NORTHERN POWERGRID

Distribution Future Energy Scenarios

Facilitating decarbonisation and forecasting future network requirements

December 2019

We distribute power to 3.9 million homes and businesses through our network of more than 64,000 substations, over 96,000 kilometres of overhead lines and underground cables, spanning almost 25,000 square kilometres.

Contents

Introduction
Foreword

Electricity networks are key to achieving decarbonisation goals. We are therefore presenting our Distribution Future Energy Scenarios (DFES) using an open data approach to engage with our stakeholders and seek your feedback to help us plan our network for future developments in our region. This will enable us to deliver the services and infrastructure our stakeholders require to fulfil their ambitions and plans for the future.

Energy networks have a central role in the decarbonisation of the economy and have, up to now, been working on scenarios to model the network requirements to achieve the 80% reduction of greenhouse gas emissions by 2050 under a range of possible pathways.

However, a lot has happened in the last year, since the Intergovernmental Panel on Climate Change special report, published in October 2018[1], highlighted that the world is not on track to limit global warming to less than 1.5°C above pre-industrial levels.

This report triggered a year of global climate change activism with widespread civil protests, including school strikes which, together with the report, resulted in a significant shift in political thinking to take action. In June, the UK displayed global leadership by adopting a net zero carbon target, which has now been enshrined in law via an amendment to the Climate Change Act 2008.

Local action is already being taken. In our region alone, approximately 80% of the local authorities have now declared a climate emergency, seven have introduced or are introducing Clean Air Zones and around two thirds have adopted or are aspiring to adopt net zero targets ahead of 2050. These aspirations need to be backed up by accelerated plans to encourage switching to non-fossil fuel alternatives.

We are already seeing significant decarbonisation of generation – the growth of renewable energy resources connected directly to our networks has been rapid and we are rolling out more active management of our network to enable the connection of even more. Whether this decarbonisation target is achieved by 2050 will depend upon the decarbonisation of generation, heat and transport. More broadly, our actions to facilitate this societal decarbonisation are set out in our plans for the transition to the role of Distribution System Operator (DSO)[4], which will see us actively manage the network in real time to balance supply and demand locally, optimising the system to deliver low-carbon energy at the lowest cost to customers.

We are therefore actively seeking engagement with our stakeholders to learn about local aspirations and plans for decarbonisation in the region. We hope that this can be facilitated by the publication of our DFES, which explains the scenario-based approach we take to inform our network planning.

Our publication consists of this summary document, together with an online visualisation tool[2] and the accompanying data behind the tool, which is available as downloadable datasets, presented in an open and accessible format on the website of the Data Mill North[3]. In this document, we share our forecasting methods and give insight into the underlying assumptions that we have used to model the potential impact that different decarbonisation pathways would have on our network.

We welcome all views on the data presented and will take your feedback into account when adjusting our forecasts for the new net zero ambitions.

We are particularly interested in your views on the growth of low-carbon technologies (LCTs) relative to the forecasts in our DFES and would welcome any information that you can provide on initiatives that you are planning to implement locally to support the journey to net zero in our region. In *Our questions to you* section (page 18), we provide opportunities for you to provide both qualitative and quantitative feedback and would welcome your views before **31 March 2020**.

We will be holding engagement events in Q1 and Q2 2020 to provide support during the process and to discuss your views.

We expect to continue to require a scenario-based approach and it will be our job to develop an investment plan that is flexible to facilitate the target, whichever pathway emerges as the front runner to deliver net zero carbon emissions.

Energy networks have a central role in the decarbonisation of the economy and have, up to now, been working on scenarios to model the network requirements to achieve the 80% reduction of greenhouse gas emissions by 2050 under a range of possible pathways.

[1] Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Available from: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf
[2] Find our visualisation tool here: https://odileeds.github.io/northern-powergrid/
[3] For more information, refer to: https://datamillnorth.org/
[4] Read our DSO v1.1 Development plan document at: https://www.northernpowergrid.com/asset/0/document/5139.pdf

About Northern Powergrid

Northern Powergrid is responsible for the electricity network that keeps the lights on for 8 million customers across the Northeast, Yorkshire and Northern Lincolnshire.

Our dedicated team, of around 2,700 employees, operates 24 hours a day, 365 days a year – no matter what the circumstances – to maintain a safe, reliable and efficient electricity supply.

We are responsible for over 96,000 kilometres of overhead power lines and underground cables, spanning c. 25,000 square kilometres, and 63,808 substations:

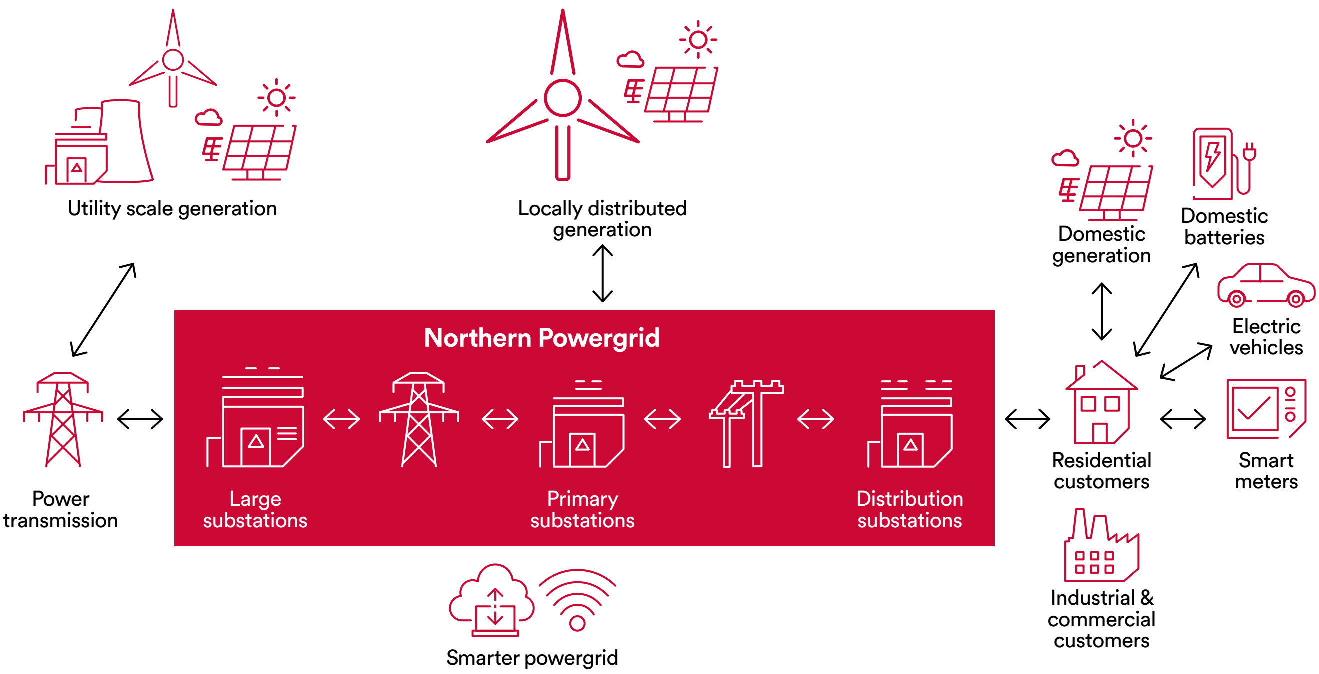
- 122 large substations (42 grid supply points and 80 supply points)
- 552 primary substations
- 63,134 distribution substations.

The amount of revenue that we recover from our customers is defined by Ofgem through a price control review process. The current eight-year price control period is called RIIO-ED1, and lasts from 2015 to 2023[5]. A proportion of the money our customers pay as part of their electricity bill (approximately £80 per year) comes to us to cover the cost of operating the network.

We are already actively planning for the RIIO-ED2 period, which will run from 2023 to 2028. RIIO-ED2 will see a period of significant change as the nation gears up to transition towards net zero carbon by 2050 and as we continue our transition towards being a DSO.

Our regional structure enables our teams to best serve the local needs of our customers.

Where we fit in the electricity industry



[5] For more information, refer to: ofgem.gov.uk/network-regulation-riio-model/riio-ed1-price-control

Purpose of this publication

We are continuously developing our scenario-based forecasting approach to manage the substantial uncertainty associated with the rate of uptake of different low-carbon technologies and are seeking your views as part of the process.

Background

Many of our regional stakeholders are setting out plans to meet the legally binding net zero greenhouse gas emission target and most local authorities in our area have declared a climate emergency.

A big part of delivering net zero involves the decarbonisation of heat and transport, which could mean a profound increase in electricity demand. However, the network impacts are difficult to predict due to uncertainty of the location and the rate of technology (such as electric vehicle (EV) and heat pump) uptake, coupled with additional uncertainties over customer behaviour – for example, the location, timing and speed of EV charging.

This uncertainty requires us to consider several scenarios in order to determine and model the future range of potential network impacts.

What are DFES and why have we published them?

Our DFES present a number of pathways for the decarbonisation of generation, transport and heat. They present our underlying assumptions and the potential network impacts. To maximise access to this information, and to enable regional collaboration, we have published the DFES in an open data format, facilitated by the Leeds Open Data Institute (ODI). The full DFES publication consists of:

- this orientation document;
- an online visualisation tool[6]; and
- downloadable data sets[7].

Who is it for and what are the benefits?

We are publishing this document, and the data associated with it, to consult with our stakeholders and seek your views on the pathways presented. We hope this will allow us to arrive at a baseline planning forecast that will help us to plan for and to meet the future energy needs of our region.

How to provide feedback?

We are interested in your feedback on any of the forecasts in our DFES. We have provided simple feedback forms and spreadsheet templates[7] to give you options on the level of information you are able to provide. Follow-up face-to-face engagement events will be held to discuss your plans and opinions.

We are particularly interested in the following aspects:

- whether you have your own projections for any of the key parameters in our DFES;
- details on any local initiatives that you are putting in place to drive the uptake that you are forecasting for any of the parameters; and
- whether your plans align with any one of the scenarios in our DFES.

