

# **Future Energy Scenarios 2022 Stakeholder Feedback Document**

## **Stakeholder input to the 2022 Future Energy Scenarios**

Final version 2.0  
March 2022



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# 1. Welcome and overview

## Welcome and introduction

Welcome to the Future Energy Scenarios (FES) Stakeholder Feedback Document. We want you to know that your feedback has been heard, how we're responding to it and how it is shaping our analysis for FES 2022. We also want to show you the proposed scenario framework and scenarios for FES 2022.

This document shares the stakeholder engagement that has taken place and the insight gathered to support and feed into the analysis and modelling for the scenarios. We have detailed where we have received differing of views from stakeholders on some subjects, the decisions we have come to, and how we have taken that insight forward for FES 2022.

In the appendices at the end of the document, we provide full transparency by looking back at the actions we set out in the FES 2021 Stakeholder Feedback Document and describe the extent to which we acted on feedback. We've also provided some of the finer details of our engagement and communication activities from the last few months.

FES iterates year on year based on feedback from stakeholders, alongside changes and developments in technology and policy as well as enhancements in the modelling and analysis. Stakeholder engagement is therefore fundamental to the FES process and ensures that the scenarios produced are credible and reliable pathways to the future of energy.

*Thank you to our stakeholder community who have contributed and supported FES over the last 12 months through a challenging time for many, particularly the first half of 2021. It is much appreciated, and we look forward to engaging with and welcoming you to the FES 2022 launch during July 2022.*

## Engaging with our stakeholder community for FES 2022

1020 stakeholders engaged with across all events  
(Includes ESO)

329 unique organisations engaged

All nine stakeholder categories represented

204 new organisations engaged for FES 2022

Our engagement to date with stakeholders for FES 2022 has largely taken place virtually, following the success of virtual engagement from FES 2021. Whilst some of the benefits of face-to-face engagement are missed, virtual engagement ensures a more efficient use of time for stakeholders and the team, and in addition, significantly reduces the carbon footprint of travelling.

**For FES 2022 we engaged with a total of 1020 stakeholders representing all nine of our stakeholder categories from 329 organisations. Of these 329 organisations, 204 were new to FES for 2022. Information regarding where we have gathered insight from is shared below and throughout the document. Our Net Promoter Score is +37.**

The range of organisations contributing to the FES 2022 scenarios spans consumer groups, research engines, government departments, renewable generators, storage & flexible providers, and utility networks. Feedback from other ESO engagement events fed into our FES analysis, including innovation and consumer projects. Further details on these can be found from page 6 onwards.

Engagement for FES 2022 will continue until publication in July as we share early insight and test our thinking with stakeholders.



A variety of engagement with stakeholders takes place throughout the year via events, the website, newsletters, and social media. The activities mentioned below are those of most significance.

The **FES 2021 launch** event took place week commencing 12 July. 570 stakeholders joined us during the week and to watch the recorded catchups. We shared key messages, key insight from our analysis, and webinars provided the next level of detail from the main report. We received strong support to continue with an online launch for FES 2022.

We commenced our FES 2022 engagement programme by hosting the **FES 2022 Call for Evidence** during September, providing all our stakeholders (including potentially new ones) with the opportunity to contribute to FES 2022. This was shared via our newsletters, website, and social media, reaching as many existing and new stakeholders as possible. We received 36 responses and shared a summary of these during October. We changed the format of the online survey to improve the experience for stakeholders.

During August we also began our **bilateral and regional engagement** with key stakeholders and organisations for FES. This more direct engagement provides us with rich and valuable insight towards the scenarios and will continue into and beyond the start of our analysis. We met with 199 stakeholders from 95 different organisations, with some being new for this year. Identifying and contacting new organisations for engagement provides us with fresh insight and gives a different perspective on traditional and well-established energy views. Each bilateral meeting is tailored; beginning with discussions about any strategic changes and insight, followed by very specific questions for each organisation.

Engagement for the **FES 2021/22 Bridging the Gap** project began in September, continuing with the theme of peaks and troughs from the previous year with a strong focus on flexibility. Engagement has taken a more targeted approach to ensure feedback from key stakeholders as well as utilising other opportunities across the ESO, for example tapping into consumer research. The report will be published in March 2022 with an online presentation and panel discussion, open to all interested stakeholders.

We have continued with the **FES Network Forum** through 2021 and will do so into 2022, with meetings taking place bi-monthly. These collaborative meetings with distribution and transmission network owners across gas and electricity provide the opportunity for early analysis to be shared as well as deep dives focussing on specific subjects. We use these meetings to test our thinking, with attendees providing a sounding board to our work.

During November we hosted a **FES 2022 consumer workshop** with organisations representing consumer and fuel poverty groups. During the session we sought feedback looking back at FES 2021 and then input for FES 2022. Research and recent reports were shared to enhance our knowledge of consumers moving to Net Zero.

More detail about engagement that has taken place can be found from page 64 onwards.

### **The scenario framework and scenarios for FES 2022**

We last changed the scenario framework for FES 2020 to better represent the major uncertainties in a world aiming for net zero. This change involved new scenarios and a new vertical axis on our framework diagram: the 'level of societal change'. For FES 2022 we are proposing to retain the same scenarios and framework as used in FES 2021. Despite the large number of government policies and strategies released ahead of COP26, and noting the outcome of COP26 itself, we feel that they remain fit for purpose in terms of capturing the range of uncertainty in the future of energy. By this we mean that the insights, engagement, and research carried out for FES 2021 had already accounted for potential policy developments ahead of them being published. In addition, our stakeholders tell us they value consistency and being able to easily compare changes from year to year. Just because the high-level framework remains the same it doesn't mean that individual modelling assumptions aren't updated – it is just that this is done within the same high-level scenario framework.

Within our FES 2022 Call for Evidence, we asked stakeholders if they were happy for us to retain the same scenario framework for FES 2022. Most respondents supported retaining the scenarios for FES 2022 with year-on-year consistency being highly valued.

During other engagement activities, the FES Network Forum for example, stakeholders have verbally confirmed that they agree the scenarios and framework remain fit for purpose.

**Therefore, based on this feedback, and considering recent policy decisions and announcements, we have decided to retain the FES 2021 scenario framework for FES 2022 as it is still fit for purpose.**

We have however, after listening to stakeholders through our engagement activities, decided to change the name of the Steady Progression scenario to **Falling Short**. Some stakeholders felt it wasn't sufficiently clear from the old name that this scenario did not meet the Net Zero target. We believe that this new name more accurately reflects the intent of the scenario. This is just a name change and **Falling Short** will perform the same role as Steady Progression in the FES framework (i.e. it represents the credible slowest progress towards decarbonisation).<sup>1</sup>

### Regional FES

We have been exploring further regionalisation of the FES with our stakeholders, through a focussed engagement campaign that included a series of bilateral engagements, forums, and questionnaires. This commenced in May 2021 and will continue as we develop our regional outputs. We are keen to understand what our stakeholders want from the regionalisation of FES and have received a broad range of valuable feedback that is helping to shape the product and end goal. Our stakeholders have highlighted the importance of developing regional outputs in line with their requirements to feed into their processes. We are exploring how to make our outputs more user-configurable so that a FES view can be personalised dependent on specific stakeholder requirements. We will continue to work with our stakeholders during FES 2022 to develop our thinking on this and the broader regionalisation activities.

### Analysis updates for FES 2022

Prior to analysis commencing, we carry out an annual procedure to review both our assumptions (i.e. based on updated policy, stakeholder engagement and technical developments) and our modelling approach – including the development of new models. For the latter, potential improvements are prioritised to ensure that the most beneficial are taken forward into the next FES analysis run with others targeting later years. At this stage in our analysis for FES 2022, we are focusing on the following areas:

- **Transport**
  - Reviewing smart charging assumptions
  - New modelling for charging locations
  - Increasing uptake of zero emission HGV, buses, and bikes
  - Reviewing vehicle efficiency.
- **Heat**
  - Regional updates.
- **I&C demand**
  - Applying more ambitious decarbonisation in Steady Progression
  - Carrying out a deep dive into data centre demand
  - Increasing levels of fuel switching across all scenarios
  - Analysing impact of increasing wholesale energy prices.

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<sup>1</sup> This change of name doesn't change anything else about the scenario and its placement within the framework where it continues to represent the credible slowest progress towards decarbonisation.

- **Bioenergy**
  - Reviewing lifecycle sustainability of biomass and how changing awareness may affect its use in the energy mix
  - Reviewing any potential over-reliance on BECCS technology in achieving Net Zero (e.g. via delivery of greenhouse gas removals) by considering a wider range across the scenarios.
- **Natural Gas**
  - Reviewing how the UK's exposure to international gas markets and prices changes from now to 2050 and how that affects its place in the energy mix
  - Reviewing how future reduction in output from UKCS is modelled.
- **Hydrogen**
  - Relative economic efficiencies of different ways of supplying hydrogen (building on last year's comparison of energy efficiency).
- **Electricity Supply**
  - Regional breakdown of offshore wind supply and updating our plant assumptions in line with latest market information such as the recent ScotWind leasing results
  - Exploring modelling of a constrained electricity system in the short term, as well as the unconstrained network as is typical in FES. This will allow additional information to be provided on areas like power sector carbon intensity and wind load factors
  - Reduction in interconnector capacity in 2030 and 2050 in some scenarios to reflect increased regulatory uncertainty for projects connecting to some countries. This gives a wider range across the scenarios compared to FES 2021.
- **Net Zero**
  - Changing the name of Steady Progression scenario to '**Falling Short**' to clearly indicate it does not meet the Net Zero target
  - Ensuring all Net Zero compliant scenarios (including System Transformation) meet relevant interim targets such as the 6th Carbon Budget.

### Improvements identified for our continued engagement:

During our engagement we constantly seek feedback to improve how we work. We identified several areas for improvements as we continue our engagement with stakeholders, some of which are listed below. A more detailed look at the improvements can be found from page 54.

#### Publication and launch

- We will share the FES 2022 launch date at least three months prior to the week of events
- We will be explicit in the software to be used for the launch to prevent any access and security issues on the day
- We will improve the registration process for the launch week so that entries appear in diaries once booked
- Working with the online conference provider and team we will improve the quality of the presentations by considering 'auto-cue' technology, training for the team and additional rehearsals
- We will ensure that all document versions (interactive and print) are available on the day of publication
- Website - we will improve the navigation on the website for the publication and provide better signposting and linkage between the suite of documents.

**We will be publishing FES 2022 during July 2022 and look forward to welcoming you during the week. If you would like to contact us at any time: [FES@nationalgrideso.com](mailto:FES@nationalgrideso.com)**

## 2. How we engage with stakeholders

Engagement with our stakeholders is a fundamental element of the FES annual cycle that starts and finishes with the publication and launch event that takes place every July. The insight and evidence we obtain through this essential engagement is then combined with our own data, research, experience, and modelling to produce the credible range of pathways for the future of energy.

Our engagement ranges from general discussion to detailed questions and insight. We have a detailed engagement plan at the beginning of each cycle and continue to add to this as we go through the process and identify new insights and areas to investigate.

### Engagement comparison: 2020 to 2021

As the energy landscape and participants change from year to year, so do the stakeholders and organisations that we contact and engage with. This is important to ensure that we are listening to a wide range of views that provide an alternative opinion or solution to existing thoughts and understanding.

The number of stakeholders we engaged with during 2021 has decreased compared to the previous year. This is due to the relatively lower number of stakeholders that joined for the virtual FES 2021 launch event compared to FES 2020. Several factors should be considered for the lower attendance this year; impact of Covid-19, virtual conference fatigue and the European Championship football final held the night before!

Whilst the number of stakeholders we have engaged with during the launch decreased, this has not negatively impacted the breadth and quality of our engagement for FES 2022. The FES launch takes on more of a 'show and tell' focus with questions and feedback mainly focussed on the modelling and analysis. The value-adding feedback we received for FES 2022 comes mostly from our bilateral meetings. We have spoken bilaterally (including regional FES engagement) with 199 stakeholders from 95 different organisations which has increased compared to last year. We engaged with organisations representing all nine of our stakeholder categories. A breakdown of these categories and sub-categories can be found on page 72 - 77.

### Engagement figures

	2019 (2020 SFD)	2020 (2021 SFD)	2021 (2022 SFD)
<b>Total number of stakeholders</b>	<b>463</b> different stakeholders <b>590</b> stakeholders across all engagement	<b>1257</b> different stakeholders <b>1713</b> stakeholders across all engagement	<b>688</b> different stakeholders <b>1020</b> stakeholders across all engagement
<b>Total number of organisations</b>	<b>224</b> different organisations <b>548</b> organisations across all engagement <b>109</b> new organisations for 2019	<b>460</b> different organisations <b>764</b> organisations across all engagement <b>347</b> new organisations for 2020	<b>329</b> different organisations <b>473</b> organisations across all engagement <b>204</b> new organisations for 2021
<b>FES launch events</b>	<b>248</b> stakeholders (London and Birmingham)	<b>984</b> stakeholders (live virtual feeds, recorded events, and catch-up sessions)	<b>570</b> stakeholders (live virtual feeds, recorded events, and catch-up sessions)
<b>Bilateral &amp; regional engagement</b>	<b>74</b> meetings	<b>185</b> stakeholders <b>86</b> organisations	<b>199</b> stakeholders <b>95</b> different organisations
<b>Call for Evidence</b>	<b>52</b>	<b>100</b>	<b>46</b> entered the survey; <b>36</b> provided actionable feedback

<b>Other engagement and interactions to note</b>	<b>50</b>	<b>30</b>	<b>55 stakeholders 31 organisations</b>
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### Stakeholder categories engaged during 2021

To ensure the breadth of our engagement is sufficient we use nine different stakeholder groups to categorise the organisations with which we interact.

#### Engagement stakeholder categories<sup>2</sup>

Stakeholder category	Total
Communities and their representatives	6
Consumers and consumer groups	27
Energy industry	486
Innovators	81
Non-governmental organisations	16
Other stakeholders including academics and universities	146
Political	43
Regulator	12
UK networks	203
<b>TOTAL of 1020 stakeholders involved across all activities</b>	

### Communication

Communicating with stakeholders continues all year round and we use a variety of techniques and media to do this. The FES newsletters are the main method for sharing information and asking for feedback as it has a large and growing distribution list (c.6200) who have actively subscribed. This is followed by the FES website and social media platforms which are accessible to anyone and everybody – even if not a newsletter subscriber.

#### Podcasts

Following the launch of FES 2021 we published a range of podcasts via the website and social media, providing the opportunity for stakeholders to listen to a range of views and discussions on topics like heat, electric vehicles, and hydrogen. We will be continuing with this during 2022 at the time of launch.

Further detail regarding our communication activity can be found on pages 64 - 71.

#### FES website

For FES 2021, we made changes to the website to make it easier for stakeholders to read and absorb the content. We did this by loading content onto individual webpages, removing the need to download the main report. In addition, we also uploaded a visual representation of the “Regional breakdown of FES electricity data” that allows customers to view regional results on maps and to select the information that is of most interest to them for their region. This is part of our ongoing drive to provide better regional granularity and customer experience.

As a result of these improvements, we have seen a significant increase in the number of stakeholders visiting the website which potentially led to a slight reduction in downloads (especially FES-in-5). We intend to build on this for FES 2022, improving the navigation, data visualisation and accessibility. Some of key statistics are shown below:

Reports	2020	2021
<b>Total document downloads</b>	21,687	15,120

<sup>2</sup> Further sub-categories are used to enhance the breakdown of information, the details of which can be found on page 72 - 77.

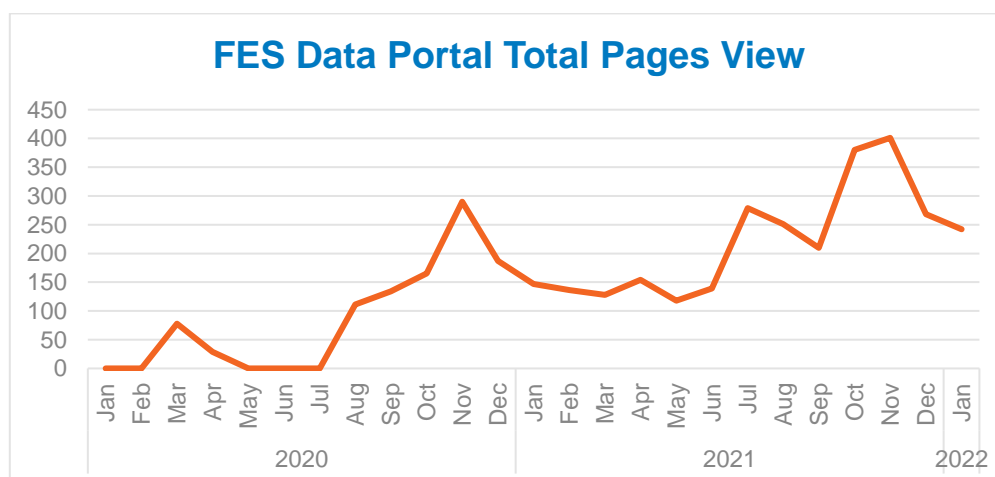


<b>Main document downloads</b>	11,229	10,532
<b>FES in 5 downloads</b>	5,138	2,542
<b>Data workbook</b>	4,081	3,430
<b>FES page views/hits</b>	62,729	116,486
<b>Average duration on FES pages</b>	2m 43s	2m 22s
<b>Scenario framework download</b>	1,171	686

### ESO data portal

The ESO data portal is a dedicated platform for customers and stakeholders to openly access ESO information. Over the last couple of years, we have added FES data to the portal. Between January 2020 and January 2022, the FES data was accessed via the data portal a total of 3,9842 times. This includes building block data, regional breakdown of FES data and electricity data supply data. The most popular of these items is the building blocks data used by Distribution Network Operators.

For FES 2022 we hope to include more data on the portal (including demand data) and will consider how best to utilise the portal for all the FES documents going forward.



### FES 2021 launch: July 2021

The FES 2021 virtual launch event took place week commencing 12 July and largely followed the same format as the previous year, with a few changes.

New for FES 2021, we ran a session in the afternoon, asking 'what next for FES?'. We were joined by a range of internal and external stakeholders to explain how they use FES for their decision making and processes.

Following on from feedback received the previous year we introduced virtual networking sessions on Wednesday and Thursday, providing the opportunity for attendees to meet each other and members of the FES team.

The events from Monday, Wednesday and Thursday were all available to watch on catch-up by the end of the week and will remain in place for a year on the conference platform. This provided flexibility for stakeholders to watch any sessions that they missed or chose to watch again.

For the question and answer (Q&A) sessions during the week we used Sli.do that was embedded into the online conference platform. This gave full visibility and transparency to the audience of the questions asked and permitted up-voting of questions to enable the most popular to be addressed. Using Sli.do was based on feedback from the previous launch where stakeholders had requested

to see all the questions posted. During the week we took 382 questions, with many answered in the live Q&A or aggregated and answered in the Q&A document published in August.

