- Too low
- Too high
- Don't know

4.8 If you consider that the levels are not appropriate, what levels would you suggest and what is the evidence to support this view?

Industrial & Commercial DSR Engagement: Businesses’ engagement with DSR is an important factor in understanding trends of DSR potential. About one third of businesses are now participating in various forms of DSR services (Triad, STOR, TOUTs, Capacity Market etc.). Our FES 2018 analysis and discussions with National Grid’s Power Responsive team suggest that these number are expected to stay flat in the next couple of years due to market uncertainty. Possible future trends are shown below.



4.9 Do you consider the 2030 Community Renewable levels above, which represent the maximum levels, to be appropriate?

- About right
- Too low
- Too high
- Don't know

4.10 Do you consider the 2030 Steady Progression levels, which represent the minimum levels, to be appropriate?

- ○ About right
- ○ Too low
- ○ Too high
- ○ Don't know

4.11 If you have a different view, what levels would you suggest and what is the evidence to support this view?

4.12 How do you see trends changing in the future (i.e. including post-2030) and why?

5. Energy Efficiency by 2030

For reference to the content of this section please see:
FES 2018 document pages 69 (Residential), 54 (Industrial) and 56 (Commercial).

The Parliamentary Office of Science & Technology (POST) published a brief on potential energy efficiency policy in 2017.

In July 2018, the Department for Business, Energy & Industrial Strategy (BEIS) published a call for evidence on measures which could improve efficiency in businesses 20% by 2030.
In June 2018, the European Parliament and European Commission have agreed a binding 32.5% improvement in efficiency by 2030.

Background
In the 2050 compliant scenarios in FES 2018, Community Renewables and Two Degrees, we have assumed the UK will meet the EU Energy Efficiency 32.5% energy efficiency targets in electricity by 2030. For electrical heat in industrial & commercial demand, we have assumed efficiency gains will be more difficult to achieve and improvement is 10% by 2030.

5.1 In the 2050 compliant scenarios in FES 2018, what level of efficiency gain should we assume by 2030 for the different sectors and components of demand?

5.2 Should we model 32.5% in homes and businesses, or should we model 32.5% in homes and 20% in businesses?

5.3 What reasoning and evidence do you have for your answer?

Home thermal efficiency (see FES 2018 pages 60-64).
The UK Clean Growth Strategy aspires to Class C thermal efficiency by 2030 in fuel poor homes, and by 2035 in all other homes where economic to do so. This trajectory was modelled in the FES 2018 2050-compliant scenarios, and using a similar trajectory, by 2050 most homes are rated B-C. A less aggressive trajectory was assumed for the other scenarios.

5.4 What are your views on these aspirations and our modelling (please include evidence where possible please)?

5.5 What levels of thermal efficiency should be modelled in the FES 2018 2050-compliant scenarios and why (e.g. should this vary by heating technology)?

Hybrid Heat Pump behaviour assumptions (FES 2018 Modelling Methods document p6): In order to reduce peak demand on the electricity system at times of high heat demand (which may only occur for a few days of the year), in FES 2018, we have assumed that hybrid heat pumps run on alternative fuel and not electricity at times of peak demand. However, recent studies have indicated this may not be the case.

If we were to change the FES assumptions to be more in line with recent studies, there would be significant *additional* electricity demand at peak.

The table below shows the potential impact, assuming 1kW-2kW demand per hybrid heat pump.

GW	2030	2040	2050
Community Renewables	0.5 – 1.0	1.8 - 3.7	3.5 – 7.0
Two Degrees	0.3 – 0.7	1.3 - 2.7	2.0 – 4.3

5.6 Should we change our assumptions to assume hybrid heat pumps will still draw electricity at peak, or should we continue to assume hybrids move completely to alternative fuel at peak?

- Yes
- No
- Don't know

5.7 If you consider that we should change our assumptions, what evidence can you provide to support your view?

Economy 7/10 Heating

We are planning to review the way we model residential heat at peak and in particular, Economy 7 and Economy 10 heat.

