

## **Shaping FES 2020**

Calling for views and evidence to inform the  
2020 Future Energy Scenarios

2 September 2019 – 27 September 2019

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# Shaping FES 2020

## How you can help shape FES 2020

The questions in this document will inform a review of the *2020 Future Energy Scenarios*. We received 70 responses to last year's *Call for Evidence*. We were delighted with the quality of information we received, and it provided an important contribution to FES 2019.

The *Call for Evidence* sits as part of our engagement with stakeholders from across the energy industry throughout the year. We also hold our conference, workshops and bilateral meetings. If you would be interested in meeting with us, please email [FES@nationalgrid.com](mailto:FES@nationalgrid.com)

## How to respond

Please complete the online survey

*Shaping FES 2020* will be open from Monday 2 September to Friday 27 September 2019.

This PDF contains all of the questions asked in the online survey. Please contact us if you have any difficulty completing the survey.

## Further evidence

Supporting evidence helps us to give your views the appropriate weighing when considering them in our analysis. We would welcome other views and evidence you may have related to our *Call for Evidence*. Please submit this, referencing the section and question your evidence refers to, by Friday 27 September to [Fes@nationalgrid.com](mailto:Fes@nationalgrid.com)

The evidence you supply could be your own analysis, reports or public studies for example.

## About FES

Our *Future Energy Scenarios* (FES) are the product of in-depth analysis by our team of experienced analysts. Collaborating with stakeholders plays a hugely important role in the development of FES. We take stakeholder insight and combine it with our own insights and the expertise of industry specialists. This results in the robust knowledge we need to produce credible pathways for the future of energy.

## More information about FES

To access our current and past FES documents and data visit: <http://www.fes.nationalgrid.com>

For further information regarding ESO publications please visit: <http://www.nationalgrideso.com>

Get involved in the debate on the future of energy and join our LinkedIn group *Future of Energy National Grid ESO*.

Write to us at:

Strategic Insights  
Electricity System Operator  
Faraday House  
Warwick Technology Park  
Gallows Hill  
Warwick CV34 6DA

## 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 will not be published as a part of our findings. We will summarise the feedback and include it in our *Stakeholder Feedback Document* in early 2020.

For all further enquiries please email the team at [FES@nationalgrid.com](mailto:FES@nationalgrid.com)

## Questions

### Questions about you

1. What is your name and email address?
2. Are you responding on behalf of an organisation or as an individual?
3. Please confirm the name of the organisation
4. What do you use the Future Energy Scenario (FES) for and how have you been involved in the FES programme in the past?

## 1. FES publications

- 1.1 Which FES 2019 publication did you use and which was most useful to you?
  - The **FES document** which provides an overview of key areas
  - **FES in 5**, which is a summary document with key headlines and statistics from FES
  - **Scenario Framework document** which details all the assumptions that are used as inputs into our models
  - **Data Workbook** which contains the outputs from the numerous models, including detailed tables, graphs and charts, beyond those included in the main document
  - **Modelling Methods document** which contains information on our modelling methodology and assumptions
  - **Frequently Asked Questions** includes all of the questions asked and answered as part of our conference and presentations.
  - **Regional breakdown of FES data**
- 1.2 What would you like to see improved in the publications?
- 1.3 This year we have launched a new, more accessible format for our Summer Outlook Report - <https://www.nationalgrideso.com/document/140411/download>  
How happy would you be seeing future FES documents in a similar format?
- 1.4 Which sections of the FES document did you find useful?

Key messages

The scenarios

- The scenario framework
- Extended analysis and spotlights
- An overview of the Future Energy Scenarios

Decarbonisation and decentralisation

- Speed of decarbonisation
- Level of decentralisation

Energy demand

- Energy demand
- Industrial and commercial demand
- Residential demand
- Transport demand
- Gas demand for electricity generation

- Demand for hydrogen production

#### Energy supply

- Energy supply
- Electricity supply
- Gas supply

#### Net zero sensitivity analysis

This year we featured a number of spotlights in FES – i.e. short informative sections on specific topics.

- How might gas and electricity demand change in a hybrid heat pump home?
- Electric vehicle charging behaviour
- Hydrogen production, use and delivery
- Oversupply of electricity
- Carbon capture, usage and storage (CCUS)
- Carbon intensity of gases in FES 2019
- Net zero technologies

1.5 Which of these did you find useful?

1.6 What spotlight topics would you like to see us cover in future? Why?

1.7 How could we make the information that you need from FES more accessible?

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

1.9 We are proposing to only publish a digital version of FES next year in order to reduce our carbon footprint. Do you have any concerns about this?