In our newsletter prior to and after the launch we provided a link to receive a hard copy of FES in 5, resulting in a request from 59 stakeholders.

During the week we used the poll function on the conference platform to gather opinion about the launch itself. We received many positive comments about the week, together with some areas for us to improve. These are shared on page 54 - 59. Most stakeholders that completed the poll were in support for holding virtual launches in the future.

**In summary, we welcomed 428 stakeholders during the week representing 223 different organisations. For each of the deep dive session on the Tuesday and Wednesday between 94 and 130 stakeholders attended per session. 142 stakeholders took the opportunity to watch the presentations on catch-up from 56 organisations.**

### **Call for Evidence: September 2021**

We began our FES 2022 engagement programme with the FES 2022 Call for Evidence. This was open throughout September and provided the opportunity for *all* stakeholders to provide input into next year's scenarios. We use this method of engagement to attract feedback from potentially unknown or new stakeholders as well as building a more quantitative understanding of which topics receive more or less interest.

Although anonymous, we encourage stakeholders to provide their contact details so we can follow up with any queries we have on their responses.

We shared the online consultation via the FES and ESO Plugged-In newsletter, FES website, and ESO social media channels.

Taking on feedback from last year regarding the medium used for the consultation, we changed the format, making it easier to complete and view all the questions at once. We advised stakeholders of this change at the time of publishing.

We published a condensed view of the responses received during October through the newsletter and website. The insight gathered and how it's been taken forward for FES 2022 can be found on pages 29 - 47.

**In summary, 46 stakeholders entered the survey with 36 providing actionable insight. Those that replied represented 33 different organisations from seven stakeholder categories. Of those 33 organisations, 18 were new for FES 2022. Whilst the number of responses was less than last year the feedback gained has been of value, providing a range of views and considerations for FES 2022 as well as increasing our stakeholder community.**

### **Bilateral and regional engagement: August to January**

Whilst stakeholder engagement takes place all year round, a significant element of our FES cycle is our bilateral engagement which follows the FES launch for immediate feedback. This engagement with key organisations and stakeholders for FES 2022 commenced in August and will continue until late Spring 2022. As was the case in previous years, this forms a fundamental part of the engagement plan to gather insight for the scenarios. We continue to proactively identify new organisations to contact to ensure a broad range of views on new subjects. This brings fresh insight in new areas and challenges the views of the status quo and established experience and knowledge.

We begin each of these meetings by asking stakeholders several key questions, focusing on the bigger picture and insight at a strategic level:

- Do you have any feedback on FES 2021?
- Did we miss anything that you would like to see in next year's scenarios?

- Do you have any views on the scenario framework, assumptions, and modelling (past or present)?

These questions are followed by more specific ones that are dependent on the organisation and stakeholder. It is worth highlighting again that most of the insight and evidence we take forward for FES each year comes from these bilateral meetings.

This engagement approach is particularly valuable as we build stakeholder relationships that not only endure between FES cycles but also allow us to test emerging thinking and proposals in particular areas as the analysis develops.

**In summary, 199 stakeholders have talked to us to from August to January from 95 different organisations providing evidence and feedback. We have, again, engaged with new organisations this year, bringing new insight to our analysis. It is also worth noting that we contacted a further 31 organisations to hear from but were unfortunate not to receive a response.**

### **Regional FES engagement: July 2021 to January**

We are increasing the granularity of our regional assumptions and analysis for FES to support understanding of future energy policy at a local level, as well as simplifying and optimising the interface with the more bottom-up scenarios currently developed by gas and electricity network companies, such as the Distribution Future Energy Scenarios (DFES). This will build upon the information we currently produce and publish, such as the regional datasets that are used in the Electricity and Gas Ten Year Statement (ETYS and GTYS) processes and ensure we are creating a deeper regional understanding in parallel with our GB level scenarios to feed into transmission network investment processes.

***Engagement with our regional partners and stakeholders plays a key role in providing insights for the ongoing regionalisation of FES.*** Carrying out frequent conversations with our stakeholders helps align assumptions and analyse potential gaps to facilitate our modelling process. Regional analysis will be used to support discussions with local gas and electricity transmission and distribution network companies who are well-placed to explain any differences at this more granular level which will enhance our understanding at a GB level. Given their unique views on their respective regions, this will provide valuable input into how we further regionalise our FES assumptions.

***Direct engagement with our regional partners to produce focused insights for each region is at the core of what we do.*** Engagement with the network companies and other key regional stakeholders has highlighted what they would like to see as part of the regionalisation of FES and how it will be beneficial to their processes. This has resulted in a better understanding of how our published FES data is used in making assumptions and as an input into our stakeholders' processes.

We have used the FES Network Forum to discuss regional development and keeping the network companies involved in the conversation about where we are going with FES, sharing our current thinking for the development of regionalisation for future publications. The forum also offers an opportunity for bilateral knowledge sharing and to receive feedback for the assumptions on our modelling such as our new spatial heat model.

A thought piece was published in December 2021 to outline our assumptions and approach to heat decarbonisation modelling and introduced our new regional heat model. We received some valuable feedback which we will be reflecting in FES 2022. A second thought piece is planned during March, to focus on discussing the regional results from FES 2021 in more detail which will again give us an opportunity to receive feedback on our modelling approach.

We will continue to engage with a broad range of stakeholders as our plan and thinking develops on the regionalisation of FES to help us validate our direction of travel, making sure it aligns broadly with stakeholders' expectations.

### **FES: Bridging the Gap: *September to date***

The FES: Bridging the Gap to Net Zero programme was first launched in November 2019. Its role is to take the FES key messages each year and investigate more closely what needs to be done in the short term to reach the UK's 2050 net zero target. We do this in close collaboration with our stakeholders, so that the final report represents an industry view of what needs to happen. To enhance this approach, we work with a guest chair, Laura Sandys CBE, who acts as an event facilitator and guest editor for the programme. Bridging the Gap provides a strong feedback loop into FES by clarifying areas of uncertainty and gathering more evidence for the forthcoming FES cycle.

Following FES 2021, this year Bridging the Gap's area of focus continues to be on the challenges to system operation with the increasing levels of renewable electricity generation required by decarbonisation. We've looked in more depth at this challenge, by modelling a week in the life of the system in 2035, using the levels of renewable energy and flexibility from our Consumer Transformation and System Transformation scenarios. We've partnered with Regen to produce a narrative for this 2035 week of high demand and low renewables, explaining how system stability and security of supply is maintained in the more flexible, more diverse, and more complex energy system of the future.

Our intention is to produce a timeline of actions required between now and 2035, to make sure that we've got the system required to deliver net zero carbon electricity. This will be informed by our own ESO plans and strategies as well as using stakeholder insight and engagement to present a whole system view. This will enable any gaps to be identified and any key policy areas will be highlighted.

The final report, with the accompanying day in the life of 2035 narrative and the action timeline, is due in March 2022 and its findings will inform the flexibility chapter of FES 2022.

**In summary, to date, 16 stakeholders have taken part in our engagement and discussions from 14 organisations on the Bridging the Gap publication.**

### **FES Network Forum: *bi-monthly***

The forums continued bi-monthly (April, June, August, October, and December) bringing together stakeholders from Gas Distribution Networks, Electricity Distribution Network Owners and Transmission Owners. The meetings allow FES output to be shared and feedback sought as well as time spent focussing on specific subjects like consumer engagement and regionalisation. These meetings provide valuable sounding boards for our work and provide opportunities for us to externally test our thinking.

Changes have been made to recent forums: building a collaborative agenda prior to the meeting, sharing the slides, recording the meetings, and highlighting any key points raised. During the October meeting a deep dive was held to explore what consumer engagement and research is taking place across the industry and to share best practice. Valuable consumer contacts and links to other pieces of research were disseminated.

Feedback on the structure and content of these meetings is constantly sought to ensure they are adding value and meeting expectations of all those that attend. The meetings are well attended and at the most recent meeting in December, 42 stakeholders attended.

**In summary we welcomed 145 stakeholders across the five most recent meetings, with an average of 29 at each meeting. We saw an increase in attendance at the last two meetings: October (33) and December (42).**

### **Ofgem and BEIS (Department for Business, Energy, and Industrial Strategy) engagement**

Engagement with Ofgem and BEIS continues regularly, both at an executive level as well as at a working level. This collaborative engagement ensures all parties are aware of developments to help make FES fit for purpose and aligned to any policy changes.



**In summary we have held several meetings with Ofgem and BEIS since the July launch, looking at the yearly FES production as well as a focus on the longer-term use and development of the scenarios used for planning. These regular meetings will continue monthly, then move to fortnightly as we near the time of publication.**

### **Innovation and projects**

We are also involved in a range of projects across the ESO and wider energy industry that bring in additional evidence and research by working on more detailed topics with our project partners. This year these innovation projects included:

- Study of weather patterns and the impact of the electrification of heating on loss of load expectations
- Hydrogen as an electricity system asset.

Consumers are fundamental to the UK reaching its net zero targets and, whilst we consider the implications on the country's population of our scenarios, we have not historically engaged with them directly. This is an area we're now starting to investigate more, and it has triggered work on the following projects:

- CrowdFlex Phase 1 - the first phase of a study into how domestic households can provide flexibility to influence energy demand and reduce stress on the electricity system
- Consumer Archetypes - investigates the development of a set of industry standard consumer archetypes in conjunction with the other energy companies. These will be used to develop a picture of where different types of consumer are across the network and how they may behave with respect to net zero and their energy consumption
- COP26 consumer engagement & local authority engagement - we polled over 4000 members of the public in August and held 12 focus groups in September to better understand the British public's view on the UK's climate change agenda and how they can get involved in the energy transition. We also held focus groups with Insight Leads from roundtables with elected representatives and officials from local authorities across GB, to understand how communities across the country can be supported in climate action and the energy transition.

Whilst these projects are separate to the core FES process, with varying timescales, the findings from them feed into the FES analysis to support improvements such as those based on stakeholder engagement and modelling improvements. Further detail on these projects can be found in appendix pages 48 - 50.

### **ENA Open Networks work**

We have continued to work as part of the ENA Open Networks project and through this have agreed a second set of building block definitions. The data associated with these new definitions was published alongside our FES 2021 publication in July and are a key input into comparing scenario projections produced by the ESO and the DNOs. They are also used as a detailed breakdown to support business planning activities and the further alignment of the GB FES and the DFES, helping us understand as a collective where there are discrepancies, both that can be explained and those that can be changed to enhance forecasting accuracy.

We have also engaged with the Whole Energy Systems workstream within the Open Networks project, ensuring that this key forum is involved in discussions to help shape our FES regionalisation activities. We recognise the importance of regionalisation being a whole system activity, furthermore, engaging more broadly across the whole system has helped to further our thinking on the part that FES regionalisation will play in the Net Zero transition.

### **International engagement**

Once again, we welcomed stakeholders from across the globe to FES and the future of energy debate. During the launch we saw attendees from global energy companies representing Asia,

Africa, and the Americas as well as stakeholders from organisations based in Ireland, Spain, and Japan. The FES newsletter is read by those in Netherlands, Finland, USA, and France amongst other countries.

### Other engagement

In addition to the engagement described above and on pages 64 - 71 of the document, the team attended numerous engagement events or held interactions with other organisations like universities, government bodies, consumer groups, local councils, and trade associations. These helped continue the future of energy discussion and bringing valuable insight and new stakeholder contacts to the team.

### Memberships

As well as our engagement programme, we also have membership and subscriptions to a variety of energy publications and data sets that provide further valuable evidence and research to the team. This is combined with stakeholder feedback and our modelling to produce the scenarios. Examples include: Oxford Economics, Aurora, Wood Mackenzie, and Bloomberg.

### What do stakeholders use FES for?

We are always interested in how our stakeholders use FES and for what purpose they use the data and findings. We recognise that many organisations like network companies use FES in their own modelling and analysis and many others use it to make decisions and reach investment conclusions. We used the FES 2022 Call for Evidence to establish what other stakeholders use FES for. Please see appendix page 51 - 53 for further detail.

### Measuring engagement satisfaction

As we engage with our stakeholders, as well as asking for feedback on how we are doing and improvements we can make (see table above), we also measure what we do. This helps us continually improve, to find better ways of working with stakeholders and to improve the engagement experience for all.

We use the Net Promotor Score (NPS) for our launch events. This is an index ranging from -100 to +100 that measures the willingness of customers to recommend a company's products or services to others. It is widely recognised as a means of measuring levels of satisfaction. A positive score above 0 is considered good, +50 is excellent and above +70 is world class. We used this measure for the launch event. Within the ESO we have an internal target of +20 to meet for our engagement activities.

For other satisfaction measures we use a scale of 1-10, asking stakeholders to rate the engagement based on their experience, with 10 being the highest.

The table below provides the measurement scores from our engagement activities. Further information on all these events can be found on pages 64 - 71.

Event	Date	Measurement score
FES launch (combined)	12 – 15 July	NPS +37
FES launch Monday	12 July	NPS +21
FES launch Wednesday	14 July	NPS +58
FES launch Thursday	15 July	NPS +39
FES bilateral engagement	Sept to date	Out of 10: 8.62 <sup>3</sup>
Formal ESO satisfaction survey	September	Out of 10: 7.43

<sup>3</sup> As at 25/01/2022

**Engagement and communication actions and improvements identified from our events for FES 2022 and beyond.**

The Stakeholder Feedback Document describes the engagement we undertook and the resulting actions. In appendix pages 54 - 59 we list the feedback we received on our engagement and communications and the actions we will take to improve.

### 3. FES 2022 Scenario Framework and Scenarios

FES sets out a range of pathways for the development of the energy sector between today and 2050. FES 2020 was the first year that included full scenarios meeting the 2050 net zero target. Our stakeholders tell us that they appreciate the fact that FES explores a range of credible futures and the major uncertainties across the energy industry.

The overriding feedback from stakeholders is that they value consistency and being able to easily compare changes from year to year. So, similarly to last year, we have decided to retain the scenario framework for another year, in line with FES 2020 and FES 2021.

Some feedback suggested changes to the scenario framework: some respondents supported the removal of non-net zero scenarios, whereas others questioned whether some aspects of the net zero scenarios were too ambitious. We feel that the existing framework continues to cover the credible range of uncertainty, and while there has been significant effort put into making the net zero achievable over the past year from the energy industry and beyond, it is still credible that the target is not met, and our stakeholders tell us that this is a useful scenario. We have therefore retained Steady Progression as a non-net zero compliant scenario, albeit with a more accurate name to be agreed.

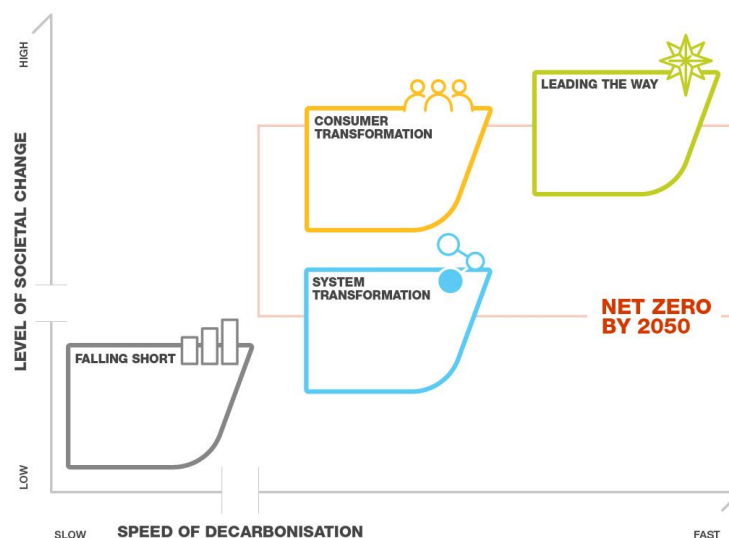
We also received feedback that it was not always clear that Steady Progression does not meet the 2050 net zero target. Whilst we feel that the framework graphic below sets this out, we have therefore decided to change the name of the Steady Progression scenario to **Falling Short**. We believe that this new name more accurately reflects the intent of the scenario. This is just a name change and **Falling Short** will perform the same role as Steady Progression in the FES framework (i.e. it represents the credible slowest progress towards decarbonisation).

More generally, we examined the policy documentation published in advance of COP26, as well as the outcomes of the conference itself, to ensure that it didn't contain anything that would necessitate a change to the scenario framework. We remain confident that the policy developments since FES 2021 remain within the credible range of uncertainty provided by the current scenario framework and, by extension, that the FES 2021 scenarios were broad enough to cover these policies. Similarly, we don't feel that the range is sufficiently narrowed by the policy developments (e.g. in relation to the decision hydrogen boilers for residential heating being pushed back to 2026) to necessitate a change in framework.

#### The scenarios for FES 2022

Figure 1

Scenario framework for FES 2022





### **Engaging across industry**

We aim to reflect the breadth of stakeholder input and uncertainty within our scenario framework. Where we haven't received clear input or direction from stakeholders on a topic, we draw on other sources of information to support our decisions. In making these decisions, we consider the purpose of FES in network investment both today and in the future, industry publications, conferences and related discussion, the direction of government policies, and the questions which we are asked by industry, government, and the regulator on a day-to-day basis. Appendix pages 60 - 63 also includes further information on how the scenario framework is applied in the modelling and a breakdown of the feedback we have received.

## 4. Summary of stakeholder feedback shaping FES 2022 analysis

Below we've provided a summary of the key points from our engagement and research to date. A breakdown of the themes of action and how we will be taking this forward for FES 2022 can be found in the appendix from pages 29 - 47.

Summaries of the specific feedback from the FES 2022 Call for Evidence, are available on our website at: [Call for Evidence](#)

### Regional FES

#### Range of views

- Stakeholders welcome a more granular view of the whole system scenarios and agree it will increase the robustness of FES. It was highlighted by network companies that we should ensure the risk of duplication of effort should be managed considering the interaction with the more bottom-up scenarios currently developed by gas and electricity network companies such as the DFES. This should involve transparency of assumptions and closer collaboration
- We received a range of views on the data that our stakeholders will require from a regional perspective as well as differing views on the definition of the regions, depending who the stakeholder is and what they will be using the data for.

#### Decisions made and rationale

- Regionalisation will have a whole system focus to provide clarity on pathways for heat, transport, and low carbon technology diffusion
- We will also need to have an enhanced understanding on how consumer behaviour will develop as this will likely vary considerably across regions. We are focussing our early efforts on improvements to our regional heat, road transport and distributed generation modelling following engagement with our stakeholders. To cater for different stakeholders requiring different regional data splits, we are exploring ways to make the data more user configurable in terms of data visualisation.

#### Key areas of uncertainty

- What data will be needed and what is the required level of granularity to fully understand regional variations?
- How will the regions be defined and what the impact will be of fuel interactions from a regional perspective?
- What is driven by demographics and network topology vs what is driven by local policy?