5.8 Are you aware of any data source or studies which you think could assist us? If so, please provide the details.

6. Domestic Heat

Technology costs: Our heat modelling in FES 2018 assumes that the full life cycle cost of low-carbon technologies decreases as more people use the technology and, as a result, its market share increases.

6.1 Do you agree with this assumption?

- Yes
- No
- Don't know

6.2 If 'No', what is your view and what information is there to support this?

6.3 Tell us in the text boxes below, how you think the costs of the following heating technologies will change as a function of their market share, and what information is there to support this?

Air Source Heat Pumps

Gas Source Heat Pumps (Borehole and Trench)

Hybrid (Gas/Electricity) Heat Pumps

Fuel Cells

Biomass Boilers

Gas Micro-CHPs (Combined Heat and Power)

Biomass Micro-CHPs (Combined Heat and Power)

Energy efficiency: We used two levers in FES 2018 to model reductions in underlying thermal demand: improved home insulation and improved appliance efficiency. Please note there are more questions about this covered in page 5 Energy Efficiency by 2030 section.

6.4 Which efficiency improvement options do you think would be most effective in terms of reducing costs and ease of implementation?

- Improved Home Insulation
- Improved Appliance Efficiency
- Other (please specify)

6.5 What information is there to support your view?

6.6 What is your view on the upper limit of appliance efficiency improvement, in COP or percentage, that can be achieved by 2040 for the heating appliances listed below?
COP - Coefficient of performance

Air Source Heat Pumps (COP)

Gas Source Heat Pumps (Borehole and Trench) (COP)

Hybrid (Gas/Electricity) Heat Pumps (COP)

Fuel Cells (%)

Biomass Boilers (%)

Gas Micro-CHPs (Combined Heat and Power) (%)

Biomass Micro-CHPs (Combined Heat and Power) (%)

6.7 Our Scenario Framework includes a decentralisation axis. How do you think this should be applied to thermal efficiency?

6.8 What information is there to support this view?

Current installations by technology base: In FES 2018, our heat modelling assumes the number of installations of low-carbon technologies based solely on the Renewable Heat Incentive (RHI) database managed by Ofgem. There is uncertainty about whether this database captures the full extent of low-carbon heating appliance installations across GB.

6.9 Could you provide evidence for a better way to estimate the current install base of the following appliances in GB?

Air Source Heat Pumps

Gas Source Heat Pumps (Borehole and Trench)

Hybrid (Gas/Electricity) Heat Pumps

Fuel Cells

Biomass Boilers

Gas Micro-CHPs (Combined Heat and Power)

Biomass Micro-CHPs (Combined Heat and Power)

Peak Gas Demand: The cold weather in March 2018 has raised interest in the relationship between annual gas demand and peak 1-in-20 gas demand.

6.10 Peak demand in the distribution networks is affected by temperature, wind speed and a seasonal factor. Do you think anything else should be considered?

6.11 Do you have any suggestions for how the peak demand modelling could be improved?

Number of heating appliances per home, hot water thermal requirements by housing segment, and hybrids: In FES 2018 we assumed that there will be one heating appliance installation per household to heat space and hot water (homes with hybrid heating systems are treated differently).

6.12 Do you agree with this assumption?

- Yes
- No
- Don't know

6.13 If 'No' what is your view and information to support this?

6.14 Could you provide evidence for the proportion of homes with dual fuel heating systems in GB?

6.15 In FES 2018, we assumed all housing types had the same hot water demand. Is this a correct assumption to make?

- Yes
- No
- Don't Know

6.16 If 'No' what is your view and information to support this?

In FES 2018 we assumed that for homes heated by gas/electric hybrid heat pumps, electricity supplies 90% of annual energy input for space heating and 25% for hot water supply, with gas providing the remainder.

6.17 Do you agree with this assumption?

- Yes
- No
- Don't know

6.18 If 'No' what is your view and information to support this?

In FES 2018 we assumed that all hybrid systems are off-the-shelf units (i.e. non-retrofitted to an existing unit).

