Distribution Future Energy Scenarios

Mapping net zero locally

2022 data

> The communities in our region have strong ambitions for a low carbon future. Our role is to manage and plan a network that ensures they meet their goals and to enable a just transition for everyone we serve. This is the decade of change, and we are ready to deliver.

Paul Glendinning
Policy and Markets Director

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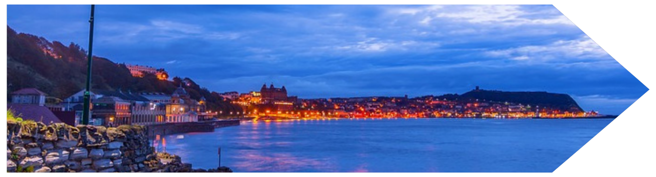

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Foreword

Our lives are becoming increasingly dependent on electricity as more people switch to electric heating and transport to cut global carbon emissions. In parallel, it is more critical than ever that we transition to reliable and resilient low carbon electricity to help protect our customers from the energy price hikes we have seen this last year.

As the electricity network operator for the North East, Yorkshire and north Lincolnshire, Northern Powergrid powers the lives of more than 8m people and has a critical role to play in enabling decarbonisation.

We are also introducing this year our distribution system operation (DSO) business unit and embracing our role in managing a network of flexible and distributed low carbon technologies, in addition to our distribution network operator (DNO) responsibilities to maintain a safe and reliable network. Planning and modelling future energy use across our region is a key part of how we manage our costs and the investment decisions that help us deliver decarbonisation in a way that is fair and just for all the communities we serve.

Our annual Distribution Future Energy Scenarios (DFES) assist us in making more effective and data-driven investment decisions to do this. This summary document, together with our latest DFES open data provides our 2022 forecasts.

In 2021 our DFES helped to form the plan for our investment requirements over the next ten years to deliver a network that enables the transition to net zero. DFES 2022 allows us to check that plan and, where necessary, make modifications. In order to meet local and national net zero targets, our network must accommodate increased numbers of the Low Carbon Technologies (LCTs) required to decarbonise transport and heat, and the renewable distributed energy resources needed to power them. We ensure these technologies can connect to a network that is resilient, flexible, and supported with strong and reliable infrastructure. The five scenarios in our DFES and our related modelling of Climate Change Committee (CCC) projections reflect different and credible pathways to this future.

Our world ...

From tiny hamlets to three of the most populous cities in the UK. Our network spans four national parks, five areas of outstanding national beauty and four heritage coasts.

This is where we live, work and serve our customers.

This year we have seen the publication of the first Local Area Energy Plans (LAEPs). These are formalised approaches to climate action involving local government, communities, businesses and stakeholders across our region. At a national level, the government has reasserted its commitment to the Glasgow Climate Pact agreed at COP26 including a 68% reduction in our emissions by 2030.

The first four scenarios in our DFES reflect National Grid Electricity System Operator's (ESO) Future Energy Scenarios (FES), breaking down the national insights and findings at a regional level. The fifth scenario is our own best-view Planning Scenario, which would see our region secure net zero ahead of the national 2050 deadline.

Your feedback is crucial: by combining your ambitions with our local knowledge and data-driven modelling, we can enable decarbonisation in our communities and our region.

Over the past year we have taken some significant steps forward in collaborative planning with our stakeholders - now DFES will take this dialogue forward.

Paul Glendenning
Policy and Markets Director

How DFES shape our planning

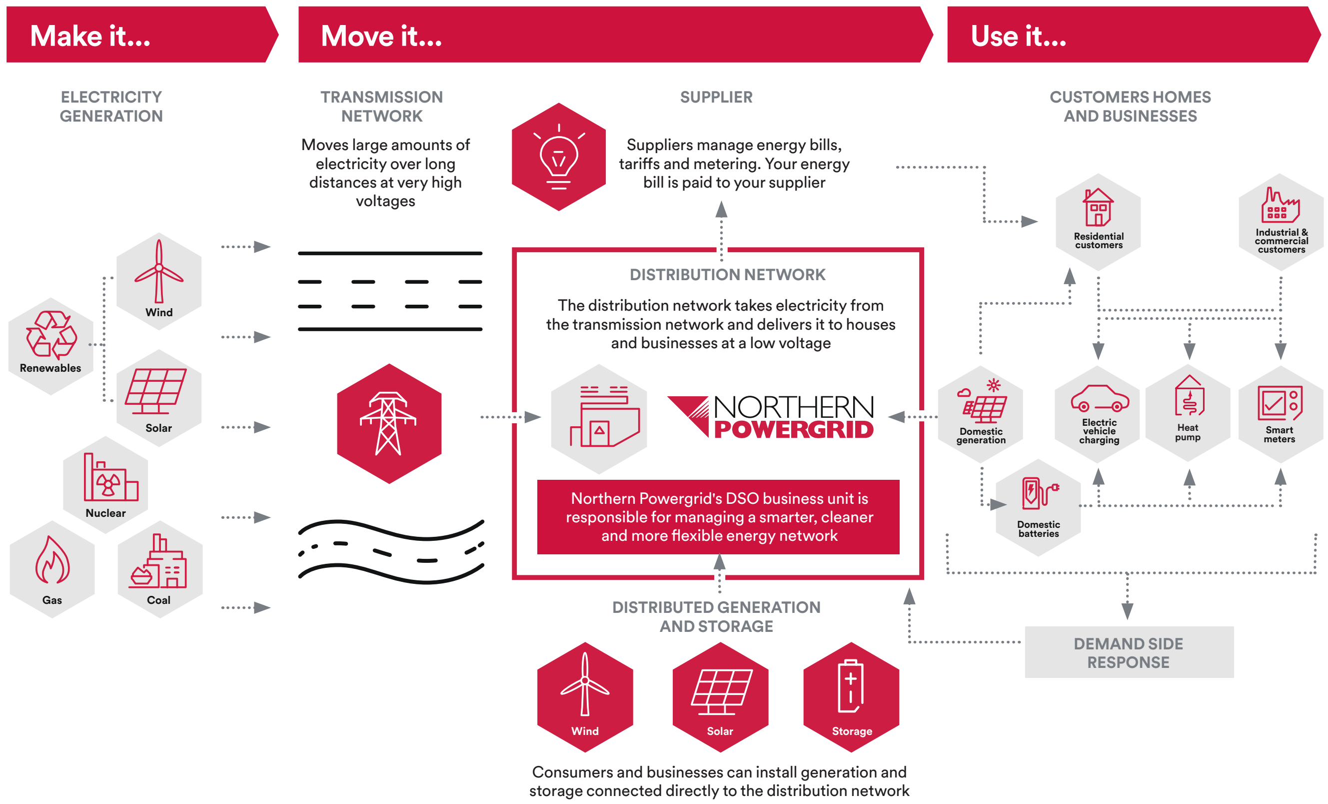
Electricity distribution networks are critical enablers for the transition to net zero.

A significant contribution to delivering net zero will involve decarbonising heat and transport, which will mean a profound increase in electricity demand to power technologies like electric vehicles (EVs) and heat pumps. However, the network impacts are difficult to predict due to uncertainty about the location and rate of technology uptake, coupled with additional uncertainties over customer behaviour – for example, with respect to the location, timing and speed of EV charging. This uncertainty requires us to consider several scenarios so we can determine and model the future range of potential network impacts.

DFES are partly for us: Northern Powergrid is responsible for the electricity network that powers everyday life for 8 million customers across 3.9 million homes and businesses in the North East, Yorkshire and northern Lincolnshire. DFES 2022 provides future energy projections for the areas that we cover. Our open data makes these available both at local authority level; and at the level of more than 120 large substations (e.g. supply points) and over 550 primary substations. It also guides our lower voltage planning at over 63,000 distribution substations and associated cables.

We use the DFES to inform how we plan to operate our network and business in the short, medium and long term. You can see our **network development plan here** and **business plan here**. Both documents have been informed and shaped by our DFES data.

Our role in the energy system



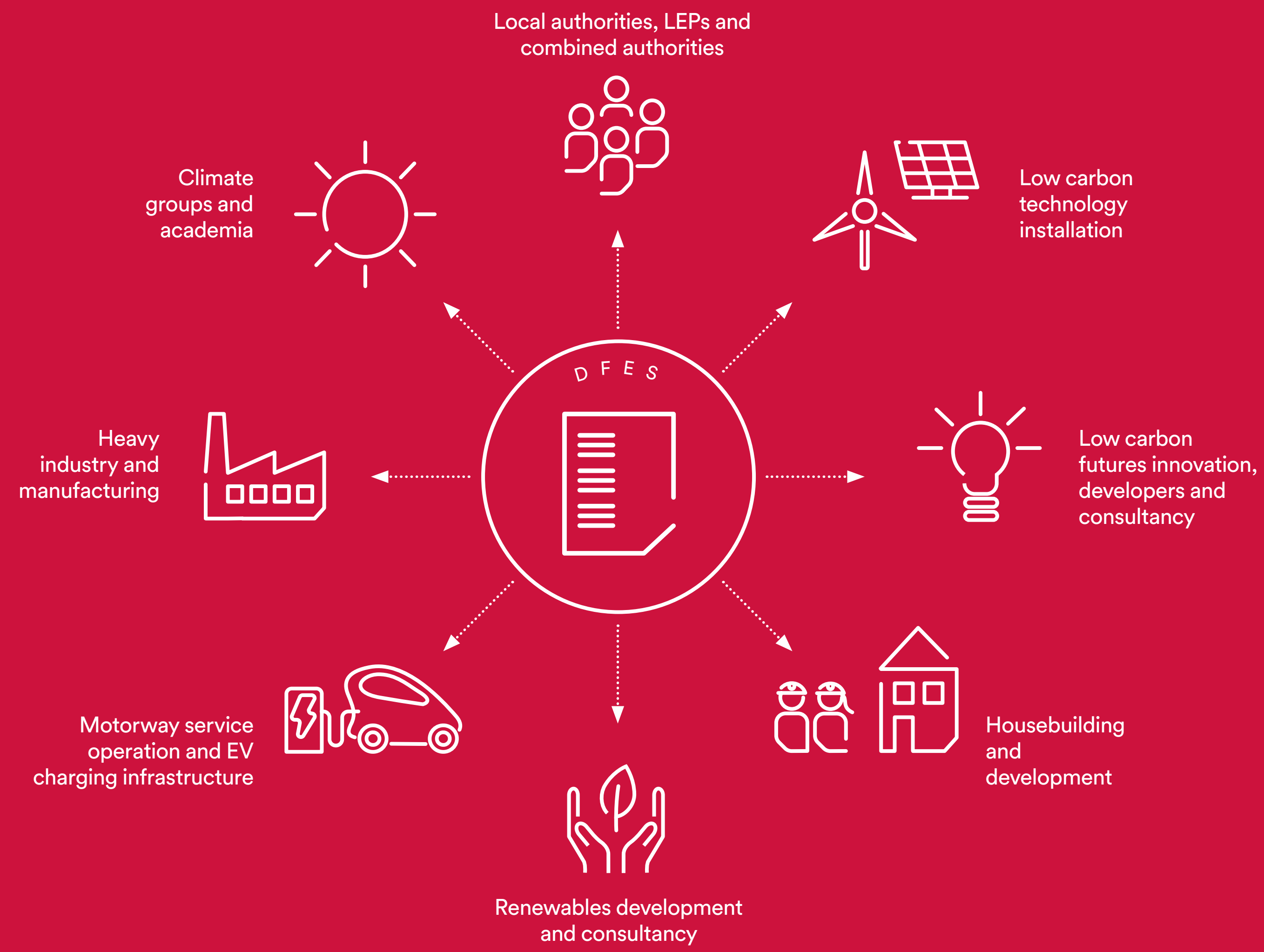
How DFES can shape your planning

But equally importantly, DFES are also for you, our stakeholders. We want scenarios to help you reflect on your net zero plans and realise your decarbonisation ambitions. As a key enabler of our stakeholders' net zero goals, we need to consider your plans in our scenarios. We urge you to inform us early of your plans, so we can continue to develop our network to ensure it is fit for the future.