1.10 Do you have any comments on the information provided in FES in 5?

1.11 Do you have any comments on the information provided in Scenario Framework document?

1.12 Do you have any comments on the information provided in Data Workbook?

1.13 Do you have any comments on the information provided in Modelling Methods document?

1.14 Do you have any comments on the information provided in Regional breakdown of FES data?

## 2. FES engagement

2.1 Did you take part in any of the following FES engagements over the last year? How useful was this engagement.

- Bilateral meetings with members of the FES team
- Call for Evidence 2018
- Launch event – breakfast briefing in London
- Launch event – conference at the NEC Birmingham
- Webinar
- Workshops on FES in autumn 2018

2.2 This year our FES conference was a week after the publication of FES 2019. Did this give you enough time to read and reflect on the document?

2.3 Over the last year we have held engagement sessions across the UK. Which of these are better located for you?

- Birmingham
- Cardiff
- Glasgow
- London
- Manchester
- Newcastle
- Warwick

2.4 How important is it to you for FES information about to be available via

- Email
- ESO website
- LinkedIn
- Twitter
- Videos on social media

2.5 Are there any other tools you would like FES to use to communicate with you?

2.6 What could be done to improve our communication with your organisation?

2.7 We publish a Stakeholder Feedback Document in February. This year we titled it 'A Forward look to the 2019 Future Energy Scenarios'. This set out our approach to the 2019 FES. How did you use this?

### 3. Scenario Design

For FES 2019, we retained the Scenario Framework that was used in FES 2018 (see below)



A lot has changed over the last year, such as the UK government legislating a new Net Zero carbon target for 2050.

Our scenarios in 2018 and 2019 were designed using the key uncertainties of “speed of decarbonisation and “level of decentralisation”.

3.1 We want to ensure that FES 2020 captures the key uncertainties in the future of energy that exist today. Please state how important you think each of the following uncertainties. We will use you responses to inform the key uncertainties used in FES 2020.

Uncertainty	Description		Very important	Quite important	Not important
<i>Speed of decarbonisation</i>	<i>An existing axis. To explore extent to which target is met early or missed.</i>				
<i>Level of decentralisation</i>	<i>An existing axis. To explore how close supply is to demand.</i>				
<i>Green ambition</i>	<i>The extent to which public sentiment and policy prioritises decarbonisation.</i>				
<i>Economic prosperity</i>	<i>The rate of economic growth.</i>				
<i>Degree of electrification</i>	<i>This would explore the balance between electrification and use of low carbon gas.</i>				
<i>Level of devolution</i>	<i>Similar to “decentralisation” but looks at extent to which a more regional approach could be taken to decarbonisation e.g. clean heat.</i>				
<i>Level of energy efficiency</i>	<i>Would attempt to stretch the range of energy demand levels (e.g. thermal efficiency of buildings).</i>				
<i>Supply-led vs Demand-led</i>	<i>Seeks to address whether a supply side solution is favoured over a demand side solution.</i>				

<i>Level of consumer engagement</i>	<i>The extent to which consumers are engaged with their energy use (e.g. respond to price signals to modify demand).</i>				
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3.2 Are there any other uncertainties that you think should be considered?

In FES 2019 two scenarios did not hit the 2050 decarbonisation target.

3.3 For FES 2020, should there be scenarios that don't meet the new Net Zero 2050 target?

3.4 Do you have any additional comments on this?

3.5 For FES 2020, should there be a scenario that meets the new Net Zero target earlier than 2050?

3.6 Do you have any additional rationale to support this view?

The individual FES 2019 scenarios were designed to include a balanced mix of different technologies.

3.7 Would it be useful to instead design scenarios that focus more on one technology over another (e.g. mass hydrogen roll-out vs full electrification)?

3.8 Do you have any additional rationale to support this view?

3.9 Do you have any other suggestions for the design of the scenarios or for the FES framework more generally?

3.10 Do you see any possible disruptors emerging in the next 12 months that could potentially influence the choice of FES framework?

## Electricity market modelling

### 4. Net zero markets

4.1 Within a "net zero carbon" scenario, which technologies do you expect to provide reliable back-up capacity to meet demand when weather conditions are not favourable for renewable generation?

