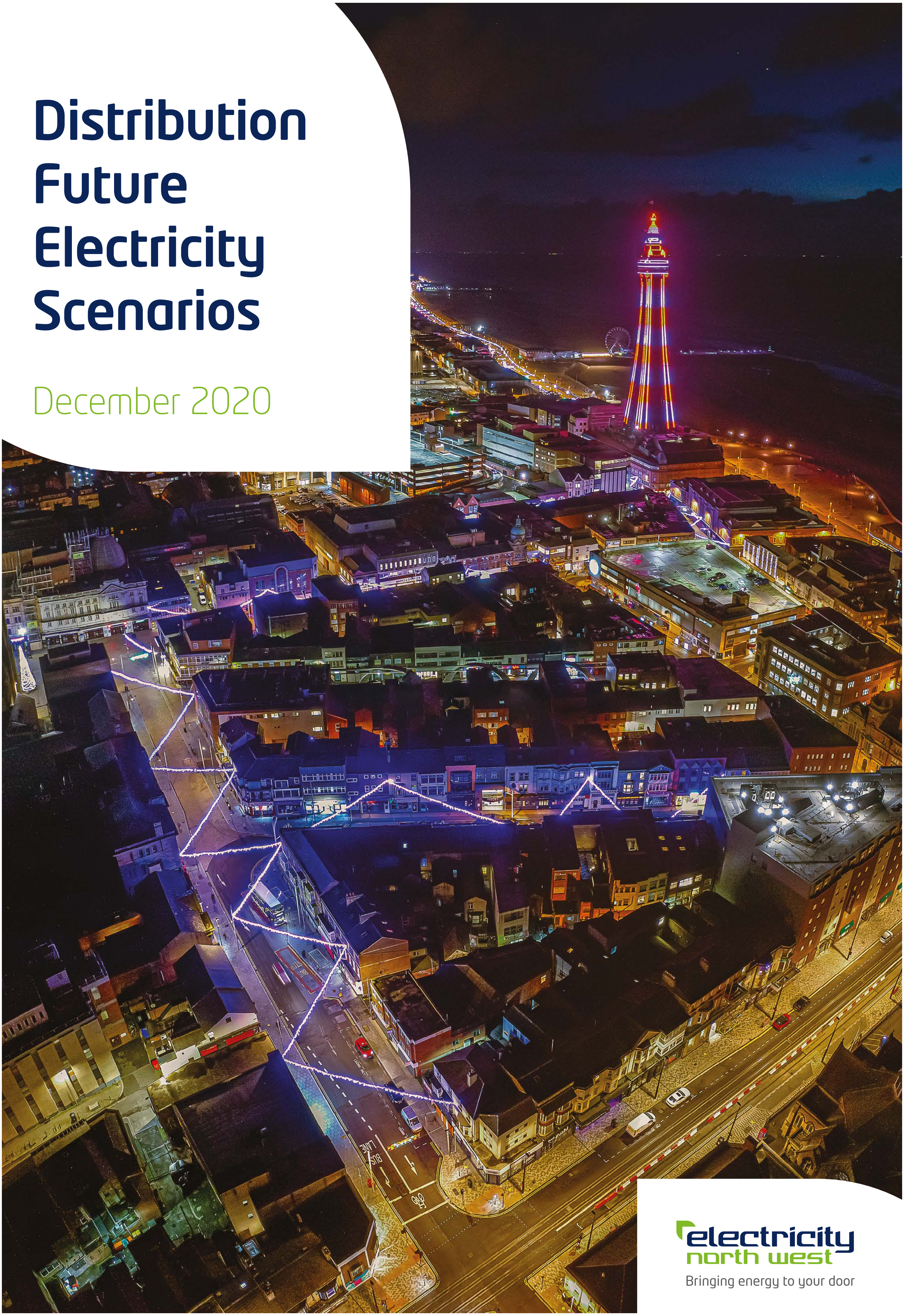
Distribution Future Electricity Scenarios

December 2020



electricity north west

Bringing energy to your door

Contents

Welcome to our annual Distribution Future Electricity Scenarios (DFES) document in which we share our view of the North West's future electricity landscape.

This year's unprecedented global pandemic has had a huge impact on the communities we serve. It has also changed the way we use electricity, reinforcing the uncertainty that surrounds future energy trends. As the North West's electricity distribution network operator (DNO), we have kept the power on for our customers and we will continue to do so as our region recovers from the pandemic. As a strategic stakeholder, we will strive to help our region 'build back better' in line with the government's Energy White Paper and Green Recovery Roadmap.

In 2019 the UK became the first major economy to legally commit to cut its greenhouse gas emissions and achieve net zero carbon by 2050. In 2020 the government announced an ambitious interim target to achieve a 68% reduction in emissions from 1990 levels, by 2030. Here in the North West we are supporting our stakeholders' ambitions to deliver net zero even sooner than the national target. Cumbria County Council and Greater Manchester Combined Authority (GMCA) have announced their intention to reach net zero carbon by 2037 and 2038 respectively.

We are committed to making sure our network is fit for the future, to meet the changing needs of our customers and to lead the region on our journey to net zero carbon. Our Leading the North West to net zero carbon plan sets out our plans to drive down our own carbon emissions, through innovation and investment in energy infrastructure, and to help our communities to do the same.

In this, our third annual DFES document, we are introducing our first net zero carbon scenarios for the North West. We have also incorporated the common GB electricity industry decarbonisation scenario framework which standardises high-level assumptions across the industry, allowing us to support whole system thinking and deliver a consistent approach for our stakeholders. At the same time, as the region's DNO, we are ideally placed to assess local trends using our 'bottom-up' methodologies, together with information from our cycle of engagement with local stakeholders.

Our DFES continues to serve a primary planning purpose for our distribution network. Shortly after this publication we will publish our Regional Insights document, in which we present the impact of the demand and generation forecasts, included in this year's DFES, on our local networks.

In 2022 we will publish our first Network Development Plan, in accordance with the EU Clean Energy Package agreement. This new energy rulebook will facilitate the transition from fossil fuels to cleaner energy and help deliver on the commitments of the Paris Agreement to reduce greenhouse gas emissions. Together with our DFES document and Long Term Development Statement, this plan will provide a comprehensive overview of our future plans for the region's electricity network.

Apart from network planning, our scenarios also provide useful insights and information to support the decarbonisation plans of our stakeholders, including our region's local authorities and our customers. In recognition of the increasing need for data transparency, we have once again published our DFES workbook. Our local stakeholders can benefit further by combining our DFES with our decarbonisation pathways. Developed in conjunction with Cadent, our main regional gas network operator, we have recently produced detailed pathways for Greater Manchester, Lancashire and Cumbria.

By providing this detailed description of the potential changes in future energy use, our DFES has proven to be an invaluable planning tool and will ultimately inform our RIIO-ED2 business plan (2023-2028). We hope you find this document useful and informative. If you have any comments or feedback, please contact us.

DFES and other planning documents

Stakeholder engagement
Ongoing
DFES considers local stakeholder plans and actions together with national policies and regional data.

Distribution Future Electricity Scenarios
December (annual)
A range of scenarios for electricity demand, distributed generation and storage from today until 2050.

Long Term Development Statement
November (annual)
Future distribution network requirements for the next five years.

Regional Insights (RI)/Network Development Plan (NDP)
Regular
RI (for 2021) contains future network impacts based on all scenarios in the DFES. NDP (from 2022), part of the EU Clean Energy Package, details future distribution network requirements for five to ten years beyond publication.

Steve Cox
Engineering and technical director
December 2020

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Our DFES 2020 at a glance

2020	Scenario	2030	2040	2050
23 TWh annual electricity	Steady Progression	26 TWh	30 TWh	32 TWh
		540,000	1.7 million	2.6 million
		100,000	330,000	500,000
		1.6 GW	1.9 GW	2.1 GW
		0.2 GW	0.3 GW	0.4 GW
12,000 electric vehicles	System Transformation	28 TWh	33 TWh	34 TWh
		760,000	2.3 million	2.8 million
		115,000	390,000	530,000
		1.9 GW	2.4 GW	3.1 GW
		0.5 GW	0.6 GW	0.9 GW
13,000 heat pumps	Central Outlook	29 TWh	36 TWh	38 TWh
		1.0 million	2.8 million	3.0 million
		120,000	430,000	650,000
		2.1 GW	3 GW	3.7 GW
		0.5 GW	0.7 GW	1 GW
1.5 GW of zero carbon generation	Consumer Transformation	29 TWh	38 TWh	45 TWh
		1.0 million	2.8 million	3.0 million
		160,000	1.1 million	2.5 million
		2.1 GW	3 GW	4.1 GW
		0.5 GW	0.7 GW	1 GW
85 MW of battery storage	Leading the Way	29 TWh	42 TWh	45 TWh
		1.0 million	2.8 million	3.0 million
		200,000	1.8 million	2.5 million
		1.9 GW	2.6 GW	3.4 GW
		0.6 GW	1 GW	1.4 GW

Impact on network

Greater reliance on electricity

Electricity use is expected to increase by 40% before 2030 and more than double by 2050. As customers become increasingly reliant on electricity, network resilience will be critical.

Electrification of transport

The number of electric vehicles on our region's roads is expected to increase to 0.5 - 1 million before 2030. We will need to understand their location and charging rates to define the effects on different parts of the network.

Net zero carbon renewable generation

By 2050 photovoltaic capacity is predicted to be four times higher and wind generation is expected to double. Active Network Management will support more local generation.

Storage

High penetration of renewable energy capacity could trigger a high uptake of grid-scale battery storage.

Electrification of heating

The installation of over a million heat pumps before 2040 could accelerate decarbonisation and support an early net zero carbon transition before 2050.

Action required

Wide participation

Central and local government are expected to introduce policies to improve efficiencies, decarbonise generation and reduce emissions in transport and heating.

Act now

Key actions to speed up decarbonisation before 2030 and support the government's 'Energy White Paper and '10-point plan' for a green industrial revolution include improvements in heating efficiency, photovoltaic installations and the electrification of transport.

Green recovery

We will support the government's Green Recovery Roadmap to help bounce back from COVID-19 and facilitate net zero carbon by 2050, by deploying a wide range of actions from Active Network Management to supporting electric vehicle charging at motorways.

Smart and flexible solutions

Increased visibility of lower voltage networks using smart meters and other new measurement techniques is key to deploy cost efficient smart solutions such as our Smart Street project and procure flexibility to avoid stranded or overloaded network assets.

Domestic electric vehicle charging for all

The increase in electric vehicles on our roads will necessitate the provision of sufficient capacity and the right equipment for customers to charge their electric vehicles at home safely.

1 Introduction

As part of our region's transition to net zero carbon, we need to consider the ways we will consume, generate and store electricity in the future, to ensure we are able to maintain an affordable, safe and resilient electricity distribution network.

In this, our third annual DFES document, we present updated forecasts up to the year 2050 and, for the first time, we include scenarios which achieve the UK net zero carbon target.