Open data like our DFES can be used to:

— Model your own future energy scenarios at a hyper-local level;
— Provide a strategic overview for predicted EV and heat pump numbers to help shape local area energy planning;
— Bolster funding applications for decarbonising interventions like local generation schemes; and
— Engage and educate people about regional decarbonisation.

If you work in the following sectors, our DFES could be a useful tool to help your planning.



Our approach to DFES

National Grid Electricity System Operator (ESO), in conjunction with the Distribution Network Operators, produces the Future Energy Scenarios for the whole of Great Britain (GB FES) from a transmission network perspective. These are not in themselves forecasts or expected pathways, as the actual pathway could be a combination of these four scenarios but they do allow an exploration of different options and pathways and provide a vehicle for discussion.

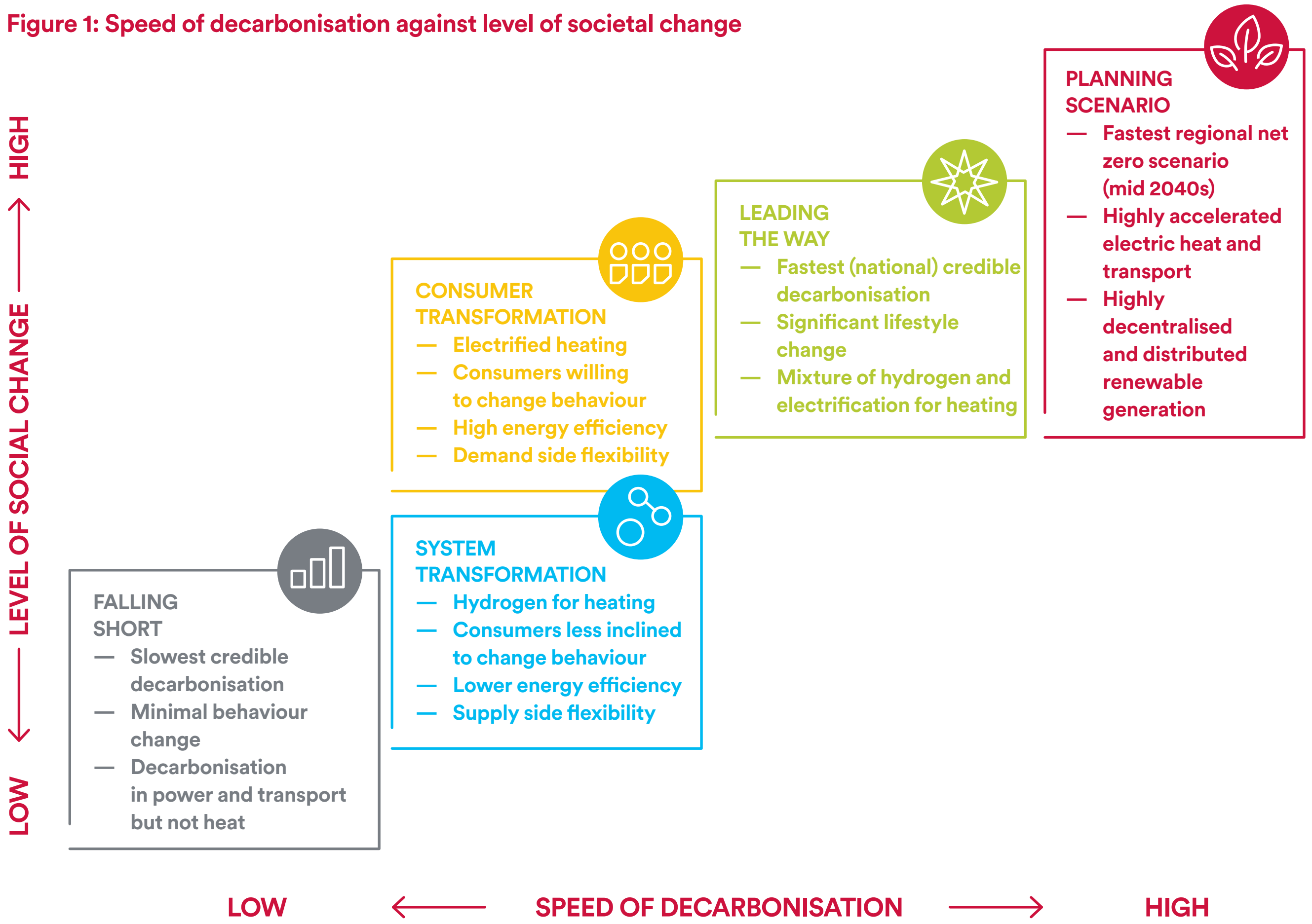
Northern Powergrid works with the ESO to help develop their forecasts and, in addition, we have developed our own forecasting model that processes data from the GB FES and other scenarios such as the Climate Change Commission (CCC). We use this data to develop our Distribution Future Energy Scenarios (DFES). This gives us a range of credible pathways for the uptake of low carbon technologies (LCTs) in our region, models their impact on the distribution network and signals locations where we may need to develop intervention options to avoid network constraints.

In addition to the four FES-aligned scenarios, we are presenting our own unique fifth scenario. All the GB DNOs have agreed through the Energy Networks Association (ENA) Open Networks Project to produce a “best view”, a scenario that sets out the most likely pathway to net zero for their respective regions.

Our Planning Scenario is our interpretation of the “best view” scenario. The Planning Scenario is based on our regional interpretation of the range of national scenarios currently available (National Grid ESO FES and the CCC scenarios in the Sixth Carbon Budget). It has also taken government policy and stakeholder feedback into consideration, as well as regional characteristics.

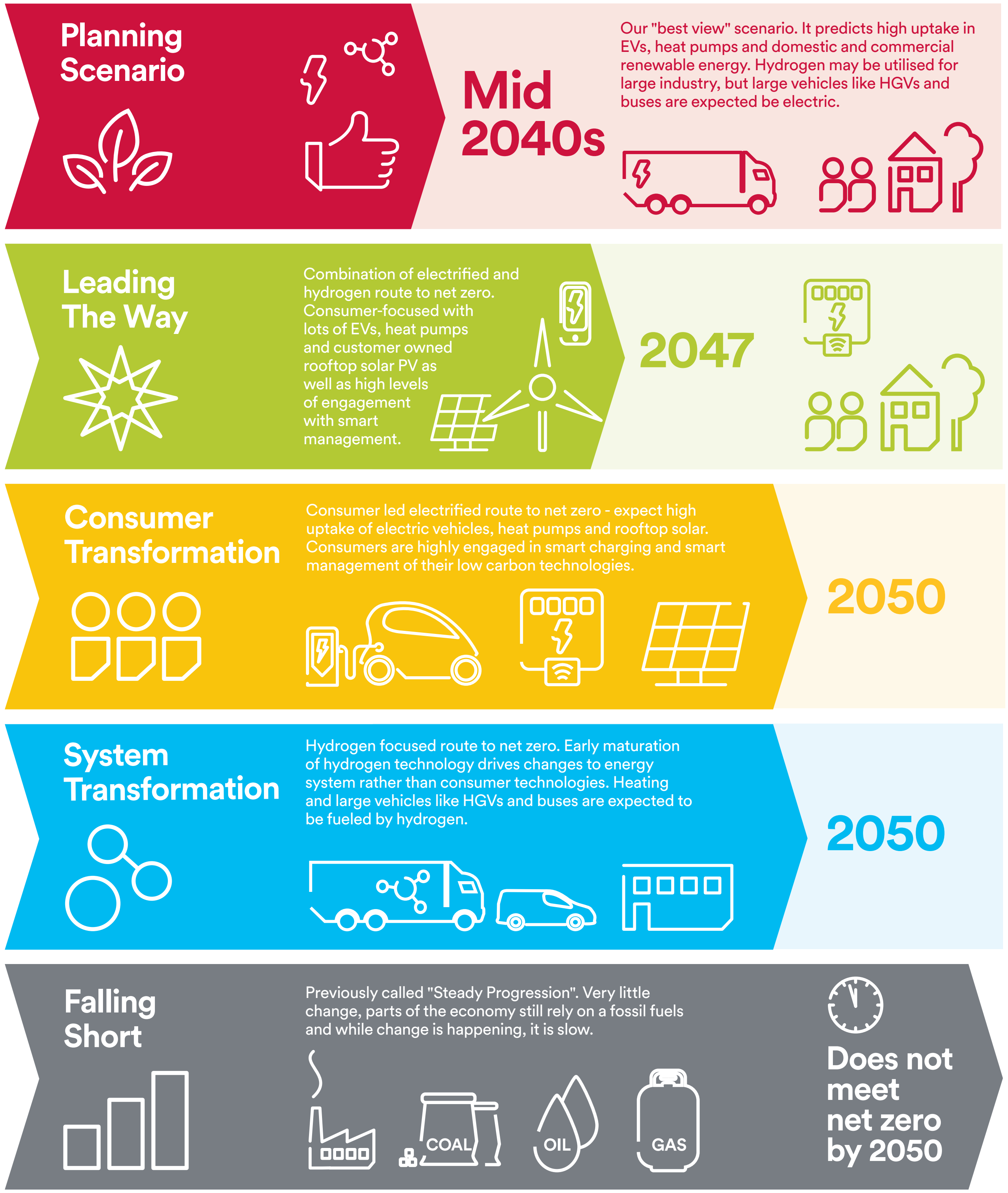
Our modelling methodology is available in our ED2 business plan documentation.