We invite qualitative and quantitative feedback and are keen to receive any information you can provide from your own forecasts.

Our network has seen:

4.4GW
of generation export capacity connected, c. 60% renewable

16% (1.1GW)
reduction of net peak demand in the last decade

51%
more EV charging points installed during 2018-19, compared to previous year

x15
more EVs registered in Q2 2019 compared to five years ago

[6] See our visualisation tool here: https://odileeds.github.io/northern-powergrid/
[7] Download our data behind the visualisation here: https://datamillnorth.org/dataset/northern-powergrid-dfes

Distribution Future Energy Scenarios
Our approach

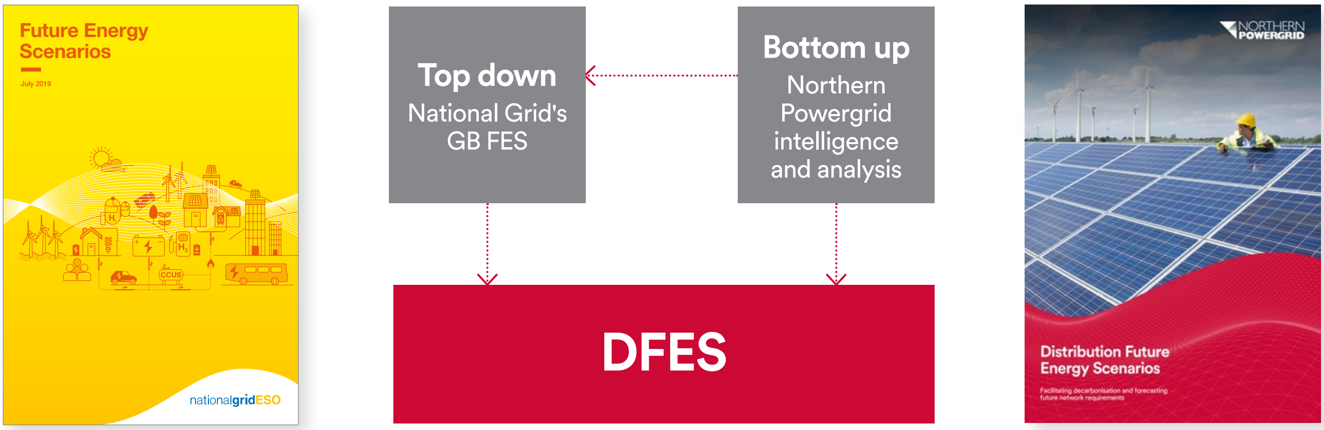
We use scenarios on the uptake of low-carbon technologies to model a range of credible potential future electricity demands in our region. We currently invest over £326m per annum in our network. Feedback on DFES will inform our investment plans for RIIO-ED2, which will require decisions on the required mix between future flexibility service requirements and expenditure on network development.

Transmission and Distribution Network Operators have been collaborating[8] through industry working groups on a common language for sharing their future energy scenarios. That means that the decarbonisation plans of stakeholders in our region can be expressed in a format that enables easy feedback into transmission and distribution network future planning.

National Grid Electricity System Operator (ESO), in conjunction with the Distribution Network Operators (DNOs), produces the Future Energy Scenarios for the whole of Great Britain (GB FES) from a transmission network perspective. The GB FES are not forecasts; instead, they allow the exploration of different future pathways, and provide a vehicle for discussion.

Northern Powergrid works with the ESO to help them develop GB FES. In addition, we have developed our own forecasting model that can take the GB FES and use this data to develop our DFES, which:
- gives us a range of credible pathways for the uptake of LCTs in our region;
- models the impact on the distribution network; and
- signals locations where we may need to develop intervention options to avoid network constraints.

Figure 1: A high-level explanation of our DFES process



[8] More information about the common language and basic building blocks being used in the industry for FES collaboration can be found at: http://www.energynetworks.org/assets/files/P5%20Whole%20System%20FES%20Report%20vPublished.pdf

Whilst having the same names as in the GB FES to aid understanding and comparison, the four scenarios in the DFES are Northern Powergrid's view at a more local level.

The four scenarios in GB FES represent different assumptions for the increase of renewable generation connected to the distribution networks and the rate of decarbonisation through the uptake of alternatives to fossil-fuelled transport and heating[9].

The Two Degrees and Community Renewables scenarios have modelled the pathway to achieve the previous Climate Change Act 2008 target (of 80% emissions reduction against 1990 baseline) by 2050.

The net zero target therefore would entail going over and above the assumptions in these scenarios.

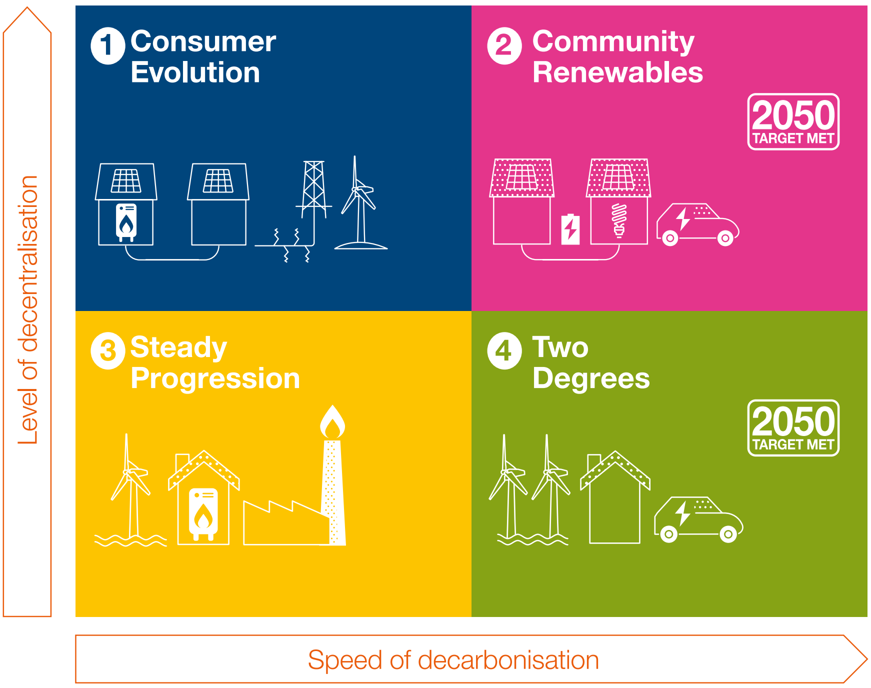
We have standardised our approach to use the same building blocks as other DNOs and the ESO.

A summary of the building blocks underpinning these scenarios can be found in Annex 1. More information about these scenarios and their underlying assumptions can be found in National Grid's 'Future Energy Scenarios' document[10].

Our DFES present a local level view for each of these scenarios, including:

- underlying assumptions on the growth of LCTs connected to 552 major (primary) substations and also aggregated to the 39 local authority areas; and
- the impact on our electricity distribution network presented as:
  - energy requirements at each primary substation and also aggregated to local authority level; and
  - peak demand and utilisation (%) at each primary substation (with two separate assumptions on customer flexibility).

Source: ESO Future Energy Scenarios 2019 fact sheet



1 In Consumer Evolution, there is a shift towards local generation and increased consumer engagement, largely from the 2040s.

2 In Community Renewables, local energy schemes flourish, consumers are engaged and improving energy efficiency is a priority.

3 In Steady Progression, the pace of the low-carbon transition continues at a similar rate to today but then slows towards 2050.

4 In Two Degrees, large-scale solutions are delivered, and consumers are supported to choose alternative heat and transport options to meet the 2050 target.

[9] More details on the scenarios can be found from the National Grid FES web pages: http://fes.nationalgrid.com/
[10] Available from: http://fes.nationalgrid.com/fes-document/

Our forecasting model produces a regional interpretation of the GB FES. This is built bottom-up by inputting key parameters of our electricity network into a scenario-based load growth model. Key input parameters include:

- the network topology;
- electricity substation half-hourly electrical data (demand and generation);
- substation locations and feeding areas (postcodes);
- annual consumption values for different profile classes; and
- connection counts by customer type – Domestic and Industrial & Commercial (I&C).

Furthermore, the model takes geospatially distributed starting year values as inputs for the parameters to be forecast, such as numbers of EVs and heat pumps, and capacities of connected distributed generation.

The modelling process (Figure 2) is informed by a range of data sources to distribute the GB FES values and growth rates for relevant building blocks across the region. This is done in accordance with the substation postcode inputs and other network information. These data sources include Experian Mosaic geographic data, local authority building stock projections, wind speed data, green space data, space heating information, and the load profiles for different customer archetypes and behaviour with respect to LCT usage, taken from research data such as Northern Powergrid's Customer-Led Network Revolution project[11]. The model was initially developed by Northern Powergrid and Element Energy as an innovation project part funded by the Network Innovation Allowance[12].

More details about how we have used this model to develop the DFES can be found in technical blogs on the Northern Powergrid Hub on the Leeds ODI website[13].

Figure 2: Our modelling process

Northern Powergrid data inputs

- Network topology
- Substation geographic information
- Customer numbers & types
- Peak demand data (kW)
- Energy data (kWh)
- Generation capacities

External data inputs compiled and input by Element Energy

- Experian Mosaic geographic data
- local authority building stock projections
- Various LCT uptake scenarios, including GB FES
- LCT & customer flexibility solution load profiles, e.g. learning from innovation projects
- Appliance efficiency data
- Data associated with distributed generation, e.g. wind speeds, green space
- Data associated with demand from LCTs, e.g. space heating, EV indicators

Load forecasting model

1
Processes Northern Powergrid inputs into monthly electrical loads (demand and generation) per substation

2
Maps the external data to each substation

Outputs

Northern Powergrid data outputs

- Load forecasts – with and without customer flexibility
- Generation forecasts
- Energy consumption forecasts
- LCT uptake projections (demand technologies)
- LCT uptake projections (distributed generation technologies)
- Energy storage uses
- Generation flows
- Network development strategies
- Potential sites for DNO-enabled customer flexibility

[11] For more information, refer to: http://www.networkrevolution.co.uk/
[12] The closedown report for the project (Improving Demand Forecasting) can be found at: https://www.smarternetworks.org/project/nia_npg_012/documents
[13] For more information, refer to: https://odileeds.org/projects/northernpowergrid/dfes/

Forecast overview

Uncertainty of LCT uptake

The peak electricity demand on the Northern Powergrid electricity distribution network has been decreasing over the last decade. We expect this trend to reverse over the next 10 years, mainly due to increased EV uptake.