6.19 Do you agree with this assumption?

- Yes
- No
- Don't know

6.20 If 'No' what is your view and information to support this?

6.21 What is your view of off-the-shelf and retrofitted hybrids in terms of cost, reliability and efficiency?

6.22 What information is there to support this view?

7. Transport

For reference to the content of this section please see:

- FES 2018 Document pages 72-77
- FES Modelling Methods document sections “Transport”
- FES 2018 Data Workbook Tabs 4.18, 4.19, 4.20, 4.22, RT1, RT2, RT3

ULEVs (Ultra Low Emission Vehicle) in FES Scenario Framework: In FES 2018 we assumed that the move away from petrol and diesel fuels in all transport sectors (domestic, industrial and commercial) is mainly driven by the decarbonisation axis, with decentralisation only having a limited impact on transport. In the FES 2018 scenarios which meet the 2050 decarbonisation target, Community Renewables and Two Degrees, we assumed that road transport would be heavily electrified, with only limited differences between the two scenarios. For reference please see RT1, RT2, RT3 tabs in FES 2018 Data Workbook.

7.1 Do you agree with the approach of road transport being mainly driven by the decarbonisation axis?

- ○ Yes
- ○ No
- ○ Don't know

7.2 What evidence and data do you have to support your view?

Smart Electric Vehicle (EV) charging: In FES 2018 we changed our approach on consumer engagement with smart technologies, following stakeholder feedback. We therefore modelled smart EV charging adoption and deployment separately from the other smart technologies. Following stakeholder feedback, policy and market updates (such as the Automated and Electric Vehicles Act 2018 and a European eco-design study on smart appliances), in FES 2018 we kept maximum levels of smart EV charging adoption similar to FES 2017 and we increased the lowest adoption levels from ~20% to ~50%. Particularly, in FES 2018 we assumed (see also Data Workbook ED8):

- Maximum adoption of smart EV charging in 2030 (seen in Community Renewables): 71%
- Maximum adoption of smart EV charging in 2050 (seen in Community Renewables): 78%
- Lowest adoption of smart EV charging in 2030 (seen in Steady Progression): 26%
- Lowest adoption of smart EV charging in 2050 (seen in Steady Progression): 61%

7.3 Do you think these are:

- ○ About right
- ○ Too high
- ○ Too low
- ○ Don't know

EV charging away from home: In FES 2018 we changed our approach on non-residential EV charging by calculating it separately rather than as part of the aggregate commercial and industrial peak load. Following stakeholder feedback, commercial and industrial users would not charge at

peak times. We also assumed that domestic users without off-road parking would charge at non-residential locations, and that they would not make additional trips to charge their vehicle.

7.4 Do you agree with the assumption that commercial and industrial EV users would not charge during peak times?

- Yes
- No
- Don't know

7.5 If not, what levels (%) of commercial and industrial EV users would charge at peak times and what is the evidence to support this view?

7.6 Do you agree that domestic EV owners without off-road parking would not make additional journeys to charge the vehicle?

- Yes
- No
- Don't know

7.7 If not, what is your view and what evidence do you have to support this view?

7.8 Do you have a view (and evidence if possible) on whether on-street (e.g. parking spaces on the side of the road), destination (e.g. shops, workplace etc), forecourt (e.g. similar to petrol stations today) or another form of charging will dominate for EV owners without off-road parking?

7.9 If not, what is your view and what is the evidence to support it?

7.10 If the UK decides to use hydrogen for heating homes, as in the Two Degrees scenario, is there a possible road transport future which uses hydrogen in all road transport (i.e. including private residential travel)?

Autonomous vehicles: In FES 2018, following stakeholder feedback, we considered the replacement and reduction aspect of autonomous vehicles, meaning a single new autonomous vehicle replacing a number of non-autonomous vehicles in the car fleet. In the modelling, we assumed that autonomous cars would reduce private owned cars at the rate of 0.5 non-autonomous private cars for each autonomous private car; and 1.5 private cars for each autonomous shared car. This was based upon an average 1.5 cars per household. For reference see our FES 2018 Modelling Methods document.