#### Sources used

- Distribution Future Energy Scenarios, FES 2022 Call for Evidence, bilateral stakeholder engagement and building blocks.

### Net Zero

#### Range of views

- There was feedback that rapid action is needed to meet Net Zero, without any feedback suggesting that progress towards net zero should be slower
- There was mixed feedback on whether all scenarios should meet the net zero target. Feedback polarised around discounting scenarios that do not reach net zero whilst ensuring there is a scenario that missed net zero as this is still credible
- Support for bioenergy was mixed, but those that didn't support it all cited concerns around the sustainability of biomass and/or how much CO<sub>2</sub> was retained, or in the case of BECCS, captured. Those that supported bioenergy highlighted its value as a carbon neutral, or in the case of BECCS, carbon negative fuel.

#### Decisions made and rationale

- Ensure all net zero scenarios meet interim milestones such as the 6th Carbon Budget in 2035 as this is government policy and helps to promote a quicker start to reaching net zero rather than waiting until closer to 2050 as per feedback
- Steady Progression will remain as a scenario that misses net zero as there is still uncertainty as to whether net zero can be met. This is acknowledged by the CCC's assessment of the UK's net zero strategy which confirms that whilst reaching net zero is achievable and affordable there remain policy gaps
- The CCC view sustainable bioenergy as being essential to meet net zero (pg153 6<sup>th</sup> Carbon Budget Report), we will continue to follow the CCC's guidance as the recognised subject experts.

#### **Key questions to address uncertainty**

- How quickly can we decarbonise? Some technologies are not ready to be deployed at scale yet.
- How successful will regulation be at ensuring a sustainable supply chain for bioenergy?

#### **Sources used**

- 6th Carbon Budget Report, December 2020, CCC.  
<https://www.theccc.org.uk/publication/sixth-carbon-budget/>
- Independent Assessment: The UK's Net Zero Strategy. October 2021, CCC.  
<https://www.theccc.org.uk/publication/independent-assessment-the-uks-net-zero-strategy/>

### **Industrial and commercial demand**

#### **Range of views**

- There was feedback from different industrial consumers about the viability of different decarbonisation solutions for their industries. Hydrogen was seen as playing an important role, but the scale of this varied
- Varying views on industrial clusters, from those who see them as a positive development, to those who were sceptical due to other factors involved in siting industrial facilities other than energy considerations
- Varying views about potential data centre uptake rates. There is a strong pipeline of new connections, but some uncertainty remains about how quickly they will connect.

#### **Decisions made and rationale**

- Increase levels of fuel switching away from fossil fuels: as net zero target has become more embedded across industry, many stakeholders are aware they will need to switch fuels so are making plans to do so. Any switching will still be based on economics
- Improve modelling of energy demand for data centres with some in-depth stakeholder engagement and new modelling capability due to feedback and uncertainty in this area.

#### **Key areas of uncertainty**

- Fuel switching rates away from fossil fuels to electricity/hydrogen
- Rates of growth in data centre demand and associated efficiency improvements
- Net effect of assumptions on underlying demand, energy prices and economic growth on electricity and gas demands.

#### **Sources used**

- Industrial decarbonisation strategy, <https://www.gov.uk/government/publications/industrial-decarbonisation-strategy>
- Net Zero Strategy: Build Back Greener, <https://www.gov.uk/government/publications/net-zero-strategy>
- Hydrogen strategy, <https://www.gov.uk/government/publications/uk-hydrogen-strategy>

- CCC NZIP model, <https://www.theccc.org.uk/wp-content/uploads/2020/12/CCC-Industry-CCS-H2-User-Guide-Assumptions-Log.pdf>
- Independent Assessment: The UK's Net Zero Strategy, CCC, <https://www.theccc.org.uk/publication/independent-assessment-the-uks-net-zero-strategy/>
- Bloomberg Data Centre forecasts.

## Heat in buildings

### Range of views

- There is a wide range of uncertainty in views for the future of heat as a whole and hydrogen vs electrification solutions
- Heat pump uptake rates to meet net zero are challenging, with some stakeholders sceptical of maximum rates of heat pump uptake whilst others are supportive. This is similar for hydrogen boilers
- There is broad agreement on the level of challenge for decarbonising heating.

### Decisions made and rationale

- We are not making any significant changes to the framework for heat modelling. Despite policy developments from Heat and Buildings Strategy and Net Zero Strategy, the existing scenario framework still covers the credible range of uncertainty. We are still awaiting the expected decision on use of hydrogen boilers in 2026. Rates of heat pump uptake driven by incentives will help support the levels of heat pump deployment in Consumer Transformation but won't be sufficient on their own. There is uncertainty over the effect of these measures and so Steady Progression still represents a credible lower bound for heat decarbonisation progress.

### Key areas of uncertainty

- Uptake rates of heat pumps
- Policy decisions on future of gas network and potential conversion to hydrogen
- Level of energy efficiency improvements.

### Sources used

- Heat and Buildings Strategy, <https://www.gov.uk/government/publications/heat-and-buildings-strategy>
- Net Zero Strategy: Build Back Greener, <https://www.gov.uk/government/publications/net-zero-strategy>
- English Housing Survey, <https://www.gov.uk/government/collections/english-housing-survey>

## Transport demand

### Range of views

- Stakeholder confidence in smart charging impact is relatively high, whereas views on Vehicle to Grid (V2G) are quite divergent in terms of likely take-up and the impact it may have on peak demand
- Efficiency assumptions can have a major impact and views on likely efficiency developments vary
- Views on likely charging solutions for households without off-street parking vary.

### Decisions made and rationale

- Widen range of V2G outcomes based on variety of stakeholder views in this area
- Continued high levels of smart charging based on consensus of stakeholder feedback



- Update HGV, bus and motorcycle uptake figures considering the ICE ban proposals
- Broaden the range of zero emission technologies considered for use in heavy duty HGVs across the scenarios due to uncertainty in this area, considering the developments in hydrogen and electric HGV technologies.

#### Key areas of uncertainty

- Uptake of smart charging and V2G (and associated impact on peak electricity demand)
- Electric vehicle efficiency changes, kWh/mile
- Rate of decarbonisation of HGV fleets, split between hydrogen and electricity as solutions for HGVs
- Miles driven per person/per car.

#### Sources used

- Transport Decarbonisation Plan, <https://www.gov.uk/government/publications/transport-decarbonisation-plan>
- SMMT new car market and parc outlook to 2035 by powertrain type
- Decarbonising UK long-haul road freight, CSRF, <https://www.csrf.ac.uk/2020/07/white-paper-long-haul-freight-electrification/>
- Commercial viability of V2G - Project Scirus white paper, Cenex, <https://www.cenex.co.uk/app/uploads/2021/01/V2G-Commercial-Viability-1.pdf>
- Real world scooter performance study, Cenex, <https://www.cenex.co.uk/app/uploads/2020/05/Real-World-Scooter-Performance-Study.pdf>
- Crowdflex NIA project.

### Overall electricity peak demand

#### Decisions made and rationale

- Adjusting peak demand underlying assumptions based on:
  - embedded benefits
  - grid code changes
  - annual to peak ratios based on industry feedback
  - analysis of past ratios to more accurately model peak demands
- No major change of assumptions of appliance demands, mainly due to lack of major external feedback or policy change.

#### Key areas of uncertainty

- Future impact of hybrid working and post-pandemic work arrangements
- Peak demand during triad periods after grid code modifications.

#### Sources used

- Transport Decarbonisation Plan, <https://www.gov.uk/government/publications/transport-decarbonisation-plan>

### Electricity generation

#### Range of views

##### Renewables

- Weather dependency means low load factors are likely, meaning higher installed capacity. There needs to be a clear business case to build the extra capacity required. We received updated numbers for installed wind capacity including specific forecasts for likely floating

wind capacities in the Celtic Sea by 2035 and total capacity for all Scottish waters by 2050.

#### Storage

- The high level of battery storage developments in the pipeline was commented on by several stakeholders although there were mixed views on how much of this would materialise. There was also an acknowledgment that additional pumped hydro storage may be developed post 2035 although it was likely only to be one or two sites due to site constraints. For other electricity storage technologies, the feedback generally agreed with the range of storage capacities (GW) and volumes (GWh) across the FES scenarios. Whilst there was some individual feedback suggesting that other electricity storage technologies should have a greater or lower representation across the scenarios there was no clear consensus
- We received feedback that storage capacity (MW/GW) was given more focus than storage volume (MWh/GWh). We also received feedback that definitions of storage categories (i.e. short duration, inter-seasonal etc) varied across organisations and would benefit from improved standardisation. In both instances the feedback was from a small number of respondents but there was no contrary feedback.

#### Interconnectors

- The development time was very much decided on a project-by-project basis, although existing UK interconnectors are all point to point. Regulatory risk had increased for some projects and was dependent on the country to which it is being connected.

### Decisions made and rationale

#### Renewables

- We will explore the relationship between load factors, capacity, and commercial viability of large-scale wind and what may happen in times of excess. This aligns with key message 3 of FES 2021 in relation to changes to markets.

#### Storage

- Battery deployment will be increased under Leading the Way to represent the large pipeline. We will review the opportunity for additional pumped hydro storage connected post 2035 in Leading the Way. Taking the balance of views, no significant changes will be made to other electricity storage technologies in the FES scenarios
- Storage capacity and volume are both covered in the FES report, but we will look to improve how this is shown, potentially with additional graphics to emphasise. We will consider if providing definitions of storage categories adds value to FES.

#### Interconnectors

- We will reflect how FES models interconnectors and if necessary, look to modify this to better reflect the variation in interconnector projects. This includes considering how we will model multi-purpose interconnectors (MPI) in the future. Ofgem have undertaken a policy review on interconnectors and announced a pilot MPI cap and floor scheme for mid-2022. Given this may be after FES 2022 publication and the fact there is still uncertainty around what configuration a MPI will take, we are unlikely to directly model MPI's in FES 2022. However, we will continue to consider how they could be modelled for FES 2023
- Longer distance interconnector projects to connect remote generation to the UK are still at a relatively early stage of development with no existing projects, meaning there is uncertainty around if and when these projects will be completed. Therefore, they will not be included at this point although this will be reviewed annually.

### Key areas of uncertainty

- Renewables: policy decisions around subsidisation of specific technologies
- Storage: development of battery storage pipeline

- Definitions of storage categories are not consistent across organisations
- Interconnectors: uncertainty around which interconnector projects will be developed
- Uncertainty around what configuration a multi-purpose interconnector (MPI) will take and when will they start to be built.

### Sources used

- Facilitating the deployment of large-scale and long duration electricity storage: call for evidence, September 2021, BEIS, <https://www.gov.uk/government/consultations/facilitating-the-deployment-of-large-scale-and-long-duration-electricity-storage-call-for-evidence>
- Consultation on changes intended to bring about greater coordination in the development of offshore energy networks. April 2021, Ofgem, <https://www.ofgem.gov.uk/publications/consultation-changes-intended-bring-about-greater-coordination-development-offshore-energy-networks#:~:text=Early%20Opportunities%20seeks%20to%20make,to%20the%20system%20by%202030>
- Interconnector policy review – decision. December 2021, Ofgem, <https://www.ofgem.gov.uk/publications/interconnector-policy-review-decision>.

## Bioenergy and BECCS

### Range of views

- There are two main views on BECCS. One is that it is a necessary technology which can provide negative emissions and reliable baseload generation. Opponents question the true lifecycle sustainability of biomass feedstock and the readiness of the technology to be deployed at the scale needed. Opponents also feel that efforts on BECCS should be spent elsewhere and, that in a worst-case scenario, efforts to deploy BECCS could take away from efforts elsewhere and have a net detrimental effect on decarbonisation.

### Decisions made and rationale

- In the short term, we will continue to use the Intergovernmental Panel on Climate Change (IPCC) accounting methods for assessing lifecycle sustainability. We must also consider how changes in public opinion may influence changes in the IPCC methods between now and 2050 (societal change)
- We will also explore lifecycle sustainability further and will publish our position where appropriate, though this may be separate to FES
- We will consider future changes to the way that emissions are treated in FES. While the current focus is on energy and emissions in Great Britain (in line with IPCC), there may be potential value in factoring in more of the global environmental impact that the UK's consumption choices will have.

### Key areas of uncertainty

- We do not know how IPCC carbon accounting standards may change over time
- To meet Net Zero, we must find a way to make energy net negative to offset emissions from other sectors such as agriculture and aviation. We will continue to work with the CCC to include their analysis on sectors beyond energy and assess other possible technology solutions both within and beyond the energy sector.

### Sources used

- <https://www.drax.com/sustainability/carbon-emissions/>
- [https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc\\_wg3\\_ar5\\_annex-ii.pdf](https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-ii.pdf)
- [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1031057/biomass-policy-statement.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1031057/biomass-policy-statement.pdf)

- <https://www.chathamhouse.org/beccs-deployment/04-feedstock-choice-carbon-efficiency-and-carbon-debt>
- <https://www.chathamhouse.org/2020/01/net-zero-and-beyond-what-role-bioenergy-carbon-capture-and-storage>
- <https://www.chathamhouse.org/2021/10/beccs-deployment>
- <https://easac.eu/media-room/press-releases/details/easac-welcomes-that-the-jrc-report-strengthens-the-case-for-shorter-payback-periods-on-woody-biomass/>.

## Gas supply

### Range of views

- Anaerobic Digestion (AD) may have greater use as a decarbonisation technology than previously considered. Potential for decarbonisation technology to increase in value has seen people invest in AD with or without subsidy. Biomethane/green gas are unanimously seen as key technologies to meet the UK's 2035 target for a fully decarbonised energy system
- Stakeholders disagree on the role of shale gas. Some believe it provides a way to reduce import dependency for gas, but opponents cite its environmental impact during extraction and feel that it is ultimately unnecessary if we invest in replacements for methane
- UK Continental Shelf (UKCS) decline is expected to be rapid once it begins but some views have been expressed that future flows at specific terminals are too conservative in FES 2021.

### Decisions made and rationale

- We will reflect on the role of AD within CCS as a source of negative emissions and include in our scenarios if we can prove its credibility by 2050. It may play more of a role in future FES publications
- We continue to review the likely role of shale gas but don't see a compelling reason to change the current position in FES
- We will review our future flow projections for consistency following feedback received.

### Key areas of uncertainty

- The most significant area of uncertainty is whether the decline in the UKCS will be initiated by a drop in demand (increased competition from other fuels and reduced demand making extraction uneconomical) or supply (legislation, reduced exploration etc.). This will have a bearing on the extent to which and when the UKCS declines.

### Sources used

- <https://www.ofgem.gov.uk/environmental-and-social-schemes/green-gas-support-scheme-and-green-gas-levy>
- <https://www.unep.org/news-and-stories/story/new-global-methane-pledge-aims-tackle-climate-change>
- <https://www.gov.uk/government/news/plans-unveiled-to-decarbonise-uk-power-system-by-2035>
- [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/1033990/net-zero-strategy-beis.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf)



## System constraints

### Range of views

- There has been some feedback that, alongside the unconstrained network modelled in FES, it would be useful to see results in the short term for a constrained network as this could impact grid emissions intensity and some renewable load factors.

### Decisions made and rationale

- We will assess how we can incorporate short term constrained network modelling into the FES 2022 results. This would improve the comparability of carbon emissions and load factors for certain technologies. FES results in the longer term are subject to more uncertainty and it is likely that network constraints will have changed significantly, therefore we do not envisage modelling a constrained network all the way out to 2050.

### Key areas of uncertainty

- There is uncertainty around how network constraints will change in later years.

### Sources used

- Operability of highly renewable electricity systems. February 2021. National Infrastructure Commission. <https://nic.org.uk/app/uploads/Operability-of-HRES-February-2021.pdf>

## Hydrogen

### Range of views

- Green hydrogen is unanimously the preferred option for end use but there is debate about how we transition to it and the role of blue hydrogen. Blending into the National Transmission System (NTS) is seen as a potential way to stimulate hydrogen demand but, in the long term, many stakeholders see local clusters being more likely than national transmission of hydrogen
- The deployment of hydrogen as either flexibility and/or baseload generation depends largely on what future markets and incentives look like as well as the availability of inter-seasonal storage. Stakeholders have different positions on this depending on their interests and unique insights
- Stakeholders unanimously see electrolysis becoming more efficient, more cost effective and as having greater capacity than previous estimates.

### Decisions made and rationale

- Scenarios will explore different ways that hydrogen will enable the energy transition between now and 2050
- Scenarios will explore the credible range of uses for hydrogen between now and 2050, both in terms of end use and in the energy system.
- Revised electrolysis capacity will be reflected in scenarios
- We will explore the relative economic efficiencies of using hydrogen in different ways to supplement the energy efficiency comparison published in FES 2021.

### Key areas of uncertainty

- Future markets and incentives for hydrogen storage and ability to buy/sell electricity at preferential prices
- Relative economic efficiencies of using hydrogen in different ways
- The implications on the transmission systems of electrification and transition to hydrogen
- The locational impact of hydrogen clusters.

### Sources used

- <https://www.gov.uk/government/publications/uk-hydrogen-strategy>
- <https://www.gov.scot/publications/draft-hydrogen-action-plan/>
- <https://www.itm-power.com/news/gigastack-project-one-step-closer-to-renewable-hydrogen-at-industrial-scale-as-phase-2-concludes>

## 5. Next steps and continuing the conversation

### Next steps

Our **engagement, analysis and modelling for FES 2022 will continue** until the time of publication and launch event during July. Our regular FES newsletter will continue to be published between now and July including content such as standalone thought pieces and information about the launch. Following the launch, we would begin to classify the engagement as FES 2023. Due to the timescales involved in our analysis processes, it is possible that some feedback during this period will not be fully reflected until FES 2023.

We need to remain relevant, add value to the processes we fuel and continue engagement with our customers and stakeholders. To keep up with the changing energy landscape and strategic ambitions, we will be reviewing the medium and long-term requirements of FES, together with the publication and engagement programme for FES 2023, taking into consideration feedback gathering, identifying improvements and changes to make.

### Regional FES – next steps

Following engagement with stakeholders to help scope our FES regionalisation activities, we intend to focus on developing regional whole system insights which will provide more clarity on possible pathways for heat, transport, and low carbon technology diffusion. As such, we intend on broadening engagement to bring in new voices and perspectives, enhancing our understanding of consumer behaviour and sense checking the FES outputs so we understand what they mean at a more local level (e.g. including what it might mean for Local Authorities). We hosted a webinar during February alongside Public First to discuss the findings from our ‘empowering climate action’ research with Local Authorities. We discussed FES at this webinar and introduced our regionalisation activities to understand how useful this could be for Local Authorities.

We want to ensure there is increased alignment between the FES and DFES and we will be continuing to work with the DNOs through the Open Networks project, ensuring further alignment of our assumptions and comparison of the building blocks data. The Open Networks project also includes a whole system workstream that we participate in.