Electricity demand seen on our distribution network has been steadily reducing due to increased uptake of energy efficiency measures and the growth of distributed generation (including wind and solar photovoltaic (PV)) connected directly to the distribution network.

Although we expect continued energy efficiency improvements, growing LCT uptake is likely to deliver an increase both in units distributed and in the electricity peak demand. We forecast that the total energy distributed (GWh) could increase between 30 and 37% by 2050 (Figure 3). The additional electricity demand could potentially exceed the capacity of the substations in some locations.

For example, Figure 4 shows the estimated breakdown of the peak demand at a particular substation under the Community Renewables scenario. Although we forecast a continued underlying improvement in energy efficiency in both the domestic and the industrial and commercial sectors, the peak demand on the network will start to increase with the deployment of heat pumps and EVs. In this example, peak demand could grow by 35% in the period to 2050.

Figure 3: Total annual electrical energy consumption projections

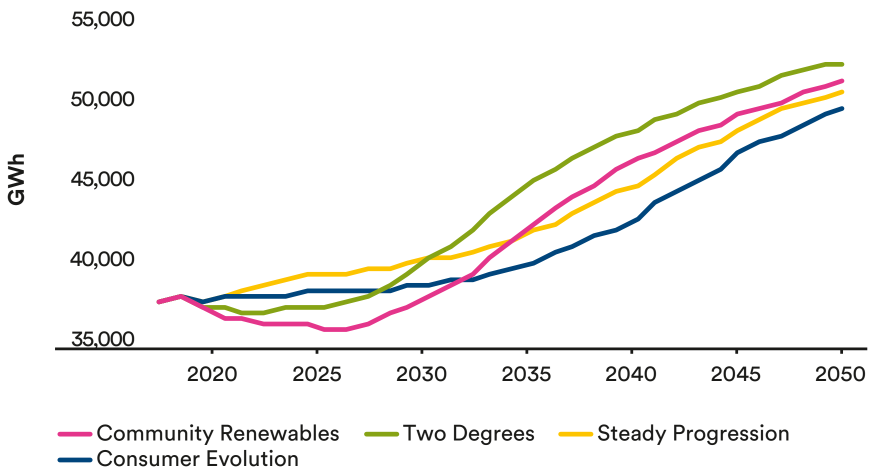
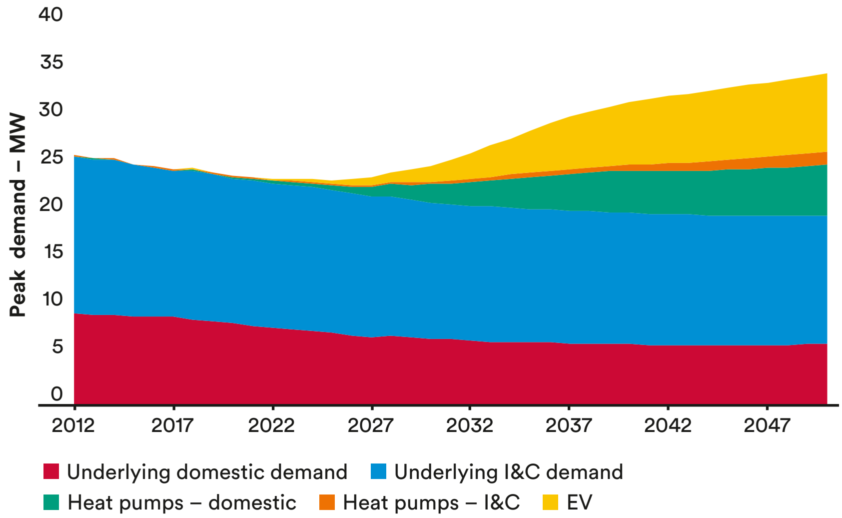


Figure 4: The potential peak demand growth under the Community Renewables scenario without customer flexibility for a typical primary substation (Hexham, Northumberland)



The range of LCT uptake projections introduce a significant forecast uncertainty. Figures 5 and 6 provide illustrative examples for EVs and residential heat pumps under each of the four scenarios. More examples can be found in Annex 2.

Figure 5: Electrical vehicle projections

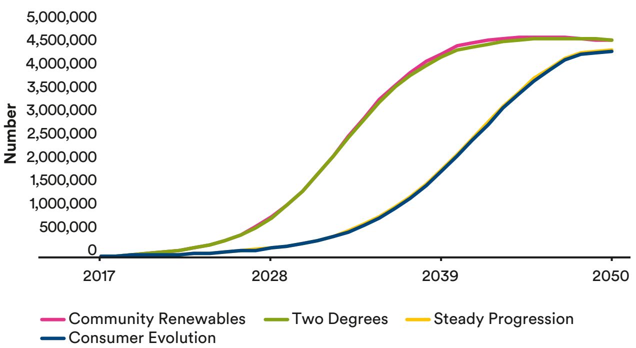
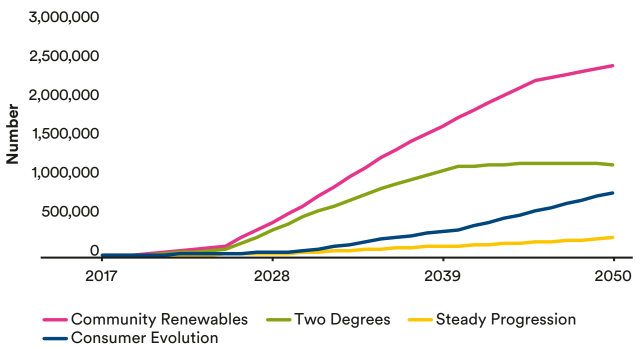


Figure 6: Residential heat pump projections



Impact of customer flexibility on peak network demand

Networks are designed to accommodate the peak demand. It is clear that electrification of heat and transport will affect the future network development needs. The extent of this impact will depend on customer flexibility, which has the potential to reduce the peak demand (Figure 7).

Our forecasting model has taken the GB FES view of the network impacts based upon the assumptions on customer flexibility for each scenario.

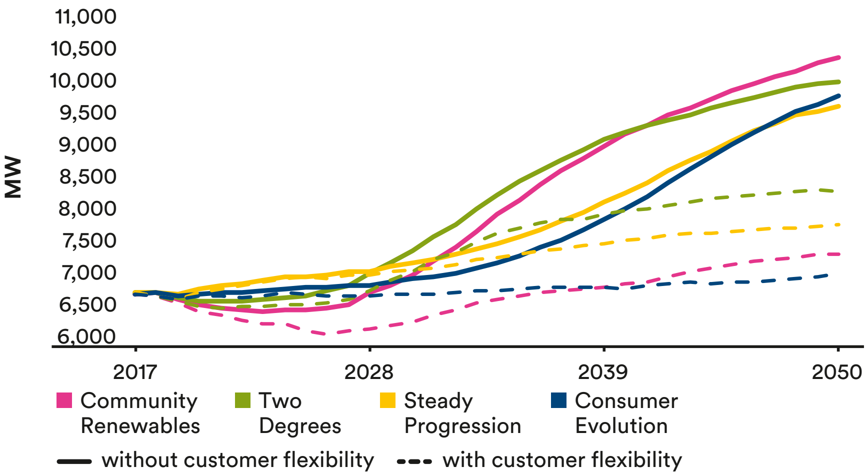
In addition, we have developed sensitivities to remove these particular assumptions to understand what the impacts would be if these market incentives were not delivered.

In the future, customer behaviour is likely to be influenced by market signals that will be either led by:

- the energy retailer, designed, for instance, to balance demand and generation to reflect the availability of local renewable generation; or
- the network operator (and potentially passed on by the energy retailer), designed, for instance, to avoid local network constraints.

The roll-out of smart meters at a large-scale, and the deployment of half-hourly settlement, will enable the availability and commodification of customer flexibility products.

Figure 7: Gross peak demand with and without customer flexibility



What we mean by customer flexibility in our forecasting model

Customer flexibility in this context means the customer's ability and willingness to shift their electricity demand or generation for a certain amount of time, in response to price signals originating from the retailer or the network operator.

For example, our modelling predicts a much lower peak demand (2-3GW difference in 2050) where EV owners respond to wholesale market signals. This flexibility could be delivered through a variety (or combination) of tools, such as:
- time-of-use tariffs;
- smart EV charging; and
- flexibility contracts.

Implications for network investment

We expect very little impact on our network during RIIO-ED1 (i.e. up to 2023). During this period, our scenarios are more tightly bunched, with some showing a continued reduction in peak demand whilst the growth of LCTs is not expected to significantly impact network capacity.