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

4.3 More generally how do you think a net zero 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)?

4.4 In our faster decarbonising scenarios, there are periods of oversupply of electricity beyond 2030 (e.g. around 6% of total annual output after 2040 in Community Renewables). Do you have any views on how the market would respond to the potential infrequent and spike periods of oversupply of excess renewable generation?

## 5. Potential capacities

5.1 For a net zero carbon 2050, please provide what range (in GW) you think will apply. As an example; if you think onshore wind will range from 8-22, then enter 8-22GW in the text box.

- Nuclear
- Offshore Wind
- Onshore Wind
- Solar
- Marine (Tidal/Wave)
- Thermal CCUS
- Negative emission bioenergy CCUS (“BECCS”)
- Unabated thermal (e.g. gas turbines/reciprocating engines)
- Biogas (e.g. reciprocating engines)
- Hydrogen (e.g reciprocating engines, fuel cells)
- Interconnectors
- Storage – battery
- Storage – non battery
- Vehicle to grid

5.2 How would your answers differ in a scenario that does not meet net zero?

5.3 Enter any supporting information you might have here. Note, you can also email us any evidence you might have at [FES@nationalgrid.com](mailto:FES@nationalgrid.com).

## 6. Emerging technologies

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

- 2025
- 2030
- 2035
- 2040
- 2045 or beyond
- Never

6.2 What business model do you envisage for CCUS? For example how will it be financed? Could it be a viable technology for power generation only or will it be combined with hydrogen production? What load factors are required for it to be economical?

6.3 What do you view as the necessary carbon price to fund CCUS technologies?

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

- 2025
- 2030
- 2035
- 2040
- 2045 or beyond
- Never

6.5 Please describe the potential business models for small modular nuclear reactors. For example, how could it be financed? Would they operate more flexibly than the current nuclear sites?

- 6.6 Is there a case to consider higher levels of marine (tidal and wave) generation than our current range of 1 to 4 GW by 2050 within the high renewable scenarios? Are higher values needed to provide predictable renewable generation? How would the market evolve?
- 6.7 What is the timeline for deployment of Vehicle to Grid (V2G) systems? Will it be focused on particular sectors (e.g. domestic, commercial)?
- 6.8 Are there any other emerging generation technologies that we should consider? What supporting information do you have regarding these (You can also email us any evidence you might have at FES@nationalgrid.com).

## 7. Distributed generation

- 7.1 What is the outlook for small scale wind (sites of less than 1MW total capacity) following the closure of the renewable subsidy programmes?
- 7.2 What is maximum amount of solar (e.g. capacity in GW) that could be deployed in a net zero carbon scenario? What market changes would allow the upper limit to increase?
- 7.3 What is the timeline for future solar growth; will it be a steady growth between now and 2050 or will there be a period of faster growth at some stage? Will growth rates differ between small scale rooftop solar and larger scale ground mount solar?
- 7.4 What policies (known or speculative) may shift the balance between growth of distributed generation and growth of transmission connected generation?
- 7.5 Which technologies will be:
- Most impacted?
  - Least impacted?

## 8. Storage

- 8.1 We considered a range of different storage technologies including batteries, pumped hydro, compressed air energy storage, liquid air and fuel cells. Are there any other storage technologies we should consider. What routes to market may they exploit?
- 8.2 Do you have any views on the potential development and role for long duration / seasonal storage, including when it could be deployed commercially? What business model do you envisage for it?
- 8.3 Do you have any views on the interaction of storage with other technologies such as renewable generation, interconnectors and Vehicle-to-Grid?

## Energy demand

### 9. Energy demand general

- 9.1 What comments do you have on our energy demand modelling approach and the data we have used?

- 9.2 Are there any sub-sectors of industrial & commercial (I&C) energy demand which you feel are particularly easy or difficult to decarbonise? Why? How might they be decarbonised?
- 9.3 Can you foresee any areas of significant energy demand growth across the industrial and commercial sectors?
- 9.4 Heating forms a major part of total I&C energy demand. Which low-carbon heating technologies do you think will be important in decarbonising space heating (mainly in the commercial sector) and high and low-temperature process heating (in the industrial sector)?
- 9.5 BEIS has consulted on reducing I&C energy demand by 20% in 2030, against 2015 levels. What levels of energy efficiency improvements do you think are economically viable and achievable for businesses, out to 2030 and 2050? Where do you think these improvements will be focused?
- 9.6 What policies do you think will emerge to improve energy efficiency in domestic homes and when might these be rolled out? These may include heating, insulation, electrical appliances, etc.