Figure 1: Speed of decarbonisation against level of societal change



Our five DFES scenarios

From 2022 to net zero by...



Changes between DFES 2021 and DFES 2022

For most parameters there is little difference between DFES 2021 and DFES 2022.

One change in DFES 2022 is the change of name for the Steady Progression scenario to Falling Short but this is a change in name only, not a change in the underlying assumptions. It is however a better description of the scenario and a warning to all that unless change comes swiftly, we will not make the progress needed to preserve our planet.

We have also observed that within the Consumer Transformation scenario, there is an increase in onshore wind compared to the 2021 data. There is an ongoing debate within Government about onshore wind and whether the 2015 moratorium that restricts its development should be lifted. If it is lifted we expect that next year's data (2023) may reflect this and indicate higher levels of onshore wind in multiple scenarios.

Figure 2: Wind energy capacity (MW) - 2021 versus 2022

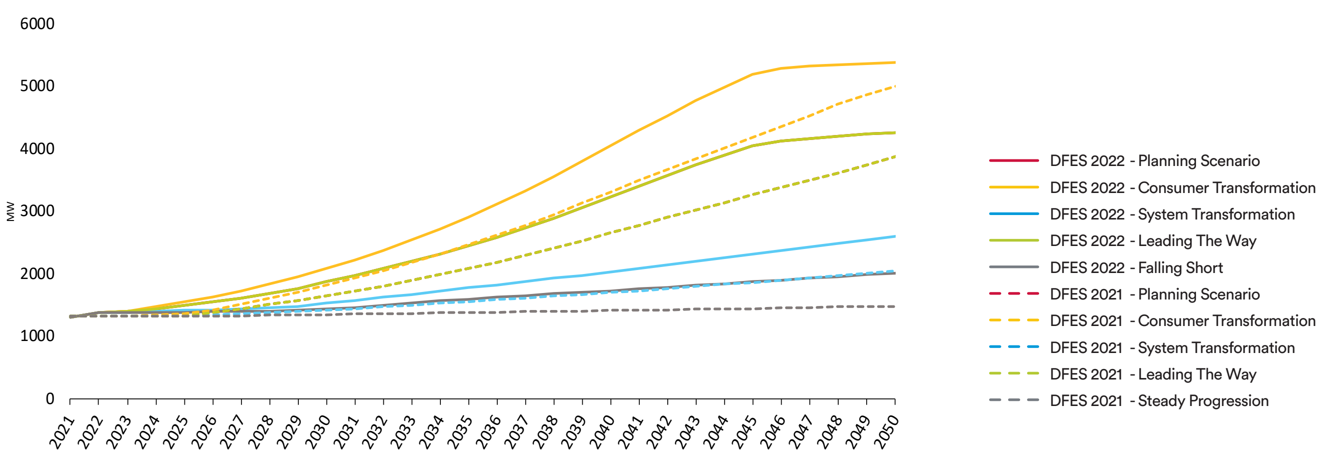
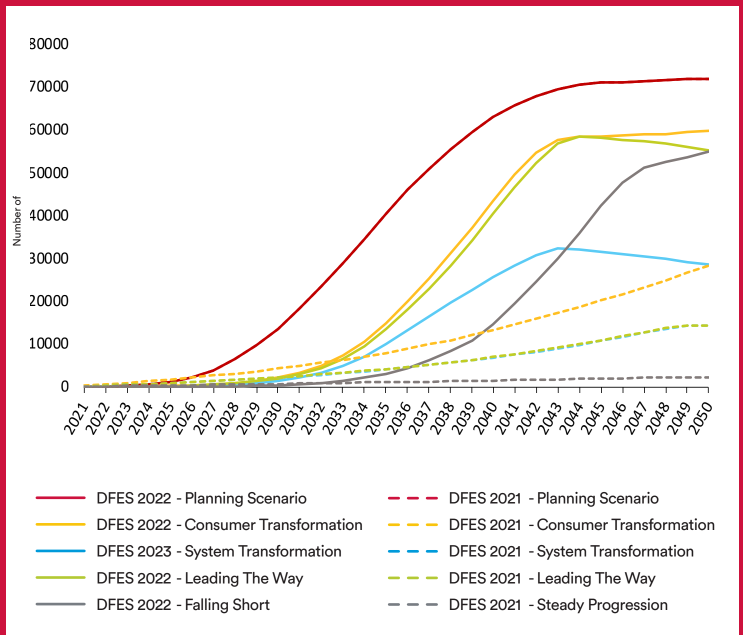


Figure 3: No. of electric HGVs - 2021 vs 2022



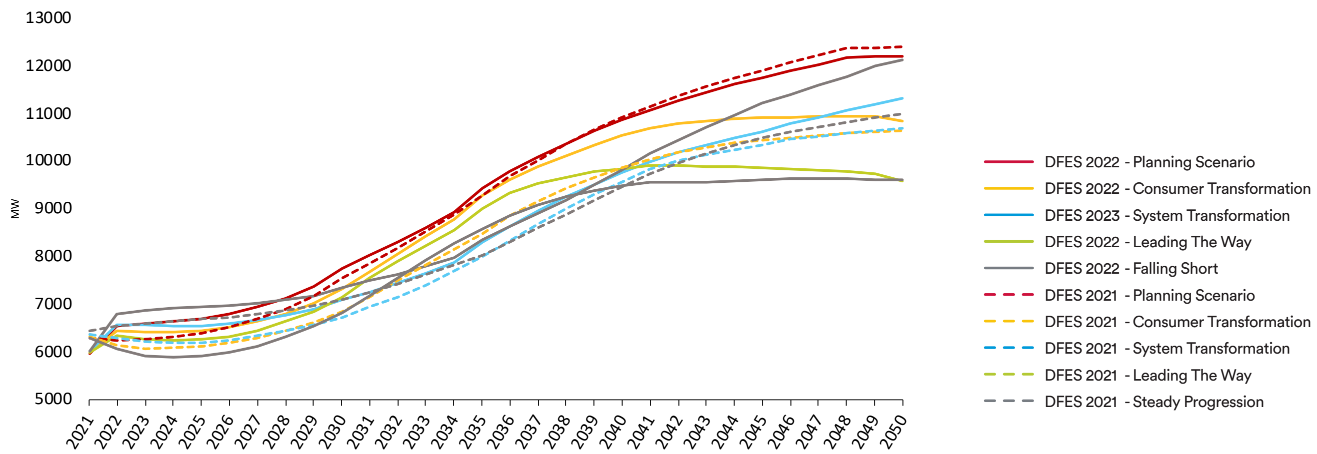
One of the most notable change within FES 2022 is an increase in the expected number of electric HGVs (eHGVs). Note that the eHGVs have also led to a corresponding increase in energy consumption in the later years within the FES scenarios.

Interestingly, when we surveyed our stakeholders, many of the responses outlined that they were not expecting heavy electric vehicles like eHGVs and buses to scale up across the region between now and 2050. Although survey respondents did note that they would expect future clean heavy vehicles would be powered by electricity rather than hydrogen when asked questions about future fuels.

Changes to peak demand

Of more important note are the changes that have occurred to our starting point and year one projections and their impact on our gross peak demand projections. These are a result of clarifying our Northern Powergrid view of actual demands, the pipeline of accepted connections, and the realities of the amounts of energy efficiency achieved compared to those forecast.

Figure 4: Gross Peak Demand (MW) - 2021 vs 2022



The step change shown between the starting year and the first forecast year is a result of a staggering increase in the number of large scale Battery Energy Storage Systems (BESS) wanting to connect to our network. This is contributing to half the increase in gross peak demand.

There is uncertainty about the coincidence of BESS charge and discharge operations with the time of existing peak demand. A diversity factor has been applied to adjust BESS demand potential to reflect the probable increase in the peak demand at affected sites. Because energy storage may be called upon to solve a network constraint at the transmission level, large scale batteries may charge at a time when the regional network is constrained to meet national need. Alternatively it may be charged at times when energy is cheapest, for example when there is high wind and solar generation. This can create new peaks on the network at previously insignificant times of the day.

There is uncertainty about when these large new plants will actually connect to our network. But, once a connection quotation is accepted we reserve the capacity for it in our forecasting.

Other types of demand connections are rapid EV charging at higher voltage levels on our network, electric battery manufacturing facilities, data centres and a growth in logistics and warehousing. New housing estates are assuming a larger load per household due to heat pump and EV connections, and this year we have received our first request for electrolyser connections to produce green hydrogen.

No mitigation from domestic efficiency savings explains the larger step change in Falling Short.

Impact of changes on our DFES 2022 Planning Scenario

Our DFES 2022 Planning Scenario has been updated to reflect the latest demands and new connections in the 2021/22 baseline. Otherwise it uses the same scenario mix as previous years.

The change in electric HGVs in FES 2022 was already factored into our DFES 2021 Planning scenario and no other changes have occurred that would trigger a change from the assumptions, informed also by the CCC scenarios and regional stakeholder feedback, that we highlighted last year.

DFES 2022 future projections

Drivers of change

Transport (EVs / eHGVs / buses)

Electric vehicles (EVs) are one of the primary drivers of change on our network. Transport contributes to nearly one quarter of UK carbon emissions, but by electrifying vehicles and powering them with clean energy, we reduce our reliance on fossil fuels. To enable the transition to EVs, our network must be prepared for higher electricity demand to provide the power needed to charge the higher numbers of EVs that we are expecting.

EV growth will be significant in the 2020s and uptake will accelerate into the 2030s across the majority of the DFES. From 2030 the sale of new internal combustion engine (ICE) vehicles will be banned, driving a sharp increase in EV ownership alongside the expected increase to availability of EVs over this same time period.