We will be using FES 2022 to test some of our new regional outputs with stakeholders, which will include enhancing the visualisation of information and providing key regional insights. Our FES 2022 regionalisation activities will be used to strengthen our regionalisation activities in FES 2023. We will also be using the Consumer Archetypes Project to increase our understanding of consumer behaviour across regions, and we plan to co-create these with industry.

### Engagement

The **FES Network Forum** meetings will continue in 2022 bringing together representatives from gas and electricity network organisations. We will share insight into FES 2022, launch information and take time to delve deeper into a range of subjects, to be collaboratively agreed with attendees.

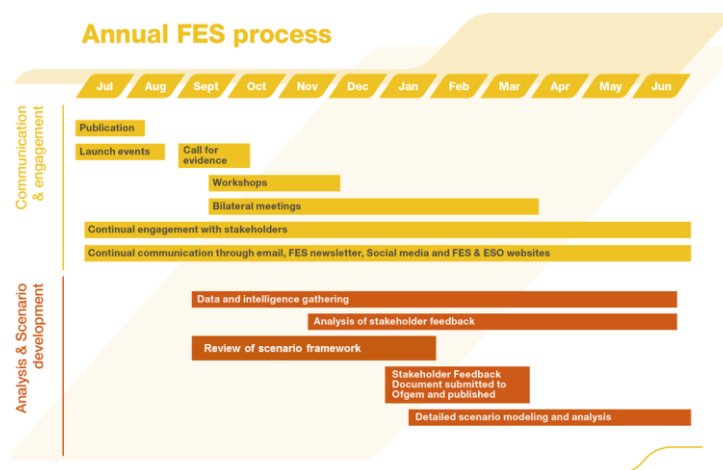
The launch of the **FES Bridging the Gap** report and findings will take place on 16 March 2022. We will present key findings from two parts of the project, relating to a day in the life of the 2035 energy system and the timeline of actions required to get there. We will discuss these findings and key messages with the audience, who will be able to pose questions to the panel.

The **FES 2022 launch** event will take place during July and will commence at the time we publish the full suite of documents for 2022. The launch will once again be mostly virtual, taking place over several days. We will look to share the exact dates with stakeholders during late Spring to allow the time to be scheduled in diaries (i.e. in line with the feedback on 3 months’ notice).

### FES annual cycle

The diagram below shows the significant steps in the FES annual process when engagement takes place and when we complete our modelling and analysis.

Figure 2  
Annual FES cycle



### Continuing the conversation

We welcome feedback all year round and encourage everyone to join the ongoing discussion around the future of energy via social media. You can contact us any time via email: [FES@nationalgrideso.com](mailto:FES@nationalgrideso.com) with any queries or feedback on our work and stakeholder engagement.

Communication will continue through regular FES newsletters, if you would like to subscribe to receive them please email: [FES@nationalgrideso.com](mailto:FES@nationalgrideso.com). Previous editions can all be found on the FES website. Newsletters published during springtime will contain information regarding the July launch including how to register to attend. The FES website is regularly updated with latest news.

Figure 3  
Methods of communication



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# A. Breakdown of stakeholder input for FES 2022 to date

Below we have provided a summary of the themes of feedback and insight we have gathered from our engagement and research in the period between the launch of FES 2021 and the end of January.

We have shown the feedback, together with other input and analysis that will inform FES 2022. We have detailed the feedback received, the action and decision we will take based on this or, where we will take a different approach, the reasons why.

Summaries of the specific feedback from the FES 2022 Call for Evidence, are available on our website at: [Call for Evidence](#)

Regional FES			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
<p>We asked our stakeholders to provide their views on what aspects of the whole energy system would benefit from a more bottom-up regional modelling approach. Several areas were put forward by our stakeholders:</p> <ul style="list-style-type: none"> <li>Hydrogen for heat and more broadly deployment of hydrogen across the whole energy system.</li> <li>Electricity Generation: topics included how technologies alter over time, more information on distribution-connected technologies and the inclusion of large tidal projects and schemes</li> </ul>	<p>Ensure that this feedback is central to our longer-term strategy for the Regional FES. Some elements will be explored as part of FES 2022, but others will materialise in later publications (e.g. as modelling development and data collection will take time).</p> <p>In the near term we are exploring improvements to our regional heat, road transport and distributed generation modelling.</p>	<p>Where relevant, we will use regional insights to inform the GB aspects of FES 2022 (as well as publishing more granular regional results and visualisations).</p>	<p>Targeted engagement with key regional stakeholders including network companies and Local Authorities</p>



- Heat decarbonisation: how heat networks will develop, solar heating and heat storage technologies
- Electric Vehicles: The uptake of EVs based on recharging availability and urban and remote uptake comparisons.
- Consumer engagement

We also asked our stakeholders how we can improve our new visualisation of our regional breakdown of FES electricity data:

- Our stakeholders informed us that it would be helpful if the FES document shows a regional breakdown of potential future emissions considering all types of current and future generation technologies.
- We were also asked to consider who the end user of the visualisation is to ensure it meets the needs and benefits stakeholders.

We asked our stakeholders what they would like to see us change, focus on, or prioritise as we develop regional whole energy system scenarios. Again, several areas were put forward by our stakeholders although granularity of data was flagged by several:

- Electricity generation: role of nuclear power in regional decarbonisation;

On consumer engagement modelling we intend on kicking off a project looking into consumer building blocks, jointly created with network companies.

We will also be broadening our engagement to bring in new voices and perspectives such as Local Authorities.

We are working closely with the network companies through the ENA to continue to simplify and optimise the interface with the more bottom-up scenarios currently developed by gas and electricity network companies such as the DFES.

<p>Planning longer term with no fossil fuel generation; Tidal stream resource</p> <ul style="list-style-type: none"> <li>Hydrogen production using Nuclear energy</li> <li>Interaction with DFES: More sharing of datasets; Assumptions being made clearer; Bringing together modelling assumptions of FES and DFES;</li> <li>Focus on where granular regional modelling can improve accuracy of forecasts for what FES is used for;</li> <li>Include a more granular view of gas scenario projections</li> <li>CO2 storage and CCUS deployment</li> <li>Top to bottom communications and interfaces</li> <li>FES toolkit for local deployment</li> <li>Different spatial scenarios in terms of economic, demographic, transport demands and infrastructure.</li> </ul>	<p>In terms of how we publish the regional data, as well as constantly increasing the amount of regional granularity we can provide, we are also exploring how best to facilitate stakeholders being able to configure the data to the granularity they require.</p>
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Net Zero			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
There was feedback that rapid action is needed to meet Net Zero, this included feedback that FES scenarios should focus more on 2030 and 2035. No feedback suggested that progress on net zero should be slower.	Investigate how we can provide more emphasis on near term decarbonisation while still focusing on the 2050 net zero target.	Ensuring all net zero compliant scenarios meet the 6 <sup>th</sup> Carbon Budget (in 2035) as well as greater focus being provided on all other relevant interim milestones.	<p>NGO</p> <p>Call for evidence</p> <p>Industry bodies &amp;</p>

			experts (including Consultancies)
There was mixed feedback on whether all scenarios should meet the net zero target.	Maintain Steady Progression as a scenario that doesn't reach net zero but rename it to more clearly acknowledge that it misses net zero.	Steady progression misses net zero by 2050.	Bilateral meetings
Whilst there was support for bioenergy, there was feedback on the importance of ensuring sustainable biomass is used and the carbon accounting of bioenergy (including BECCS) is appropriate.	There is uncertainty around emissions from bioenergy which relate to how sustainable the processes used to grow and harvest the feedstock are. Therefore, we will continue to engage with relevant stakeholders such as BEIS and CCC to ensure we are modelling emissions of bioenergy correctly.	We will continue to review this area and use the scenarios to show an appropriate range of options for bioenergy deployment	

Industrial and Commercial			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Policy changes from I&C decarbonisation strategy, Net Zero strategy, hydrogen strategy.	Adjust our fuel switching assumptions in line with policy incentives and industry feedback.	Changes in energy demands for different fuels in the I&C sector, increased electricity and hydrogen demands in some scenarios.	Policy documents.
I&C fuel switching rates to electricity and hydrogen.			Trade bodies I&C customers

Views on future likely I&C cluster development.	Model planned I&C clusters in greater detail.	Greater medium-term certainty in industrial and hydrogen demand in cluster locations.	Policy documents I&C consumers
<b>Fuel Prices</b> Volatility in energy prices and future projections	Adjust our models to take account of economic growth and I&C energy retail prices.	Price spikes impacting short term demand forecasts	Consultancies
<b>Data Centres</b> Feedback on future demand from data centres and insights into the viability of efficiency improvements in data centres.	Model planned additional demand forecast for Data Centre connections in greater detail.	Increased energy demands for data centres in all scenarios.	Trade associations and data centre operators
Feedback on the drivers of future data centre demand.	Adjust our forecasting models to recognise the impact of efficiency improvements in the years to come.	Varying rate of growth across scenarios.	
Feedback regarding the current UK data centre landscape; what types of data centres, how many, and where.			

Heat in buildings			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Policy document and landscape changes.	Reflect publications such as the Heat and Buildings strategy.	Lower bound of heat pump uptake.	Policy documents Trade bodies Energy suppliers Consultancies
Specific feedback on some of our initial regional heat outputs.	Develop and improve our regional heat modelling capabilities.	Improved regional modelling outputs, granularity, and accuracy.	Trade bodies Energy networks
Policy changes and low carbon technology support, heat pump grants.	Incorporate impact of subsidy changes and HP price forecasts to heat modelling.	Central assumptions on heat pump uptake rates.	Trade bodies Policy documents

Transport Demand			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Policy developments affecting HGV, Bus and Motorcycle uptake. Data on baseline bus and HGV kWh/mile efficiencies.	Broaden the range of zero emission technologies considered for use in heavy duty HGVs across the scenarios.	Faster uptake of zero emission HGVs in our net zero scenarios than modelled previously. A greater role for BEV HGVs in the scenarios due to the increased uptake rate required to meet the 2035 target.	Government policy changes Trade bodies
Feedback on smart charging, vehicle to grid engagement rates and demand per charge-point archetype assumptions.	Develop and update our smart charging and V2G engagement assumptions. Adjust demand per charge-point archetype.	Changes in peak demand impact from V2G and smart charging.	Trade bodies Energy suppliers
Innovation and behaviour change for charging for households without off street parking.	Adjust range of outcomes for charging for households without off street parking.	Varying outcomes between destination charging, near-home rapid hubs and on-street charging solutions.	Trade bodies Consumer groups

Overall electricity demand (excluding EVs)			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Feedback on main drivers of demand and translation into peak demands.	Review and adjust demand annual/peak ratios.	Changes to peak demand across scenarios	PTE (BEIS Panel of Technical Experts)
Impact of grid code modifications change to Triads.	Improve understanding of embedded benefits and impact of their removal on peak demand.	Changes to demand side response assumptions across scenarios.	PTE

Electricity Generation				
Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Overall mix	The proportions and amounts in the 2021 scenarios are broadly correct but timings are heavily dependent on technical and commercial readiness. Even for high technical readiness, investment decisions will be deferred until the business case is clear for a given technology. Clear policy, routes to funding and revenue generation will all help to narrow the margin of uncertainty. This is especially true for technologies with a high capital cost like nuclear or tidal range. These insights align with Key Messages 1 and 3 from FES 2021.	FES focusses on technologies which have both commercial and technical viability between now and 2050, which we will continue to do. We will continue to pay attention to changes in the market and reflect that in our publications.	We will adjust timings in line with insight gathered on for readiness of specific technologies and markets.	Government policy – both firm commitments and ambitions  Industry groups for given technologies  Net Zero Market Reform Programme
Onshore and Offshore Wind	Weather dependency means low load factors likely, meaning higher installed capacity. There needs to be a clear business case to build the extra capacity required. We received updated numbers for installed wind	Consider the complexities and enablers to reaching government target for installed wind capacity.	Our narrative will explore the relationship between load factors, capacity, and commercial viability of large-scale wind and what may happen in times of excess.	Industry representatives  Published government targets



	capacity including specific forecasts for likely floating wind capacities in the Celtic Sea by 2035 and total capacity for all Scottish waters by 2050.			
Offshore Wind	There is a specific request for a breakdown of installed offshore wind capacity, by region, by scenario.	This is now a question we ask all wind development stakeholders.	Our modelling will reflect updated estimates of installed capacity and a regional breakdown where possible.	Industry representatives
Tidal and Marine Sources	<p>Tidal energy and marine resources in general may be underdeveloped or under-represented in national policy and, consequently, FES.</p> <p>The industry believes that there is increasing government backing for tidal range generation. Capacity in Wales could be tripled and by 2034, there could be up to 10GW available, providing up to 20TWh per year.</p> <p>There is seen to be minimal detrimental impact to the marine environment, especially when compared to potential destruction from climate change.</p> <p>There is a high up-front cost for Tidal Range but also a long (120 year) life span.</p>	Explore the potential for greater installation of tidal generation capacity (tidal stream and tidal range)	<p>Our modelling will reflect technologies which are deemed credible based on their technical and commercial readiness. The latter is sometimes based largely on government policy positions for certain technologies.</p> <p>We will ensure that explanations are provided for why any specific technologies have been left out of scenarios as part of the narrative. This may be in the form of a separate publication.</p>	Industry Representatives

	Under a RAV model, such as the one for Sizewell C Nuclear Plant, we could expect a cost of c.£45/MWh			
Load factors	Confirmation that increasing diversity and flexibility in the generation mix is likely to lead to lower load factors and higher installed capacities. There may be new business cases emerging to harness the increased capacity that comes with low load factors to use surplus energy in ways that may seem inefficient in isolation, but are good compromises when the wider energy efficiency, cost, environmental impacts, and public support is considered.	This reflects our current understanding, but we will continue to explain it in the report.	No Change – this is already modelled	Industry Representatives
<b>Storage</b>	It was noted by several stakeholders that there is significant battery capacity in the pipeline although not all of it will be developed. There was also an acknowledgement from some stakeholders that there was scope for another pumped hydro storage site post 2035. Feedback generally agreed with the	Battery deployment will be increased slightly in Leading the Way. We will review the opportunity for additional pumped hydro storage particularly in the post 2035 period in Leading the Way. No significant changes to the range of capacities and volumes for other electricity storage technologies will be made to the FES scenarios.	Increased battery and PHS capacity in Leading the Way.  All scenarios but especially those that require high levels of flexibility.	Bilateral meetings Industry bodies & experts including consultancies

	range of storage capacities (GW) and volumes (GWh) for other electricity storage technologies across the FES scenarios.			
	In terms of energy storage, the volume stored (e.g., GWh) is as important as the power rating (e.g. GW).	Although we do model volume and power, we will look to make it clearer in the report.		NGO Bilateral meetings
	It would be helpful to define different categories of storage i.e. short, long, inter-seasonal as organisations seem to use different definitions.	We will consider if this will make the report clearer and if so, add relevant definitions. BEIS currently define long duration storage as >4hrs and have a power capacity of at least 100 MW.		Industry bodies & experts including consultancies Bilateral meetings Call for evidence
Interconnectors	The time needed to develop and build an interconnector can vary significantly from project to project as each one has different characteristics (i.e. cable length, routes). There is also increased regulatory uncertainty and therefore risk for projects connecting to some countries.	Continue to engage with interconnector developers and update our interconnector model to incorporate the latest project timelines and uncertainty.	The updated information on timelines and uncertainty has resulted in a reduction in the interconnector capacity in 2030 and 2050 across the scenarios, compared to FES 2021.	Bilateral meetings Interconnector Developers
	As well as “point to point” interconnectors, some developers are considering multi-purpose interconnectors (MPI’s) to the UK. Some stakeholders	We will consider how MPI’s could be modelled in FES 2023. For FES 2022 we will discuss the potential impact of MPI’s as a future technology, but it may not be	This may change the characteristics of interconnectors in some scenarios, for example different load factors.	Bilateral meetings Interconnector Developers Call for evidence

	<p>felt that FES should include these options. However, others also acknowledged that there was uncertainty around what configuration an MPI would take, as well as when they would first be developed, although they are expected to become a reality.</p> <p>There was also a relatively small amount of feedback that longer distance interconnectors linked to remote generation would help to provide security of supply to the system and should be considered.</p>	<p>possible to explicitly include it in the modelling.</p> <p>We will continue to engage with relevant developers and follow the development of this technology.</p>	<p>No direct action taken in the absence of specific information.</p>	<p>Bilateral meetings Interconnector Developers Call for evidence</p>
Gas	<p>The ESO must ensure that FES is technologically agnostic – the branding suggests a preference towards electricity.</p> <p>No significant changes to gas generation predictions.</p>	<p>We have included this feedback in our early storyboarding activity for FES 2022 and will continue to find and action opportunities to demonstrate the “whole energy system” nature of FES.</p>	<p>No change – our editorial governance processes regularly challenge us to remain neutral in our analysis and commentary. This is because, despite being the ESO, FES is a whole energy system document and so this is how we treat our analysis and engagement.</p>	<p>Industry representatives</p>

Bioenergy and BECCS			
Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
BECCS could provide a greater source of baseload generation, especially in winter to help reduce overall emissions because of an expectation that BECCS plants will respond to a carbon price more than to an electricity price.	We will engage further with diverse stakeholders and conduct our own research into lifecycle sustainability of Biomass generation feedstock to ensure a balanced view in FES.	We will ultimately continue to base our carbon accounting on the standard set by the IPCC (and BEIS/CCC).	Bilateral meetings with bodies representing various sides of the debate.
While no concerns have been raised around any supply constraint for Biomass in the numbers being modelled in FES, there is debate about how sustainable the feedstock is. There is concern that the nuance around bioenergy feedstock is hard to convey. There is a real risk that biomass (and, to a lesser extent, BECCS) could turn <b>out to be a net</b> carbon emitter depending on how it is deployed and could take the focus away from other decarbonisation activity.	<p>Explore other means of carbon abatement including greater societal change.</p> <p>We will continue to explore the whole supply chain and wider environmental impacts of BECCS.</p>	<p>We will ultimately continue to base our carbon accounting on the standard set by the IPCC.</p> <p>We will continue to model based on credible levels of societal change but will explain the changes needed in some of the hard to abate sectors.</p>	<p>Bilateral meetings with bodies representing various sides of the debate.</p> <p>Chatham House publication comparing different feedstocks.</p>

Gas Supply				
Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
UKCS	<p>UKCS decline rate may be faster than expected, though it would likely be a small difference. This may be a correction of previous optimism. Once the decline of gas starts, it is expected to be rapid.</p> <p>Assumptions on UKCS supply into specific terminals unduly pessimistic.</p> <p>Government ambition for no unabated gas generation on the electricity system past 2035.</p>	We must balance the feedback that is received here on UKCS. Assumptions in Leading the Way may be extended to other scenarios.	2035 ambition for no unabated gas for power is currently targeted in Leading the Way but may be reflected in other scenarios.	<p>Industry representatives</p> <p>UK Government press release</p>
Shale	The closer we get to 2030 without progress on shale gas, the less chance we have of shale developing in this country.	Some stakeholders believe that shale gas should not appear in the scenarios at all, and others feel that it provides a means to reduce import dependency and could potentially be lower in terms of emissions than other supplies (e.g., LNG).	Currently we have shale gas supply in Steady Progression only. This may be pushed back to later in the period to reflect latest position. New exploration appears less likely in general since FES 2021 but, equally, until this is explicitly ruled out, it is credible to retain it in Steady Progression.	Industry representatives
Interconnectors / LNG / Norway	No changes suggested for gas interconnectors	N/A	N/A	N/A



Biogas and Green Gas	<p>Biomethane is seen as a key transitional technology until mid-2030s for heat while hydrogen or electric heating scale up.</p> <p>Green gas use (and corresponding reduction of natural gas demand) seen as essential to meet target for no unabated gas generation by 2035.</p> <p>We received updated projections for operational CHP plants using biomethane and updated collection rates.</p>	<p>We will revisit our underlying assumptions for biomethane production and will update where necessary.</p> <p>The general stance in FES is that bioenergy supply in general should be targeted towards areas where there is no viable decarbonised alternative or to produce negative emissions. However, there is a caveat for biogas particularly when it can be produced from waste in other sectors and reduce e.g. landfill gas escaping into the environment.</p>	<p>Update biomethane production capacities and implementation timings as appropriate.</p>	<p>Green Gas Support Scheme</p> <p>Industry representatives</p>
	<p>FES currently sees 28TWh as a credible biomethane production capacity. Industry is divided on whether this is ambitious or conservative. Some sources suggest there is a potential for at least 54.5TWh to 73TWh by 2030 of biomethane.</p>	<p>We may need to engage stakeholders further where conflicting points of view cannot be reconciled.</p>	<p>Our models will ultimately represent what we can justify as a credible range.</p>	<p>Industry representatives</p>
	<p>Carbon price likely to influence growth in anaerobic digestion (AD). Global Methane Pledge can't be met without dealing with emissions from rotting</p>	<p>We already model the influence of changing market incentives such as carbon prices through our societal change axis. This is reviewed regularly to ensure that it</p>	<p>Continued reflection of the influence of carbon prices in our models.</p>	<p>Industry representatives</p> <p>Green Gas Support Scheme</p>

waste. AD is a decarbonisation technology which offers energy as a by-product rather than the other way around. Sequestered carbon from AD may then be combined with hydrogen to make more biomethane.