Our DFES will help us to continue to meet the growing needs of our 2.5 million customers by facilitating the electrification of transport and heating, the growth of renewable distributed generation (DG) and the wider decarbonisation plans of our stakeholders.

Green recovery

During the first three months of 2020 renewable energy made up almost half of the country's electricity consumption. In June 2020, we saw a record-breaking two-month period during which no coal was burned to generate electricity, the longest period since the industrial revolution.

Just a year after the UK became the first major economy to announce a 2050 net zero carbon emissions target, the UK government announced its Green Recovery Roadmap which outlines the actions needed to progress a net-zero aligned economic recovery from the impact of COVID-19. In late 2020 the government also announced its ten-point plan for a green industrial revolution and published its Energy White Paper.

Recognising the need for coordinated and systematic actions for a cleaner energy system, the UK has committed to follow the EU Clean Energy Package. As part of this new energy rulebook, all GB network operators are required to publish a Network Development Plan (NDP) every two years. We will publish our first NDP in 2022, setting out how we plan to develop our network over the next five to ten years, based on our latest DFES.

Document objectives

The main objective of this document is to present our forecasting scenarios for electricity demand, DG and battery storage which are used in our network planning. As a result of our work on the Open Networks project our scenarios are focused on whole system thinking and are aligned with the DFES of other network operators and the National Grid electricity system operator's (ESO) Future Energy Scenarios (FES).

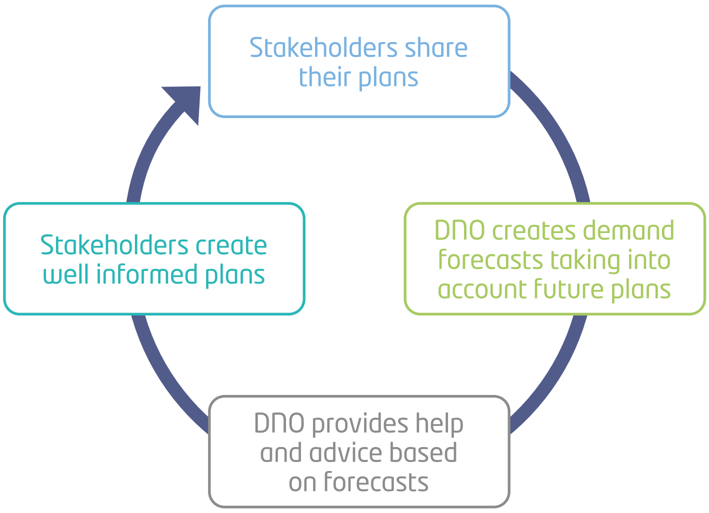
The future levels of electricity demand, DG and battery storage are expected to be significantly affected by the level of societal change, the progress of decarbonisation plans and by uncertainties around the future role of hydrogen and its interaction with electricity in a net zero carbon future.

As part of our network planning process, we consider these scenarios to deliver the most cost-efficient interventions. This, in practice, means that traditional network reinforcement options are considered along with flexible services and innovative solutions to allow, among other things, the connection of electric vehicle (EV) charge points, heat pumps and sources of renewable generation.

Engaging with our stakeholders

The development of our DFES is discussed as part of our cycle of engagement with our stakeholders. We take direct inputs from local authorities, as well as our industrial and commercial (I&C) customers.

Our cycle of stakeholder engagement



Our forecasts are then published in this DFES document and associated workbook to help our customers and local authorities develop their plans.

We also provide additional advice to support local stakeholders with their plans via direct contact at the planning stage, and as part of a wider whole energy system approach that goes beyond electricity. For example, we have recently produced decarbonisation pathways for Greater Manchester, Lancashire and Cumbria.

Both our DFES and regional decarbonisation pathways are important components of our stakeholder engagement as they provide useful insights to inform decarbonisation plans for local authorities and other stakeholders.

Document structure

This document comprises three further main sections:

- Section 2 outlines our five scenarios within the common framework adopted across the GB electricity industry
- Section 3 presents electricity demand-related forecasts for all scenarios. These include maximum demand that is a key part of our network planning, as well as forecasts of low carbon technology uptake focusing on EVs and heat pumps
- Section 4 presents electricity generation and storage forecasts for all scenarios. These include photovoltaics (PV) and wind capacities, which are the most dominant types of DG, as well as battery storage.

Once again, this DFES document is accompanied by a data workbook of detailed forecasting outputs for all scenarios including tables and charts. The data covers maximum and minimum electricity demand, EV and heat pump uptakes, DG and battery storage capacity across the whole of our region.

We are aware that many stakeholders are keen to understand what our scenarios specifically mean to them. Therefore, our interactive workbook allows you to examine what the scenarios mean for one or more supply areas. This allows local authorities and communities to examine our forecasts on a local basis to understand possible future uptake levels of low carbon technologies and DG capacities in their region, along with the associated electricity demand.

Continuous improvement

In a continually changing energy landscape, it is important that our DFES evolves. As one of our key decision-making tools, we are seeking further input from regional stakeholders on the future of electricity in the North West to support the continuous improvement of our DFES.

Please provide your feedback via email to development.plans@enwl.co.uk.

Defining the net zero carbon scenarios

The transition to net zero carbon goes beyond electricity and requires wider action across all energy vectors including transport, industry, heating and aviation. It also requires societal change in the way energy is used. For example, energy efficiency is a key initiative for accelerating decarbonisation.

To produce our scenarios, we needed to identify what net zero carbon means for electricity distribution in the North West. To do this we worked with our expert partner, Element Energy, who has analysed studies from the Committee on Climate Change, the Energy Systems Catapult and National Infrastructure Committee. This analysis defined what is required to meet the net zero target in the North West in terms of the volumes of EVs and heat pumps, renewable generation capacity and the efficiency measures needed in the domestic and I&C sectors. This analysis has also identified how all these electricity-related components would be affected if hydrogen were to take a dominant role in the future.

Our DFES differs from other net zero carbon transition scenarios as it provides long-term forecasts of future levels of demand and DG, rather than a centrally planned pathway to achieve net zero carbon. To achieve this, we continue to use models that show the impact of customer choice and societal change.

The way we develop our net zero scenarios highlights the necessary national and local conditions needed to incentivise our customers to decarbonise their activities or invest in low carbon technologies.

For example, our modelling considers how bringing forward policies to ban internal combustion engine (ICE) vehicles can incentivise more customers to start using an EV. Our forecasts also consider how access to gas networks could discourage customers from the early adoption of heat pumps and how policies incentivising low carbon heating can make a difference.

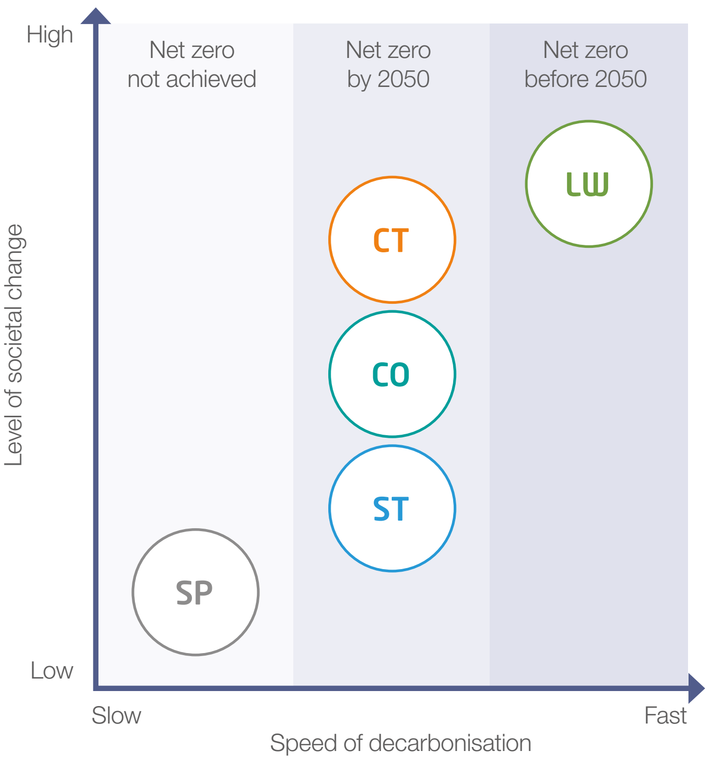
The 2020 scenarios

We have produced a set of five scenarios: **Steady Progression**, **System Transformation**, **Consumer Transformation**, **Leading the Way** and **Central Outlook**.

The first four have been defined using the same high-level assumptions across the industry. **Central Outlook** is an additional scenario that, in line with our previous DFES, considers those central assumptions relevant to our region.

All scenarios are modelled using regional data and our unique bottom-up methodology developed as part of our ATLAS project, which makes them representative of the North West.

Our Distribution Future Electricity Scenarios 2020



Steady Progression (SP)
Slow decarbonisation
Not meeting net zero targets
Limited efficiencies

System Transformation (ST)
Hydrogen helps to meet net zero beyond 2040
Limited efficiencies

Central Outlook (CO)
Average assumptions across the other scenarios

Consumer Transformation (CT)
Electrification of transport and heating help to meet net zero
High uptake of renewable DG
High efficiencies

Leading the Way (LW)
Net zero before 2050
Early electrification of transport and heating

DFES as part of whole system forecasting

Four of our scenarios reflect the same high level assumptions and are defined using a common framework agreed with all GB DNOs and the ESO, with two axes to define the scenario assumptions: the speed of decarbonisation versus the level of societal change.

The aim of this alignment is to support whole electricity system thinking and ensure a co-ordinated approach.

The real value of this standardisation is to create a common language and familiarity for stakeholders when accessing electricity demand and generation forecasts from multiple organisations.

For example, use of this common language means that high uptake trends of EVs should be expected for Leading the Way across the industry. However, this does not mean that these trends follow the same trend across all regions or between regions within the same licence area.

Modelling local stakeholder plans

We can see from our engagement with local stakeholders that their ambitious regional net zero carbon targets are supported by their actions to accelerate decarbonisation. Local enterprise partnership and local authority plans and actions from I&C customers are key to help decarbonise the North West.

Decarbonisation plans and other planned developments from local stakeholders are modelled in our DFES to improve the accuracy of regional demand forecasts.

> We have enhanced our forecasting methodology to model decarbonisation plans and planned developments from local stakeholders, in addition to projects which already have quotes to connect to our networks.

An example is the Garden Village development in Tameside, Greater Manchester. Approximately 2,500 homes are proposed, 30% of which will be affordable. The local authority has secured Housing Infrastructure Funding for its development and is keen to drive low carbon synergies wherever possible. It is anticipated that provision for EV charging and heat pump technology will be required. The proposed programme for the construction of the development is expected to be phased from 2021 until 2028.

We concluded that this project should be included in DFES 2020 because it has local authority backing, it has secured funding and forms part of the Greater Manchester Spatial Framework. The same approach has been followed for other new developments.