7.11 Do you agree with the 0.5 private cars replacement rate for private autonomous cars?

- Yes
- No
- Don't know

7.12 If not, what rate of replacement do you consider will occur with the introduction of autonomous cars and what evidence do you have to support this view?

7.13 Do you agree with the 1.5 private car replacement rate for shared autonomous cars?

- Yes
- No
- Don't know

7.14 If not, what rate of replacement do you consider will occur with the introduction of autonomous cars and what evidence do you have to support this view?

7.15 How do you see trends of autonomous vehicle uptake changing the total number of vehicles in the future and what evidence do you have to support this view?

7.16 Do you have a view on when the roll-out of autonomous vehicles will commence (please provide evidence if possible)?

Vehicle to grid: In FES 2018, following stakeholder feedback, we introduced vehicle to grid (V2G) for the first time into the scenarios. We conservatively assumed that only the most engaged domestic EV consumers would take part in V2G.

7.17 Do you agree with the approach of only the most engaged domestic consumers taking part in V2G?

- Yes
- No
- Don't know

7.18 If not, what is your view and what is the evidence to support it?

7.19 Do you think we should include commercial and industrial EV users in V2G in the future?

- Yes
- No
- Don't know

7.20 What is the evidence to support this view?

8. Whole Energy System

Hydrogen plays a big part in the decarbonisation progress. Two of our FES 2018 scenarios meet the 2050 decarbonisation targets – Two Degrees and Community Renewables. In Two Degrees which is a more centralised world, we have around 250TWh of H2 produced from steam methane reforming and flowing into the domestic, commercial, industrial and transport sectors. In Community Renewables, which is a more decentralised world, H2 is produced from electrolysis and goes to the transport sector.

8.1 Do you have any comments on the level of H2, the way it is produced and the also the way it is used in the whole system for either Two Degrees or Community Renewables?

Biomass and Biogas are important contributors for decarbonisation and play a significant role within our decentralised scenario of Community Renewables. In 2050 through a combination of biomass and biogas, we have around 180TWh of bio energy in 2050 in Community Renewables.

8.2 Do you have any view and evidence related to this level of bio energy?

Considering the FES Framework, we have used a variety of technologies which have been assessed against the decentralised and decarbonised axes. For example, CCUS is one of the key technologies for decarbonisation and in FES 2018, it's only available in the centralised worlds (Two Degrees & Steady Progression).

8.3 Do you have any comments and evidence for additional technologies that should be included within FES or views around how we have deployed the various technologies across the scenarios?

9. Electricity Market Modelling

For reference to the content of this section please see:

- FES 2018 Document pages 92 – 111
- FES Modelling Methods document pages 10 – 16
- FES 2018 Data Workbook Tabs CP1 – CP5, 5.1 – 5.9, ES1 and ES2

Generation technologies: In FES we assume a range of installed electricity generation capacities for different technologies across the scenarios. These ranges are intended to cover the credible upper and lower limits for different technologies.

In the table below we are seeking your views on what you consider will be the upper and lower capacity ranges for a number of different technologies.

9.1 For 2030, please provide what range (in GW) you think will apply, for example: if you think on-shore wind will range from 8-22, then enter 8-22GW in the text box. The current capacities as of 2017 are shown in brackets for your information.

Biomass (3.3 GW)

Combined cycle gas turbine (28.5 GW)

Carbon capture utilisation and storage (0.0 GW)

Interconnector (4.0 GW)

Marine/Tidal (0.0 GW)

Nuclear (9.2 GW)

Offshore wind (6.1 GW)

Onshore wind (11.5 GW)

Reciprocating engines/Open cycle gas turbine (2.1 GW)

Solar (12.4)

Storage - battery (0.2 GW)

Storage - large scale e.g. pumped hydro, compressed air energy storage & liquid air (2.7 GW)

Storage - hydrogen/fuel cells (0.0 GW)

Vehicle-to-grid (0.0 GW)

9.2 Enter any supporting information you might have regarding your answers above here. You can also email us any evidence you might have at FES@nationalgrid.com please reference this page and question please.

Now we'd like your views on 2050 as well.