## 10. Gas demand

FES profiles seasonal variation in gas demand using historical data with an adjustment applied to account for the effects of climate change. When it comes to forecasting peak 1 in 20 demand however, actual i.e. non-climate-adjusted data, is used. This is due to the assumption that even as average seasonal temperatures rise over time there would still be periodic cold spells such as occurred on 1st March 2018.

- 10.1 Do you have any views on this assumption?
- 10.2 Could you provide evidence for alternative methods of incorporating climate change effects into peak gas demand modelling?

With growing capacity of renewable generation and interconnection FES assumes gas fired power generation would evolve into the role of primarily flexibility provider alongside other storage solutions. In our most decarbonised scenarios this leads to very low load factors for this asset class post-2030s.

- 10.3 Could you provide evidence for the range of minimum annual load factors required for CCGTs, OCGTs, and CHPs to ensure economic viability?

To model 1 in 20 peak gas demand we make use of power dispatch modelling in order to include the contribution of gas demand from power generation. We are proposing to use EMR derating factors as proxies for generation load factors for the different technologies on a peak 1 in 20 demand day

(See page 52 of 2019 Electricity Capacity Report for conventional, renewable plants and storage derating factors and page 5 of Panel of Technical Experts Final Report on National Grid's Electricity Capacity Report for interconnectors derating factors).

- 10.4 Do you have any evidence to suggest alternative value should be used?

## 11. Domestic heat

In the FES workbook table ED1 we have published our assumptions on residential thermal storage. FES assumes 25% of heat pump installations are paired with some form of thermal storage (based on estimates of hot water tanks remaining in UK homes).

11.1 In zero carbon scenarios, how much residential thermal storage do you think there will be?

11.2 Do you think it will be possible for thermal storage to meet the winter peak day demand and if so, by when?

Most heat networks today are powered by gas CHPs and are also associated with high network losses. FES has nonetheless defined heat networks as low-carbon because of the assumed flexibility for non-disruptive fuel switching to low-carbon sources that they offer.

11.3 Do you agree with this assumption?

11.4 Could you provide evidence for the barriers for uptake of low-carbon heat networks?

11.5 What are the emerging innovations or tested solutions for reducing heat network losses?

FES assumes heat pumps are more likely to be installed in buildings with high thermal efficiency performance. Given recent developments in high temperature heat pumps that allow retrofit to conventional radiators.

11.6 Could you provide evidence to support either maintaining or modifying this assumption?

11.7 Could you provide evidence of heat pump performance in low thermal efficiency buildings?

FES assumes that the available technology options for decarbonising heat would perform differently depending on the area of the country they are deployed.

11.8 Do you agree with this assumption and why?

11.9 Could you comment or provide evidence for the importance of the factors listed below as potential regional drivers of heat decarbonisation and what technologies would be most affected by each of these drivers?

- i. Disposable income
- ii. Building stock
- iii. New build/demolition rates
- iv. Housing density
- v. Industrial and commercial activity
- vi. Social housing
- vii. Geography/topology
- viii. Demographics
- ix. Infrastructure (on or off grids)
- x. Population
- xi. Regional/local governments/communities

In FES, storage heaters are treated as less preferable to heat pumps or other forms of low-carbon heating technologies because of their relatively lower efficiency and higher operating costs. However, given that storage heaters are very cheap to install and practically have no demand at system peak.

11.10 Do you agree with our current assumption?

11.11 Could you provide evidence of innovation in storage heater technology that supports their use as viable alternatives to heat pumps?

To achieve deep decarbonisation with hybrid systems, FES assumes that the gas/hydrogen boiler component of a hybrid heat system would act in effect as a storage mechanism for the electric

heat pump component. This means that the gas/hydrogen boiler would meet only 20 – 35% of annual heat demand depending on the assumed building thermal efficiency.

11.12 Do you agree with this assumption?

11.13 Could you provide evidence that supports a different range of proportional contribution of gas/hydrogen boilers to total heat output of a hybrid system?

## 12. Transport

In FES 2019 we assumed biofuel could play a significant role in heavy and light goods road transport in the 2020s, and then could be steadily replaced by hydrogen in the decarbonising scenarios in the 2030s, with hydrogen being produced via electrolysis or industrial steam methane reformation. We published data in the FES workbook table ED5.