	2025	2030	2040	2050
Consumer Transformation	391,377	1,734,078	4,612,614	4,211,467
System Transformation	221,150	1,005,491	4,327,703	4,241,804
Leading The Way	382,317	1,856,121	4,520,504	3,265,163
NPg Planning Scenario	523,703	1,843,408	4,589,052	5,013,445
Falling Short	201,739	799,403	3,628,975	4,781,906

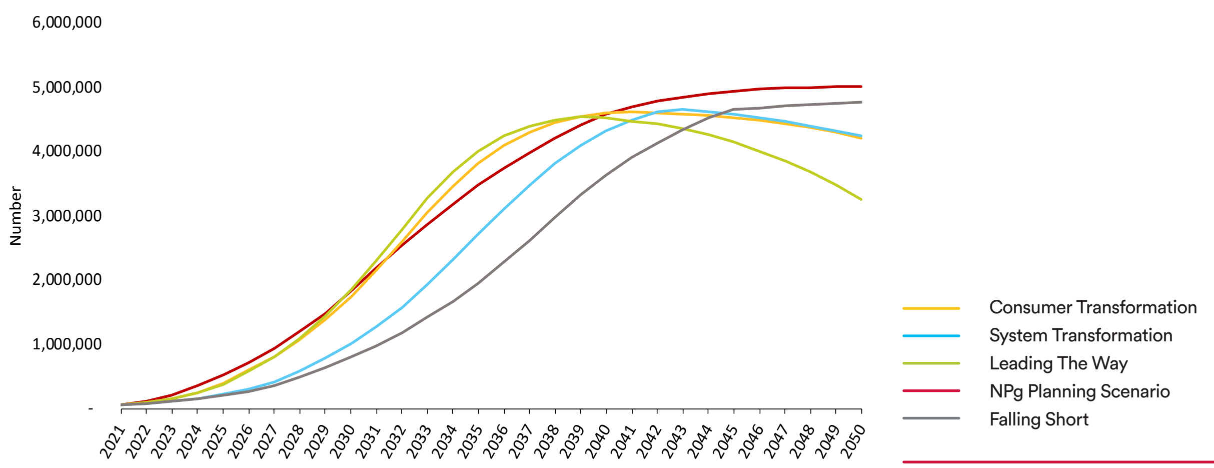


Figure 5: No. of electric vehicles (cars and vans)

Electrification is also seen for heavy goods vehicles (HGVs) and buses in the non-hydrogen scenarios. Our Planning Scenario accomodates high levels of electrification for heavy vehicles.

	2025	2030	2040	2050
Consumer Transformation	973	5,378	58,128	78,267
System Transformation	738	4,304	38,732	42,309
Leading The Way	1,161	6,094	56,712	71,889
NPg Planning Scenario	2,040	18,083	78,337	90,077
Falling Short	361	1,588	21,418	69,592

Figure 6: No. of electric buses and HGVs

Drivers of change

Heating (Heat pumps)

Heating is the other primary driver for change on our network as we transition from gas powered boilers to heat pumps powered by electricity. The increase in heat pump numbers, like EVs, will increase the demand for electricity on our network.

Heat pump growth will begin in the 2020s, but the 2030s will be the decade of accelerated uptake of across the DFES in which there is high electrification of heat. In contrast, there are fewer heat pumps overall in the System Transformation hydrogen-based scenario, with a greater proportion of these heat pumps being hybrid – which means they are designed to work in tandem with a hydrogen gas network. Nearly two thirds of the total heat pumps in 2050 in the System Transformation scenario are estimated to be hybrid.

	2025	2030	2040	2050
Consumer Transformation	114,619	596,248	2,429,889	3,224,513
System Transformation	87,361	202,468	784,423	1,960,917
Leading The Way	243,436	819,729	2,299,343	2,766,866
NPg Planning Scenario	145,981	691,754	2,409,952	3,568,971
Falling Short	66,655	188,885	810,031	1,751,705

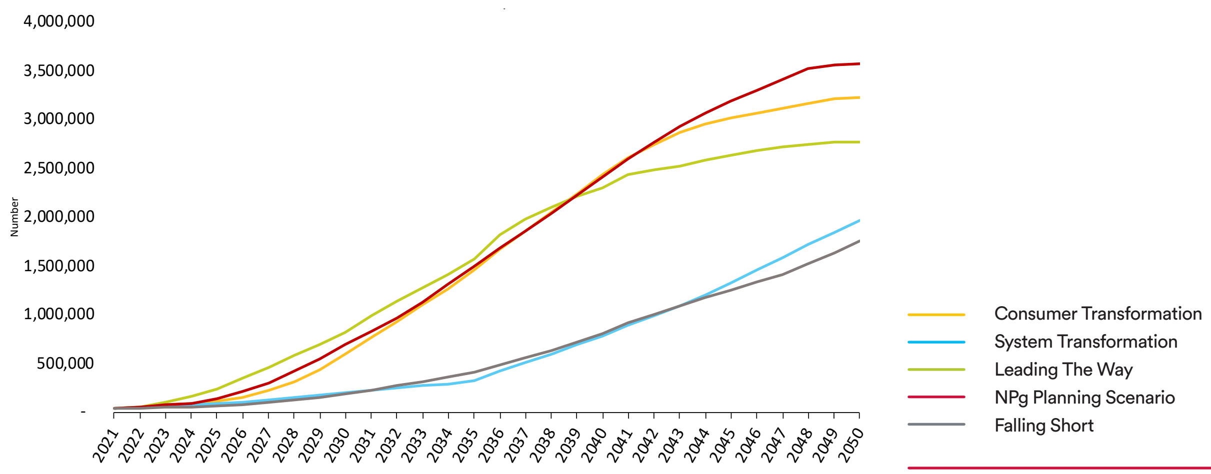


Figure 7: No. of total heat pumps

The residential portion of the total heat pumps are shown below, and there will also be district heating schemes covering a portion of residential customers. District heating scheme will connect to our higher voltage network and domestic heat pumps will connect to our lower voltage network.

	2025	2030	2040	2050
Consumer Transformation	98,648	551,826	2,330,062	3,098,580
System Transformation	76,970	174,052	703,510	1,845,410
Leading The Way	229,764	782,367	2,206,518	2,651,521
NPg Planning Scenario	134,329	667,995	2,324,055	3,395,550
Falling Short	59,717	178,713	785,552	1,706,498

Figure 8: No. of residential heat pumps

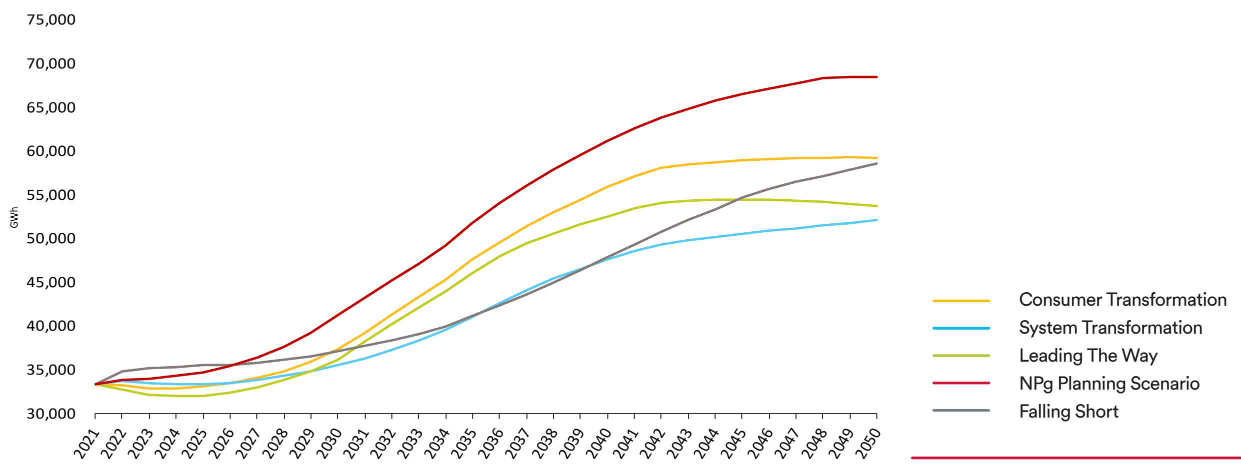
Demand

Total consumption

As a result of the electrification of heat and transport, electrical energy consumption is expected to increase significantly in all of the DFES scenarios. However, the growth in renewable technologies like solar and wind power will ensure that the increased energy that we do consume is procured from clean sources.

	2025	2030	2040	2050
Consumer Transformation	33,082	41,276	55,992	59,200
System Transformation	33,364	37,287	47,644	52,121
Leading The Way	32,070	40,167	52,541	53,754
NPg Planning Scenario	34,763	45,188	61,248	68,578
Falling Short	35,522	38,410	47,895	58,670

Figure 9:
Electric energy consumption (GWh)



Over the 2020s, all five scenarios predict a relatively stable net constant of electric energy consumption, despite significant uptake in LCTs like EVs and heat pumps. The reason that net consumption stays constant, and indeed even reduces in some scenarios, is because the increased energy demand needed for EVs and heat pumps is outweighed by an increase in energy efficiency measures. The government's recent announcement to **invest £1bn in energy efficiency** measures for households like better insulation will contribute to an overall lowering of enery demand over the next seven years, despite uptake of LCTs. Ultimately though, the balance will tip back and in the 2030s when we expect mass acceleration of LCT uptake, electrical energy consumption will begin to rise significantly in all scenarios.

Demand

Fuel switching and electrolysers

Electricity consumption is also impacted by industry switching from fossil fuel power to electricity. Over the next two decades, industry fuel switching will drive a noteworthy increase in energy demand. Energy demand from electrolysers will also increase during this period, in particular between 2040 and 2050. This would result from the maturation of hydrogen production and storage technologies that unlock the so called 'last mile' of decarbonisation by providing green solutions to those industries still reliant on fossil fuels. The 'System Transformation' scenario strongly favours this pathway to decarbonisation.

The underlying domestic and I&C energy consumption requirements for everyday lighting, appliance and core workplace usage remains significant despite some efficiency savings. The decarbonisation of heat and transport dominate the increase.

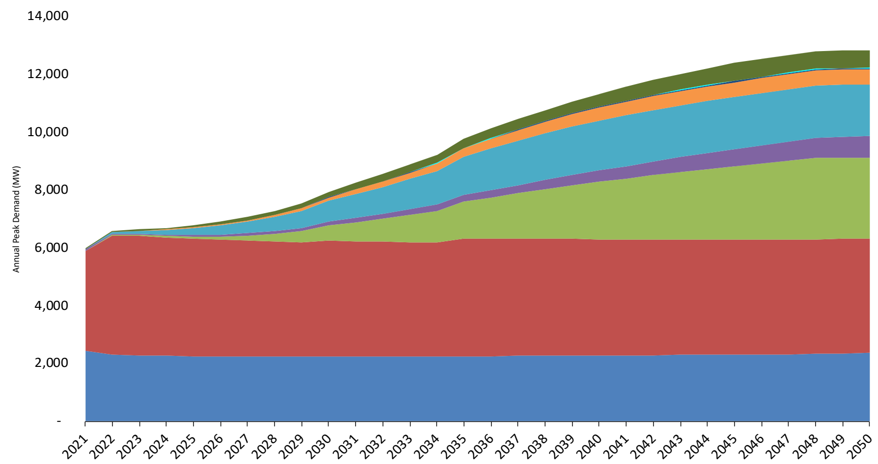


Figure 10:
Planning Scenario contributions to peak demand (MW)

Domestic Underlying
I&C Underlying
Heat Pumps Domestic
Heat Pumps I&C
EV Cars and Vans
Electric HGVs
Electric Buses
Electrolysers
Large Industry Fuel Switching

The gross peak demand for power is the parameter that matters most for forecasting future network constraints. It is expected to increase significantly in all of the DFES scenarios. Again this is driven largely by the electrification of heat and transport. There is uncertainty over the operation of large storage which can create new peaks on the network outside of the traditional winter peak evening hour.