DFES 2020 assumptions on electricity demand components

Demand components	Steady Progression	System Transformation	Central Outlook	Consumer Transformation	Leading the Way
Domestic thermal efficiency	Low	Medium	Medium	High	High
Domestic appliance efficiencies	Low	Medium	Medium	Medium	High
Domestic appliance volumes	High	High	Medium	Medium	Low
Non-domestic energy efficiency	Low	Medium	Medium	High	High
Domestic heat pumps	Low	Medium	Medium	High	Early high
Non-domestic heat pumps	Low	Medium	High	High	Early high
Electric vehicles	Low	Medium	High	High	Early high
Smart charging and vehicle-to-grid charging	Low	Medium	Medium	High	High
Air conditioning	High	Medium	Medium	Medium	Low
Demand connections (HV and LV networks)	Lower confidence	Historical confidence	Historical confidence	Historical confidence	Historical confidence
Local stakeholder plans	Lower confidence	Confidence based on project ranking	Confidence based on project ranking	Confidence based on project ranking	Confidence based on project ranking

DFES 2020 assumptions on distributed generation and battery storage

DG and storage components	Steady Progression	System Transformation	Central Outlook	Consumer Transformation	Leading the Way
Photovoltaics - small (<1MW)	Low	Medium	High	High	Medium
Photovoltaics - large (>1MW)	Low	Medium	Medium	Medium	High
Wind generation	Low	Medium	Medium	High	High
Combined heat and power plants	High	Medium	Medium	Medium	Low
Other renewable (hydro, biogas, biomass)	Low	Medium	Medium	Medium	High
Flexible generators (gas, diesel)	High	Medium	Medium	Medium	Low
Domestic batteries	Low	Medium	Medium	Medium	High
Non-domestic batteries	Low	Medium	Medium	Medium	High
Generation and battery connections	Only limited from accepted	Only accepted	Only accepted	Only accepted	Only accepted

3.1 Forecasts of peak demand

Our networks need to have enough capacity to meet the future electricity needs of our stakeholders. This means that across all voltage levels, our networks are required to accommodate peak demand to assure security of supply for all our customers.

Focus on true demand

To ensure we can meet our stakeholders' needs, we must evaluate the true (underlying) electricity demand placed on the network. This allows us to quantify demand when embedded generators are not operational, for example, in the dark when there is no solar generation or on calm days when wind generation is low.

From a whole system perspective, with the advance of Active Network Management systems on our networks, our ability to assess true demand will allow other network operators and the ESO to understand which effects on demand, seen locally and at the interface with transmission, are due to Distribution System Operation (DSO) functions or the normal load patterns of customers.

Demand growth up to 2030

Following a short period of demand reduction due to efficiencies and the effects of COVID-19 on commercial growth and EV uptake, demand is expected to fall and then return to 2020 levels by 2023.

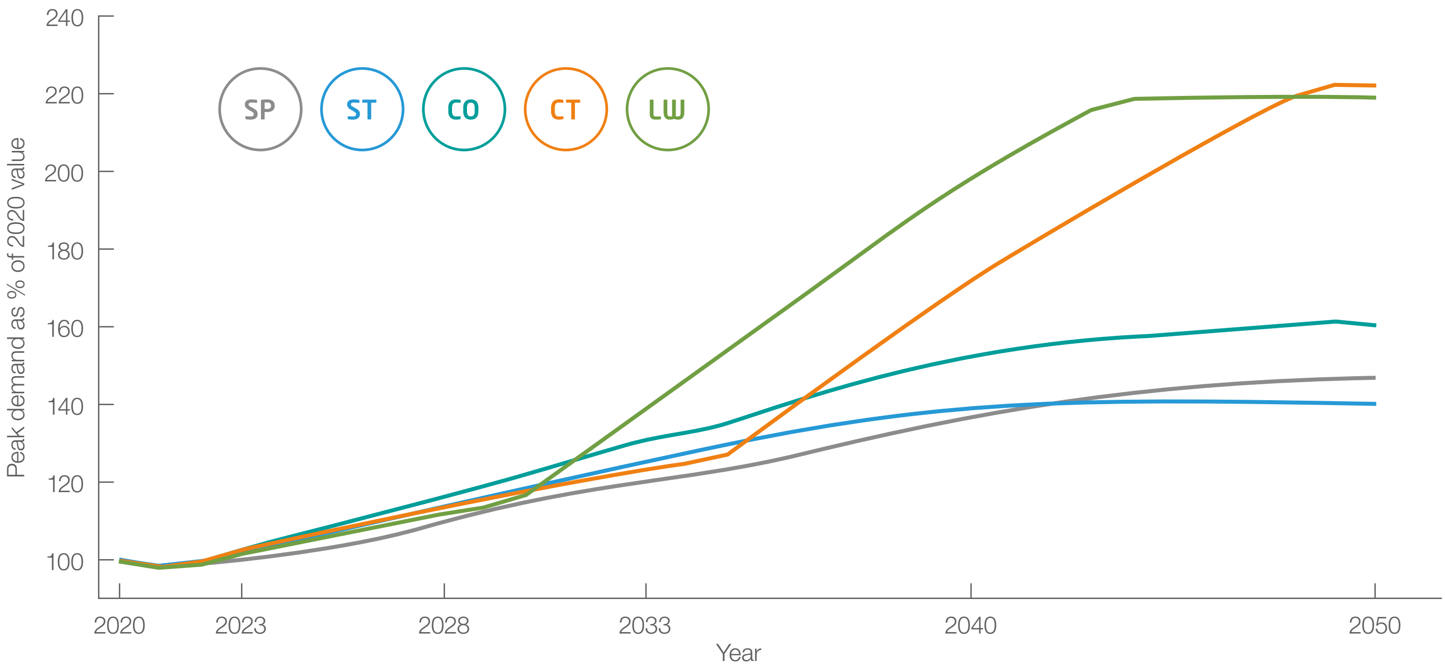
After 2023 and up to 2030, growth in demand is mainly driven by planned developments. These schemes include decarbonisation plans and other projects from I&C customers with formal offers to connect. Projects or decarbonisation plans that do not yet have a connection quote are included if they have strong backing from central and local government and have already secured funding, for example 'shovel ready' schemes that will benefit from the government's Getting Building Fund and are part of local authority spatial framework plans.

Confidence factors are used to model the likelihood of quoted and accepted connections to energise, as well as the expected peak demand they will realise compared to their contracted capacity. These factors are estimated based on the historical performance of a large sample of small and medium sized projects connected to the high voltage network. More detailed per project assessment is carried out for the larger projects connected at 132kV and 33kV networks. It should be noted that these projects are modelled using half-hourly through year demand profiles in line with our ATLAS methodologies. This allows proper bottom-up modelling, given that the effects of these projects at lower voltages can be different as they are aggregated at higher voltage levels due to the different times of peak demand across different locations and voltage levels on the network.

Steady Progression considers reduced confidence factors, recognising that in a world where the UK does not meet the net zero carbon target, many decarbonisation plans could be only partly accomplished. Factors such as lower economic prosperity levels could be a critical factor for not meeting the target. This results in **Steady Progression** showing the lowest peak demand growth by 2030.

Central Outlook and **System Transformation** exhibit the highest demand growth between 2020 and 2030. This is because these two scenarios consider average efficiencies that reduce domestic and I&C demand more than **Steady Progression** but less than the other two scenarios. Demand growth is slightly higher for **Central Outlook** due to the higher uptake of EVs in this period.

Future trends of annual peak true demand



Demand growth for **Consumer Transformation** and **Leading the Way** are in the middle of the scenario range within the period up to 2030. Even though both scenarios consider the highest levels of EV charging and all planned developments are expected to complete, high levels of energy efficiencies result in significant reductions for both domestic and I&C demand. The reduction is slightly higher for **Leading the Way**, as the highest levels of societal change see customers using less energy and more efficient domestic appliances.

The electrification of transport is increasing demand, but the long-term effects are mitigated as smart charging will shift demand away from peak loading.

Demand growth after 2030

The long-term uncertainties around the electrification of heating result in a wide range of peak true demand levels across the scenarios after 2030.

Early adoption of heat pumps in the **Leading the Way** scenario makes overall demand double by 2040, whereas **Consumer Transformation** meets similar levels closer to 2050. The effects of the highest efficiencies in **Leading the Way** are mitigated by the fastest decarbonisation achieved by customers incentivised to adopt more pure battery EVs rather than plug in hybrids compared to all other scenarios.

Central Outlook's true demand forecast is in the middle of the range as it does not consider high heat pump uptake, but its higher EV uptake compared to **System Transformation** and **Steady Progression** bring higher long-term demand levels than these scenarios. Due to the increasing levels of smart EV charging and vehicle-to-grid in the long term, the effects of EV charging at the time of peak demand are lower compared to the corresponding effects of heat pumps. This is the main reason that **Central Outlook** demand is closer to the bottom rather than the top end of the 2050 peak demand range.

System Transformation shows the lowest demand growth in the long term. This is due to the more dominant role of hydrogen in heating in this scenario after 2040 which brings peak demand below all other net zero carbon scenarios, and below **Steady Progression**, which exhibits the highest penetration of air conditioning in the long term.

3.2 Annual consumption of electricity

In many cases DNOs need to consider the loading of networks beyond times of peak demand. This allows us to quantify the requirements of flexible services, the derating of network asset capacity when demand stays close to the peak value throughout the day – known as continuous asset ratings – and the significance of minimum demand to forecast reactive power as presented in our two previous DFES publications.

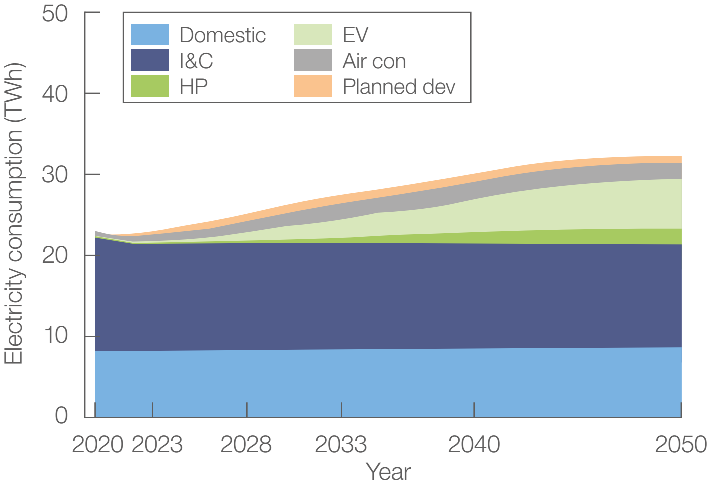
Our forecasts of annual electricity consumption are calculated using detailed half-hourly modelling through year and are indicative of how we expect our customers to use electricity in the future.

In **Steady Progression** the low levels of societal change are reflected in the limited effects of efficiencies in reducing domestic and I&C demand. They are also reflected in the high uptake of air conditioning in a society that focuses on comfort rather than willingness to achieve net zero carbon.