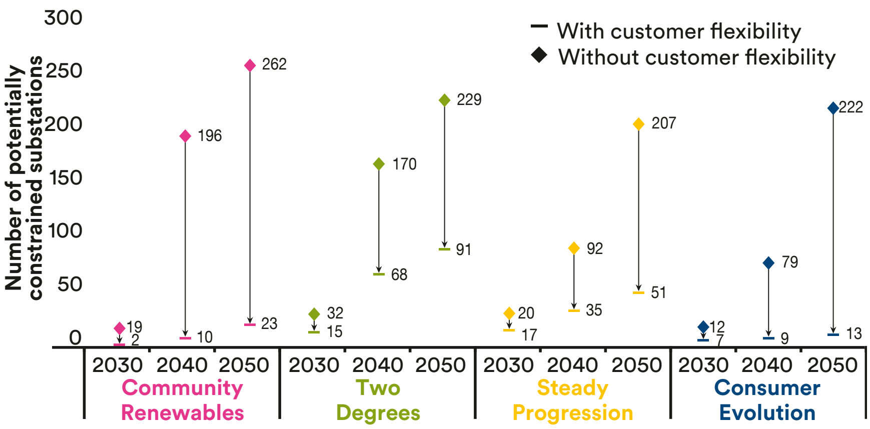
By the end of the 2020s, we expect a small number of our primary substations (less than 3%) to require intervention and we are committed to using flexibility wherever we can to avoid or defer investment, provided this is feasible and economic. This number increases to 5% if we assume that wholesale market customer flexibility signals are not sufficiently developed. More secondary substations are affected, but the impact is relatively small as a percentage of the asset population – less than 1% of pole-mounted and ground-mounted secondary substations could be constrained with customer flexibility, and 2% without.

In the 2030s, a significant increase in demand is expected, where EV uptake and electrification of heat are key drivers. This will have a varied impact on the peak loading of substations across the region due to differences in regional demographics. There is a high uncertainty about the effects on our network. Under the high-deployment scenarios, the number of potential constraint points could be in the hundreds for primary substations and in the thousands for our secondary substations, depending upon the level of uptake of time-of-use tariffs and smart charging. These sources of customer flexibility, particularly those exercised by EV drivers, could again have the potential to reduce the impact on system peak demand significantly, reducing the number of constraint points on the network.

The following figures show the estimated number of substation constraints (i.e. where demand exceeds capacity) in 2030, 2040 and 2050 for each scenario, with and without the customer flexibility assumed in the GB FES.

The diamonds at the tail of the arrows represent the number of substations with potential capacity issues without customer flexibility and the line at the tip of the arrow represents the significantly reduced number as a result of market-driven customer flexibility.

Figure 8: The impact of market-driven customer flexibility incentives on the forecasted number of primary substation constraints

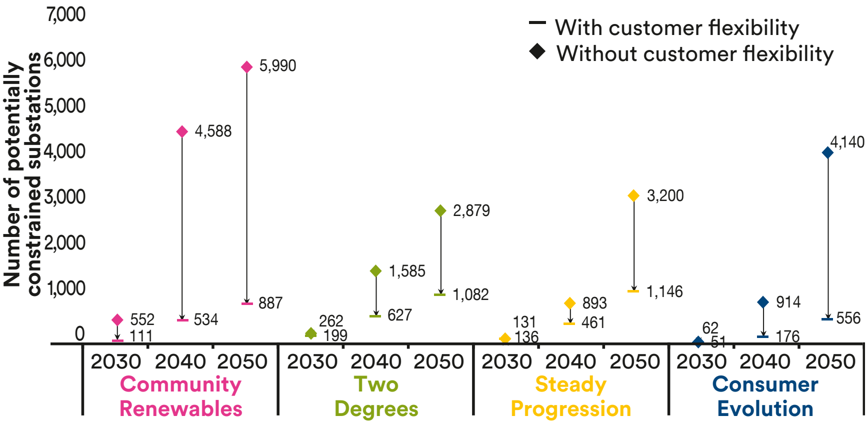


Visibility of future network constraints

Figures 8, 9 and 10 provide quantitative information on the number of substations potentially reaching full capacity under each scenario, on all of our network. You can access the detailed data by downloading the *Peak utilisation at primary substations* (with or without customer flexibility) spreadsheets from Data Mill North[14]. A utilisation rate of 100% for a substation means that the gross demand exceeds the declared capacity of the substation for a number of half-hour periods. This does not necessarily signal the need to invest (in network or non-network solutions); it is only an indication of the need to carry out a further assessment. For example, it may be possible to transfer the demand to an adjacent substation, or some of the peak demand might already be met by the generation connected to the network.

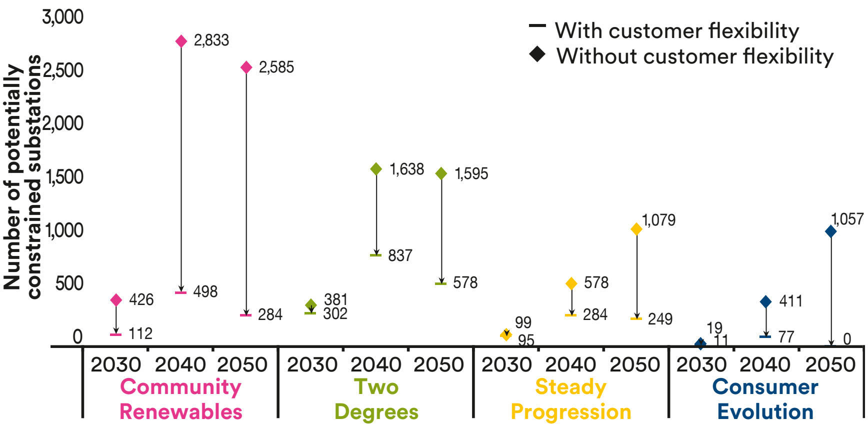
[14] Download our data here: https://datamillnorth.org/dataset/northern-powergrid-dfes

Figure 9: The impact of market-driven customer flexibility incentives on the forecasted number of ground-mounted secondary substation constraints



The impact of heat pumps as well as EVs drives the higher number of constraints in Community Renewables. Domestic PV is significant in both the Community Renewables and Consumer Evolution scenarios so any contribution it can make at peak times would reduce the high variation visible in the chart. The percentage of constraints in the ground-mounted secondary substation network reaches up to 4% by 2050 with customer flexibility (and no contribution from PV) but could reach 21% without it.

Figure 10: The impact of market-driven customer flexibility incentives on the forecasted number of pole-mounted secondary substation constraints



Pole-mounted secondary substations are mostly located in rural areas. The percentage of constraints in the pole-mounted secondary network is less than 2% by 2050 with customer flexibility (and no contribution from PV) but could reach 8% without customer flexibility.

Planning to achieve net zero

Our forecasts are currently based upon the GB FES which contain two pathways to achieve the 80% emissions' reduction by 2050. The key task this year, following the amendment of the target to net zero, is to work with our regional stakeholders and with National Grid to develop a set of scenarios that provide a pathway to net zero.

These scenarios and their associated pathways will be influenced by national, regional and local policies on facilitating LCT uptake, e.g. in association with local clean air aspirations and regional transport policies, etc.

Analysis of these pathways will enable us to forecast the potential locational impacts on the networks and we can then put plans in place to address these. These may be:

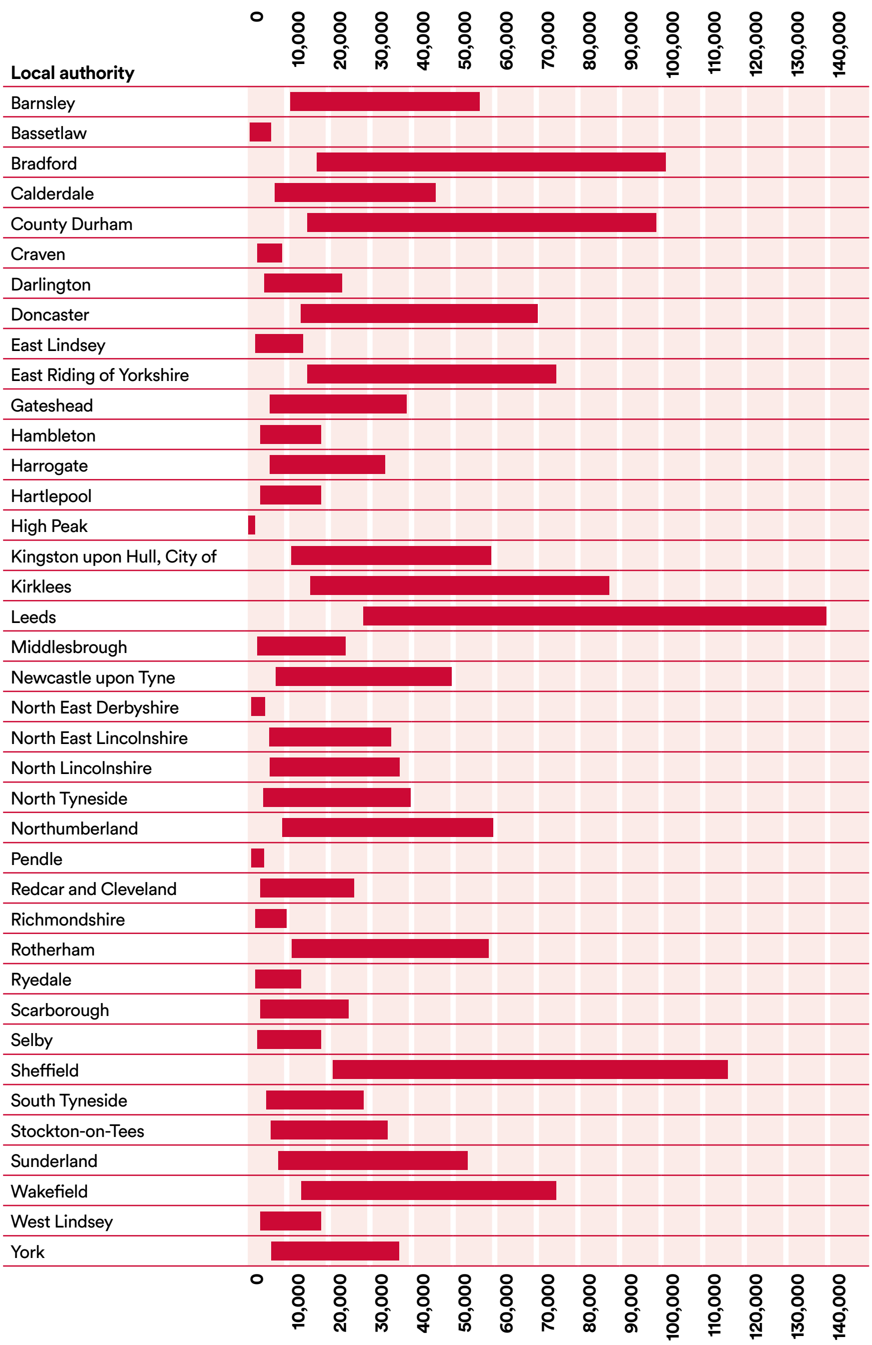
- working with suppliers to facilitate time-of-use tariffs;
- developing smart charging incentives;
- deploying flexibility services from distributed energy resources;
- targeted low voltage monitoring and network reinforcements; and
- targeted reinforcement of the high voltage and extra high voltage networks.