The Leading the Way scenario achieves the lowest increase due to its ambitious measures for demand reduction which encompass both efficiency savings and behaviour. Examples of behaviour changes include car sharing and reducing space heating target temperatures. The uncertainty in the adoption of such measures is substantial.

Demand

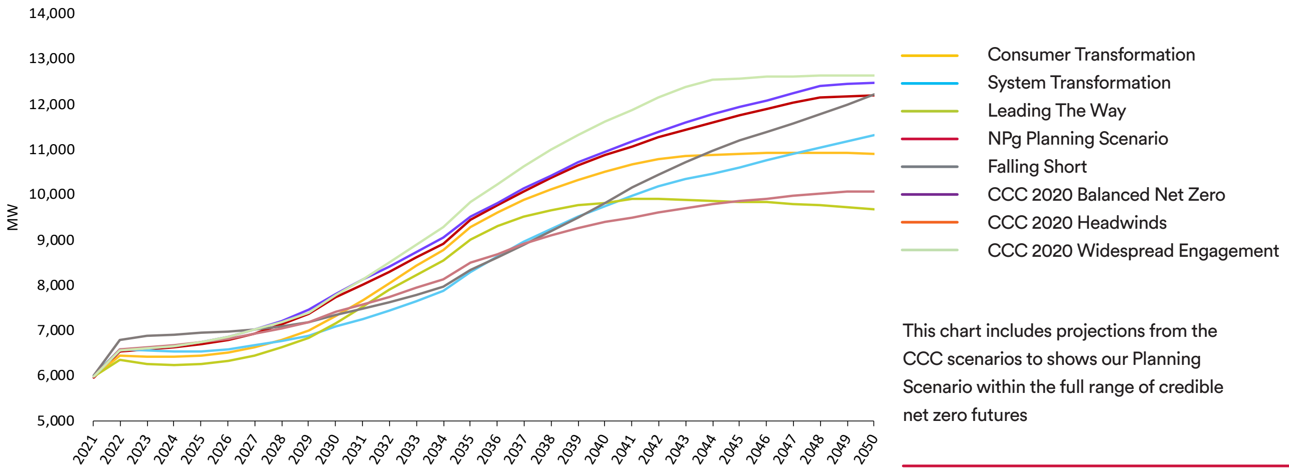
Gross peak demand

Looking at the impacts on peak demand across the whole range of scenarios, including the CCC scenarios, there is still a substantial level of uncertainty to which we have to plan our future network investment requirements.

Our Planning Scenario has therefore been devised in a way that it can switch to whichever pathway is showing itself as dominant in the early 2030's.

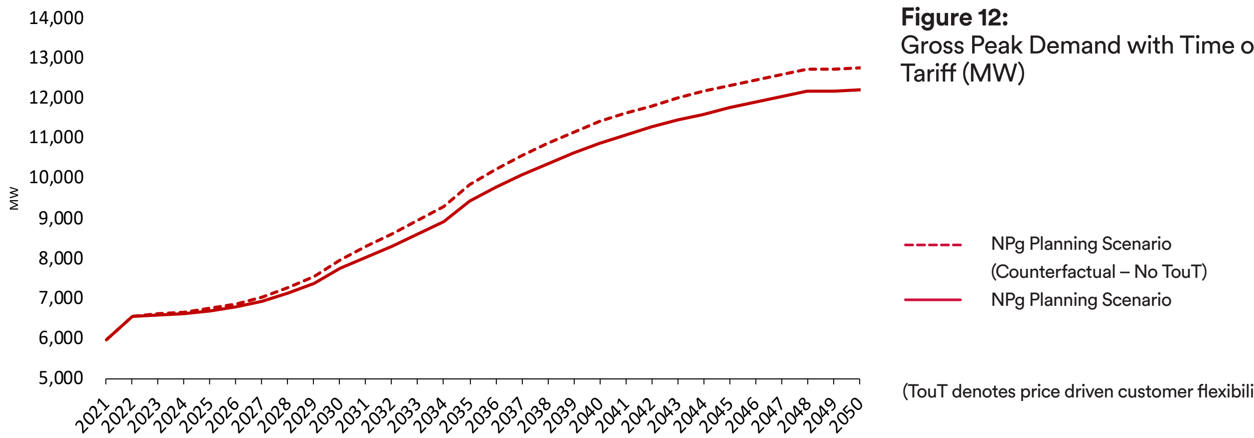
	2025	2030	2040	2050
Consumer Transformation	6,439	7,328	10,524	10,916
System Transformation	6,541	7,084	9,759	11,322
Leading The Way	6,255	7,158	9,827	9,678
NPg Planning Scenario	6,699	7,746	10,873	12,196
Falling Short	6,947	7,352	9,815	12,219

Figure 11:
Gross Peak Demand (MW) (includes CCC scenarios)



This chart includes projections from the CCC scenarios to shows our Planning Scenario within the full range of credible net zero futures

Figure 12:
Gross Peak Demand with Time of use Tariff (MW)



(TouT denotes price driven customer flexibility)

When it comes to managing the increase in gross peak demand, Time of Use Tariffs (TouT) will automatically, and by design, help manage some of the expected constraints (see Figure 12). However, there is further uncertainty about the extent to which we can rely on a measure of price driven flexibility from the TouT that we do not directly procure as a DNO. Even with the support of TouT, the impact of increased electrification will require additional network solutions to manage network constraints. Our first recourse is to the procurement of customer flexibility called upon by our Distribution System Operation (DSO) Business Unit, additional network solutions are outlined in our 2023-28 business plan.

Demand

Network constraints

The pathway that emerges will greatly influence the number of constraints we will have to find flexibility solutions for. These can be provided from both the demand and the generation side.

Figure 13: No. of primary and major substation constraints

We see from the constraints chart that the System Transformation scenario leads to a greatly reduced number of constraints by 2040 compared to the other scenarios. This is because the System Transformation pathway relies on hydrogen technologies in which large parts of the energy system will by powered by hydrogen gas that won't require as much distributed electrical energy demand or generation.

The infographic overleaf shows the most extreme aspect of the uncertainty regarding the future pathways; a predominantly hydrogen, or a non-hydrogen future.

Both represent viable pathways to net zero, but the network requirement for the separate scenarios are worlds apart. We must be ready to deliver whichever scenario shows itself as the dominant pathway to net zero, which is why we must build in measures for uncertainly when we utilise the DFES to make investment decisions.

We are not considering the Falling Short scenario as a potential route to net zero because it does not meet the carbon emission reduction target by 2050.

A Tale of two 2050s... Planning Scenario vs System Transformation

PLANNING SCENARIO

The Planning Scenario favours an electrical route to decarbonisation, with high levels of consumer adoption of low carbon technologies and community engagement with a decentralised and flexible electricity network.

Most houses will have rooftop solar PV, often accompanied by a household battery for additional storage. Electric heat pumps will provide warmth.

Cars and personal transportation vehicles will be electric and many households will have two-way chargers.

Many communities will be engaged and have invested in community energy projects

Heavy industries will be powered by electricity, often with renewable power generated on site. Industrial heat pumps will provide heating needs.

Heavy vehicles like HGVs and electric buses will be electric.

Large-scale battery storage will provide grid flexibility and back up power for when the sun is not shining and wind is not blowing.

Large scale renewable developments both on and off-shore will provide clean, green power.

NETWORK

Whatever 2050 looks like, our network will be at the centre of it, powering lives and communities as we always have done. Our DFES helps us to prepare our network to meet the needs of our customers and stakeholders, no matter what technology and solutions will ultimately deliver net zero.

NETWORK

SYSTEM TRANSFORMATION

The System Transformation scenario has high levels of consumer adoption of low carbon technologies like EVs but lower adoption of technologies like heat pumps and electric heating systems, instead relying on hydrogen-based power sources and a more centralised energy network that is similar to the one we are used to today.

Heavy industry and manufactuing will be powered by a combination of electricity and hydrogen.

Households will still have EVs and may have domestic solar PV. Heating will more likely be provided by hydrogen via the gas network or hybrid heat pumps.

Hydrogen will be stored and used in the existing gas networks in place of fossil gas to provide a source of heating.

Excess renewable power will be used to create hydrogen as a replacement for fossil gas.

Heavy vehicles like HGVs and buses will be powered by hydrogen.

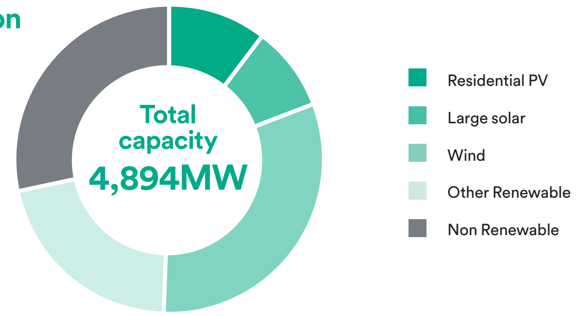
Renewable electricity will provide power for the System Transformation scenario but as electricity demand will be lower, there will be less generation capacity.

Energy Generation

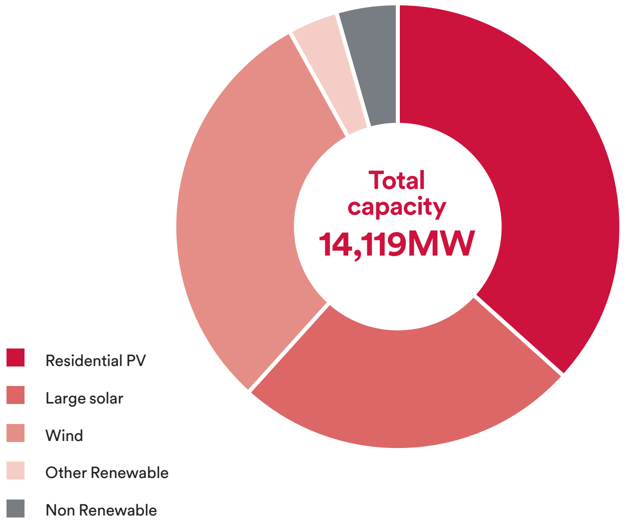
The amount of generation required to power the demand for electricity is also dependent upon which DFES scenario becomes the dominant pathway.