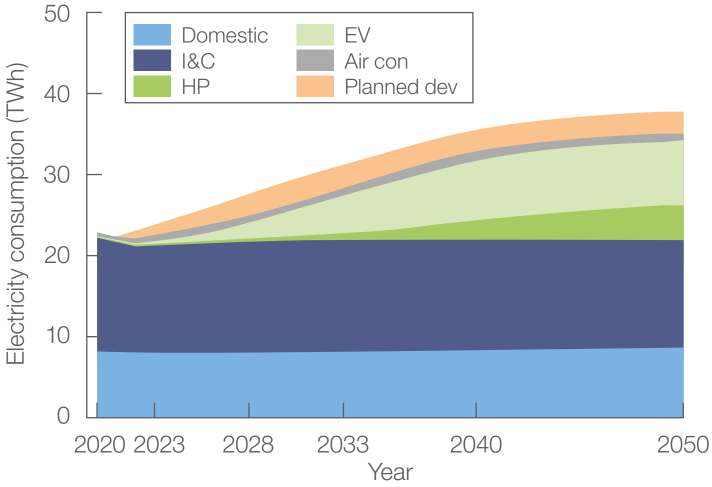
Annual electricity consumption is expected to double before 2040 to meet early net zero carbon targets as a result of the electrification of transport and heating.

In **System Transformation** there are moderate impacts from efficiencies in reducing domestic and I&C demand. The significant long-term role of hydrogen to meet the net zero carbon target limits the volumes of heat pumps in the system. EV charging is the major factor that increases overall electricity consumption for this scenario. However, the higher levels of smart EV charging in the long term limit the effects on peak demand.

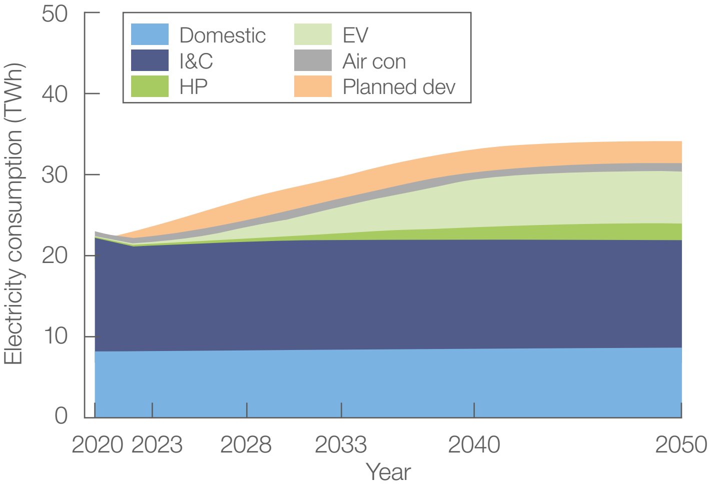
Future annual demand for Steady Progression



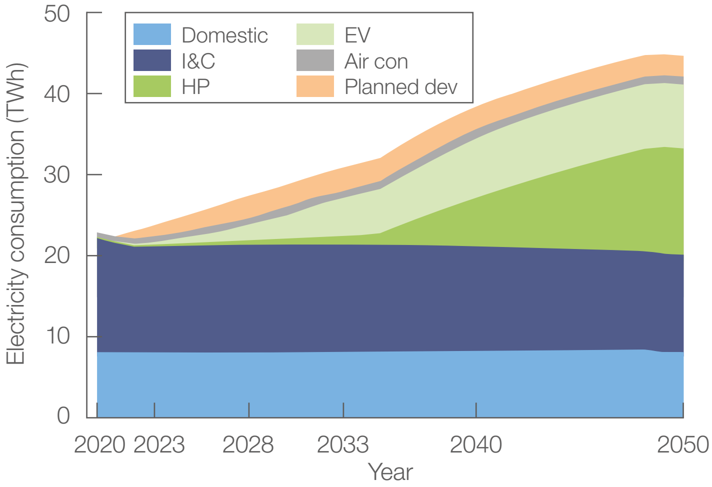
Future annual demand for Central Outlook



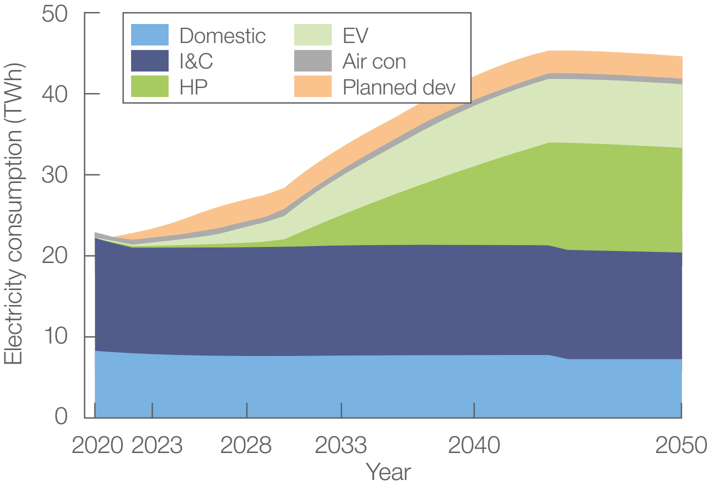
Future annual demand for System Transformation



Future annual demand for Consumer Transformation



Future annual demand for Leading the Way



In **Central Outlook** electricity consumption is mainly increased by high levels of EV charging. Long-term reductions in domestic and I&C demand due to efficiencies are offset by the high adoption of heat pumps by non-domestic customers.

In **Consumer Transformation** electricity consumption shows a very slow growth before 2030 as the increase in EV charging is offset by high levels of efficiencies in domestic and non-domestic demand. In the longer term, the high uptake of EVs and domestic heat pumps results in electricity consumption more than doubling after 2040.

Similar trends for overall electricity consumption are shown in the **Leading the Way** scenario. The higher demand reductions from domestic and non-domestic efficiencies are exceeded by the high uptake of heat pumps and pure battery EVs which consume more electricity than plug-ins.

3.3 Electrification of transport

According to BEIS 2018 figures, the transport sector accounts for around a third of the UK's carbon emissions and the transition to net zero carbon requires immediate action to speed up decarbonisation. The government's decision to bring forward the ban on sales of new petrol and diesel vehicles to 2030 is expected to be a critical contributor to the decarbonisation of transport.

To accelerate the transition to net zero carbon in the North West, it is likely that action plans and policies will be implemented, resulting in close to 2.5 million pure electric vehicles by 2040.

Future volumes of electric vehicles

Our scenarios consider forecasts of the volumes of cars and vans that require charging from electricity networks. This includes plug in hybrids (PHEV) and pure battery EVs (BEV). We have worked with Element Energy to forecast the volumes of EVs in our licence area. Customer choice has been modelled regarding the future willingness of our customers to adopt a BEV or PHEV instead of other vehicle types including diesel/petrol and hybrids.

We have used the Department for Transport (DfT) forecasts of the total EV numbers by 2050 across all scenarios. The scenario assumptions are also closely tied to recommendations in the Committee on Climate Change (CCC) technical report on policies required to achieve net zero carbon emissions by 2050.

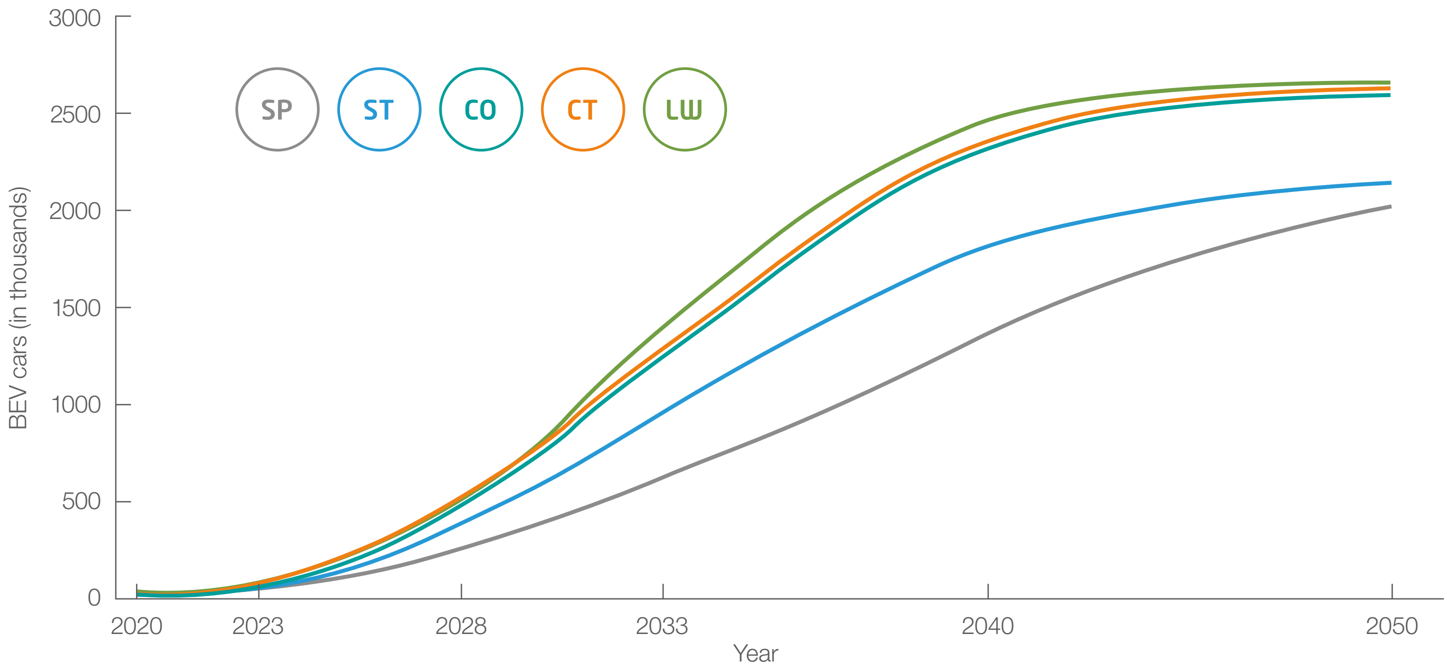
Steady Progression considers a 2040 ban on sales of new ICE and hybrid vehicles. Both BEV and PHEV vehicles show a continuous growth up to 2050 with an uptake trend that is the slowest across scenarios due to the late ban on petrol and diesel vehicles.