Circa 45 AD plants expected to be built within 4 years under the green gas support scheme leading to projected growth in the short to medium term. Leading developers are starting to commission plants without subsidy, basing the business model on the value of decarbonisation technology.

reflects updated stakeholder feedback.

## System constraints

Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
Most comments recognised the value of the current FES modelling related to flexibility. There has been some feedback that alongside the unconstrained network modelled in FES, it would be useful to see results in the short term for a constrained network. This is to reflect the real-world impact that constraining off renewables for	Assess how we can incorporate constrained network modelling into the current suite of FES results. This could be an additional short-term (e.g. 5 year) sensitivity analysis on the existing scenarios.	Improved accuracy of load factors and carbon emissions in the short term and better alignment with historical out-turn. It may also allow the requirement for energy storage to mitigate constraints to be modelled.	Industry bodies & experts (including consultancies)  Bilateral meetings

network constraints has on power system intensity and wind load factors. The National Infrastructure Commission have also recognised that the location of increased renewable deployment on the network (I.e., where resource is high) can add challenges to managing the network. These challenges can lead to increased network constraints.

Hydrogen				
Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Source and stakeholder group
General Role of Hydrogen	Green hydrogen is unanimously the preferred option for end use but there is debate about how we transition to it and the role of blue hydrogen in this transition.	This feedback generally aligns with the underlying assumptions behind FES 2021 with some caveats (e.g. around System Transformation and whether green hydrogen could be scaled up quickly enough to meet required demand).	Updated figures and increased clarity within commentary.	Scotland Hydrogen Action Plan
	Policy is unclear about whether hydrogen generation should be used for flexibility or baseload and what the commercial incentives will be.	We aim to provide greater clarity on the ways we may transition to hydrogen and its role in the whole energy system.		Industry representatives
	Stakeholders see hydrogen as a transformative source of flexibility, the value of which is expected to rise dramatically as the electricity			UK Hydrogen Strategy

	generation mix becomes more diverse.			
Markets	<p>Market Reform: Electricity price and grid fees are likely to be the main cost drivers rather than CAPEX.</p> <p>Cheap electricity can change the way we deploy hydrogen and may make the use of hydrogen-based storage preferable over more efficient vectors due to its potential for overall best business case</p>	We will explore the relative energy efficiency and economic efficiencies for different technologies with respect to heating as an indicative end use (and potentially other applications).	<p>We will consider including this in scenarios depending on how credible the added insight would be.</p> <p>Commentary on relative energy efficiency and economic efficiency of hydrogen compared to other vectors.</p>	Industry representatives
Deployment of Hydrogen	Clusters are emerging as key to leading the transition to hydrogen.	Ensure this is considered in current modelling – especially regarding the role of the National [Gas] Transmission System.	Changes reflected in modelling as appropriate (including locational detail).	<p>Industry representatives</p> <p>UK Hydrogen Strategy</p>
Demand and Storage	There may be potential for government subsidies for commercial diesel to transfer to Hydrogen to stimulate demand.	We will explore this further with relevant stakeholders and monitor the likelihood of this.	We will model based on credibility, which typically comes from a policy commitment.	Industry representatives
	Blending into the NTS would provide a reliable demand and an incentive for people to invest in hydrogen generation – but this limited capacity could curtail hydrogen production unless there is also investment in inter-seasonal geological	We will seek greater clarity on the likelihood of large scale inter-seasonal storage being available and commercially viable.	To be included in modelling as appropriate.	Industry representatives

	<p>storage. This also allows for hydrogen production in times of excess renewable generation, for sale back to the network to cover low renewable periods.</p>			
Electrolysis and Electricity Generation	<p>Large scale storage improves the commercial viability of mass hydrogen production. Manufacturing capacity for electrolyzers likely to be stronger than demand and there are good economies of scale i.e. not a constraint to deployment – rather the opposite.</p> <p>No change in assumptions for how electrolyzers will operate but co-located sites may be likely.</p> <p>Mid 2030's expectations for electrolysis deployment at scale updated.</p> <p>Efficiency improvements: £400 per kW possible by 2025 as is a 50% increase in generation capacity for the same footprint.</p>	<p>We will seek greater clarity on the likelihood of large scale inter-seasonal storage being available and commercially viable. However, this feedback aligns with the comments on the importance of hydrogen storage in FES 2021.</p> <p>Seek wider views on electrolysis estimates.</p>	<p>It is likely that we will increase the amount of electrolysis capacity that we model in at least the LW and ST scenarios.</p>	<p>Industry representatives</p>

## B. Innovation projects

**We have provided further detail below about the innovation and research projects that we are involved in for FES.**

### 1. Study of weather patterns

Weather patterns will have a significant impact on electricity generation and, as heat is electrified, the level of demand. Historically we have developed our scenarios such that they are compliant with the current electricity security of supply standard of 3 hours Loss of Load Expectation (LOLE). We have also undertaken further sensitivity analysis by running our pan-European market dispatch model against a small handful of historic weather years some of which include more extreme low wind / low solar periods. These so called 'Dunkelflaute' conditions (literally translating as "dark doldrums" or "dark wind lull") don't all last the same amount of time; they come in a range of durations each with a different likelihood of occurrence.

Each event is likely to have a different impact on the operation of the system. To further optimise the mix of flexible assets that will be required to respond to low renewable output, we are first investigating options for increasing our understanding of the likelihood and duration of these weather events. As of early December, we are in discussion with stakeholders from academia to scope a potential project. This project will help to answer some of the concerns that our stakeholders have raised at past FES launch events.

### 2. Hydrogen as an electricity system asset

The need to cost effectively decarbonise heat and the challenge this poses for electricity networks has led to a resurgence in innovation around low carbon gases, including hydrogen, and the conversion of our natural gas system into a low carbon gas system. Alongside the heating sector, there is also an increased interest in the use of Hydrogen for other purposes, such as industry, power generation and transportation. The generation and use of hydrogen have clear impacts on the electricity system and, whilst it provides many opportunities to the broader energy system such as cross vector storage, it could potentially also pose several challenges if not carefully managed.

As ESO we need to understand how the development of hydrogen markets will interact with the electricity system, and how targeted hydrogen investment can more effectively support the electricity system.

This project will provide further information to support our treatment of hydrogen (e.g. in our electricity dispatch modelling). This will better represent:

- the different hydrogen value chains
- the reality of how electrolyzers will be operated (taking into account electricity input, and hydrogen end use value)
- the scale of electrolyzers (the current model assumes large centralised systems, but in reality, they will be at a range of scales including behind the meter, similar to battery storage systems)
- the location - both geographically and also on the networks, and the ability to model hydrogen storage such as salt caverns, pressurised tanks etc.



### **3. National Grid ESO CrowdFlex Phase 1 [report](#)**

CrowdFlex Phase 1 is the first phase of a study into how domestic households can provide flexibility to influence energy demand and reduce stress on the electricity system. Leveraging Octopus Energy and Ohme's large customer datasets, this study found that consumers switching from a flat to a Dynamic (Agile) or Static (Go) Time of Use Tariff reduced the proportion of daily demand consumed during the evening peak (4-7pm) by an average of 15% and 17% respectively. The study also assesses one-off events where consumers are notified in advance to 'turn up' or 'turn down' their energy consumption over a two-hour period. 'Turn down' events materially reduced peak demand: -59% in demand over the period for EV households and -41% for non-EV households, compared to the average evening peak power demand. While these findings are encouraging and support the assumptions in FES 2021 around consumer engagement, it's important to note that they are derived from Octopus customers who represent a more engaged consumer type compared to the GB average. Other reports are finding that many consumers need more support through access to trusted knowledge and advice, to reach this level of engagement. We are very aware of the need to build understanding of how different consumer types may face different barriers based on regional and demographic differences (see consumer-related projects below).

### **4. Consumer archetypes project**

We are investigating the development of a set of industry standard consumer archetypes in conjunction with the other energy companies. These will be used to develop a picture of where different types of consumer are across the network and how they may behave with respect to Net Zero and their energy consumption. We want to create this set of archetypes covering both gas and electricity to benefit the further development of future energy scenarios across the whole energy system (i.e., gas and electricity, transmission, and distribution). In developing the archetypes, we want to make sure that they are adaptable when consumer behaviours and opinions change so consumers move between archetypes and we can understand the steps that can be taken to influence consumers to move between groups. We also want to make sure we can define new archetypes when the need emerges, so they are not just a snapshot in time. We want this work to ensure vulnerable consumer groups are better understood and the steps are clear on how to support them.

Learning from our experience through Open Networks where the building blocks for electricity were created as a common standard and language and starting position, we want to use this as template for co-creating consumer building blocks. This will allow us to use a common language and apply the learning on both a national and regional level. We need this to be a collaborative approach so that we can reflect all areas of the network and understand localised changes and make joint strategies as industry. We have discussed the project with energy companies both at the network forum and through bilateral meetings and have gained support for this valuable and important potential project.

To date, we have discussed this project with the network companies through the FES Network Forum and received valuable insight on the benefit the project will drive. Several the network companies have expressed an interest to be involved in the project and we have had bilateral discussions to further understand their perspective. We have also discussed the project with the Consumer Insights team within Ofgem and with the ESO RIIO-2 Stakeholder Group (ERSG).

We have engaged with several potential suppliers and are currently assessing the best route to deliver the project, including through innovation, ensuring the benefit is realised by as many parties as possible. We have developed a RFI which has been reviewed by the network companies and has been sent to relevant potential suppliers. This will be used to help us understand who is best placed to work with us on this to further develop our understanding of consumer behaviour and how to apply this to our modelling.

### **5. COP26 ESO and Public First consumer engagement**

Working with Public First, we polled over 4000 members of the public in August and held 12 focus groups in September to better understand the British public's view on the UK's climate change agenda and how they can get involved in the energy transition.

The research demonstrated that different types of consumers across the country face different challenges when it comes to being enabled and empowered to participate in, and benefit from, action on climate change. We set out our findings and suggested a roadmap for engaging each of those different groups. The full detailed report can be found at the following link: [Empowering climate action: Inspiring and supporting consumer participation in the energy transition](#).

We also published a report focussed on Empowering climate action through local authorities in which we brought together the insights from the consumer polling and focus groups with insights from roundtables with elected representatives and officials from local authorities across Great Britain, to understand how communities across the country can be supported in climate action and the energy transition. The report outlines key challenges and opportunities for local authorities in supporting climate action in communities across the country. Reports can be found [here](#).

We are hosting a Webinar alongside Public First to discuss the findings from the research with Local Authorities. We will be discussing FES at this Webinar and introducing our regionalisation activities to understand how useful this could be for Local Authorities.

## C. What do stakeholders use FES for?

We have detailed below the responses to the question posed in the FES 2022 Call for Evidence asking stakeholders what they use FES for together with the stakeholder category they represent:

- Information and plans for the future of the UK Energy Industry (*Other stakeholders, small businesses*)
- We frequently quote the scenario approach to politicians we encounter to help show how much needs to be done to get to Net Zero. The modelling is helpful to show holistic messages. (*Innovators, Manufacturers and Technologists*)
- We used FES 2021 to get an idea of what impact future energy scenarios will have on older consumers. (*Consumers and consumer groups, Consumer groups and charities*)
- We use it as forward fuel mix modelling cases in our valuation models. (*Innovators, Manufacturers and Technologists*)
- To provide a deeper understanding of the long-term energy futures for the UK (*Non-governmental organisations, Other non-governmental organisations*)
- Primarily use the data workbook to understand what ranges the system could look like under different Net-Zero scenarios. This also helps to get a sense of how important each technology is, as any technology which appears significant across all scenarios indicates that National Grid views it as very important. In particular, it is interesting to see the mix of VRE, baseload, storage and interconnection. (*Energy industry, Small generators*)
- As evidence for likely future market developments for ourselves and clients (*Energy industry, Industry bodies & experts including Consultancies, Trade bodies*)
- General info on the market ((*Energy industry, Industry bodies & experts including Consultancies, Trade bodies*)
- As a sector-specific organisation, we use FES as an indicator of what the wider market is expected to look like at Net Zero etc. (*Energy industry, Industry bodies & experts including Consultancies, Trade bodies*)
- It informs strategy and policy development as well as providing useful elements for our modelling and forecasting. (*Political, UK Government Bodies*)
- I use the data to help me understand the future of the AC Grid (*Other stakeholders, Small businesses*)
- Demand forecasting for our Gas Distribution networks. (*UK Network, Gas distribution networks*)
- Analysis of Future Direction. (*Other stakeholders, Small businesses*)
- We compare and contrast data from FES with our own research and that of other organisations to better understand the necessary and credible steps to achieving net-zero. This helps shape and inform our own work. (*Non-governmental organisations, Environmental Groups*)

- Our project is working to establish the contribution tidal stream energy can make to the future energy system. The FES projected power capacities of each technology have been used as inputs to our energy system models. *(Energy industry, Small generators)*
- We look to the FES as the benchmark guide to future energy systems. This allows us to gauge the value of our proposed activities and demonstrate the need for the tidal range power generation schemes. The inclusion (or not) of tidal range power generation in FESs is important to us and other stakeholders. *(Innovators, Infrastructure providers)*
- Provides a robust evidence base to use in discussions relating to CCUS and hydrogen policy. *(Energy industry, Industry bodies & experts including Consultancies, Trade bodies)*
- We manufacture and supply Network Heat Pumps, a potential leading solution for Net Zero Heat, with much lower impact on the grid and Capacity requirement than Air Source Heat Pumps. We use FES to consider and understand potential scenarios, and we look to engage in influencing better outcomes for Grid and Consumers. *(Innovators, Manufacturers and Technologists)*
- We use FES to inform our modelling analysis, forecasting of future power market needs and price dynamics, forming a view of the energy market trends and developments, understanding the assumptions and baselining data behind government policies and targets, benchmarking our internal projections, as well as for getting insights on the wider market drivers and cross-sector impacts. *(Energy Industry, Transmission directly connected demand)*
- Analyse the scenarios and the thinking within and behind them, which helps with our own (global) scenario planning *(Innovators, Manufacturers and Technologists)*
- Comparison with internal long-term forecasts; strategic background. *(Energy Industry, Generators (including big 6))*
- FES plays a key role in the ETYS and NOA processes and underpins both of those outputs. Additionally, we use the FES as an input into regional CBA assessments to determine potential reinforcement need and in our Regional FES publication, specifically the demand datasets. *(UK Network, Gas and Electricity Transmission Companies)*
- Use to understand potential future energy system mix so that we can consider the opportunities and challenges from a company perspective. Understanding potential for CM auction sizes. We think the way that FES is communicated as not being forecasts should continue. FES should not be considered 'favoured' pathways for industry. *(Energy Industry, Storage and Flexibility)*
- We use the FES framework to inform the distribution network focused scenario forecasting exercise, called Distribution Future Energy Scenarios (DFES). This is used for strategic planning of distribution networks, regulatory reporting, and preparation of business plans. A common set of building blocks is used such that reporting is consistent. Some of the assumptions used in FES feed into the longer term DFES projections. *(UK Networks, Distribution network operators)*

- We use your Future Energy Scenarios as a basis for power and energy planning for the GB electricity system. We have used it to determine the future energy storage requirement of long, medium, and short duration energy storage (for the GB power system) to achieve net zero by 2050, including the required transition from 2030 to 2050.) *Energy industry, Industry bodies & experts including Consultancies, Trade bodies)*
- We undertake and commission research which aims to better understand the potential role of nuclear energy alongside other low carbon sources in the future energy mix, in support of Government policy of achieving Net Zero. We use the outcomes from FES to help us further our understanding, and to observe the information on energy system decarbonisation that is being received by the Public and Policymakers. We can use the outputs to appreciate, alongside other modelling tools, the actions that are required by the nuclear industry to deliver positive decarbonisation outcomes and how technology, policy and financial developments that are outside the control of the nuclear industry can lead to different outcomes for Nuclear. *(Innovators, Manufacturers and Technologists)*
- To establish the basis of the ESO's thinking on the future of our energy problems, which are in my opinion very substantial, and to help you reach realistic assessments of the different scenarios. *(Other stakeholders, Other including media)*

## D. Engagement and communication improvements

From our engagement we have identified the following areas to improve for FES 2022 and beyond.

Note that it is possible to receive conflicting feedback in some areas (including across different FES iterations) and, while our responses try to address concerns, we can't always fully reflect one piece of feedback without undoing changes made in response to other feedback. We always try to reach the optimum solution based on feedback received.