Different substations will be impacted differently, depending on the demographics of the connected customer base and the activities of the local authorities, both of which will have an impact on the rate of uptake of LCTs. As this document shows, there will still be great uncertainty on what are the pathways to achieve net zero.

As described in the previous sections and illustrated in Annex 2, the uncertainty around LCT uptake is huge. Figure 11 illustrates the range of EV uptake uncertainty across the scenarios for each local authority within our region for the period up to 2030.

We are seeking our regional stakeholders' views on their plans and expectations, particularly on any new initiatives being proposed to achieve net zero in the region we serve. The next section describes how you can get involved.

Figure 11: Potential range of EV uptake by 2030



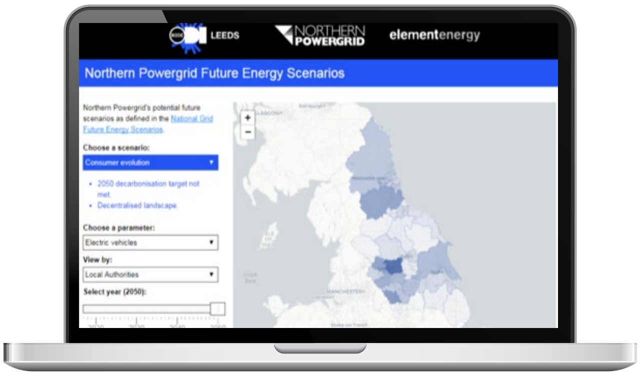
Provide your views
Access to the datasets

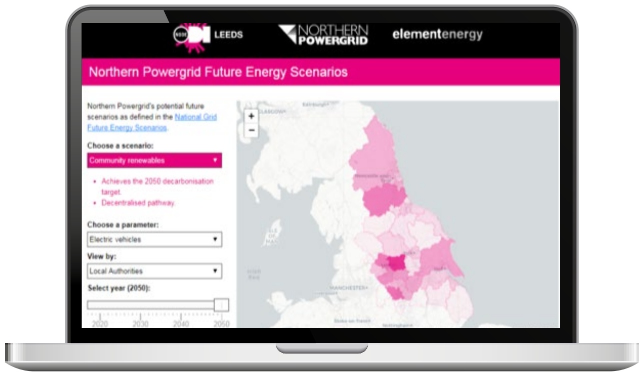
We have partnered with the Open Data Institute (ODI) in Leeds to facilitate a meaningful consultation with our regional stakeholders.

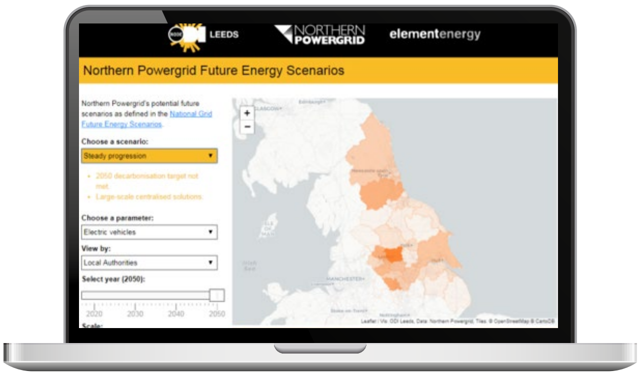
Alongside publication of our datasets on Data Mill North, we are keen to present the data in the way that is relevant to our stakeholders and enables them to explore the scenarios easily.

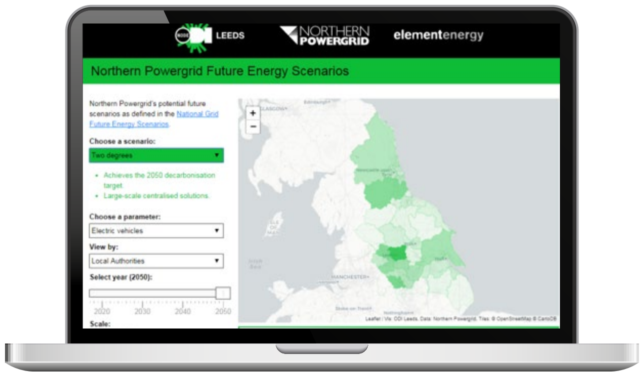
Working with the Leeds ODI we have taken the data from our forecasting tool, regionalised it and presented the key underlying variables and output in the form of a geospatial map supported by fully accessible data tables.

To view our visualisation of the data specific to your local area, visit the ODI Leeds website: odileeds.github.io/northern-powergrid/









Clicking within the substation or local authority boundary (depending on the view selected) will reveal the data relevant to that geographic area.

When viewing the data by ***local authorities***, you will see:

— the total value of the parameter selected (e.g. the total number of EVs) in the local authority area; and

— a bar chart with the breakdown for each of the relevant Northern Powergrid primary substations in the local authority area (e.g. EVs supplied by each substation).

When viewing the data by ***primary substations***, you will see the total value of the parameter selected for each primary substation. ***Primary substations (with local authorities)*** overlays this data with the local authority borders.

The methods and assumptions have been explained below the map, in the section ***About this visualisation***, as well as in our technical blogs.

The geospatial map includes a sliding bar for selecting the reference year and allows users to adjust the key variables, as follows:

Scenario:
— Community Renewables
— Two Degrees
— Steady Progression
— Consumer Evolution

View by:
— Local authorities
— Primary substations
— Primary substations (with local authorities)

Scale:
— By 2050 – shades the map areas by reference to the maximum value (number or MW) in 2050 for the parameter within the boundary being viewed (substation or local authority)
— In year – shades the map areas by reference to the maximum number in the year being viewed.

Parameters:
— Electric vehicles (number)
— Heat pumps (number)
— Domestic photovoltaic installed capacity (MW)
— Large solar generation installed capacity (MW)
— Wind generation installed capacity (MW)
— Other generation installed capacity (MW)
— Energy storage installed capacity (MW)
— Domestic underlying energy consumption (MWh)
— Industrial and commercial underlying energy consumption (MWh)
— Total energy consumption including electric vehicles and heat pumps (MWh)
— Peak demand at primary substations
  – Without customer flexibility
  – With customer flexibility
— Peak utilisation at primary substations
  – Without customer flexibility
  – With customer flexibility

Definitions of each parameter have been provided at the end of this document, in Annex 5.

To download the underlying data for each of the parameters, please visit Data Mill North: https://datamillnorth.org/dataset/northern-powergrid-dfes

For ease of reference, we have produced MS Excel workbooks which show the forecasts on a local authority level alongside substation level data.

We understand that different stakeholders may wish to explore the data with a varying degree of granularity. We have therefore provided a number of datasets which would suit these various needs.

Alongside providing forecasts for key locations on the distribution network (such as primary substations or grid supply points), we have published datasets which display DFES on a local authority level. These include MS Excel workbooks with charting tools, which could be useful for viewing the data behind different LCT forecasts.

If you would like to view the data behind the geospatial map, substation level data can be found in CSV files, provided separately for each parameter and scenario combination.

Full description of datasets and documents published on Data Mill North can be found in Annex 4.

Our questions for you

Future energy requirements are uncertain as the country transitions towards net zero in 2050. We are seeking your inputs and views to arrive at a baseline planning forecast to inform our plans for meeting the future energy needs of our region.

As a network operator, we need to plan ahead to be ready for this uncertain future, making sure that the required interventions are delivered where and when needed to deliver best value for customers whilst meeting their future energy needs. These interventions could be a mixture of procured flexibility services and network investment which have longer planning timescales. This is why we are consulting regionally to seek views on a range of scenarios to identify the most likely pathway over the next 10, 20, and 30 years.

We are interested in your views and have produced a qualitative and a quantitative feedback form to collect them. Views can be expressed for the whole of the Northern Powergrid region, for our Northeast or Yorkshire licence area, by local authority or Local Enterprise Partnership, or both, and even down to primary substation level for local energy schemes.

Qualitative feedback:
Annex 3 provides a simple feedback form to enable you to provide qualitative feedback. An electronic version of this form is available from the link below.

There are just nine questions:

1. Do you have your own projections for any of the key parameters?
2. If so, do you have more than one scenario?
3. Which, if any, of the scenarios in our DFES provides the closest fit with your local plans?
4. Does this range of scenarios capture your local plans? If not, please explain why not.
5. If there isn't a close match, are your projections higher, lower or somewhere in the middle?
6. Please tell us of any local initiatives that you are putting in place to drive the uptake that you are forecasting for any of the parameters.
7. Please provide feedback on improvements we could make to our data visualisation tool, to the downloadable data formats and/or to our feedback forms/events.
8. Please provide any views on how scenarios are most useful to you. For example, do you prefer to have visibility of a single future energy plan or of a range of potential future pathways?
9. Please provide any other comments.

You can access the electronic version of both forms from: https://datamillnorth.org/dataset/northern-powergrid-dfes

Quantitative feedback:
In addition to the qualitative feedback, if you do have your own run of numbers for any of the parameters, we are interested in feeding your projections into our modelling.

To facilitate this, we have provided a quantitative feedback workbook which enables you to add your own upper, lower and central projection for the parameters of your choosing.

Next steps

We are starting to prepare our plans for the next price control period, RIIO-ED2 (1 April 2023 to 31 March 2028) and your feedback will be instrumental in ensuring this framework is adequate to deliver your local near-term plans.