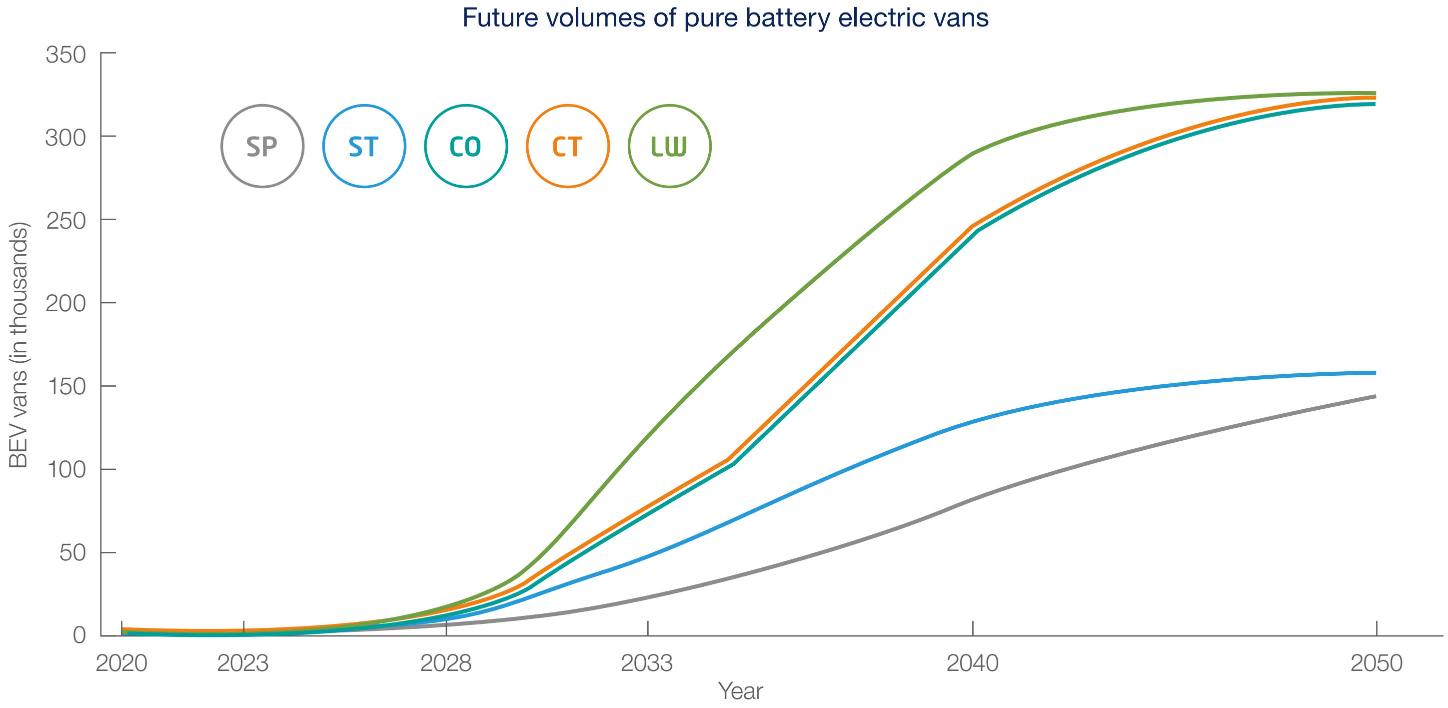
In **System Transformation** a 2035 ban on sales of new ICE and hybrid vehicles is in line with the 'at the latest' recommendation from CCC. This accelerates the adoption of BEVs compared to the Steady Progression scenario. In the longer term this scenario exhibits the highest uptake of plug in hybrids as new PHEVs are available in the market up to 2050.

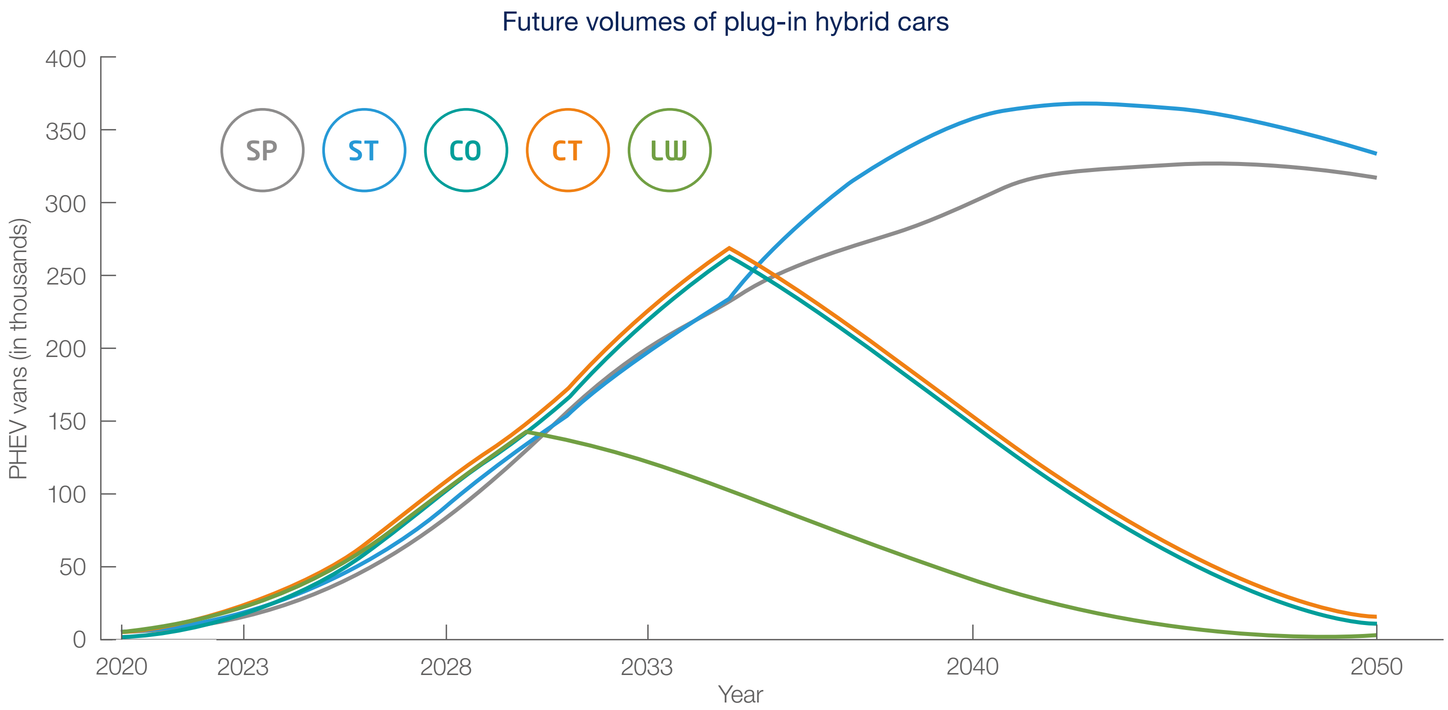
Central Outlook and **Consumer Transformation** consider the same EV uptake trends which are in line with the UK government's ten-point plan and Energy White Paper. The future BEV volumes in the two scenarios are driven high by the ban on new ICE and hybrids by 2030, which is also in line with CCC's more ambitious recommendations. New PHEVs are also banned after 2035, which has the consequent effect of increasing the volumes of BEVs in the long term with a more evident effect on vans.

Leading the Way goes beyond CCC recommendation to speed up the transition to net zero carbon before 2050. In this scenario, new ICE, hybrid and PHEV sales are banned after 2030. This provides a very rapid uptake of BEVs, whereas the volumes of PHEVs and the associated greenhouse gas emissions reduce faster than all other scenarios.

Future volumes of pure battery electric cars




Future volumes of pure battery electric vans
BEV vans (in thousands)
350
300
250
200
150
100
50
0
SP
ST
CO
CT
LW
2020
2023
2028
2033
2040
2050
Year


Future volumes of plug-in hybrid cars
PHEV vans (in thousands)
400
350
300
250
200
150
100
50
0
SP
ST
CO
CT
LW
2020
2023
2028
2033
2040
2050
Year

From vehicles to charging

Knowing the number of EVs registered in our area is not enough to understand how they are going to affect the loading of our networks.

Our network planning requires us to understand where, when and at what capacity the EVs in our area will be charged.

Our modelling considers local residential and non-residential charging. The geospatial data is taken from our Reflect NIA project (2019-2020 – working with Element Energy and the University of Strathclyde). Residential charging is assumed to be carried out mainly overnight for customers with access to off-street parking and is higher in areas with larger numbers of households expected to own an EV. Non-residential charging considers the locations of existing chargers, eg at service stations, car parks, supermarkets etc, and regional data around work and shopping locations.

The way that our customers are likely to charge their EVs is not only differentiated by the location, but is also expected to change through time. As more and more EVs appear on our roads and their batteries need to be charged, the loading of the electricity network will increase. To make best use of our existing network assets and to keep network charges low for customer bills, we will need to adopt smart EV charging to shift demand away from peak times.

Given our access to local measurements of half-hourly electricity profiles, we are well positioned to understand the times that electricity demand is expected to increase due to smart EV charging. Using our bottom-up modelling, demand shifts at local level are aggregated at higher voltages. This way our forecasts can improve planning of our higher voltage networks (33kV and 132kV), as well as provide valuable insights to the ESO and the transmission operator on the effects expected at the different interfaces with the transmission network.

3.4 Electrification of heating

According to Energy Systems Catapult, heating accounts for over a third of the UK's total carbon emissions. The decarbonisation of heating requires significant action from central and local government, as well as domestic and I&C customers.

This can be achieved via two main pathways:

- a fully electrified pathway with high uptake of heat pumps, and
- a less electric pathway where hydrogen plays a more significant role.

The recent announcement of the government's ten-point plan gives us more confidence in the way we model heat pump uptakes for new houses. As modelled across all scenarios, gas boilers in new houses are not expected to be an option for our customers after 2025.

However, what remains unclear is to what extent customers in existing properties will be incentivised to adopt a heat pump. Any further incentives for heat pump installation could result in significant uptake in the mid-2020s, which is not reflected in our current forecasts.

The role of hydrogen – our whole system approach

The future replacement of natural gas boilers with hydrogen-fuelled boilers could play a key role in the decarbonisation of the UK heating sector.

In 2020 we worked closely with Cadent, the region's main gas network operator, to develop decarbonisation pathways for Greater Manchester. As part of this work, our expert partner Guidehouse (previously known as Navigant) produced a balanced scenario that meets Greater Manchester's 2038 net zero target. In this balanced scenario, hydrogen plays a dominant role in the decarbonisation of 96% of properties in Greater Manchester, currently using traditional gas central heating. Similar decarbonisation pathways have been published for Lancashire and Cumbria.

Our work with Cadent has provided whole system insights to GMCA and has informed its approach to the decarbonisation of heating. Combined with our DFES, our decarbonisation pathways aim to supplement our engagement with local stakeholders and provide whole system insights. They provide minimum cost pathways with a whole system focus that can inform local stakeholder decisions, while our DFES is a set of forecasts which aim to capture future uncertainties around electricity demand and generation.

Our DFES 2020 takes into account the significant but long-term uncertainties around the role of hydrogen in the decarbonisation of heating. As highlighted in the electricity demand section, these uncertainties are the main factor driving the wide range of future peak electricity demand levels. In practice, this wide range means that we need to monitor any advances in the use of hydrogen as this could significantly affect load-related investment in our networks.

Future volumes of heat pumps

As with the forecasting of EV numbers, our forecasting of future volumes of heat pumps is based on customer choice. This is expected to be dependent on subsidies for net zero heat options, policies supporting the electrification of heating and their location.

> In the absence of hydrogen from the future heating landscape, over two thirds of our domestic customers would need to adopt a heat pump to meet net zero carbon before 2040.