Engagement and Communication		
You said:	We will:	Where was the feedback gathered?
<b>Communication</b>		
Making our newsletters and email more interesting by including more graphics	We will look to add in graphics and images into our newsletters and other communications.	Call for Evidence
Consider hosting short interactive webinars on specific topics	During 2022 we will look to host webinars for our stakeholder community based on the subject of thought pieces that we write and publish. We will look to invite stakeholders with specific knowledge on this subject together with an open invite for all.	Call for Evidence
Using more accurate icons for FES 2022	Working with the design agency we will ensure all graphics used in the documents and presentations are fit for purpose and are an accurate representation.	Call for Evidence
Utilising an API for accessing data in the workbook	We will continue to add and expand on the FES data that is made available in machine readable format and via API in future cycles. We have been increasing the data made available in machine readable format via the ESO Data Portal ( <a href="#">link</a> ) over the past FES cycles. Currently we have: Data in "Building Block" format, The Energy Supply data table from the data workbook, The	Call for Evidence

	Electricity Ten Year Statement regional data, including GSP shapefiles. Plus, data from other areas of the ESO. These files can be accessed via API - more details can be found <a href="#">here</a> .	
Providing engagement updates for the rest of the year post FES launch	We will continue to share updates and early FES insight through our newsletter and via the ESO newsletter – Plugged In. In the December and January FES newsletter we will be sharing thought pieces looking at our new regional heat model and a 10 year look back at FES	Call for Evidence
Clarity on who to talk to in the team and to understand who deals with what together with a management structure	We will look to share a team structure with key areas of focus in a future newsletter and website.	September 2021 Stakeholder Satisfaction Survey
<b>Website</b>		
Include some headline findings rather than broad key messages; analysis snapshots would be welcome	We will look to include more of our “key insights” (which contain more direct analysis snapshots) from each of the main sections of the document onto the website.	Call for Evidence
There are numerous ways to access the same information, the website could be simplified with better use of navigation	We will provide clearer navigation on the website and better signposting to the suite of documents.	Call for Evidence
<b>FES documents</b>		
Ensure the non-interactive version is available at time of launch as the interactive version does not allow for copy and paste	For FES 2022 we will ensure that all versions of the main report are available on the day of publishing.	Call for Evidence
Be clear that the main report is an interactive version	For FES 2022 we will explicitly set out if the documents are interactive, printable, or other at the time of publishing. This will be visible both on the website and within the relevant documents.	Call for Evidence
Provide varying levels of granularity for varying audiences	While it may not be possible to provide narrative for all levels of granularity, we plan to make the granularity of our data and visualisations more	Call for Evidence



	configurable to ensure that it meets the needs of our stakeholder base.	
Improve the navigation of the main document as it can be difficult to follow, current perception is that it is full of links and jargon	We will work with our design team to improve the navigation of the main document, looking to other sources for best practice and seeking to further reduce any jargon.	Call for Evidence
Provide more detail regarding nuclear energy and how its role varies in scenarios	We will build on FES 2021 insights in terms of how nuclear energy may have a potentially broader role in the energy industry across the scenarios. For instance, production of hydrogen and heat in addition to electricity generation as well as more insight into its contribution to flexibility.	Call for Evidence
Consider numbering the scenarios in the future if they remain unchanged (for example CT20, CT21) to enable referencing aspects that have changed since last year	Where references to scenarios from previous publications are made in FES 2022, we will ensure that this is clear (i.e. potentially via some form of numbering).	Call for Evidence
Could FES be split by technology like the CCC's 6th Carbon Budget – to provide more technology specific analysis	Where appropriate, we split FES by technology (e.g. different types of generation or heating system). We will explore the extent to which we can expand on this in FES 2022 whilst retaining other relevant splits such as sectors, fuels etc. As in previous years, our data and analysis will be able to be broken down by technology using the data workbook.	Call for Evidence
<b>FES launch event</b>		
More advance notice of the launch event – 3-6 months in advance would be ideal	We will share the launch date for FES 2022 no later than April (i.e. 3 months prior).	Call for Evidence
Ensure links are sent out after the event for viewing the presentations	As soon as possible after the launch event has concluded, we will share links to view the presentations. This can be via the website or newsletter, over social media and directly to those that attended.	Call for Evidence

Spread the sessions out more so it is easier to attend all of them	While we make recordings of the sessions available for people who missed them, we are keen to maximise numbers at the sessions themselves. As such we will seek further feedback on how best to achieve this (noting that other stakeholders have previously expressed a preference for sessions to be compressed into single days).	Call for Evidence
Launch sessions to include more analysis insight rather than repeating FES – explain more of the implications and modelling	Presentations for FES 2022 to include more content on the aspects and implications of the modelling and less duplication of content from the main FES report.	Call for Evidence
Host breakout sessions on specific topics	For FES 2022 we will consider altering the format of the breakout sessions to focus on specific subjects.	Call for Evidence
Some attendees commented that the questions weren't answered sufficiently and needed more of a yes or no – the question was a challenge to the assumptions	As in other forums, it is not always possible to provide a yes or no answer to questions on complex topics – especially when exchanges are recorded as caveats can be very important. However, we are always keen to receive challenges to our assumptions and will ensure that answers to questions are as helpful as possible. This includes any responses included in FAQ documentation.	On the day satisfaction survey
Stakeholders would like more in depth information into the modelling and assumptions and less of a summary of what is already published in the FES report	We will consider providing more information on the assumptions and modelling that is not covered in the main report. This could be a specific deep dive. Also, we will include better signposting to the modelling and assumptions document in the full suite.	On the day satisfaction survey
Comments received focused on the quality of the recorded presentations – how they need to be more engaging, less rushed, and scripted. Some stakeholders said it was difficult to stay engaged	We will look to improve the quality of the presentations by using a different format for recording them and streaming through the platform. We will also look at training requirements for the team as well as incorporating graphics on screen to make them more engaging.	On the day satisfaction survey

Some stakeholders experienced issues with WTV's virtual conference software, particularly those using Microsoft edge. In some instances, the streaming platform was blocked by company firewalls	In event pre-read we will continue to highlight any potential issues with using different browsers and, when links are sent, advise attendees to test them in advance.	On the day satisfaction survey
Several attendees requested access to the presentation slides before or at the same time as the presentation	For future events, we will consider whether sharing some or all the slides in advance of the presentation may improve engagement. However, more generally we will share slides as soon as possible after the presentations.	On the day satisfaction survey
Comments were received about the registration process and how it could be improved by sending calendar invites for selected sessions	For future events we will work with the conference provider, seeking to send calendar invites for the separate sessions.	On the day satisfaction survey
Several stakeholders requested earlier joining instructions, agenda, timings for the day and other information.	In addition to the information shared via the FES newsletter we will look to provide further information via the website and directly to those that have registered.	On the day satisfaction survey
Some attendees commented that having a higher character limit in the Sli.do Q&A would have been useful	We will look to increase the capacity in the Q&A function to raise longer questions whilst also noting the risk that this could be detrimental to the broader Q&A process for all attendees.	On the day satisfaction survey
Some stakeholders have requested to have a session on some of the modelling methods used, for those interested in data science and modelling.	We will consider hosting a session specifically on modelling methods	On the day satisfaction survey
<b>Bilateral engagement</b>		
Some stakeholders provided feedback that they would like more frequent sessions and regular contact throughout the year.	We will look to offer further opportunities for engagement throughout the year via the FES newsletter.	Bilateral satisfaction survey

Feedback was received that we should consider if one hour is long enough for adequate discussions	When planning our engagement and understanding what we need to discuss with stakeholders we will look to schedule time longer than an hour where appropriate.	Bilateral satisfaction survey
For specific questions and points to discuss, sending these in advance would help structure the session	For future bilateral meetings, where possible, we will send stakeholders questions to advance for awareness.	Bilateral satisfaction survey

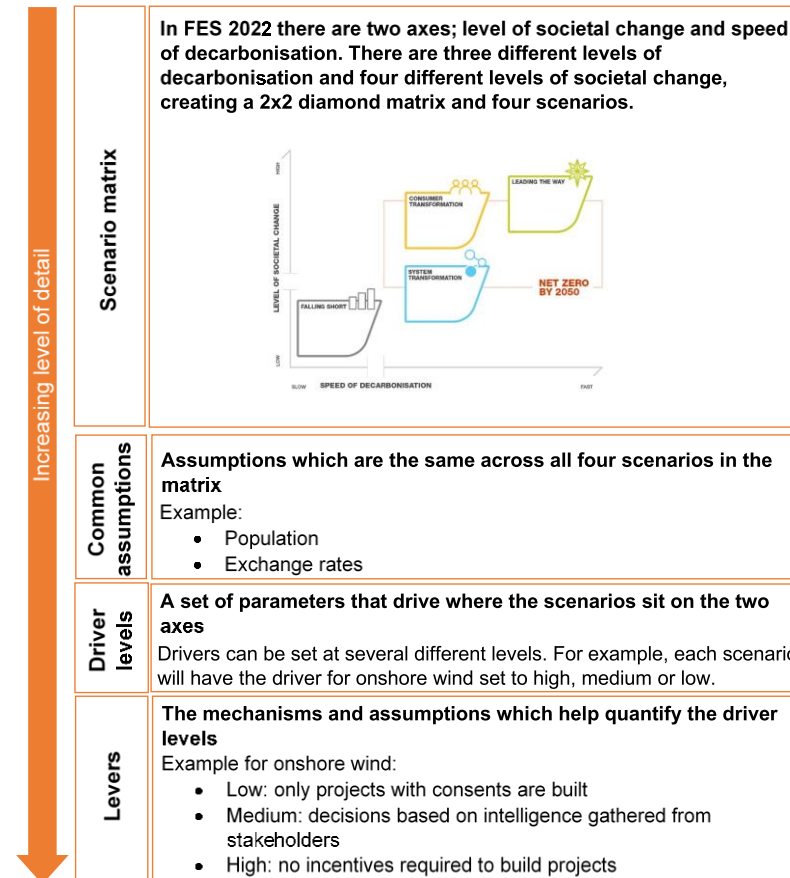
## E. Creating the Scenario Framework

The Scenario Framework is a structured approach which ensures that our scenarios are internally consistent while also exploring the credible range of uncertainty as a set of scenarios. It allows us to articulate the story behind each possible future we're analysing and presenting and how this has come about. Figure 4 shows the stages in creating scenarios, starting with the Scenario Matrix, where we decide how many scenarios there will be, and how they will be differentiated at the highest level. There are then stages with increasing levels of detail, culminating in the assumptions and levers, which describe how we choose the inputs into our detailed models.

It is important to note that, while the high-level Scenario Framework may not change, this does not preclude changes to individual modelling assumptions, and we expect these to evolve year on year in response to feedback and changes to the external environment.

Figure 4

Creating the  
scenario framework



We have detailed the below the feedback we have received from stakeholders during our engagement on the Scenario Framework and Scenarios.

Scenario Framework and Scenarios		
You said:	We will:	Evidence:
<p><b>You valued year on year consistency and supported retaining the existing scenario framework.</b></p> <p>Specific verbatim includes:</p> <p><i>"I think you need to keep cases consistent. Since published the scenarios have changed names making it difficult to explore the changes. Each case should follow the same principle basis each year. If another case is introduced, it should be in addition to the established cases for a period accepting that you retire cases after time. Changing scenarios one year to the next diminishes the value of FES as it indicates that in the previous year you got the possible scenario wrong"</i></p> <p><i>"The scenarios are clear and helpful."</i></p> <p><i>"No, the four main scenarios look credible going forward."</i></p> <p><i>"The scenario framework appears to be fit for purpose. The axes being used feel to be the correct ones if we are to really achieve net zero. We believe that there should not be any changes made to the scenario framework."</i></p> <p><i>"Overall, the FES framework works well and represents a good balance between potential future pathways for the energy system."</i></p>	<p>Retain the same scenarios and scenario framework for FES 2022. For the avoidance of doubt, changing the name of the Steady Progression scenario for FES 2022 will not diminish in any way the ability to compare against SP 2020 or SP 2021.</p>	<p>Call for Evidence Bilateral FES Network Forum</p>

<b>Beneficial to retain a scenario that does not meet net zero target</b>	Retain the Steady Progression scenario and, in line with feedback received, make it explicitly clear that this scenario does not meet the Net Zero target for 2050.	Call for Evidence Bilateral FES Network Forum
<p>Specific verbatim includes:</p> <p><i>"I think the scenario-based approach is essential with so much uncertainty, and having some scenarios that get to net zero by 2050 and one or two that don't give good comparators"</i></p> <p><i>"The scenario framework is good, and it is important not to have too many scenarios but for each to represent a distinct pathway. Theoretically there are an infinite number of possible pathways, so the four scenarios you have chosen (including the Steady Progression reference scenario) is probably about right."</i></p>		
<b>Changes to consider including a scenario that is 'most likely' and removing scenarios that fail to meet the target</b>	<p>Continue, in the longer (i.e. 2050 timescales), to produce scenarios rather than a single "most likely" view as we believe this is more valuable in terms of allowing the range of uncertainty to be explored. In the shorter term, we will continue to publish data corresponding to our 5-year forecast.</p> <p>As noted above, we have to consider all feedback around whether a scenario that doesn't meet the 2050 Net Zero target should be included or not and, on balance, we believe that there is value in including such a scenario. This is based on the purpose of FES being to capture the range of uncertainty and it is currently difficult to say that it is certain that this target will be met.</p>	Call for Evidence Bilateral FES Network Forum
<p>Specific verbatim includes:</p> <p><i>"We have the same general comments regarding the scenario framework as for FES 2021. We would prefer a more balanced set of scenarios that recognise the risks around Net Zero as well as the ambition. We think the Further Ambition scenario is too optimistic to be very useful. A "most likely" central scenario would be more useful"</i></p> <p><i>"It feels as though scenarios that do not get us to Net Zero in time are really not worth being used other than as a negative reference. We need to show several scenarios that DO get us to Net Zero to show the optionality."</i></p>		



<p><b>Resolutions at COP26 could change the energy landscape and could result in the need to make changes to the scenario framework to account for this.</b></p>	<p>Consider the outcomes of COP26. At this stage we do not believe there is a need to adjust the framework as a result of COP26 or the UK-specific policy and strategy developments published in advance of it.</p>	<p>Call for Evidence Bilateral FES Network Forum</p>
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## F. Overview of engagement events and communication activity

FES 2021 launch event week Monday 12 July – Thursday 15 July 2021		
<ul style="list-style-type: none"> <li>1282 registered to attend via the platform</li> <li>c450 delegates joined during the week</li> <li>142 watched on catch-up</li> <li>56 joined the virtual networking sessions</li> <li>Overall NPS for the week: +37               <ul style="list-style-type: none"> <li>Monday NPS: +21</li> <li>Wednesday NPS: +58</li> <li>Thursday NPS: +39</li> </ul> </li> <li>Average 94 – 130 delegates per session on Wednesday and Thursday sessions</li> <li>c.100 FES 2021 document downloads from the dedicated launch platform.</li> <li>Delegates rated between 67% - 100% format and content meet expectations</li> </ul>	<b>On-the-day satisfaction survey</b> Positive feedback: <ul style="list-style-type: none"> <li>Support for a virtual launch next year reducing the need to travel and providing options to join live or watch on catch-up</li> <li>Format allowed attendees to dip in and out during the week joining for the subjects of their interest</li> <li>The presentations provided detailed information in an easy-to-understand way at a time of great change</li> </ul>	<b>Summary of scenario feedback for FES 2022</b> All feedback received during the launch was focussed on the event itself and the results the modelling and analysis.
	<b>On-the-day satisfaction survey</b> Improvements for consideration: <ul style="list-style-type: none"> <li>More in-depth information into the modelling and assumptions</li> <li>Recorded presentations could be improved, making them more engaging and less scripted</li> <li>Registration process could be improved, ensuring that dates are added automatically to calendars</li> <li>Earlier joining instructions, timings for the day and agenda would be beneficial</li> </ul> These are all included in our engagement improvements on page 54 - 59.	
<b>Stakeholder quotes:</b> <ul style="list-style-type: none"> <li>“As a novice to this industry helped me understand the situation and everyone involved very clear despite complexities. Thankyou”</li> <li>“Really useful to be talked thru the slides rather than try and read them dry. Understanding is much higher (But I admit to being a 70-year-old retired engineer!)”</li> </ul>		

- “Loved it - thank you, really timely oversight of some very important areas”
- “Easy to join and useful for my needs. It is a very wide area, as came out in some of the Q&A questions. I am looking forward to the heat and hydrogen sessions”
- “Well done to the team”
- “Loved the early hard copy of FES in 5”
- “Slick and informative. Well done”
- “In depth, professional and comprehensive delivery across products and presentation at a time of energy change and transition”

### FES 2022 Call for Evidence September 2021

#### FES 2022 Call for Evidence ran for four weeks during September

- Launched beginning of September
- 46 stakeholders entered the online survey, with 36 providing actionable feedback
- MS Forms used for the consultation to improve the experience for stakeholder and following feedback from the previous year
- All questions visible at all times to responders
- Navigation and transparency increased from previous years

#### Summary of feedback for FES 2022

- In October 2021 we shared a summary of the feedback we received with stakeholders via the website and newsletter. This can be found [here](#).
- The feedback is also referenced on pages 29 - 47.

### Regional FES scoping engagement July – August 2021

#### Overview

As part of the scoping phase for the Regionalisation of FES, structured interviews with 16 external stakeholder groups were completed between in July and August. The insight received from these engagement exercises is being used to help shape the next steps in the project,

#### Positive feedback:

Stakeholder feedback points to several areas for the ESO to explore, including different ways to define regions and fuel interactions, having a whole system focus, and learning lessons from existing cross-fuel collaboration. There was a positive reaction to being able to get a better view of technology uptake and consumer/customer trends at a regional level. There is broad support for closer collaboration on the creation of more granular scenarios. More interactive tools can make it easier to use FES outputs to generate relevant insights and

#### Summary of feedback for Regional FES 2022

Stakeholders would welcome a more granular view of whole system scenarios and agree it would increase the robustness of FES.