12.1 When do you think we will see significant numbers of commercial vehicles running on biofuel?

12.2 When do you think we will see significant numbers of hydrogen fuelled vehicles?

We published our electric vehicle projections in the FES 2019 data workbook table ED5 “electricity cars, number of vehicles.” For FES 2019 we assumed medium and small electric cars achieve cost parity with petrol cars in the mid to late 2020s.

12.3 What are your views on this?

We published our “Vehicle to Grid” (V2G) projections in the FES 2019 data workbook table ED5 “V2G generation at peak, total V2G capacity”. We currently assume V2G peak generation will reach just under 100MW by 2025, and could reach levels as high as 600MW by 2030, 6400MW by 2040 10200MW by 2050. It is constrained by those cars parked, able to export and signed up to a V2G tariff.

12.4 What do you think of our projections?

A number of aviation manufacturers are aiming to mass market light electric aircraft in the late 2020s. Research is in progress on hydrogen fuel powered flight. Biofuel is seen by many in the industry as either an interim or ideal solution for long haul flight.

12.5 By when do you think the short-flight market could be fully electric?

12.6 When do you think we could see hydrogen powered flight and on what kind of aircraft, assuming hydrogen is produced for heat decarbonisation in the early 2030s?

12.7 What role do you see biofuel playing in aviation up to 2050?

12.8 A number of engineering and shipping companies are investigating low or zero carbon maritime transport. These concepts look at fuels such as LNG, biofuel, hydrogen and electricity. What fuels do you think will be adopted by the shipping industry and when?

## 13. Gas Supply

13.1 What are we likely to see with the international LNG Market?

E.g.

- Near future in global LNG market is very uncertain until 2022-3

- There is a growing supply of LNG projects coming online in next couple years
  - LNG demand is mainly driven by Asian markets (biggest importers)
  - Weather implications across LNG importing countries will determine level of gas GB will get
- 13.2 What are the growth opportunities for shale gas?
- E.g.
- Currently UK shale industry is experiencing many issues related to environmental concerns
  - Restriction on drilling and fracking is causing the shale gas industry to move slowly
  - Low gas prices and availability of gas across globe also play a role in accelerating shale industry
- 13.3 What are the opportunities for bringing in hydrogen from other countries?
- 13.4 Gas import dependency is on a rise in the future due to decline in production. Currently GB relies on a medium range storage to match demand, would new seasonal storage be required to meet future demand?

## 14. Whole System

In our net zero sensitivity for 2050 we assumed a balanced approach between hydrogen and electrification. In heat we assumed 45% of homes were on hydrogen. GB electricity demand was 543TWh assuming high energy efficiency levels.

- 14.1 What proportion of homes could be on hydrogen in different net zero scenarios?
- 14.2 Is anything needed to make these levels happen?
- 14.3 In a high electrification net zero pathway, what do you think is the highest percentage of GB's energy that could be electrified?
- 14.4 What would have to occur for your suggested levels to happen?

Currently the UK has carbon budgets which last until 2032, and aim to achieve 57% carbon reduction below 1990 levels (1725 MTCO<sub>2e</sub>).

- 14.5 Given discussions on zero carbon targets by 2050, do you think there is a possibility that the carbon targets will be reviewed by the UK before 2032?
- 14.6 What do you think the transition to 2050 will look like? Will the pathway be steady, gradually accelerate towards 2050, or accelerate before 2050?
- 14.7 What policies do you think will be added or enhanced in order to meet the UK's 2050 targets?
- 14.8 Do you think there a possibility that the UK's zero carbon target could be reviewed at a later date and then brought in ahead of 2050? Why do you think this?

## 15. Modelling Approach

- 15.1 What areas of the modelling carried out for FES 2019 do you feel could be improved, and if so how?
- 15.2 Are there any new areas that you feel we need to include in our modelling for FES 2020 or beyond that have not been identified elsewhere in this document?

This is the end of our questions.

If you have any other views and evidence you would like us to review as part of *Shaping FES 2020* please submit this, referencing the section and question your evidence refers to, by Friday 27 September to [Fes@nationalgrid.com](mailto:Fes@nationalgrid.com). Supporting evidence helps us to give your views the appropriate weighing when considering them for analysis. Alternatively please leave any other comments in the box below.