9.3 Please provide what range (in GW) you think will apply, for example: if you think on-shore wind

will range from 8-22, then enter 8-22GW in the text box. The current capacities as of 2017 are shown in brackets for your information.

Biomass (3.3 GW)

Combined cycle gas turbine (28.5 GW)

Carbon capture utilisation and storage (0.0 GW)

Interconnector (4.0 GW)

Marine/Tidal (0.0 GW)

Nuclear (9.2 GW)

Offshore wind (6.1 GW)

Onshore wind (11.5 GW)

Reciprocating engines/Open cycle gas turbine (2.1 GW)

Solar (12.4)

Storage - battery (0.2 GW)

Storage - large scale e.g. pumped hydro, compressed air energy storage & liquid air (2.7 GW)

Storage - hydrogen/fuel cells (0.0 GW)

Vehicle-to-grid (0.0 GW)

9.4 Enter any supporting information you might have regarding your answers above here. You can also email us any evidence you might have at FES@nationalgrid.com please reference this page and question please.

In FES we want to ensure that we appropriately account for the economic and financial viability of new and existing assets including electricity generation, interconnectors and storage.

9.5 Do you have views on the minimum levels of revenue that existing assets would need in order to be economically viable and remain open?

9.6 Do you have any views on how long economic losses could be sustained before an existing asset would close?

9.7 Do you have views on the minimum levels of revenue that would be needed to support investment in new assets?

Markets with high renewable and low carbon generation: In FES 2018, we said that we expect growth to continue at pace for most low carbon technologies driven by falling costs, technology developments and the drive for decarbonisation. We also said that we anticipate there will be periods of excess electricity in Great Britain from around 2030. This is due to the capacity required to meet

security of supply standards at peak times which means that there may be periods of oversupply when demand is low and weather conditions for renewable generation are favourable.

9.8 In your view, how do you think a high renewable / low carbon scenario could be delivered? For example, this could be by continued subsidies, market-driven without subsidies or by some other forms of support (e.g. capacity market)?

9.9 Assuming a scenario that delivers a market with high levels of renewable and low carbon generation, do you have any views on how the market would respond to the potential oversupply of excess renewable generation (e.g. local demand increasing to absorb the energy, excess energy being curtailed etc)?

9.10 Which technologies do you expect to provide reliable back-up capacity to meet demand when weather conditions are not favourable for renewable generation?

9.11 Do you have a view on how this back-up generation would need to be supported financially to mitigate potential low load factors?

Emerging technologies: In FES we consider the deployment of a number of emerging technologies that are not currently operating at commercial scale. In terms of emerging technologies:

9.12 By when do you expect carbon capture utilisation and storage (CCUS) to enter full commercial operation?

- 2025
- 2030
- 2035
- 2040
- 2050
- Never

9.13 In terms of business models, do you believe CCUS would be a viable technology for power only, or does it need to be considered in terms of a joint-business model such as being combined with hydrogen production (e.g. fuel synthesis)?

9.14 By when do you expect small modular nuclear reactors to be deployed in Great Britain?

- 2025
- 2030
- 2035
- 2040
- 2050
- Never

9.15 We currently assume that small modular nuclear reactors are able to operate more flexibly than large-scale nuclear. Do you agree with this assumption?

- Yes
- No
- Don't know

9.16 If 'No', should we be modelling them with similar flexibility?

- Yes
- No
- Don't know

9.17 Which other emerging technologies do you think could be deployed commercially between now and 2050? For example, advanced Modular Reactors co-located with storage (e.g. molten salt), or is geothermal feasible in GB by 2050?

9.18 Do you have a view on the feasibility of negative emission technologies such as biomass CCUS?

Distributed generation: In FES 2018, we changed the Scenario Framework to explore the growth of distributed generation more explicitly by having two scenarios with higher levels of decentralisation. In terms of distributed generation:

9.19 Are there any policy or regulatory changes (known or speculative) that may impact growth of distributed generation?

9.20 Which distributed generation technologies are likely to be:

Most Impacted?