There is a need to ensure scenario creation is coordinated and that there isn't a duplication of effort

building on an understanding of what stakeholders would value and how they want to be involved.	<p>more visibility of upcoming changes can help manage downstream impact.</p> <p><b>For improvement:</b> Stakeholders have said they would welcome a more granular view of whole system scenarios and agree it would increase the robustness of FES. A need has also been identified to ensure scenario creation is coordinated and that there isn't a duplication of effort. There also needs to be transparency of the assumptions driving the regionalisation of the FES, and potentially for feedback loops with stakeholders to sense-check outputs.</p>	<p>There is a need for transparency of the assumptions driving the regionalisation of the GB FES, and potentially for a level of feedback loops with stakeholders to sense check outputs There is broad support for closer collaboration on the creation of more granular scenarios</p> <p>More interactive tools can make it easier to use FES outputs to generate relevant insights More visibility of upcoming changes can help manage downstream impact</p>
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<b>Network Forum</b> <b>April – December 2021</b>		
<p><b>Overview</b></p> <ul style="list-style-type: none"> <li>145 stakeholders have joined across the last five meetings, with 33 attending in October and 42 attending the December meeting. This is an increase from previous meetings.</li> <li>Topics discussed have included: early insight into demand analysis, deep dive into consumer research and engagement, Regional FES as well as regular updates on FES 2022</li> </ul>	<p><b>Positive feedback:</b> Stakeholders have welcomed the collaborative approach</p> <p><b>For improvement (from FES 2021 Forum meetings:</b></p> <ul style="list-style-type: none"> <li>Sharing the agenda in advance of the meeting and asking for any other items (this is now completed)</li> <li>Agreeing collaboratively items to cover and deep dives to explore at the meetings (this is now completed)</li> <li>Sharing action and key points raised during the meeting (this is now completed)</li> <li>Sharing a recording of the meeting with the distribution list (this is now completed)</li> <li>Consider smaller breakout groups in the future for specific topics</li> </ul>	<p><b>Summary of feedback for FES 2022</b> Attendees provided feedback on the FES 2022 scenarios and scenario framework, stating that the current framework is fit for purpose and recognising the need to consistency and ability to compare year on year.</p> <p>Attendees provided feedback direct to the team on the early insight into the demand analysis</p> <p>Attendees provided valuable on Regional FES, consumer engagement and consumer building blocks project.</p>

## Bilateral meetings (involving ESO and one other organisation) for FES 2022 August 2021 to January

### Overview:

- We have met with 141 stakeholders from 81 different organisations
- Most of the insight and evidence we consider and take forward for FES 2022 comes from these meetings
- Stakeholder satisfaction measure (to-date) is 8.53 (based on a score of 1 – 10)
- We identified in advance of the meeting what we would like to know from stakeholders
- Each meeting was tailored for each organisation with specific questions asked for each topic represented
- All meetings have been held virtually
- Bilateral engagement continues through till late spring

### Positive feedback:

- Stakeholders have welcomed the opportunity to provide feedback to FES 2022.
- Many cited that the discussions and conversation has been open, free flowing and useful

### Improvements for consideration:

- More frequent sessions and regular contact throughout the year.
  - Consider if one hour is long enough for adequate discussions
  - For specific questions and points to discuss, sending these in advance would help structure the session
- These are all included in our engagement improvements on page 54 - 59.

### Feedback for FES 2022:

The feedback gathered from these meetings and how we are taking it forward is shown in pages 29 - 47. It is too lengthy to include here. For reference, we have received input on:

- Net Zero
- Bioenergy
- BECCS
- Electric storage
- Battery deployment
- System flexibility and
- Interconnectors amongst other topics.

### Stakeholder feedback and quotes:

- “Useful discussion and clearly very knowledgeable about the work.”
- “Material you produce is really useful. Including making the data available. So, keep doing what you're doing.”
- “Some targeted questions that were asked in the session could have been shared in advance to provide better clarity of question and answer”.
- “The team was engaging, and we have had a constructive exchange”

## FES 2021 online communication

### FES website:

For FES 2021 we added the key insight from the main report onto individual webpages of the website to make the content more accessible and easier to digest for stakeholders. As a result of this we have seen a significant increase in website traffic. Some of the key stats are shown below for the period between March 2021 to January 2022:

- 54,977: FES pages total views

### Positive feedback:

- Very good at communicating with the industry
- The present FES communications are good
- Continue with a virtual launch next year reducing the need to travel and providing options to join live or watch on catch-up
- Excellent communication overall.
- The website is very clear, and it is easy to download the FES reports and workbooks. The workbooks in particular contain a lot of the necessary base

- 8,276: FES documents combined downloads
- 591: Stakeholder feedback document
- 6,621: FES 2021 – interactive downloads
- 3,792: FES 2021 – print downloads
- 2,521 FES in 5 downloads
- 1,598 Data workbook downloads
- 450: Scenario Framework downloads
- 417: Regional breakdown of FES data downloads
- 193: FES 2021 FAQs downloads
- 199 Key changes document downloads
- 40: Modelling methods document downloads
- 495: Regional Breakdown of FES 2021 data (electricity)
- 612: Regional Breakdown of the FES data 2021 (workbook)
- 7,699: FES page views on FES launch day
- 21,129: FES document downloads during July 2021
- 50%: Over 50% of FES page views accounted for the 14k visits to the ESO site during July. The top three most visited pages during July 2021 included the FES 2021 Homepage, FES 2021 Documents and the Future Energy Scenarios page.

### Newsletter

During 2021 and into 2022 we have continued to publish the FES newsletters sharing our latest news and inviting feedback. Here is some data our newsletters:

#### There are currently 6,200 active subscribers

- Published nine newsletters from March 2021 to January 2022
- Average of 26% recipients open each publication
- Top four countries receiving newsletters are UK, Netherlands, US, Finland
- Other countries reached include Moldova, South Korea, Nigeria, Singapore, and Barbados
- The most read articles and links within the newsletters were for 'FES is published' and the registration link for the FES 2021 launch

### Email queries

data that we need for our analyses and it is clear you have done a huge amount of work to prepare these.

#### Improvements for consideration:

- Make newsletters and emails more interesting by including more graphics
- Website improvements to include APIs for the data workbook and improve the website to make navigation to documents more accessible.
- Provide engagement updates for the rest of the year post FES launch
- Ensure presentation material is shared ahead of events, share earlier joining instructions, agendas, timings for the day and information on troubleshooting when using IT to attend events
- Short (30-60 min) interactive webinars on specific topics

These are all included in our engagement improvements on page 54 - 59.

- 01.03.21 – to January: During this period, we have received 123 queries
- We have continued to receive and respond to a wide range of queries to our FES mailbox account. With queries received from a wide reach of stakeholders including **public**, suppliers, industry experts, storage & flexibility providers, academics & universities, and local authorities covering a broad range of topics. We have continually responded to most queries within our agreed standard of service of five days. For those queries requiring more detailed analysis we have taken longer than the five-days to respond to stakeholders due to the nature of the query, keeping them informed throughout.

#### **ESO Twitter**

- We had 1,579 total engagements and a total of 64,477 impressions (likes) on FES related articles with the highest being 13,043 for: 'We've published our 2021 Future Energy Scenarios' (July 21) tweet.

#### **Podcasts**

Last year we hosted five podcasts together with an introduction focussing on the future of energy with a total audience of 3,785 listeners. Episode one was the most listened to podcast with 876 listeners and the second most popular, episode five with 670 listeners. Here is a summary of podcasts:

- July 2021: Introduction: The Future of energy
- July 2021: Episode 1: Net zero and consumers
- July 2021: Episode 2: The road to clean: Electric vehicles and decarbonisation
- August 2021: Episode 3: Transforming an electricity network with renewables
- September 2021: Episode 4: The Future of Heat
- September 2021: Episode 5: Hydrogen: the fuel of the future



## G. Stakeholder groups we have engaged with during 2021

We use the categories below to inform us and other interested parties' which sectors across the energy industry and wider we have engaged with. These are the same categories that we used last year and so can provide a comparison against the previous year which is found on page [43].

Stakeholder category	Subcategory
Communities and their representatives	<ul style="list-style-type: none"> <li>Impacted Local Communities and Residents</li> <li>Parish Councils</li> <li>Local Campaign Groups and advocacy groups</li> </ul>
Consumers and consumer groups	<ul style="list-style-type: none"> <li>General public/individual responses</li> <li>Consumer groups and charities</li> </ul>
Energy industry	<ul style="list-style-type: none"> <li>Energy Suppliers</li> <li>European and International networks</li> <li>European TSO</li> <li>Generators (including Big 6)</li> <li>Industry bodies &amp; experts including Consultancies, Trade bodies</li> <li>Interconnectors</li> <li>Offshore Gas Companies</li> <li>Offshore Transmission Owners</li> <li>Operating Margin Providers</li> <li>National Grid ESO</li> <li>Shippers</li> <li>Small Generators</li> <li>Small Renewables</li> <li>Storage and Flexibility</li> <li>Terminal Operators</li> <li>Transmission directly connected demand</li> </ul>
Innovators	<ul style="list-style-type: none"> <li>Environmentalists</li> <li>Manufacturers and Technologists</li> <li>Infrastructure providers</li> </ul>
Non-governmental organisations	<ul style="list-style-type: none"> <li>Environmental Groups</li> <li>Other non-governmental organisations</li> </ul>
Other stakeholders	<ul style="list-style-type: none"> <li>Academics, Universities and Schools</li> <li>Finance and investment community</li> <li>Small businesses</li> </ul>

	Other including media
Political	Devolved Administrations European Administration Members of European Parliament Members of Parliament Local Authorities UK Government Bodies
Regulators	Regulatory bodies
UK Networks	Distribution Network Operators Gas and Electricity Transmission Companies Other UK networks – water, communications Gas Distribution Networks

Below is a breakdown of stakeholder groups and organisations engaged with during the year of 2021 for FES 2022.

The numbers shown in the table below are the total amount, 1020 of stakeholders that have been involved across all our engagement activities. Some may have taken part in more than one event during this time. The total number of individual, unique stakeholders is 642.

#### Stakeholder breakdown for all engagement activities during 2021 for FES 2022

Stakeholder category	Total
Communities and their representatives	6
Consumers and consumer groups	27
Energy Industry	486
Innovators	81
Non-governmental organisations	16
Other stakeholders including academics and universities	146
Political	43
Regulator	12
UK Networks	203
	<b>Total 1020</b>

Below is a further breakdown of the stakeholders we have engaged with to provide transparency

Main category	Sub-category	Count
<b>Communities and their representatives</b>	Impacted Local Communities and Residents	0
	Parish councils	0
	Local Campaign Groups and advocacy groups	6
<b>Consumers and consumer groups</b>	General public/individual responses	14
	Consumer groups and charities	13
<b>Energy Industry</b>	Energy Suppliers	47
	European and International Networks	18
	European TSO	5
	Generators (including Big 6)	54
	Industry bodies & experts including Consultancies, Trade bodies	145
	Interconnectors	10
	Offshore Gas Companies	8
	Offshore Transmission Owners	0
	Operating Margin Providers	2
	National Grid ESO	129
	Shippers	5
	Small Generators	9
	Small Renewables	9
	Storage and Flexibility	27
	Terminal Operators	3
	Transmission directly connected demand	15
<b>Innovators</b>	Environmentalists	3
	Manufacturers and Technologists	52
	Infrastructure providers	26
<b>Non-governmental organisations</b>	Environmental Groups	4
	Other non-governmental organisations	12
<b>Other stakeholders</b>	Academics, Universities and Schools	43
	Finance and investment community	36
	Small businesses	52
	Other including media	15

<b>Political</b>	Devolved Administrations	10
	European administration	0
	Members of European Parliament	0
	Members of Parliament	0
	Local Authorities	8
	UK Government Bodies	25
<b>Regulator</b>	Regulatory bodies	12
<b>UK Networks</b>	Distribution Network Operators	69
	Gas and Electricity Transmission Companies	73
	Gas Distribution Networks	60
	Other UK networks - water, communications	1
	<b>Total</b>	<b>1020</b>

Below is a breakdown of stakeholder groups for each engagement event:

#### Stakeholder breakdown for the FES 2021 launch event

Stakeholder category	Total
Communities and their representatives	3
Consumers and consumer groups	13
Energy Industry	243
Innovators	39
Non-governmental organisations	6
Other stakeholders	77
Political	9
Regulator	1
UK Networks	37
<b>TOTAL</b>	<b>428</b>

#### Stakeholder breakdown for the FES 2021 launch event – ‘catch-up’

Stakeholder category	Total
Communities and their representatives	1
Consumers and consumer groups	5
Energy Industry	73
Innovators	6

Non-governmental organisations	0
Other stakeholders	51
Political	0
Regulator	1
UK Networks	5
<b>TOTAL</b>	<b>142</b>

#### Stakeholder breakdown for FES 2022 Call for Evidence

Stakeholder category	Total
Communities and their representatives	0
Consumers and consumer groups	1
Energy Industry	14
Innovators	7
Non-governmental organisations	2
Other	7
Political	1
Regulators	0
UK Networks	4
<b>TOTAL</b>	<b>36</b>

#### Stakeholder breakdown for five FES Network Forum meetings

Stakeholder category	Total
UK Networks	88
Energy Industry	57
<b>TOTAL</b>	<b>145</b>

#### Stakeholder breakdown for FES 2022 Bridging the Gap programme

Stakeholder category	Total
Communities and their representatives	1
Consumers and consumer groups	0
Energy Industry	6
Innovators	2
Non-governmental organisations	0

Other stakeholders	2
Political	3
Regulator	1
UK Networks	0
<b>TOTAL</b>	<b>TOTAL 15</b>

#### Stakeholder breakdown for FES 2022 bilateral and regional meetings

Stakeholder category	Total
Communities and their representatives	1
Consumers and consumer groups	0
Energy Industry	75
Innovators	18
Non-governmental organisations	8
Other stakeholders	5
Political	24
Regulator	4
UK Networks	64
	<b>TOTAL 199</b>

## H. Comparison of engagement and stakeholders – 2020 - 2021

	2021	2020
<b>Total number of stakeholders</b>	<b>642</b> different stakeholders <b>1020</b> stakeholders across all events	1257 different stakeholders 1713 stakeholders across all events
<b>Total number of organisations</b>	<b>329</b> different organisations <b>473</b> organisations across all activities <b>204</b> new organisations for 2021	460 different organisations 762 organisations across all activities 347 new organisations for 2020
<b>Bilateral &amp; regional meetings</b>	<b>95 organisations</b> <b>199</b> stakeholders	80 organisations 185 stakeholders
<b>FES launch events</b>	<b>428</b> stakeholders	790 stakeholders
<b>FES launch on ‘catch-up’</b>	142 stakeholders	194 stakeholders
<b>Call for Evidence</b>	<b>46</b> entered the survey <b>36</b> provided a response <b>33</b> different organisations	100 responses 62 organisations 21 as individuals
<b>Workshops (webinars for 2020)</b>	n/a	116 stakeholders 68 organisations

Stakeholder category	2021 Total	2020 Total
Communities and their representatives	6	20
Consumers and consumer groups	27	183
Energy Industry	486	764
Innovators	81	198
Non-governmental organisations	16	33
Other stakeholders	146	233



Political	43	111
Regulator	12	46
UK Networks	203	125
	<b>Total 1020</b>	<b>Total 1713</b>

# I. Review of our engagement and communication actions from FES 2021

Below we have provided a review of the actions that we said we would deliver for *FES 2021* (as set out in the 2021 Stakeholder Feedback Document), together with an update on how we have delivered against those actions or, where we have not taken forward an action, the reason why.

Engagement and Communication		
Stakeholders said for FES 2021:	We said we would for FES 2021:	Updated: What we did for FES 2021:
You would like the audio quality and consistency to be improved to reduce time lags and stuttering's	Working with the team, IT, and production company we will ensure that audio quality is improved and a better experience for stakeholders	For the FES 2021 launch <b><i>we did</i></b> work closely with the production team to improve the audio quality, ensuring presenters used better headsets. We also rehearsed beforehand to test the audio quality.
You missed the networking and 1:1 aspect of a face-face event	We will investigate the options available to us for both a virtual event and one that facilitates networking and 1:1 for FES 2021 launch event. This will be reviewed and is dependent on the ongoing Covid-19 pandemic	For the FES 2021 launch <b><i>we did</i></b> host a series of virtual networking sessions on Wednesday and Thursday in between the deep-dive presentations. These were welcomed by those that attended.
You would like slower commentary for the presentations	Ensure that presentation delivery is slower by carrying out additional rehearsals beforehand	<b><i>We did</i></b> rehearse the presentation delivery before the live event and also re-recorded presentations where needed.

You would like larger slides on the web platform and on the screen for longer to digest the information	Working with IT and production teams we will ensure that slides are bigger on the screen and stay for longer to improve the experience for stakeholders	For FES 2021 <b><i>we did</i></b> change how we displayed the slides during the presentations, providing the option for viewers to have the slide fill the full screen. We also provided the slides as a resource post event.
You would like to see presenters face separate from the slides	Working with IT and production teams we will ensure that slides are bigger on the screen and separate from the presenters to improve the experience for stakeholders	
You would like longer time for the Q&A section of the launch event	Consider longer Q&A sessions or options to host separate Q&A events on specific topics for FES 2021	For each of the deep-dive presentations <b><i>we did</i></b> host a 35min Q&A slot on that topics. All Q&A's were then captured in the Q&A document published during August.
You would like visibility of all the questions asked by the audience	Consider the best option for sharing all the questions on the webcast (e.g., use of Sli.do) for FES 2021	For FES 2021 <b><i>we did</i></b> use Sli.do during all the Q&A sessions so that all questions were visible to attendees. Stakeholders were able to vote for the most popular questions.
As there are many documents that make up the suite of FES you would like to see a document overview	Consider sharing a document overview graphic during any webinar and static graphic on the webcast platform for FES 2021. This could also be published on the FES website	For FES 2021 <b><i>we did</i></b> make changes to the website to provide clearer visibility on the full suite of documents. In the main FES document. <b><i>Providing better signposting and titles for all documents in the suite will be taken forward for FES 2022.</i></b>
You were confused why the ESO is covering gas supply	Be clear up front why we are covering gas supply and demand – both in the documents and launch events	FES is a whole energy document, and the scenarios cover all energy aspects and wider economy when considering carbon emissions in our calculations for meeting net zero. Taking a view of gas as well as electricity is essential for considering the whole energy system. The

		importance of whole system thinking was one of our Key Messages in FES 2021.
<b>You would have liked more eye contact from the presenters during their presentation</b>	Working with IT service and the team of presenters, we will ensure the presenters are looking at their camera to increase eye contact	<b>We did</b> work with the production team and presenters to increase the level of eye contact with the camera. This was tested during rehearsals and feedback provided. As we are new to hosting and delivering virtual events on this scale, we will continue to invest in bespoke training as well as hiring the right technical support teams.
<b>You thought the presentations were too robotic and scripted, less pre-recorded presentations</b>	Working with the team and investigating training options, in conjunction with the comment about speed of delivery above, we will ensure presentations appear less scripted and consider hosting all live presentations for future virtual event	For FES 2021 we used both live and recorded presentations to reduce the risk of network and IT issues. For recorded presentations <b>we did</b> rehearse several times and also re-recorded the presentations if the original quality was poor. <b>We will take this feedback forward for future events.</b>
<b>You would have liked more diversity in the presenters</b>	Look at all options across the team to increase range of diversity in the presenters – offering support and training for those that may not be comfortable presenting	For FES 2021 <b>we did</b> use a diverse range of presenters from different backgrounds. The presenters represent the diversity we have in our team. We aim to ensure that the people most relevant in our team are presenting as this will deliver the best outcome for the viewer. Diversity in our team and across the ESO is important to ensure varied perspectives, creativity, faster problem solving and employee engagement.