The PV sector (both domestic and large scale) shows some of the widest variations between the DFES. This is because the hydrogen pathway (System Transformation) does not require the same levels of future generation as the electric pathways.

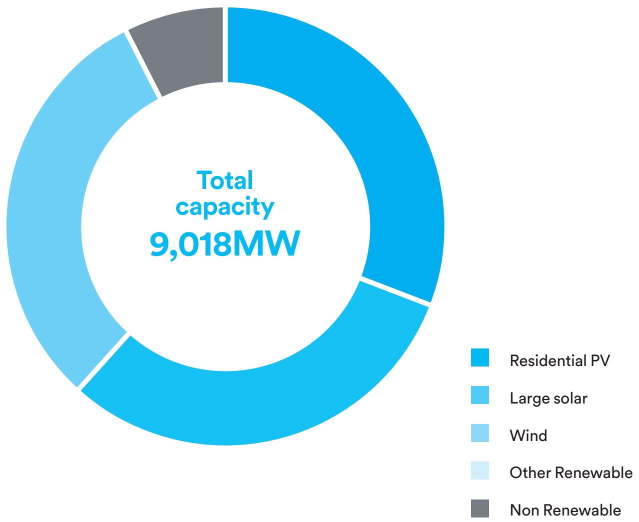
Generation mix 2021



Planning Scenario generation mix 2050



System Transformation generation mix 2050



Generation

Solar PV

	2025	2030	2040	2050
Consumer Transformation	795	1,643	3,462	5,363
System Transformation	561	933	1,751	2,586
Leading The Way	777	1,599	3,359	5,191
NPg Planning Scenario	777	1,599	3,359	5,191
Falling Short	462	591	918	1,255

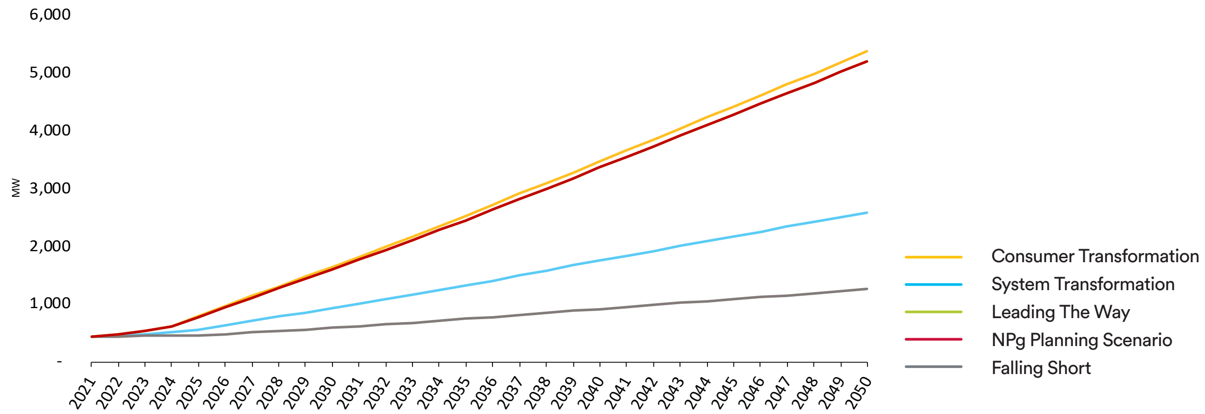


Figure 14:
Residential PV capacity (MW)

	2025	2030	2040	2050
Consumer Transformation	855	1,202	2,001	2,586
System Transformation	855	1,202	2,001	2,586
Leading The Way	1,104	1,803	3,036	3,532
NPg Planning Scenario	1,104	1,803	3,036	3,532
Falling Short	746	875	1,272	1,544

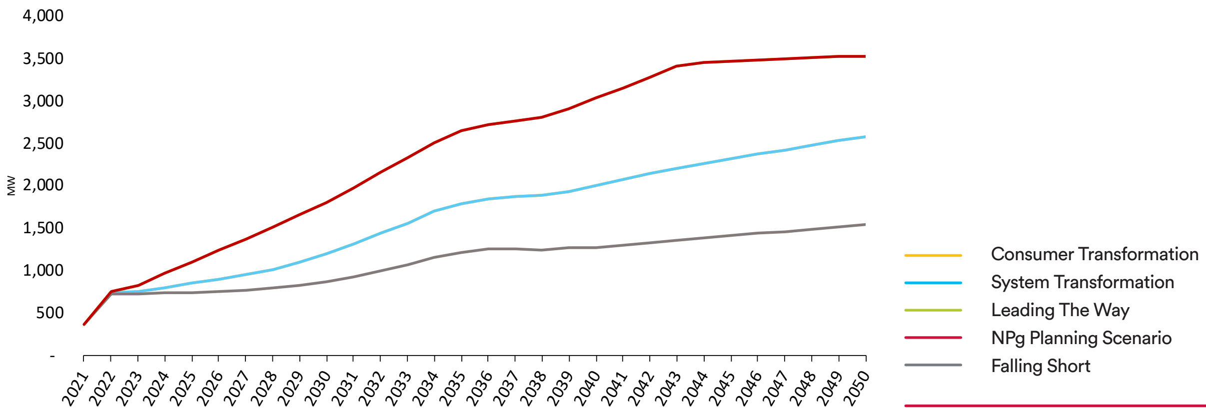


Figure 15:
Large scale PV capacity (MW)

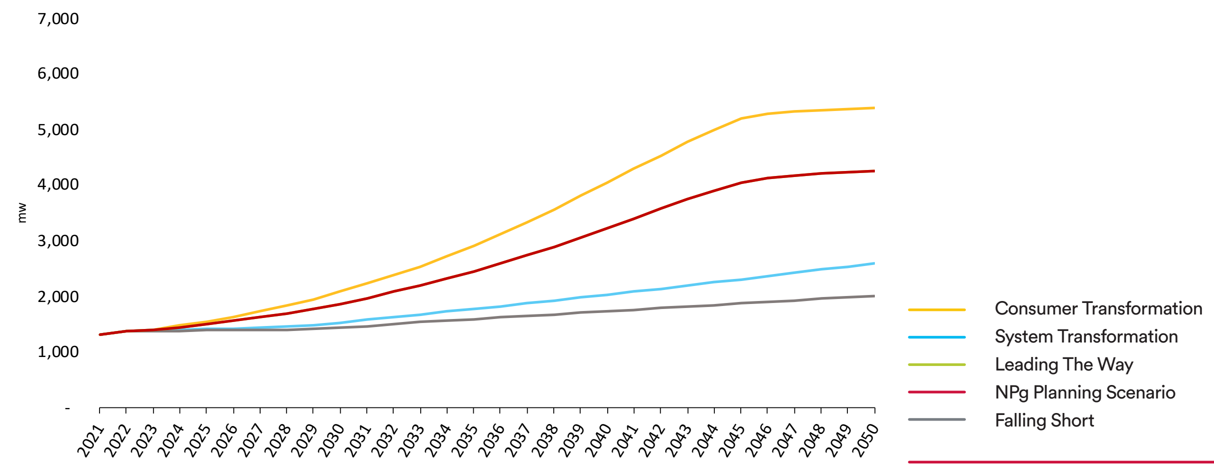
Large scale solar is less prominent in Consumer Transformation as the pathway favours smaller and more decentralised generation. However our experience at Northern Powergrid is showing substantial growth in large solar projects and local area energy plans (LAEPs) are expressing similar ambition.

Generation

Wind

	2025	2030	2040	2050
Consumer Transformation	1,553	2,091	4,059	5,384
System Transformation	1,418	1,538	2,039	2,606
Leading The Way	1,503	1,874	3,237	4,264
NPg Planning Scenario	1,503	1,874	3,237	4,264
Falling Short	1,393	1,436	1,739	2,020

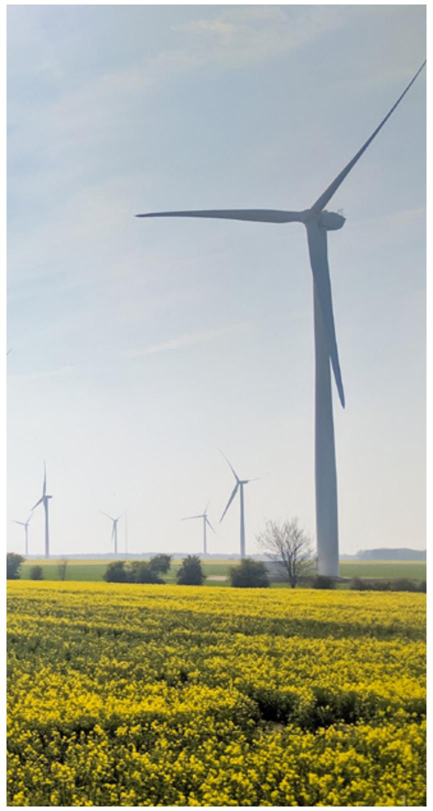
Figure 16:
Wind energy capacity (MW)



We assume that all future wind connected to our network will be onshore as offshore has higher capacity connections that typically suit a transmission interface. As noted in the change section of this document the onshore wind ambition in Consumer Transformation has increased. We are currently sharing the Leading The Way ambition for wind in our Planning Scenario. However we are keeping a careful watch on the Consumer Transformation higher projections too because we are beginning to see ambitious onshore wind capacity in local area energy plans. The current incentives for onshore wind have not yet persuaded us to move to the higher projection though.

There are ongoing conversations at a national level about removing the de facto moratorium on onshore wind. If the ban is lifted this may impact our data projections in next year's (2023) DFES.

Storage requirements are similarly lower in the System Transformation (hydrogen-forward) pathway.