Our formal business plan submission to Ofgem will be in early 2021, and we are spending the whole of 2020 developing our plans, consulting with stakeholders and refining those plans accordingly.

To facilitate this journey our timetable for this consultation is as follows:

2019	2020				2021	
December	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**
— Publish DFES document, visualisations and data	— Stakeholder workshops — Data collection	— Data analysis	— 2020 GB FES	— 2020 DFES		— Publish draft RIIO-ED2 plan
				— Stakeholder workshops	— Stakeholder workshops	
		— Publish and consult on business plan emerging thinking	— Publish and consult on business plan emerging thinking	— Publish and consult on business plan emerging thinking	— Publish and consult on business plan emerging thinking	

During Q1 2020, and commencing in January, we will be holding workshops to explain the process and collect your views and data.

This will be followed by data analysis during Q2 2020 and bilateral discussions, where appropriate, to reconcile the data and to refresh our planning scenarios.

During Q2 and Q3 2020, we will be sharing our findings with National Grid ESO to support its preparation of the 2020 GB FES.

In Q3, we will refresh our 2020 DFES which will take into account the 2020 GB FES and also contain the planning scenario generated by this local engagement process.

Finally, in Q4 we will finalise our plan for RIIO-ED2 for submission to Ofgem in Q1 2021.

We will also be utilising our work on scenarios to support the common planning scenario produced through the Energy Networks Association. This is to inform Ofgem's Challenge Group as part of the RIIO-ED2 price control reviews for transmission and gas distribution networks.

Glossary

CO_2:
Carbon dioxide, the most common greenhouse gas

DNO:
Distribution Network Operator

DSO:
Distribution System Operator

ESO:
Electricity System Operator

EV:
Plug-in electric vehicle

Flexibility:
One's ability to shift one's demand or generation to a different time

GB FES:
Future Energy Scenarios for Great Britain, developed from the transmission network perspective

GW:
Gigawatt – one thousand megawatts (million kilowatts) of electrical power

GWh:
Gigawatt hour – a measure of electrical energy equivalent to a power consumption of one thousand megawatts (million kilowatts) for one hour

I&C:
Industrial and Commercial (sector)

kW:
Kilowatt – one thousand watts of electrical power

kWh:
Kilowatt hour – a measure of electrical energy equivalent to a power consumption of one thousand watts for one hour

LCTs:
Low-carbon technologies. Technologies that have the ability to reduce the emissions associated with energy consumption (e.g. electric vehicles, heat pumps, solar panels)

LV:
Low voltage (<1000V)

MW:
Megawatt – one thousand kilowatts of electrical power

MWh:
Megawatt hour – a measure of electrical energy equivalent to a power consumption of one thousand kilowatts for one hour

Net zero:
Legally binding greenhouse gas emission target which requires UK to reduce nearly all of its emissions by 2050 (compared to 1990 levels), introduced on 27 June 2019 by amending the Climate Change Act 2008

Network constraints:
Areas of the network where the demand or generation exceed the designed network capacity

Peak demand:
The maximum electrical demand on the electricity network

RIIO-ED1 or ED1:
The current price control period for electricity distribution network operators which runs from 1 April 2015 to 31 March 2023

RIIO-ED2 or ED2:
The next price control period which will run from 1 April 2023 to 31 March 2028

Solar PV:
Solar photovoltaics, solar panels

Time-of-use tariff:
Tariff that reflects the true cost of electricity based on the time, i.e. higher at peak times and lower at times when the demand is low

Annexes

Annex 1 – Distribution Future Energy Scenario assumptions and building blocks

Community Renewables

Achieves 80% reduction in carbon emissions by 2050

— Local energy schemes flourish, consumers are engaged and improving energy efficiency is a priority
— UK homes and businesses transition to mostly electric heat
— Consumers opt for electric transport early and simple digital solutions help them manage their energy demand
— Policy supports onshore generation and storage technology development
— Green energy innovation to meet local needs

Two Degrees

Achieves 80% reduction in carbon emissions by 2050

— Large-scale solutions are delivered
— Consumers are supported to choose alternative heat and transport options to meet the 2050 target
— UK homes and businesses transition to hydrogen and electric technologies for heat
— Consumers choose electric personal vehicles and hydrogen is widely used for commercial transport
— Increasing renewable capacity, improving energy efficiency and accelerating new technologies such as carbon capture, usage and storage are policy priorities

Steady Progression

Does not achieve 80% reduction in carbon emissions by 2050

— The pace of the low-carbon transition continues at a similar rate to today but then slows towards 2050
— Consumers are slower to adopt electric vehicles and take up of low-carbon alternatives for heat is limited by costs, lack of information and access to suitable alternatives
— Although hydrogen blending into existing gas networks begins, limited policy support means that new technologies such as carbon capture, usage and storage and battery storage develop slowly

Consumer Evolution

Does not achieve 80% reduction in carbon emissions by 2050

— There is a shift towards local generation and increased consumer engagement, largely from the 2040s
— In the interim, alternative heat solutions are taken up mostly where it is practical and affordable, e.g. due to local availability. Consumers choose electric vehicles and energy efficiency measures
— Cost-effective local schemes are supported but a lack of strong policy direction means technology is slow to develop, e.g. for improved battery storage

The key building block levels are shown overleaf.
Source: ESO FES 2019.

Assumption name	Community Renewables	Two Degrees	Steady Progression	Consumer Evolution
Support for low-carbon solutions	High	High	Low	Low
New heat technology adoption rates	High	High	Low	Medium
Consumer engagement – residential	High	Medium	Low	Medium
Smart energy	High	Medium	Low	Medium
District heat	High	Medium	Low	Low
Hydro generation	High	Medium	Low	Medium
Waste generation	High	Low	Low	Medium
Biomass dedicated generation	High	Medium	Low	Low
Combined heat and power gas generation	Low	High	Medium	Medium
Combined heat and power renewable generation	High	Medium	Low	Medium
Pure electric vehicles	High	High	Low	Low
Home thermal efficiency levels	High	High	Low	Medium
Plug-in hybrid electric vehicles	High Medium/Low – varies across the time horizon	High Medium/Low – varies across the time horizon	High	High
Wind generation (onshore)	High	Medium	Low	Medium
UK continental shelf reserve	Low	High	High	Medium
Wind generation (offshore)	Medium	High	Medium	Low
Solar generation – small	High	Low	Low	Medium
Carbon capture and storage generation	Low	High	Medium	Low
Domestic batteries	High	Low	Low	Medium
Demand side response – I&C	High	Medium	Low	Medium
Solar generation – large	Medium	High	Low	Low
Smart meters	High	High	Low	Low
Hydrogen vehicles	Medium	High	Low	Low
Smart appliances	High	Medium	Low	Medium
Distribution connected batteries	High	Medium	Low	Low
Hydrogen (electrolysis)	High	Low	Low	High
Hydrogen (steam methane reforming)	Low	High	Medium	Low
Domestic gas/electric hybrid system engagement levels	High	High	Low	Low

Annex 2 – LCT uptake scenarios and their network impacts

Demand

The following charts and tables show the Northern Powergrid totals for the potential uptake of electric vehicles and heat pumps. We have provided the underlying data on the ODI website with disaggregation down to local authority level and also primary substation level.

Figure 12: Electric vehicle uptake forecast

	2020	2030	2040	2050
Community Renewables	56,135	1,393,292	4,452,122	4,588,641
Two Degrees	55,599	1,381,697	4,367,503	4,571,662
Steady Progression	31,748	278,425	2,162,869	4,361,224
Consumer Evolution	31,641	272,232	2,121,728	4,336,572

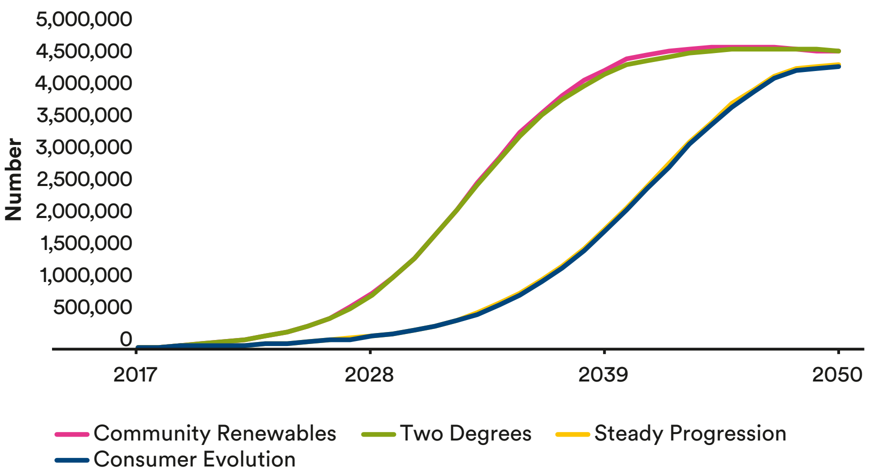


Figure 13: Residential heat pump uptake forecast

	2020	2030	2040	2050
Community Renewables	37,408	642,616	1,763,365	2,427,748
Two Degrees	29,677	500,801	1,142,767	1,172,753
Steady Progression	23,798	49,663	142,953	236,772
Consumer Evolution	27,355	70,836	349,191	809,250