<b>You would like greater interaction between stakeholders during the launch event and other virtual engagement</b>	Investigate other options available to us for hosting virtual engagement on a platform that allows for stakeholder interaction	For FES 2021 <b>we did</b> use additional functions of the online platform to provide interaction – this included Sli.do for Q&A and hosting virtual network sessions.
<b>You would like greater length of time in between each of the deep-dive sessions during the launch week</b>	Look to increase the amount of time in between each session to allow more break time for future launch events	For FES 2021 launch week, <b>we did</b> allow for 15 minutes break between each session. <b>We did</b> also provide all events from the week on catch-up to provide flexibility.
<b>You would like the interactivity in the main FES report and FESin5 to work on all devices</b>	Work with our service provider to ensure that interactivity of the documents works on all devices	Our design agency was in the process of developing PDF software that would allow the popular interactive elements of the main document to work on tablets and mobiles. However, it was considered too much of a delivery risk and so a tablet-compatible version was produced. Specifically, to recognise this limitation, <b>we did</b> directly publish FES content on the website for the first time to allow a more mobile / tablet-friendly alternative.
<b>In the FES in 5 document, you would like to know when each scenario will achieve net zero</b>	Look to include this detail for the 2021 FES in 5	The 2021 FES in 5 included the dates that each of the scenarios met the net zero target (as well as a chart showing the trajectory between 2020 and 2050).
<b>You would like the online survey tool to be easier to navigate and complete with options to move back and to save responses</b>	Seek to find a better alternative to ask the questions and gather feedback for any future online Call for Evidence engagement. We will also carry out a full review of the Call for Evidence to establish if it is still fit for purpose	For the FES 2021 Call for Evidence, <b>we did</b> change the format to use MS Forms making navigation easier and ensuring all questions were visible.
<b>You would like to have an agenda and questions in advance for meetings</b>	Ensure that all stakeholders that attend meetings are sent the agenda, pre-read material and questions to be asked in advance to help manage expectations	For FES 2021 <b>we did</b> share in advance of the meeting with stakeholders the key points to be discussed and the reason for the

<p><b>You would like the meetings to be timed and structured better to allow opportunities to discuss more detailed subjects.</b></p>	<p>Ensure that all stakeholders that attend meetings are sent the agenda with timings and any pre-read in advance to help manage expectations.</p>	<p>engagement. This feedback will also be taken forward for FES 2022 and beyond to ensure stakeholders are well informed prior to any engagement.</p>
<p><b>You would like us to publish our sources and supporting evidence used in the scenarios</b></p>	<p>We will consider publishing the sources we use and the contributors that have fed into the scenarios for FES 2021 – noting potential confidentiality and regulatory restrictions.</p>	<p>For FES 2021 <b><i>we did</i></b> publish a breakdown of the stakeholder categories that provided feedback for the scenarios, however this <b><i>did not</i></b> include the individual sources or evidence. This is something <b><i>we will consider for FES 2022.</i></b></p>

## J. Review of our actions and commitments for FES 2021

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>The impact of Covid-19</b>	Covid-19 has had a direct impact on demands over the summer. We saw demands start to recover as lockdown lifted – and the most recent lockdown and tiering systems are less severe than the first. Covid-19 will have an impact on day-to-day life in the short term although the long term is harder to predict.	Continue to review data whilst we are creating FES 2021.	Short term impacts to the scenarios in the short term, longer term impacts being considered.	<i>FES 2021 included a specific section at the start of the document to provide the background assumptions around COVID-19 that underpinned the analysis.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Net Zero</b>	In terms of how we flex non-energy aspects such as land use changes or aviation across the scenarios, most respondents agreed that our existing approach was appropriate.	Noting the interest in this area we held a dedicated stakeholder workshop on the subject.	The workshop involved a number of different stakeholder views. However, there was a consensus that we could consider flexing these non-energy aspects more across the scenarios and conducting sensitivity analysis where appropriate.	<i>We flexed the emissions from non-energy aspects of FES. We also showed a more disaggregated view of emissions by sector so the level of flexing could be easily identified.</i>
	On negative emissions, there was support for the use of BECCS (whilst noting	Noting the divergence of views and uncertainty in this	The workshop involved a number of different stakeholder views. However, there was a consensus	<i>We reduced the negative emissions produced from</i>

	the importance of sustainable biomass and regulation of the whole carbon lifecycle) as well as other negative emission approaches. However, there was also clear feedback that FES 2020 was perhaps too reliant on BECCS.	area, we held a dedicated workshop on the subject.	that while BECCS in the power sector was an important element of net zero, there are other options that should also be considered and so we will review this area and provide more of a range of options across the scenarios.	<i>BECCS for power in Leading the Way, we also added DACCS to that scenario as an alternative negative emission option.</i>
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Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Industrial and commercial demand</b>	What occurs in these sectors with respect to future growth, decarbonisation and energy efficiency is directly dependent on long term, effective, policies, incentives, trade agreements and cross border markets. There is a very wide range of potential outcomes.	Review the energy efficiency assumptions in FES 2021, as well as the economic modelling carried out for FES.	A range of electricity, gas, hydrogen, and biofuel demands for industrial and commercial energy demand	<i>Energy efficiency and economic modelling were reviewed, and the results fed into FES 2021.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Heat in buildings</b>	Energy Efficiency: The balance of views on the level of building efficiency assumed in FES 2020 is that the high case scenarios are much higher than the current evidence supports.	Continue to ground our assumptions on the latest available evidence and redouble the effort checking them with key stakeholders. We will also be using a bottom-up modelling approach to optimize uptake of insulation and storage.	More balance between level building level efficiency and scenario technology mix based on cost minimization. Potentially higher fuel consumption levels.	<i>As a result of the updated analysis in this area, the energy efficiency assumptions for Consumer Transformation were reduced to be closer to those in System</i>



				<i>Transformation (i.e., less like Leading the Way).</i>
<b>Heat in buildings</b>	Hybridization/backup heating: There is a wider variety of heat pump usage configurations in use than has been captured in FES 2020. The use of back up heaters in heat pump installation designs for example is area that could be improved.	Consider wider range of heat pump configurations, including the extent to which back up heating might be required to support demand in cold winter days.	More hybrid technologies in both on-gas and off-gas dwellings.	<i>FES 2021 included significantly more heat technologies that previous publications – partly as a result of the new spatial heat model that was used for the first time.</i>
<b>Heat in buildings</b>	Technology mix representativeness: Stakeholders appreciated the wide range of technologies being considered in the scenarios. They want FES to continue to be technology agnostic especially within individual technology segments e.g., heat pumps.	Use more bottom-up approaches to projecting technology uptake based on whole building heat cost minimization.	Changes in technology mix within the scenarios and potential impact on the range of fuel use across the scenarios.	<i>The new spatial heat modelling allowed the analysis for FES 2021 to be built on “bottom up” assumptions for the first time.</i>
<b>Heat in buildings</b>	Consumer impact: Stakeholders would like FES to better demonstrate the cost impact of heat decarbonization on consumers.	Use more bottom-up approaches to projecting technology uptake based on whole building heat cost minimization. Illustrate with examples average cost of the different technology options. Consumer cost of various technology types will be included in the new heat model, along with assumptions of any potential grants.	Changes in technology mix within the scenarios and potential impact on the range of fuel use across the scenarios. Using the specific consumer costs within the modelling based on varying assumptions across the scenarios.	<i>Again, the introduction of the new spatial heat model allowed consumer cost impact to be modelled more directly and led indirectly to the new consumer behaviour assumptions around reducing required temperature at peak times.</i>
<b>Heat in buildings</b>	Regional approach: Mandating the end of gas boilers use will be difficult to implement	Adopt a new spatial heat model recently developed as part of an NIA project to better define local	Better delineation of regional differences in heat technology uptake.	<i>The new spatial heat model was used in</i>

and a local approach that gets consumers, communities, local authorities, GDNs, DNOs, and DSOs working together on heat decarbonization is seen as the surest way to both get buy-in from consumers and achieve the best whole system outcomes.	variations in heat decarbonization solutions.	<i>the FES analysis for the first time.</i>
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Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Transport demand</b>	Feedback on our uptake rates for low carbon road transport was balanced, with no strong consensus emerging on potential changes. However small changes in assumptions can significantly change energy demand, particularly levels of automation, number of vehicles and miles travelled.	In the absence of significant evidence on future driving trends and wide range of uncertainty on automation, we will leave the general themes from FES 2020 unchanged.	Overall transport uptake projections will remain largely unchanged.	<i>Overall transport uptake projections remained largely unchanged.</i>
<b>Transport Demand</b>	<p>Energy consumption figures for road vehicles appear to be too low.</p> <p>The Department for Transport (DFT) has recently updated its EV energy consumption assumptions from 0.15kWh/mile to 0.22kWh/mile. The modelling does not appear to correctly include</p>	<p>Update our energy consumption assumptions for road vehicles using the most recent DFT information.</p> <p>Update our modelling to include charging and discharging losses.</p>	<p>Increased energy demands from road transport compared to FES 2020 on a like-for-like basis, both on an annual and importantly, <i>peak</i> basis. Smart charging, Vehicle to Grid and adoption of EV in the period to 2030 reduces the impact of this change.</p> <p>Increased energy demand from road transport, compared to FES 2020 on a like-for-like basis.</p>	<i>This change was made for FES 2021. It continues to be an area that we review regularly as it can have a large impact on the energy system.</i>

	battery charging and discharging losses.			
<b>Transport Demand</b>	Vehicle to Grid – there is a wide range of outcomes – it could be very significant or insignificant going forwards depending on customer appetite and commercial frameworks in the energy market.	Retain the range of V2G assumptions we have from FES 2020	Overall V2G assumptions will remain largely unchanged.	<i>Overall V2G assumptions remained largely unchanged.</i>
<b>Transport Demand</b>	The government has recently indicated its ambition to ban the sale of new petrol/diesel cars from 2030 – FES 2020 has a projected date between 2032 and 2040.	The 2030 target will be reflected in the FES 2021 scenarios.	The 2030 target will be reflected in the FES 2021 scenarios, although it should be noted that this target is not yet in law and there is a range of possibilities on what this ban will do in the second-hand vehicle market, and therefore electric vehicle uptake.	<i>The main FES document included an infographic setting out which targets were met in which scenarios.</i>
<b>Transport Demand</b>	Maritime and Aviation demand are subject to international agreements. What occurs with our nearest neighbouring countries could also be different.	Continue to monitor developments on alignment between EU and UK maritime and aviation decarbonisation policies and guidance from CCC	Overall aviation and maritime demand assumption will remain largely unchanged.	<i>Overall aviation and maritime demand assumption remained largely unchanged.</i>
<b>Transport Demand</b>	Hydrogen will play a key role in decarbonising aviation & shipping, as well as other heavy transport, including rail. Hydrogen use for transport will likely coincide with hydrogen use in other sectors e.g., industrial and building heating.	We will continue to consider hydrogen use in heavy transport and aviation & shipping across the scenarios, taking guidance on demand from stakeholders such as the CCC. In addition, we will consider hydrogen use in cars	Hydrogen use in HGVs would remain largely unchanged with likely faster rate in uptake. An increase in hydrogen use for cars in scenarios with high hydrogen availability.	<i>These changes were made.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Overall electricity demand (excl. EV's)</b>	<p>Energy efficiency assumptions are more ambitious than those assumed by other parties – as a result energy demands are also lower than other projections.</p> <p>Whilst desirable, improved home insulation continues to be expensive and disruptive to install.</p>	<p>Review our energy efficiency assumptions in all areas – industrial and commercial processes, building insulation and heating technologies, and residential appliances.</p> <p>Review our assumptions against the UK Government's "10 Point Plan" on tackling climate change.</p>	We will review the data and make changes – it's too early to say what the outcome will be as the modelling is not complete.	<i>Changes made in relation to energy efficiency assumptions brought FES energy demands closer to other projections.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Electricity generation</b> Overall mix	<p>From our Call for Evidence, it is evident that our stakeholders strongly feel that wind energy, particularly offshore wind, will be dominant by 2050. This would then be supported by solar and nuclear power.</p> <p>While storage was also seen as a key technology to support system flexibility.</p>	This feedback is broadly in keeping with our scenarios in FES 2020. We will continue with wind dominated scenarios but will look at a wider range in some of the technologies that saw less support (e.g., BECCS for power generation).	Our generation mix as presented in the FES report and the accompanying data tables.	<i>Wind capacity increased in FES 2021 relative to FES 2020.</i>
<b>Electricity generation</b> Floating wind	Explicitly show floating offshore wind within the FES scenarios.	We will look to split out floating offshore wind within the datasheets.	Data tables provided alongside the FES document.	<i>Whilst floating wind was explicitly included in the results (e.g., SV.28), it was not split out in the Data Workbook. We</i>

				<i>will focus on ensuring this split is provided for FES 2022.</i>
<b>Electricity generation</b>  Steady Progression	In light of recent announcements including the 10-point plan, we will review the level of ambition within the Steady Progression scenario.	The generation mix will be reviewed to see if a lower carbon intensity now reflects the edge of the credible boundary. Whilst it is too early to say exactly what changes will be made, we are considering options such as increased offshore wind and Gas CCS.	A change in the generation mix in Steady Progression and reflected within the data tables and charts published alongside FES. Lower overall carbon intensity.	<i>More renewable capacity was included within Steady Progression and this, alongside CCUS in the later years of the scenario, meant that carbon intensity reduced in FES 2021 relative to FES 2020.</i>
<b>Electricity generation</b>  CCS	A wider range of BECCS for power generation should be explored within our Net Zero scenarios.  CCS could be applied to Energy from Waste (EfW) generation capacity.	We will review the range of Negative Emissions Technologies available assessing options against the scenario framework. The location of EfW sites will be reviewed and those close to proposed CCS hubs will be treated as candidates for CCS abatement.	A potential broader range of CCS within the generation mix as shown in the data tables published alongside the FES document.	<i>CCS range broader in FES 2021 than in FES 2020.</i>
<b>Electricity generation</b>  Load factors	Examine the offshore wind load factors used within the FES scenarios in light of new offshore wind generation technologies	Work with offshore wind developers to improve offshore wind load factors used within the FES modelling.	Improved accuracy of load factors in all scenarios.	<i>Results of load factor review fed into FES 2021.</i>
<b>Electricity generation</b>  Storage	Examine the quantity of long duration electricity storage in FES	We will look at the quantity of long duration storage to see if it is economically feasible to increase.	In scenarios that require high levels of flexibility, this will increasingly be provided by long duration storage.	<i>We increased the maximum volume of electrical storage in 2050 from 167 GWh to 203 GWh. In addition, hydrogen</i>

				<i>storage was included in the net zero scenarios to allow hydrogen to be used to provide inter-seasonal flexibility to the electricity system (i.e., via electrolysis, hydrogen storage and hydrogen generation).</i>
<b>Electricity generation</b> Interconnectors	We received some observations about the time required to build a new interconnector evidenced by some of the recent long-distance interconnectors.	Update our interconnector model to use the latest project timelines and risk mitigation solutions.	With updated information our internal model should produce better estimates and require less manual adjustment.	<i>Results of detailed review fed into FES 2021 interconnector analysis.</i>
<b>Electricity generation</b> Gas	Stakeholder had a wide range of views on the future role for gas. It was suggested that sites that remain open will see decreased operating hours. Some felt that unabated gas should be retired as early as 2030. The CCC have suggested 2035 subject to security of supply.	Continue to review the role of gas power stations in light of net zero targets. Particular attention will be paid to the phased reduction of unabated gas as we move to a renewable dominated power sector.	Changes in our generation mix as presented in the FES report and the accompanying data tables.	<i>Leading the Way reduced unabated gas capacity significantly so that only a very small amount remained on the system post-2035. The other net zero scenarios included more unabated capacity past 2035 but this capacity operated at a very low load factor.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Bioresource</b>	Should consider having a breakdown of total bio resources into different feedstock categories.	We will consider adding bio resources level for each scenario by different bio form such as wood pellet, energy crop and waste.	Additional output for each scenario including bio resources level breakdown by different bio form such as wood pellet, energy crop and waste.	<i>An infographic setting out the different types of bioresource was included in the main FES 2021 document.</i>
	Should reduce the reliance on BECCS to achieve net zero	We will explore additional negative emission technologies and solutions to help reduce the reliance on BECCS and achieve net zero.	Potential for wider range of negative emission approaches across the scenarios.	<i>As noted above, a wider range of negative emission solutions were applied in FES 2021 relative to FES 2020.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Gas supply</b> Shale	Opinion is divided regarding the future of shale gas production, and whether it is consistent with net zero scenarios.	Consider the feedback carefully, and objectively assess how (UK) shale gas may contribute to the gas supply mix in each scenario.	Including indigenous shale gas production where framework assumptions make this a credible option.	<i>Shale gas was only included in the Steady Progression scenario for FES 2021.</i>
<b>Gas supply</b> Interconnectors	Interconnectors have the potential to support the growth of the UK hydrogen production industry by providing a route into the European market.	Consider the possibilities of interconnectors importing and / or exporting hydrogen to and from the Continent.	Potential re-purposing of existing interconnectors.	<i>The transition from natural gas to hydrogen for the interconnectors was considered at a high level in FES 2021 and varied by scenario (e.g., in LW there was specific modelling of hydrogen imports).</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>System flexibility</b>	Include hybrid interconnectors with the scenarios.	Examine new interconnectors and consider whether they will be hybrids.	Any changes to our interconnector modelling will be set out in detail in the FES report and the accompanying data tables.	<i>As set out in the FES 2021 Key Message #2, offshore coordination will be very important to accommodate the levels of offshore wind capacity and hybrid interconnectors are likely to be part of this.</i>

Theme	Feedback and insight gathered:	We will:	Shown in scenario through:	Updated: What we did for FES 2021:
<b>Hydrogen</b>	Should consider hydrogen from nuclear as a production method in various forms i.e., Low temperature, high temperature, thermochemical. Potential for it to be cost competitive with other production if technology reaches maturity quick enough and there is policy support.	We will consider adding hydrogen from nuclear in varying levels to the scenarios.	Potential for one or more of the scenarios to include hydrogen from nuclear.	<i>Hydrogen from nuclear was included in FES 2021 in the Consumer Transformation and System Transformation scenarios.</i>
	Policy support is one of the most important factors for any production method and across the whole industry	We will consider bringing the importance of policy support out into the scenarios more in FES 2021.	Consider spotlight on hydrogen policy.	<i>Spotlight not included due to hydrogen policy outlined in Energy White Paper and Hydrogen Strategy.</i>



i.e., storage, transportation, demand.

There is opportunity for both blue and green hydrogen production in the UK. Blue is generally seen as something that could offer the short-term scale up

In the scenarios a mix of blue/green hydrogen production will be considered. There will be a consideration of the timing of each technology scaling up.

Mix of sources of hydrogen across the scenarios.

*The FES 2021 scenarios included a range of applications of blue and green hydrogen (in addition to imports, biomass gasification and hydrogen from nuclear).*

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