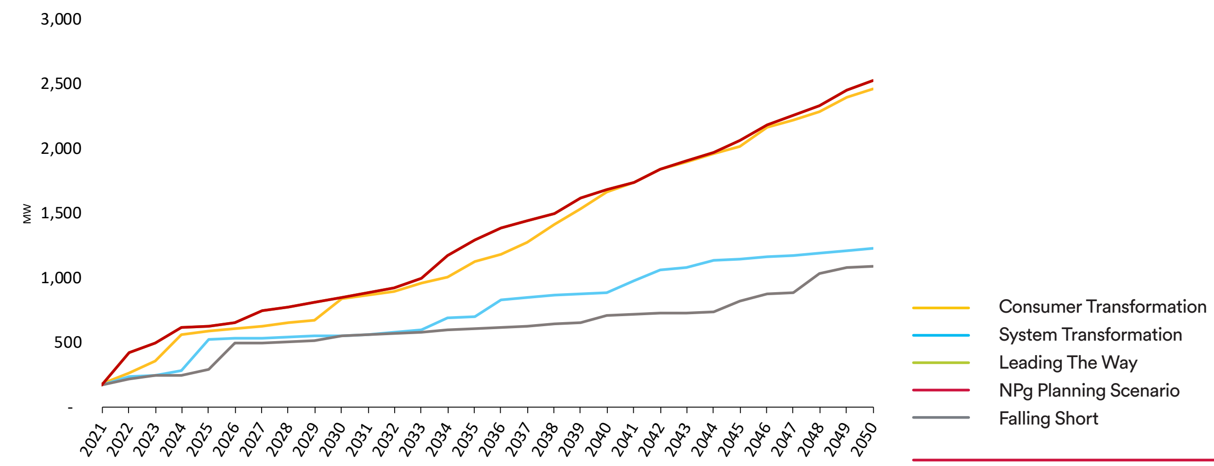
Goole Fields wind farm in the East Riding of Yorkshire

Energy storage

Energy storage

	2025	2030	2040	2050
Consumer Transformation	591	837	1,667	2,466
System Transformation	525	557	891	1,226
Leading The Way	631	849	1,681	2,532
NPg Planning Scenario	631	849	1,681	2,532
Falling Short	289	556	709	1,092

Figure 17:
Energy storage capacity (MW)



All five DFES forecast an increase in energy storage capacity across our region by 2050, with the most rapid rate of uptake occurring in the 2030s LCT boom. For EVs, heat pumps and solar PV alike, the shift will result from combination of the improved cost benefit profiles of these technologies, regulation and policy to encourage LCT uptake (eg the 2030 ICE ban) and behaviour changes in wider society.

In the more ambitious scenarios like Leading the Way upon which our own Planning Scenario is based, there will be a symbiotic growth between energy storage capacity and the increasing flexibility requirements of the region as the need for the latter, facilitates the growth of the former. As more customers benefit from owning flexibility assets like batteries, energy storage will also increasingly be co-located with renewable generation to maximise the benefits of the two technologies under a single connection to the network.

Pillswood battery energy storage system at Cottingham, near Hull *Image credit: W Harmony Energy*

Concluding remarks on future energy projections

The next 10 years are the most critical since the Electricity Boards were founded in the 1940s. Historically, day-to-day safe and reliable operations' and not the climate emergency have been the biggest driver of our investments. That has changed today. No matter which of the scenarios presented in this document comes to fruition, we are already readying our network for significant change.

Our greatest concern at the moment is the level of uncertainty about what the future pathway will be. It is clear that there is wide variation. Therefore, we have to balance the need for proactive investment, to enable regional decarbonisation with the need to ensure efficient delivery at a time when customer energy bills are a significant issue due to the increase in wholesale energy costs.

Of particular help to our planning will be understanding the real operating regimes of the new technologies and having access to data that allows us to be more certain of their contribution to demand at the peak hour.

"The electrification of heat and transport will fundamentally change the way we all engage with energy.

Our DFES helps us predict and prepare for this change so that we can deliver a decarbonised future that meets the needs of the people we serve."

Jim Cardwell
Head of Distribution System Operation Policy

Accessing DFES

Our open data approach

We make all of our DFES data open and accessible to everyone. As one of our data partners, Open Innovations produces visualisations of our DFES data that show on regional maps where we can expect low carbon technology growth.

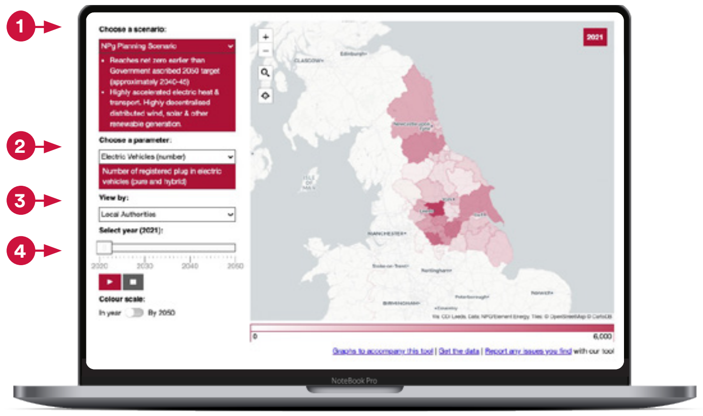
All of our DFES visualisations can be found on the Open Innovations website:
odileeds.github.io/northern-powergrid/2022-DFES/

How to use our data visualisation tool

1 Select scenario:
- Regionalised view of National Grid ESO's FES:
  - Steady Progression
  - System Transformation
  - Consumer Transformation
  - Leading the Way
- Based on Northern Powergrid's Best View scenario:
  - Planning Scenario

3 View by:
- Local authority areas
- Primary substations
- Primary substations (with local authority boundaries)

4 Scale:
- By 2050 – shades the map areas by reference to the maximum value (number, MW or MWh) 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



2 Select parameters, including;
- Electric car, bus and heat pump numbers
- Domestic photovoltaic installed capacity (MW)
- Large solar generation installed capacity (MW)
- Wind generation installed capacity (MW)
- Total renewable 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 EVs and heat pumps (MWh)
- Peak demand at primary substations (with and without customer flexibility)
- Peak utilisation at primary substations (with and without customer flexibility)
- Industrial fuel switching (including electrolyser use for hydrogen)

Clicking within the substation or local authority boundary will reveal the data relevant to that geographic area.

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 area (e.g. EV charging supplied by each substation).

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

The geospatial map includes a sliding bar for selecting the reference year and allows users to adjust the key variables.

Our DFES data sets

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 will 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 at 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.

All of our DFES data sets can be found on the Data Mill North website:
datamillnorth.org/dataset/northern-powergrid-dfes-2022

"Over the past decade it's been a pleasure to work on the DFES and witness the data transition from early prototypes through to the rich and mature industry standard models we use today. DFES helps us to understand how future low carbon technologies will impact our network and is helping facilitate wider conversations about future energy with customers and stakeholders in our region. It contributes to a carbon free energy future and I am proud to be part of it."

Mary Black
Senior System Forecasting Engineer

"Working on the DFES has been a great way to understand the present position of our network and the future energy scenarios that we have a big part to play in. In the transition to an increasingly active network with Distribution System Operation (DSO), it is increasingly important to build wider awareness of our network's capabilities and better understand our customers' requirements. It's a privilege to be part of our growing and diverse DSO team that is tasked with championing open data and supporting customers to be more involved in the region's transition to net zero."

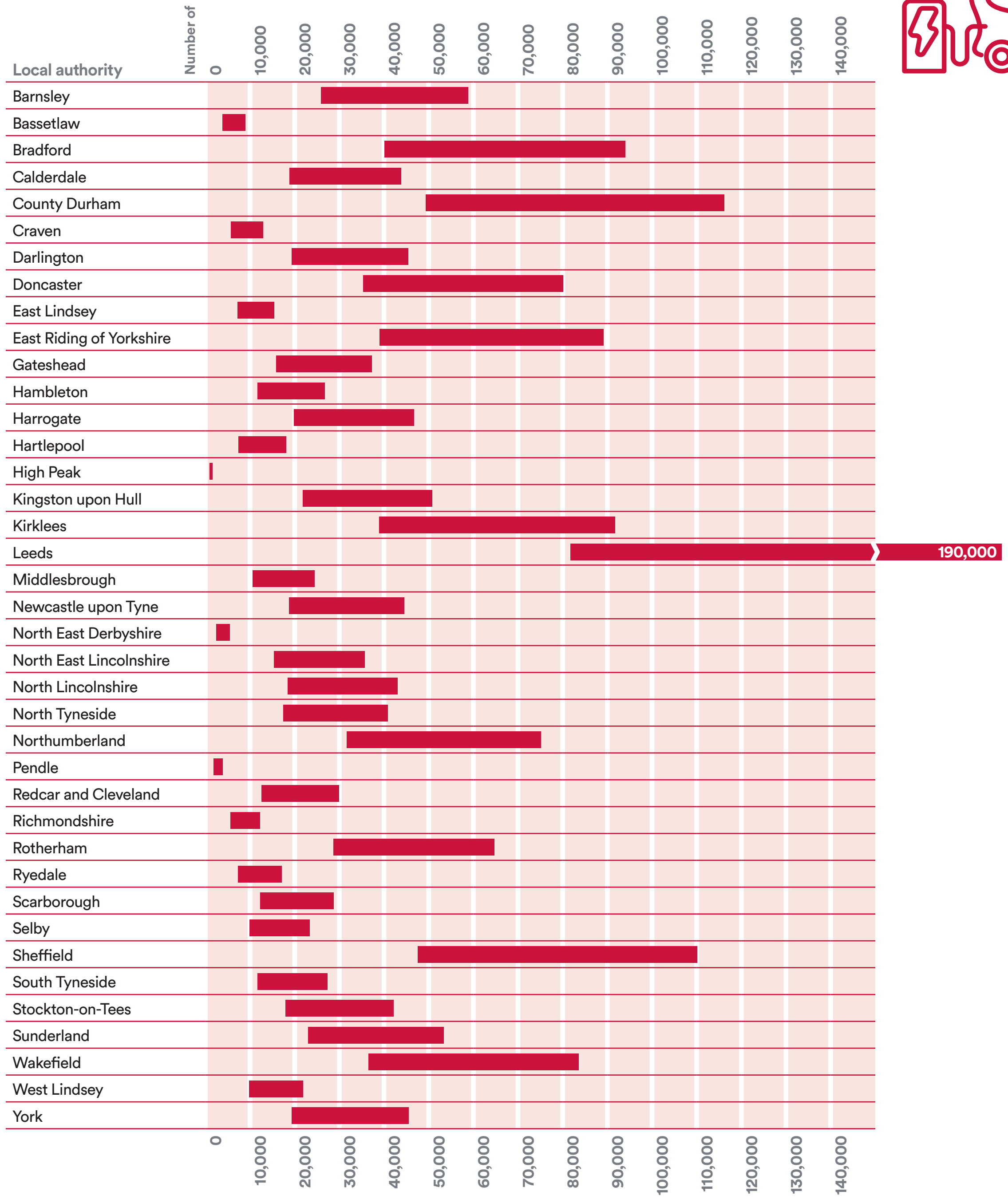
Neal Wade
System Forecasting Engineer

Using our data

We publish our data in two views. One view shows the future energy projections at each of our substations and is useful to stakeholders looking to connect to our network.