All our scenarios consider the Clean Heat Grant, the government's proposed replacement for the Renewable Heat Incentive in 2022. They also take into account regional access to the gas network, given that off-gas customers are more likely to adopt heat pumps first.

In **Steady Progression** the heating sector does not achieve net zero carbon. Gas networks continue to supply local customers mainly with natural gas with a lower amount of biogas. Even though the installation of gas boilers in new buildings will be banned from 2025, existing buildings will still be able use gas boilers. This results in the lowest uptake of heat pumps across all scenarios, since heat pumps are likely to be installed mainly in new buildings located away from the gas network.

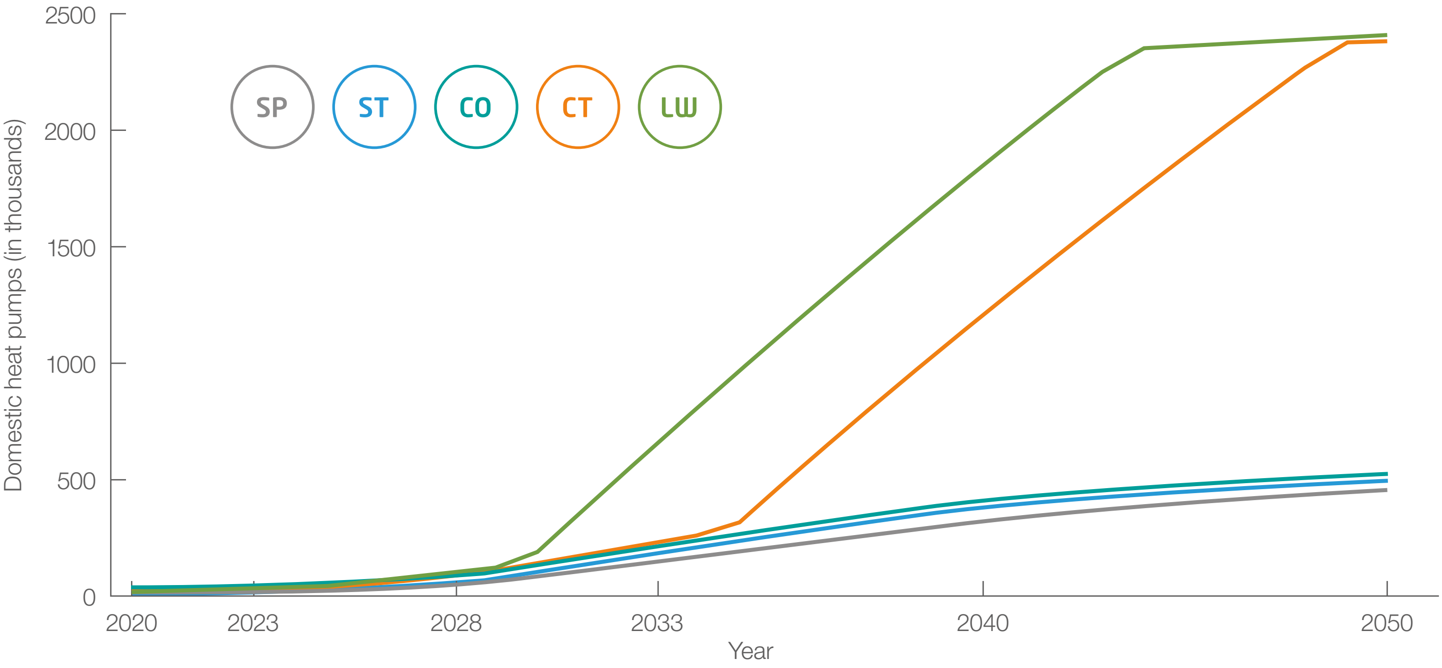
In **System Transformation** the future role of hydrogen is key to the decarbonisation of the heating sector. After 2040 all existing gas boilers switch to hydrogen. Heat pump uptakes are slightly higher than the **Steady Progression** scenario as the installation of oil and coal boilers in existing buildings is banned after 2030.

In **Consumer Transformation**, electrification is the main path to decarbonisation of the heating sector. Policies that support this transition, importantly, include the banning of gas boilers in existing buildings by 2035 and the banning of oil and coal boilers after 2027. These policies will incentivise customers to install heat pumps with the tipping point for high uptake of heat pumps coinciding with the 2035 ban on gas boilers.

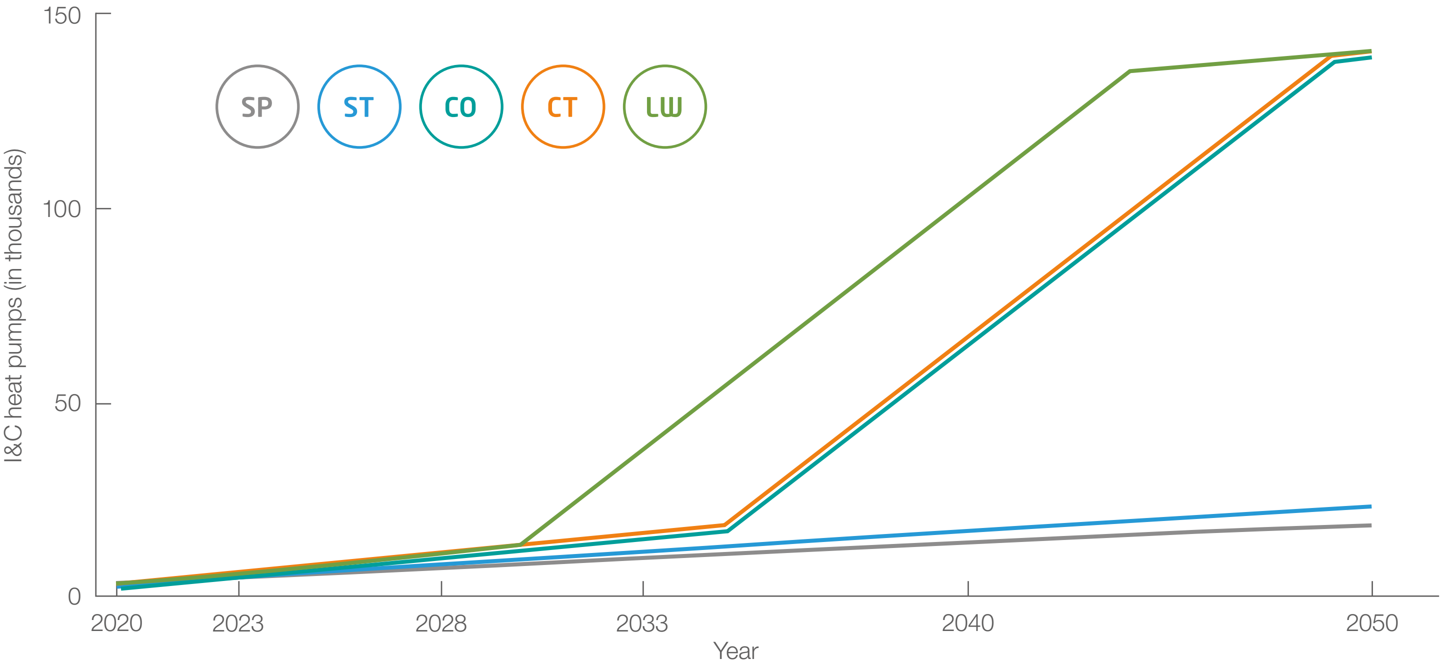
In **Leading the Way**, the electrification of heating is accelerated to meet net zero before 2050. This is achieved mainly by banning gas boilers in existing buildings after 2030. Over two thirds of domestic customers adopt a heat pump before 2040 to achieve the early decarbonisation of the heating sector.

Central Outlook uses **System Transformation** trends for domestic and **Consumer Transformation** trends for I&C heat pumps. This results in slightly higher peak demand trends than the **System Transformation** scenario.

Future volumes of domestic heat pumps



Future volumes of industrial and commercial heat pumps



To fully decarbonise the electricity supply sector, higher levels of electricity generation from renewable sources will be required across Great Britain. In transmission networks the future mix of zero carbon generation is expected to include more offshore wind farms, as well as nuclear power plants and bioenergy with carbon capture storage.

Zero carbon renewable generation will play a key role in distribution networks, meaning that we expect to see significant growth in PV and wind farms to meet the long-term growth in demand.

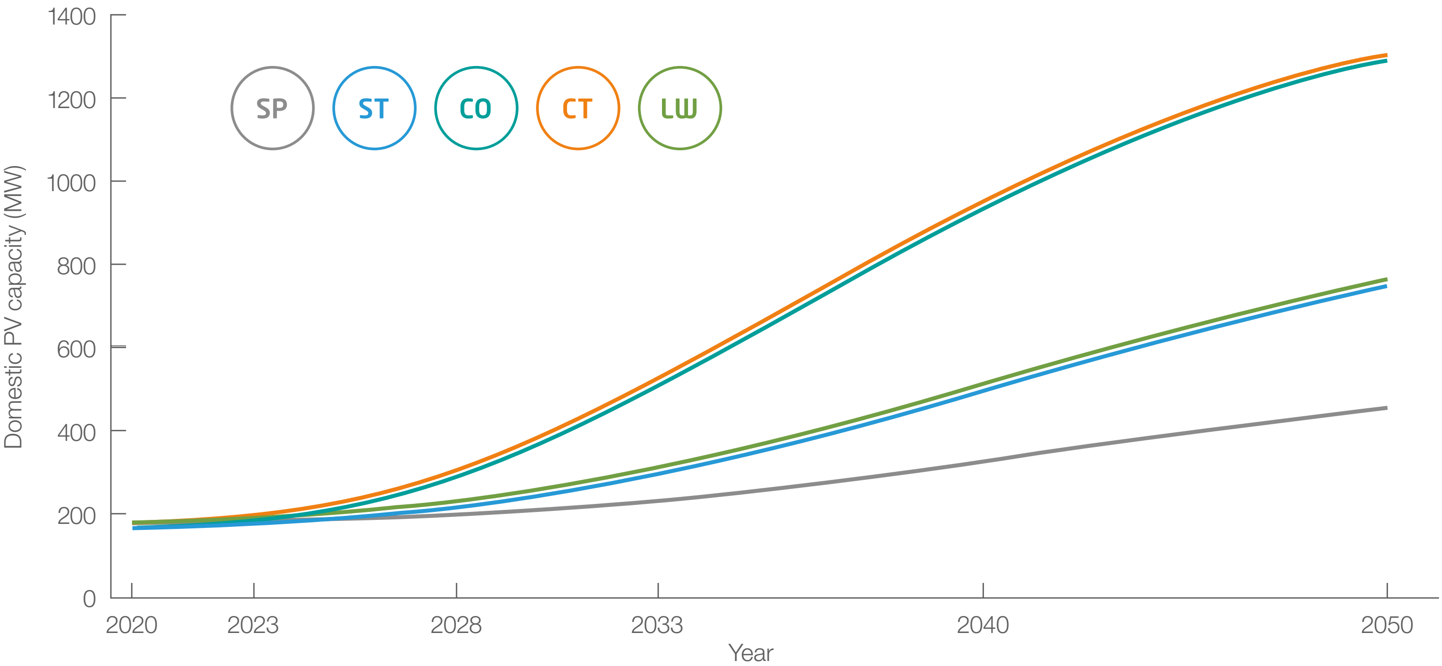
The intermittent nature of PV and wind farms connected at transmission and distribution levels requires flexible assets that are connected to distribution networks and can provide whole system services. Over the last five years we have seen a significant penetration of gas-fuelled flexible generators across the North West. During the last two years we have started to connect large grid-scale batteries to our networks and have received an increasing number of connection applications.