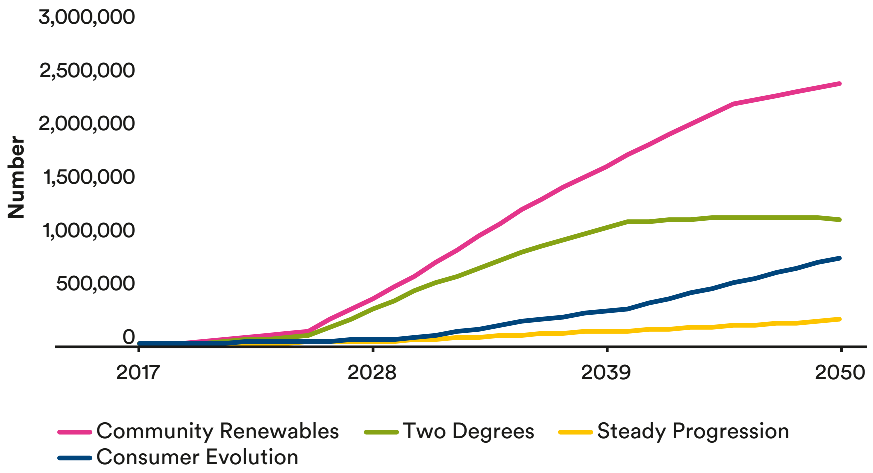
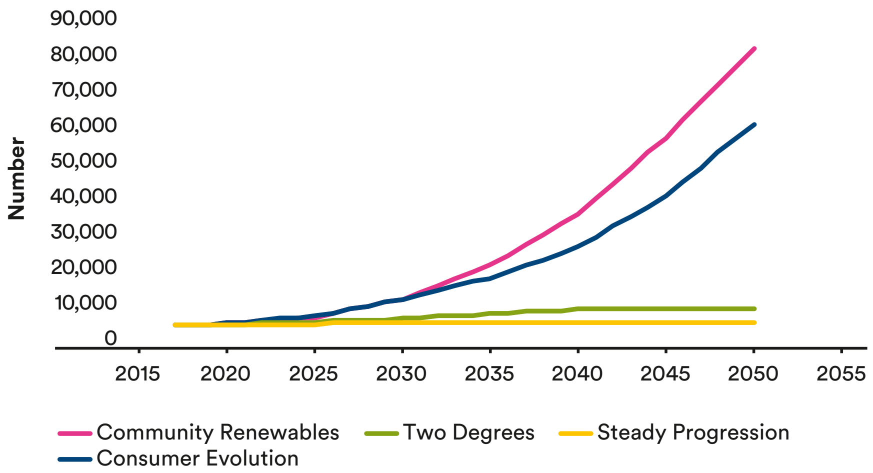


Figure 14: I&C heat pump uptake forecast

	2020	2030	2040	2050
Community Renewables	6,510	13,459	37,077	82,798
Two Degrees	6,261	7,940	37,077	10,813
Steady Progression	6,173	6,886	37,077	6,931
Consumer Evolution	6,570	13,369	37,077	61,865



Generation and storage

The following tables and charts show the Northern Powergrid totals for the potential increase in generation and storage capacity connected to the network. Again, we have provided the underlying data on the ODI website with disaggregation down to local authority level and also primary substation level.

Figure 15: Residential PV capacity uptake forecast (MW)

	2020	2030	2040	2050
Community Renewables	492	1,671	2,489	2,797
Two Degrees	440	568	697	799
Steady Progression	440	568	697	799
Consumer Evolution	464	933	1,430	1,756

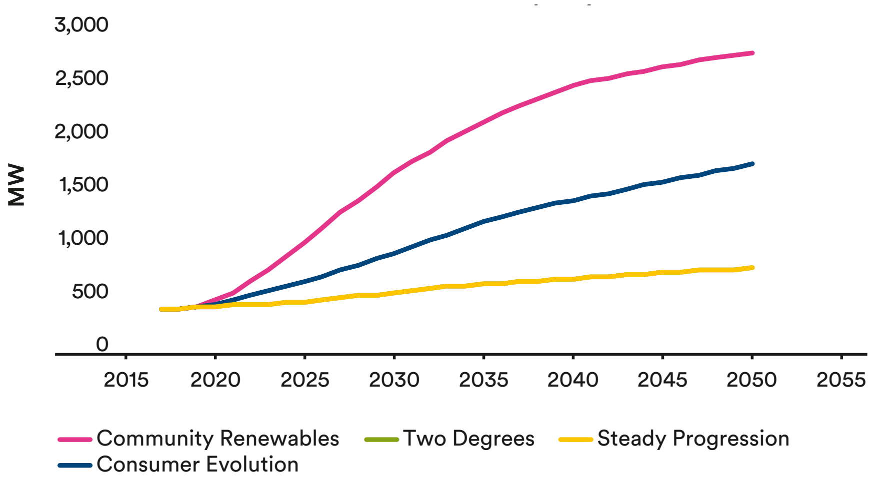


Figure 16: Large-scale PV capacity uptake forecast (MW)

	2020	2030	2040	2050
Community Renewables	349	1,040	2,067	2,218
Two Degrees	345	991	2,124	2,289
Steady Progression	332	460	1,075	1,138
Consumer Evolution	337	541	1,238	1,350

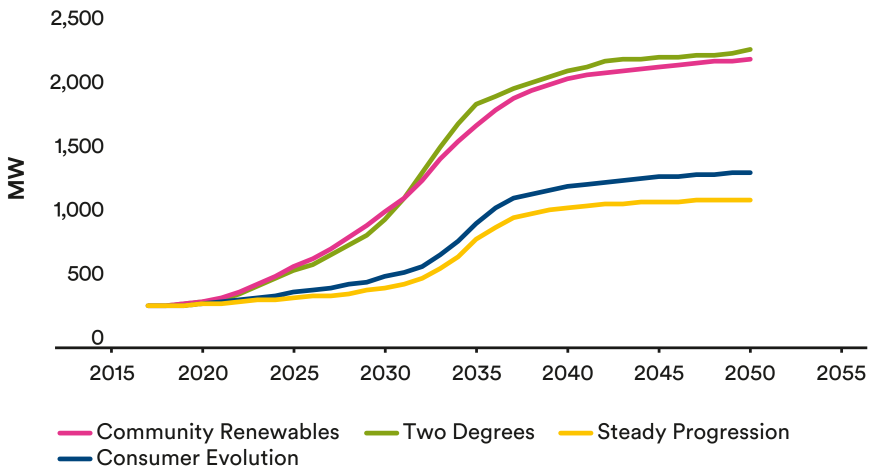


Figure 17: Wind energy capacity uptake forecast (MW)

	2020	2030	2040	2050
Community Renewables	1,467	2,449	4,924	6,904
Two Degrees	1,450	1,684	1,963	2,176
Steady Progression	1,440	1,488	1,563	1,613
Consumer Evolution	1,456	1,960	2,944	3,646

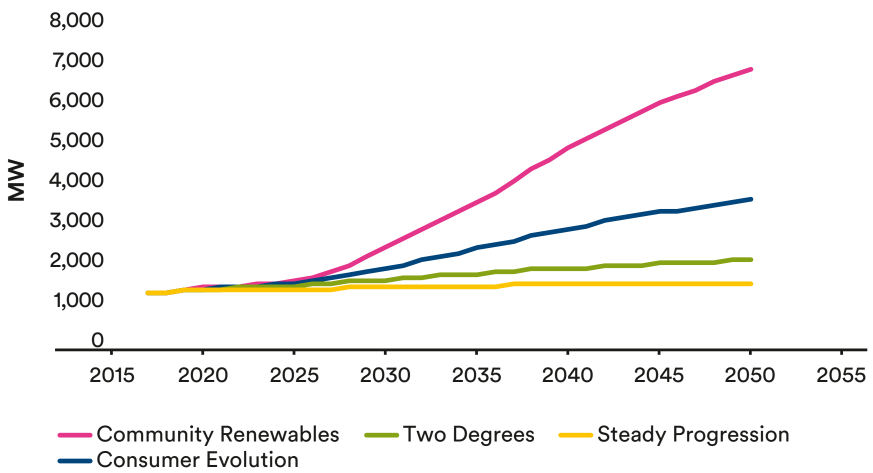


Figure 18: Other distributed generation capacity uptake forecast (MW)

	2020	2030	2040	2050
Community Renewables	1,921	2,355	2,718	2,989
Two Degrees	1,893	2,071	2,114	2,294
Steady Progression	1,909	2,004	2,145	2,218
Consumer Evolution	1,732	1,813	1,939	2,119

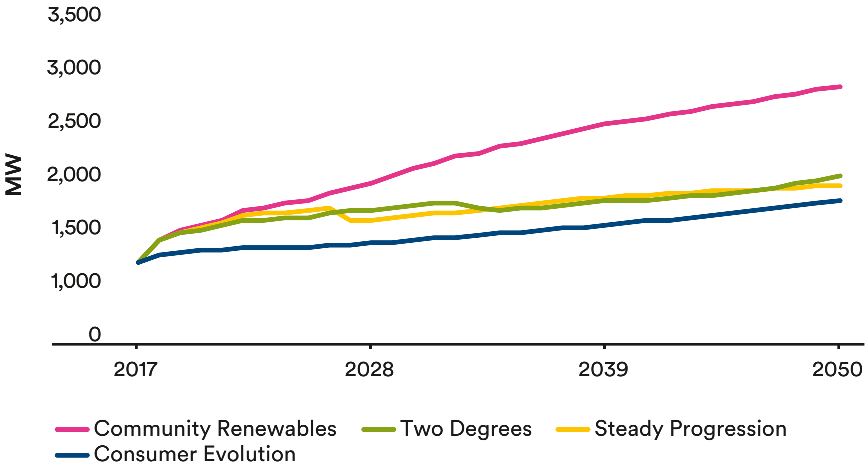
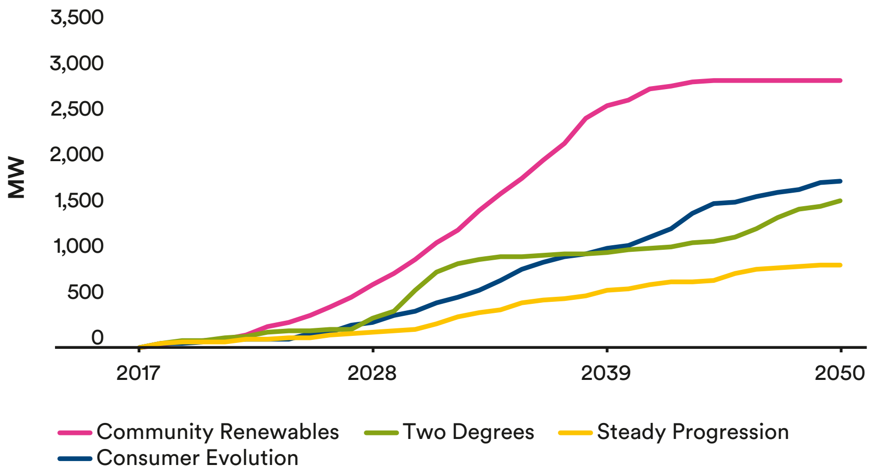