Least Impacted

9.21 In FES 2018, 65% of total capacity was assumed to be decentralised by 2050 in the Community Renewables scenario. What challenges are there regarding the capability of distribution and local networks to deliver such change?

9.22 Are you able to provide details of potential constraints that would limit this growth?

9.23 If a hydrogen network is built to help decarbonise heat, will it also be used for distributed electricity generation (e.g. hydrogen combustion engine, fuel cells)?

Storage: In FES 2018, we considered a range of different storage technologies including batteries, pumped hydro, compressed air energy storage, liquid air and fuel cells. We also considered business models in which storage was co-located with renewable generation (e.g. batteries being co-located with solar).

9.24 In your view, are there any other storage technologies that we should be including in FES 2019?

9.25 Do you have any views on the potential development and role for long-duration / seasonal storage, including when it could be deployed commercially?

9.26 Do you have any views on the interaction of storage with other technologies such as renewable generation, interconnectors and vehicle-to-grid?

European markets and commodity prices: We use a pan-European model called BID3 for our electricity market modelling. In FES 2018 we modelled the impact of decarbonisation in Europe based on scenarios developed by other European Transmission System Operators and ENTSO-E.

9.27 In terms of our European scenarios, do you think we are using the most appropriate sources for these countries?

- Yes
- No
- Don't know

9.28 If 'No' which other sources do you recommend?

9.29 In terms of commodity prices, what do you think are the most reliable sources of data for modelling power market?

Data provision: In FES 2018, we presented a more comprehensive set of electricity market data in tabs ES1 and ES2 of the Data Workbook to make it easier to find the relevant information.

9.30 Do you have any feedback on these changes?

9.31 What other electricity market data assumptions or outputs would you like us to publish, and why?

10. Gas Supply

For reference to the content of this section please see:

- FES 2018 Document pages 112 - 121
- FES Modelling Methods document section “Gas Supply” (Pages 17 -19)
- FES 2018 Data Workbook Tabs 5.10 - 5.17, GS1, GS2

10.1 **Hydrogen**: Do you believe hydrogen blending should be included within gas supply for FES 2019?

- Yes
- No
- Don't know

10.2 If 'Yes', please explain why and provide evidence of a credible blend ratio:

10.3 If 'No', please explain why:

Shale: In FES 2018 we assume that GB shale gas is only produced in the slower decarbonising worlds of Consumer Evolution and Steady Progression. The ranges are developed from the Institute of Directors Report “Getting Shale Gas Working” produced in 2013 but modified due to a slower drilling schedule.

10.4 Do you believe that shale gas should be included within the faster decarbonising scenarios?

- Yes
- No
- Don't know

10.5 Please explain the reasoning for your answer:

10.6 Are there other developments in shale gas production that we should be considering for FES 2019?

Green Gas: The high case for Green gas in FES 2018 was ~12 bcm/yr by 2050 split between biomethane (4.3bcm) and BioSNG (7.6bcm).

10.7 Do you agree with this approach?

- Yes
- No
- Don't know

10.8 If 'No', what is your view on what the Green Gas high case should be and what information is there to support this?

10.9 Are there other Green Gas technologies that we should be including in our modelling for FES 2019? Please provide views and evidence:

10.10 **LNG Gas Supply**: LNG gas supply in 2017 was ~ 5bcm. When do you think we will see LNG supplies increase to greater than 15bcm/year again?

- In 1-2 years
- In 3-10 years
- In 11+ years

10.11 Please explain the reasons for your answer:

UK Continental Shelf (UKCS): In FES 2018, three of the four scenarios have no UKCS supply by 2050. Supply from the UKCS cease in Community Renewables (by 2042), Consumer Evolution (by 2047) & Two Degrees (by 2049).

10.12 When do you think we will see zero gas supply from the UKCS?

- 2030-2035
- 2035-2040
- 2040-2045
- 2045-2050
- Post 2050

10.13 Please explain the reasons for your answer:

10.14 Interconnector Flows: What do you think will be the main issues affecting gas supplies to GB from continental Europe?

The End

You have now reached the end of our Call for Evidence Online Consultation.
Thank you for your time and the online feedback

Energy Insights Team