Unlike flexible generators, battery storage is a zero carbon technology that is expected to continuously grow to provide not only behind-the-meter services, but, importantly, flexible services to transmission and distribution operators.

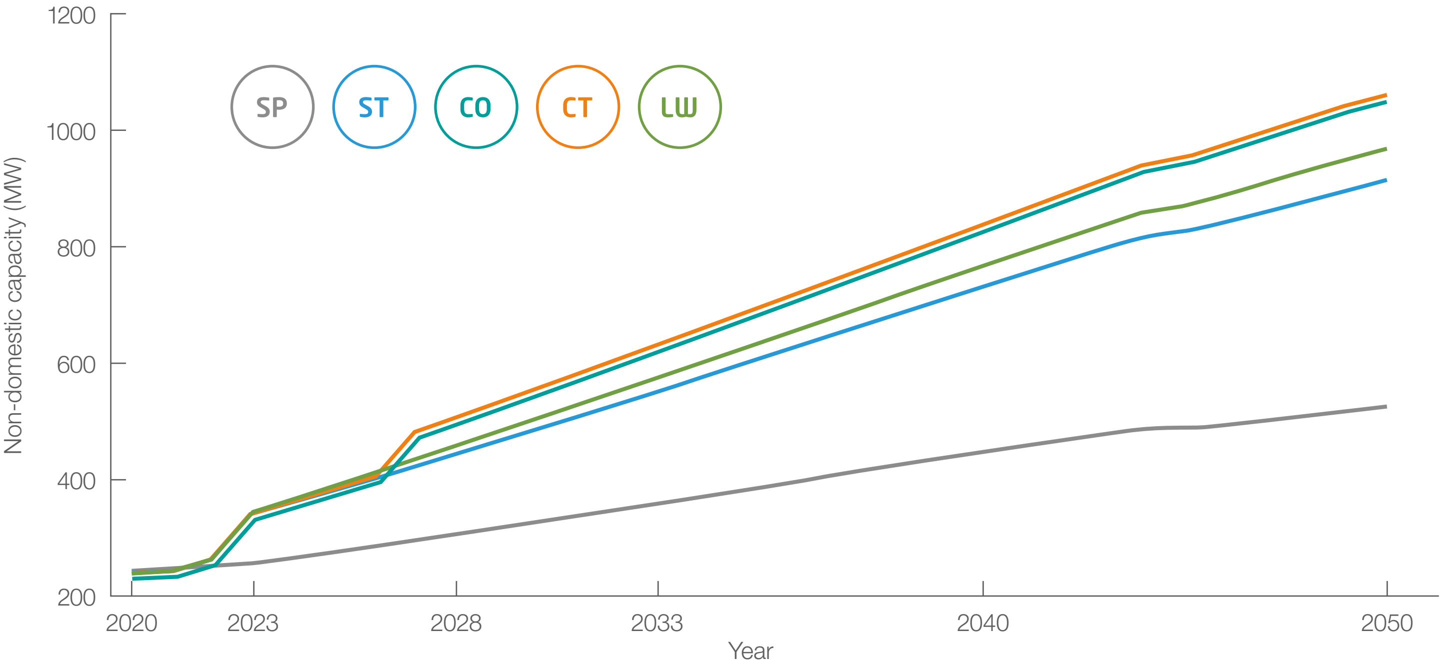
4.1 Distributed generation

All of our scenarios show continuous growth in PV and wind farms, the main zero carbon technologies which will accelerate decarbonisation. Small PV installations were supported by the Feed-In Tariff until early 2019 and future installations are likely to continue receiving Smart Export Guarantee payments. Larger PV and wind installations can earn revenue in the capacity market and through ‘contracts for difference’, but reduced capital costs will facilitate increased long-term penetration of onshore wind farms and larger PV, rather than generators relying on subsidies alone.

Future total installed capacity of domestic PV



Future total installed capacity of non-domestic PV



Our approach to modelling DG connections remains the same as last year's DFES, as only accepted DG connections are considered.

In **Steady Progression** we have the highest uptake of flexible generators, the majority of which are gas-fuelled.

This scenario also considers the highest levels of combined heat and power (CHP) generation. Similar to the other scenarios, gas-fuelled generation (mainly flexible DG and CHPs) is reduced in the long term, but this scenario considers the highest level of gas-fuelled generation by 2050.

System Transformation shows a moderate uptake of PV and wind farms to decarbonise electricity generation. Meeting net zero carbon by 2050 means the remaining flexible generation and CHP capacity is at lower levels than **Steady Progression**.

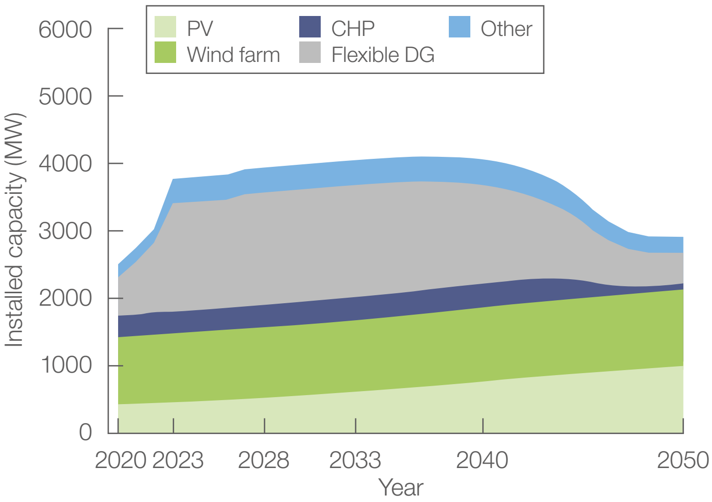
Speeding up the North West transition to net zero carbon would require over 1,000 MW of PV and over 500 MW of wind generation before 2040.

Central Outlook uses the same uptake trends as **System Transformation** for most DG technologies but considers higher volumes of small and large PV installations. The main DG growth in the short term comes from accepted flexible generators.

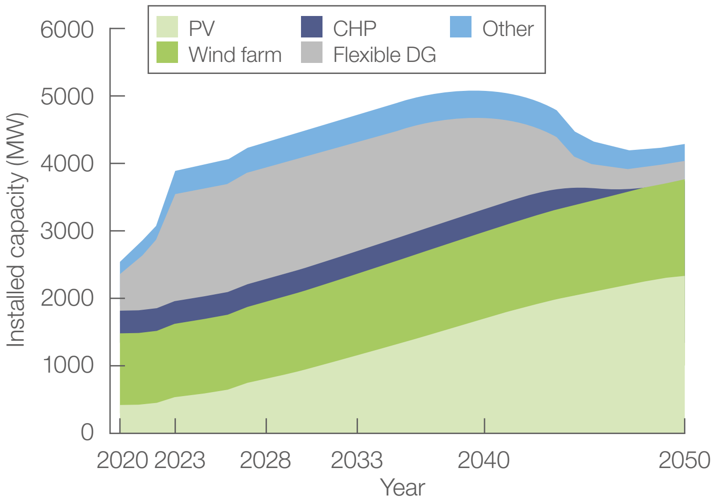
In **Consumer Transformation** over 1,300 MW of additional PV and 500 MW of wind farms are commissioned before 2040, helping to decarbonise local generation across the North West faster than any other scenario. Within a whole electricity context this scenario considers the highest contribution of DG to decarbonise the UK's generation mix by 2050.

In **Leading the Way**, the decarbonisation of the UK's electricity generation sector is accelerated by the offshore wind generation connected to transmission networks. The decarbonisation is also supported by the most significant reduction of gas-fuelled flexible generation.

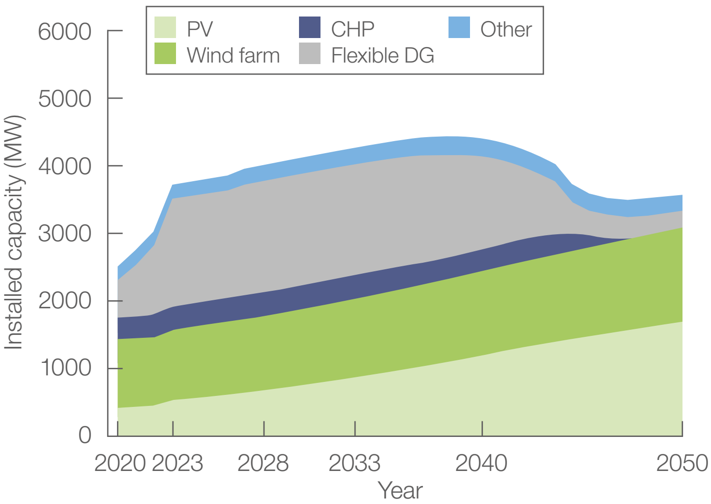
Steady Progression forecasts for distributed generation



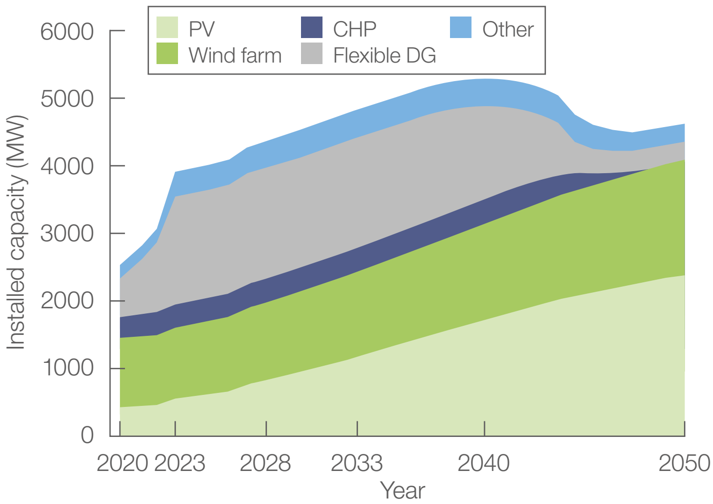
Central Outlook forecasts for distributed generation



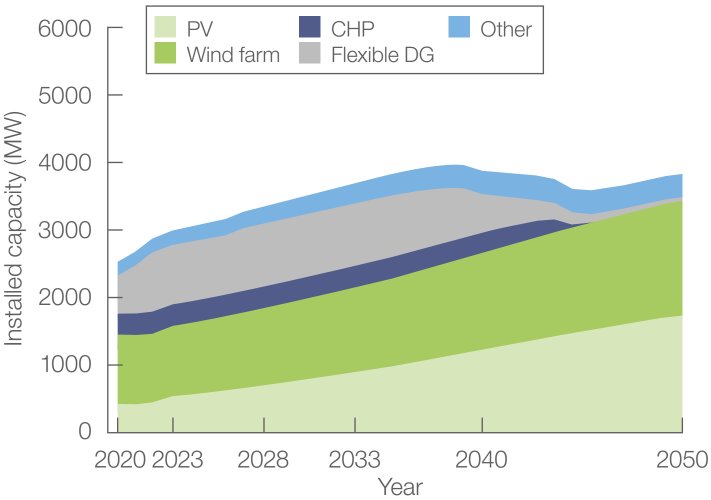
System Transformation forecasts for distributed generation



Consumer Transformation forecasts for distributed generation



Leading the Way forecasts for distributed generation



4.2 Battery storage

More flexibility will be required to support a cost efficient transition to net zero carbon. Battery storage is a key technology which can allow customers connected to our networks to benefit from behind-the-meter services and to provide flexible services to us and the transmission operator.