Figure 19: Storage capacity uptake forecast (MW)

	2020	2030	2040	2050
Community Renewables	74	958	2,691	2,903
Two Degrees	87	628	1,066	1,595
Steady Progression	67	196	640	907
Consumer Evolution	64	398	1,111	1,809

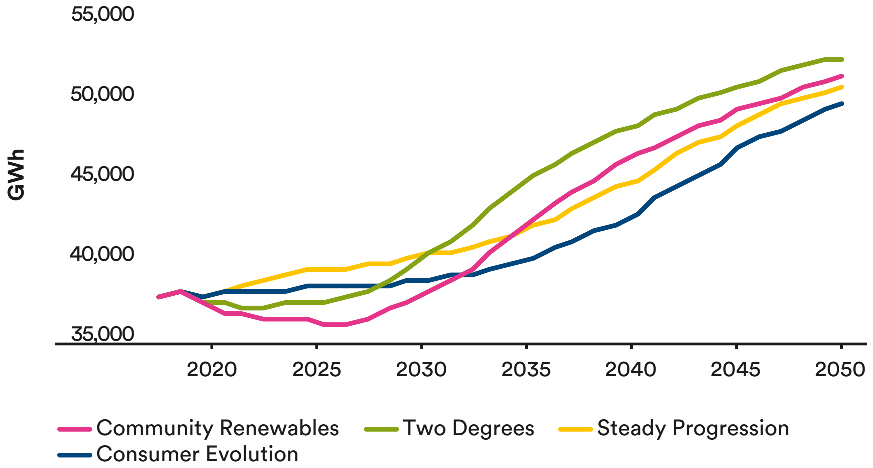


Energy distributed

The total energy distributed (GWh) will increase as the number of LCTs such as electric vehicles and heat pumps increase, although the underlying consumption is expected to continue reducing with continued improvements to energy efficiency. The table and chart below illustrate the total energy consumption for the four scenarios, and demonstrates an increase of between 30 and 37% over today's values.

Figure 20: Total annual electrical energy consumption projections (GWh)

	2020	2030	2040	2050
Community Renewables	37,066	38,112	46,371	51,042
Two Degrees	37,458	40,432	48,169	52,066
Steady Progression	38,401	40,438	44,932	50,366
Consumer Evolution	38,124	38,974	42,932	49,411



Annex 3 – Qualitative feedback form

If possible, please use online form – a MS Word version of this feedback form is available from: https://datamillnorth.org/dataset/northern-powergrid-dfes

In addition to the qualitative feedback, if you do have your own run of numbers for any of the parameters, we are interested in feeding your projections into our modelling. To facilitate this, we have provided you a blank workbook which enables you to add your own upper, lower and central projection for the parameters of your choosing – also available from the link above.

Organisation name		
Region (e.g., local authority or LEP):		
Respondent contact details	**Name**	
	Position	
	Email	
	Telephone	
I agree to Northern Powergrid contacting me to discuss my submission		**Yes/No**

1. Do you have your own projections for any of the key parameters? Please provide details of which parameters and add a description of the level of detail.	
Electric vehicles	
Residential heat pumps	
Industrial and Commercial (I&C) heat pumps	
Other heating	
Residential solar PV capacity	
Large-scale solar PV capacity	
Wind energy capacity	
Storage capacity	
Domestic energy consumption/efficiency	
I&C energy consumption/efficiency	

2. If so, do you have more than one scenario? Please provide details.

3. Which, if any, of the scenarios in our DFES provides the closest fit with your local plans? (Delete those not applicable. CR – Community Renewables; TD – Two Degrees; SP – Steady Progression; CE – Consumer Evolution)					
Electric vehicles	**CR**	**TD**	**SP**	**CE**	**NONE**
Residential heat pumps	**CR**	**TD**	**SP**	**CE**	**NONE**
I&C heat pumps	**CR**	**TD**	**SP**	**CE**	**NONE**
Residential solar PV capacity	**CR**	**TD**	**SP**	**CE**	**NONE**
Large-scale solar PV capacity	**CR**	**TD**	**SP**	**CE**	**NONE**
Wind energy capacity	**CR**	**TD**	**SP**	**CE**	**NONE**
Storage capacity	**CR**	**TD**	**SP**	**CE**	**NONE**
Domestic underlying energy consumption	**CR**	**TD**	**SP**	**CE**	**NONE**
I&C underlying energy consumption	**CR**	**TD**	**SP**	**CE**	**NONE**

4. Does this range of scenarios capture your local plans? If not, please explain why not.

5. If there isn't a close match, are your projections higher, lower or somewhere in the middle? (Delete those not applicable)

Electric vehicles	Higher	Middle	Lower	No Forecast
Residential heat pumps	Higher	Middle	Lower	No Forecast
I&C heat pumps	Higher	Middle	Lower	No Forecast
Residential solar PV capacity	Higher	Middle	Lower	No Forecast
Large-scale solar PV capacity	Higher	Middle	Lower	No Forecast
Wind energy capacity	Higher	Middle	Lower	No Forecast
Storage capacity	Higher	Middle	Lower	No Forecast
Domestic energy consumption/efficiency	Higher	Middle	Lower	No Forecast
I&C energy consumption/efficiency	Higher	Middle	Lower	No Forecast

6. Please tell us of any local initiatives that you are putting in place to drive the uptake that you are forecasting for any of the parameters. Provide hyperlinks to relevant published documents.

7. Please provide feedback on improvements we could make to our data visualisation tool, to the downloadable data formats and/or to our feedback forms/events.

8. Please provide any views on how scenarios are most useful to you. For example, do you prefer to have visibility of a single future energy plan or of a range of potential future pathways?

9. Any other comments

Annex 4 – Data sources

DFES data is available for download on the Data Mill North website: **https://datamillnorth.org/dataset/northern-powergrid-dfes**

To assist you in navigating the datasets, we have provided descriptions of the data in the chart below. The data is grouped and ordered as follows:

Feedback forms		
File	**Description**	**File type**
Feedback template (Qualitative)	A MS Word document (as shown in Annex 3) to allow respondents to provide qualitative feedback.	.docx
Feedback template (Quantitative)	A MS Excel workbook that allows respondents to submit their own forecast data for any of the parameters of their choosing.	.xlsx

Datasets		
Data	**Description**	**File type**
Northern Powergrid level data	Data for the key parameters at Northern Powergrid level. This is a single MS Excel workbook bringing together all of the parameters, each provided on a separate sheet (together with all the scenarios).	.xlsx
Local authority level data	Data for the key parameters at a local authority level. This is a single MS Excel workbook bringing together all of the parameters, each parameter broken down further into four separate sheets (one for each scenario).	
Local authority charting tools	Data for the key parameters at a local authority level, grouped by technology. A number of MS Excel workbooks providing useful tools for analysing the data, grouped by technology and by local authority, e.g. an EV workbook.	
Metadata	A MS Excel workbook providing helpful information about the data, e.g. percentage splits of each primary substation across local authorities, the connectivity between primaries, bulk supply points and grid supply points.	
Grid supply point level data	Data for the key parameters at grid supply point (i.e. connection points between the GB transmission network and Northern Powergrid's distribution network) level. A single MS Excel workbook bringing together all the parameters and scenarios, provided on separate sheets.	
Major site level data	Data for the key parameters at bulk supply point (i.e. connection points on Northern Powergrid network which are fed from the grid supply points and which supply the primary substations) level. Three MS Excel workbooks bringing together all the parameters and scenarios, provided on separate sheets.	
Primary substation level data	A series of over 50 files and links to the data shown in the geospatial Leeds ODI visualisation tool – a separate file for each parameter and for each scenario combination.	

Annex 5 – Parameter definitions

Parameter	Definition
Electric vehicles (EVs) (number)	Number of registered plug-in electric vehicles (pure battery electric and hybrid vehicles)
Heat pumps (number)	Number of heat pumps in residential households and commercial properties, including from district heating schemes
Domestic photovoltaic installed capacity (MW)	Installed capacity of solar PV panels on domestic roofs for installations less than 4kW
Large solar generation installed capacity (MW)	Installed capacity of large-scale solar farms
Wind generation installed capacity (MW)	Installed capacity of onshore and offshore wind farms
Other generation installed capacity (MW)	Installed capacity of all other generation including biomass, waste, combined heat and power plants, gas, other thermal generation
Energy storage installed capacity (MW)	Installed capacity of electrical energy storage (predominantly batteries)
Domestic underlying energy consumption (MWh)	Annual energy consumption by residential households, excluding electric vehicle and heat pump consumption
Industrial and commercial underlying energy consumption (MWh)	Annual energy consumption by industrial and commercial properties, excluding electric vehicle and heat pump consumption
Total energy consumption, including electric vehicles and heat pumps (MWh)	Total energy consumption by domestic households and industrial and commercial properties, including electric vehicle and heat pump consumption
Peak demand at primary substations (MW)	Peak half-hourly demand within the year
Peak demand with customer flexibility at primary substations (MW)	Peak half-hourly demand within the year, if load is shifted by e.g. time-of-use tariffs and smart charging of EVs
Peak utilisation at primary substations (%)	Peak half-hourly demand within the year as a proportion of primary substation capacity
Peak utilisation with customer flexibility at primary substations (%)	Peak half-hourly demand within the year as a proportion of primary substation capacity, if load is shifted by e.g. time-of-use tariffs and smart charging of EVs

Contact us

Your feedback is important to us and should be sent to:
npg.system.planning@northernpowergrid.com

Please contact us if you have any questions.