The other view shows projections by local authority. This view is something we are now actively using to understand local area energy plans that are being published. In turn LEPs can make use of the DFES projections by Local Authority area for their own strategic future energy planning purposes.

Figure 18: Our electric vehicle predictions by local authority (by 2030)



Case study: Transport for the North

Using DFES to help plan regional EV charging

In November 2022, Transport for the North launched its Electric Vehicle Charging Infrastructure (EVCI) model. The bespoke framework was developed to support local and national planning for EV charging infrastructure to meet growing present and future need.

Transport for the North applied a whole systems data driven approach to capture information like road users, socio-economic data, land-use information, housing data, predicted EV numbers and sub-station geographic distribution to deliver the comprehensive EVCI framework that maps EV charging needs across the region.

The framework identified the need to install 161,000 EV charge points across the north by 2030. Currently there are 8000 EV chargers installed across the region, 5% of the 2030 target. Transport for the North estimates that, 470 new charge point installations are needed per week between now and 2025, increasing to 620 new installations per week between 2025 and 2030.

One of the data sources that informed the EVCI was our DFES – which Transport for North used to inform the geographic distribution of required chargers, relative to the location of DNO substations and network capacity. It also applied the open DFES data to run some costing estimates for the energy and substation capacity requirements of this increased EV charging need.

This partnership is just one example in which our open source DFES data can support the regional transition to net zero. By informing Transport for North's EVCI, we can help our partners enable the regional acceleration of EV charging infrastructure, all while ensuring that the plans for increased EV charging is captured in our data to inform how we invest in the network that serves the North East, Yorkshire and northern Lincolnshire

In future we hope to extend our collective thinking with Transport for the North. Applying the DFES, DNO insights and the ECVI framework to explore how we can:

- Map charging need outputs more closely to our network assets – linking charging needs to capacity and demand needs at a regional level;
- Explore where network reinforcements may be necessary to enable high-capacity charging hubs; and
- Continue to inform scenario and network planning data so that we deliver an energy system that meets the needs of the region we serve.

> **It is important that the delivery of charging infrastructure is user-centred, placed-based and outcome-focused, and to achieve this a data driven approach is paramount. In this way, we can work with our data and delivery partners like Northern Powergrid to ensure access to EVs is equitable, accessible and inclusive.**
>
> **Simon McGlone**
> Senior Major Roads Planning and Strategy Officer, Transport for the North

Glossary

Climate Change Committee (CCC): Independent, statutory body that advises the UK and devolved governments on reducing greenhouse gas emissions (GHG) and adapting for climate change impacts.

Decarbonisation: The reduction, and ultimately elimination, of GHG emissions.

Demand Side Response (DSR): Changes in the power consumption of an electric utility customer to match the demand for power with the supply. Often supported with financial incentive.

Digitalisation: Focused digital and technology agenda that supports the integration of digital technologies to improve Northern Powergrid's everyday business activities.

Distributed generation (DG): Embedded and distribution connected generation; these are generators connected to the distribution system, rather than the transmission system.

DNO: Distribution Network Operator – DNOs own, operate and maintain the electricity distribution networks.

DSO: Distribution System Operation – the secure operation and development of an active distribution system comprising of networks, demand, generation and other flexible DER. Northern Powergrid is currently performing functions of DSO today and growing the scope and scale of this activity through time as more LCTs are connected.

Electrolyser: A device that splits water into hydrogen and oxygen using electrical energy.

ESO: Electricity System Operator – National Grid ESO is the electricity system operator for Great Britain, managing national electricity flows to ensure that supply and demand are balanced.

EV: Plug-in electric vehicle, conventionally powered by a lithium ion battery.

GB FES: Future Energy Scenarios for Great Britain. The Energy System Operator's scenarios outline four different credible future of energy pathways for the next 30+ years. GB FES considers energy demand and supply on a wholesystem basis.

Flexibility: The ability to increase or decrease the production or consumption of energy at a given or requested time in order to support the wider electricity network and optimise capacity available for customers.

Geospatial mapping: Spatial analysis techniques that typically employs software capable of rendering maps, processing spatial data, and applying analytical methods to terrestrial or geographic datasets, including the use of geographic information systems.

Gross Demand: The total energy demand of a given region. It represents the quantity of energy necessary to satisfy consumption within the designated geographical region.

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.

Heat pump: An electrical device that transfers heat from a local source (air, ground or water) to the space to be heated. Typically uses three to four times less electricity than direct electrical heating due to the availability of heat from the local source. As the electricity system decarbonises, so does this sort of heat supply.

HEV: Hybrid electric vehicle that combines a conventional internal combustion engine (ICE) with an electric propulsion system powered by a battery. May plug-in to charge the battery or work on fuel only.

HGV: Heavy goods vehicle – any truck with a gross combination mass of over 3,500 kg.

HV: High voltage – electricity supplied between 1,000 and 20,000 volts.

Hydrogen: a fuel produced by separating hydrogen from other molecules using one of a number of processes.

ICE: Internal combustion engine – a heat engine in which the combustion of fuel occurs to power a vehicle. Traditionally run on petrol or diesel fossil fuels.

I&C: Industrial and commercial (sector).

Industrial fuel switching: The process of switching from traditional fossil fuels to low carbon fuels like biomass, hydrogen and clean electricity to power industry.

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.

Low carbon energy system: An energy system which uses energy sources that do not produce carbon dioxide emissions during operation, such as solar and wind.

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

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 emissions target which requires UK to reduce nearly all of its GHG emissions by 2050 (compared to 1990 levels).

Network constraints: Areas of the network where the demand or generation exceed the designed network capacity, voltage or fault level limits

Peak demand: The greatest amount of electricity used on the network within a given time period (typically a year).

RIIO-ED2 or ED2: The next regulatory price period, set by Ofgem, which runs from 1 April 2023 to 31 March 2028.

Solar PV: Solar photovoltaics – solar panels.

Time-of-use Tariff (TouT): 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 relative to the supply.

Building blocks and working with the other networks

Summary of key input assumptions by scenario

Category	Sub-category	Planning Scenario	Consumer Transformation	Falling Short	System Transformation	Leading the Way
Domestic	Thermal efficiency	Medium	High	Low	High	High
Domestic	Appliance efficiency	Medium	Medium	Low	Medium	High
I&C	Energy efficiency (all types)	High (rapid rollout pre 2030)	High	Low	Medium	High
EV scenario	Uptake scenario	High	High	Low	Medium	High
HP scenario	Domestic HPs	Medium in ED2 rising to High in 2050	High	Low	Medium	High
PV scenario	Solar generation (plant greater than 1MW)	High	Medium	Low	Medium	High
PV scenario	Solar generation (plant less than than 1MW)	High	High	Low	Medium	High
Wind scenario	All	High	High	Low	Medium	High
Electricity storage	Short duration (< 2 hours)	High	High	Medium	Low	High
Electricity storage	Medium duration (2 - 4 hours)	High	Medium	Low	Medium	High

All DNOs produce a Best View Scenario as part of our DFES, this best view being the single scenario that reflects the highest certainty over the next 1-10 year period. By offering a Best View Scenario, we hope to offer more clarity about demand and generation patterns regionally in the short term and to remove the complexities of multiple scenarios for stakeholders.

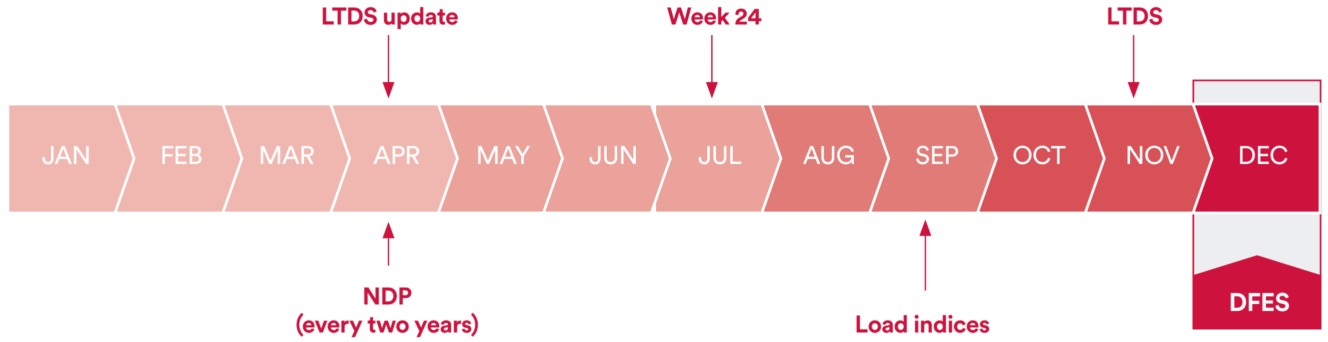
In developing our Best View Scenario, we are working to three justification criteria that ensure all network operators are aligned in their approach.

- alignment with existing and announced Government policies;
- consideration of stakeholder engagement inputs; and
- use of regional and local characteristics.

Assumptions for key inputs in the Planning Scenario

Key building blocks	Assumptions
Electric vehicle uptake	— In line with the Government's Ten Point Plan, it assumes a ban on new Internal Combustion Engines (ICEs) by 2030 and includes a ban on hybrids by 2035
Heat pump uptake	— In line with the CCC's Balance Pathway scenario, it meets the Government's Ten Point Plan targets of 600,000 heat pumps being installed annually by 2028 — It assumes a ban on the sale of new gas boilers from 2025
Energy efficiency	— Domestic thermal efficiency is assumed to be moderate. Appliance efficiency assumptions meet current EU targets for 2030 — I&C energy efficiency is aligned to EU energy efficiency targets
Renewable energy sources	— Solar PV assumptions based on high large solar uptake and high domestic PV take up reaching 3402 MW by 2030 and 8723 MW by 2050 — Wind assumption supported by recent wind turbine sizes and behaviours reaching 1874 MW by 2030 and 4264 MW by 2050

Annual timeline for network planning reports



Forcasting outputs are reported in several annual reporting & network planning processes including Distribution Future Energy Scanarios (DFES), Week 24 submission to ESO/TO and Long Term Development Statement (LTDS). These outputs are for data used in network planning and other data worth sharing with stakeholders.

DFES focuses on forecasting outputs that are used as inputs in network impact assessments. Results of network impact assessments such as the capacity headroom information is presented in the Network Development Plans (NDP) for all DFES scenarios.

Contact us

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

Please contact us if you have any questions.