Our scenarios include forecasts of domestic and grid-scale storage. Growth in residential storage is shown mainly after 2030 across all scenarios. This happens as more domestic customers choose to buy PV with a battery. These customers can benefit from future smart network functionality which will allow them to purchase electricity from the network when it is cheaper and export when prices are higher.

There are more commercial drivers for the uptake of larger, grid-scale batteries. Currently most large size batteries are installed to provide balancing services to the ESO or behind-the-meter services to I&C customers. In many cases they can also provide DSO flexible services. However, in the long term, grid-scale batteries are expected to make more revenues from electricity price arbitrage, meaning their charging and discharging periods could be more dependent on the variation of electricity prices throughout the day.

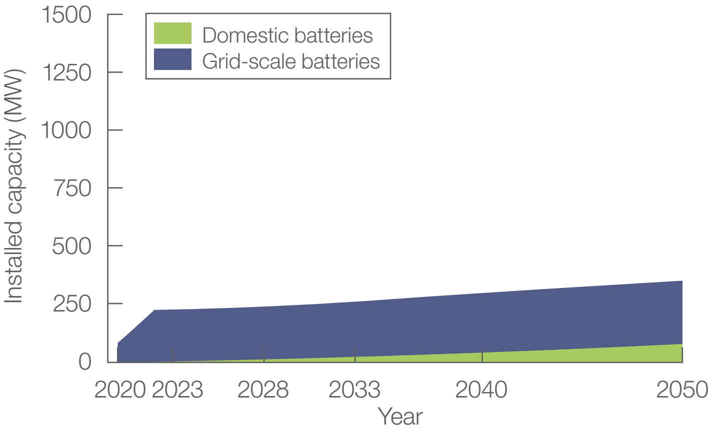
In **Steady Progression** only a limited number of accepted battery connections for projects that have already made significant progress are considered. In the long term flexible services are mainly provided by gas-fuelled generators and the role of batteries is limited; this is reflected in the slowest uptake trend across all scenarios.

In **System Transformation** all accepted large battery connections move forward. In the long term, battery installations continue to grow and take over gas-fuelled turbines in the provision of zero carbon flexible services. However, the future dominant role of hydrogen limits the electrification of heating and the overall need for batteries is lower as there is less need for flexibility.

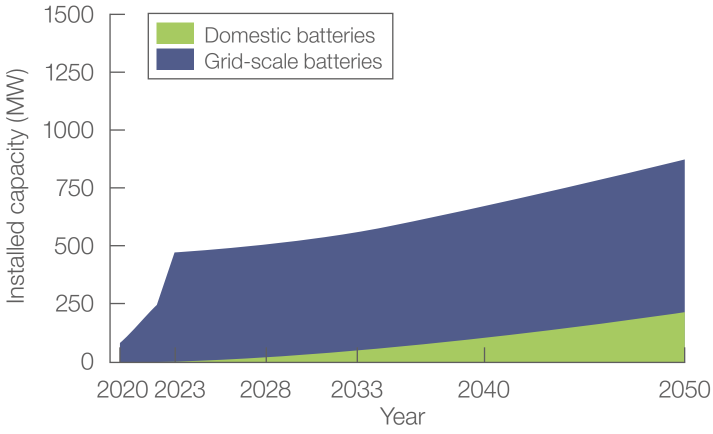
Consumer Transformation and **Central Outlook** also show that all accepted large battery connections are moving forward and are responsible for the step change in storage capacity between 2020 and 2023. In the longer term, both scenarios show higher total battery capacity compared to **System Transformation** due to the higher PV uptakes in these scenarios driving higher levels of domestic battery installations.

In **Leading the Way**, decarbonisation is accelerated as a result of more renewable generation from PV and wind farms connected to the distribution and transmission networks. This is the main driver for the higher uptake of grid-scale batteries across all scenarios which are the main source of zero carbon flexibility in the longer term.

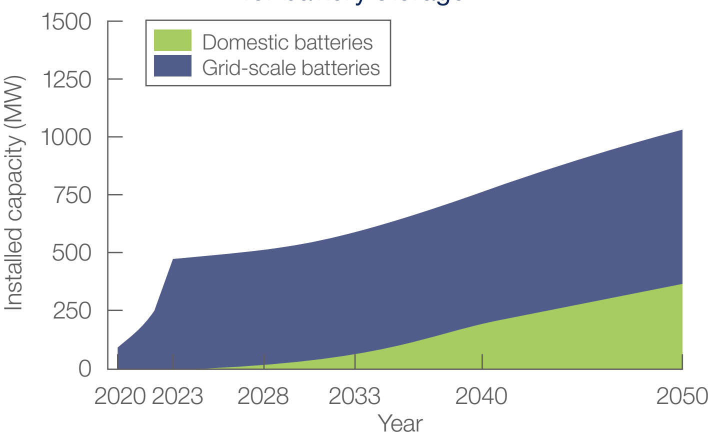
Steady Progression forecasts for battery storage



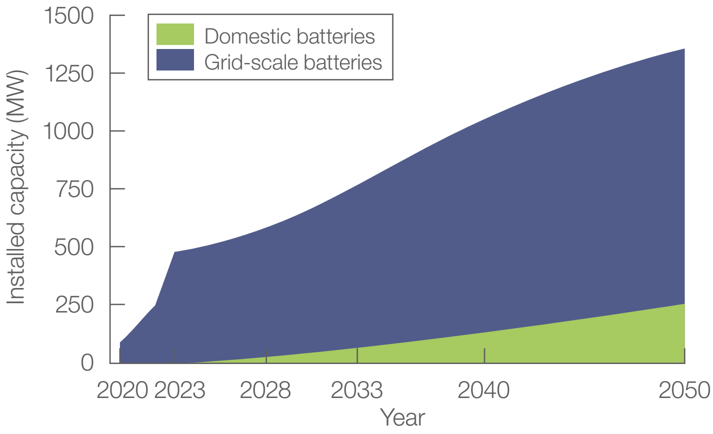
System Transformation forecasts for battery storage



Consumer Transformation and Central Outlook forecasts for battery storage



Leading the Way forecasts for battery storage



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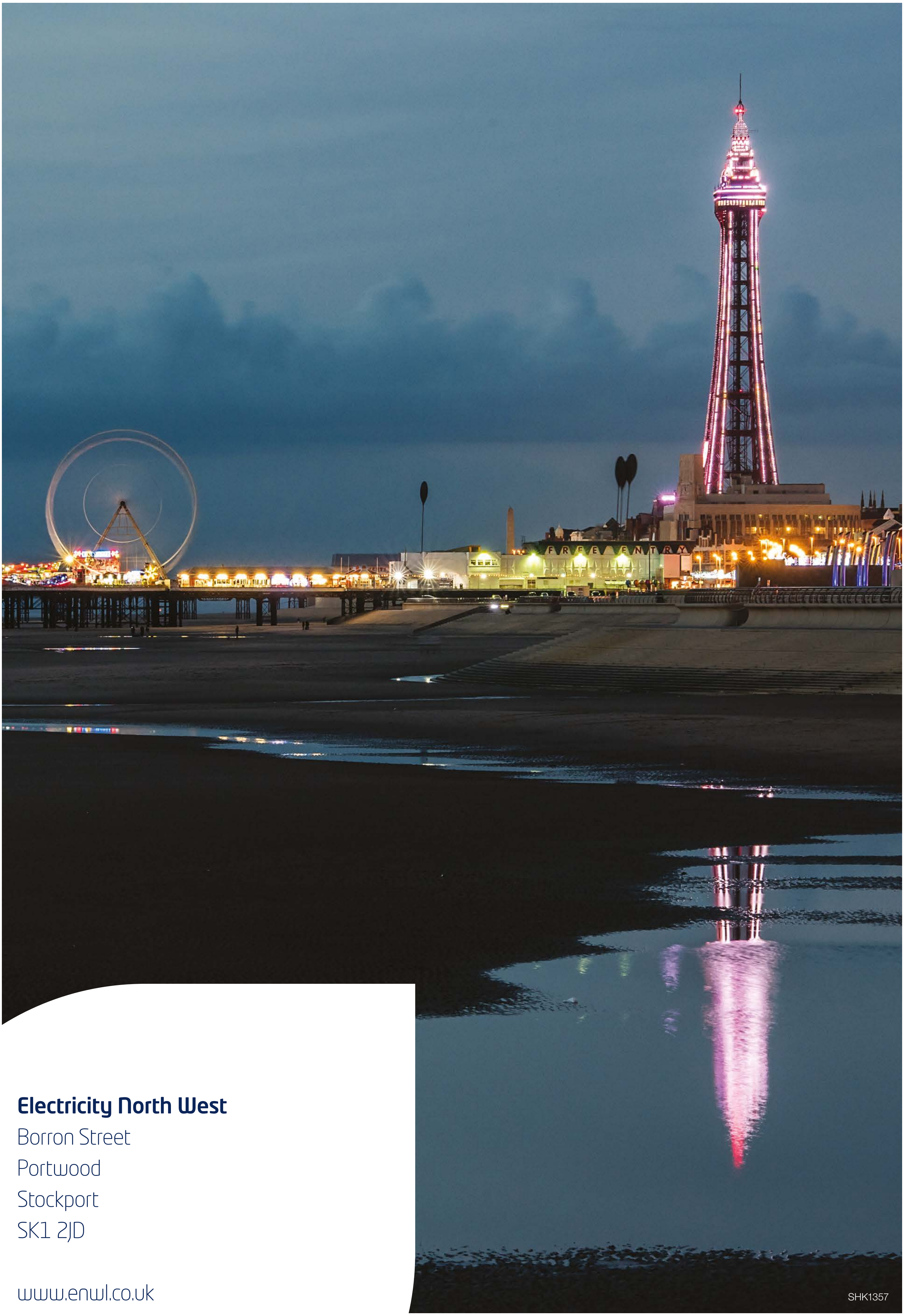

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