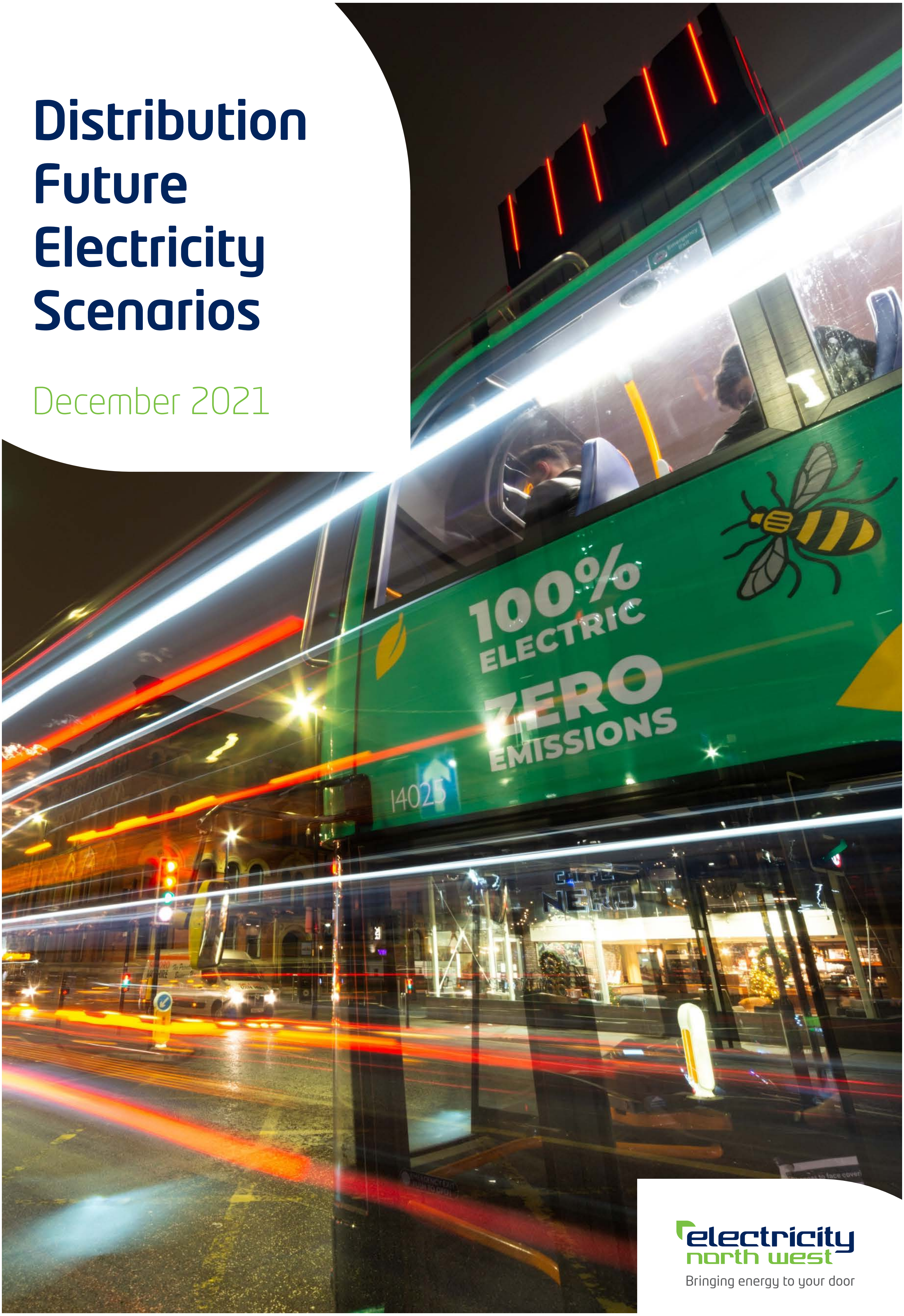
Distribution Future Electricity Scenarios

December 2021



electricity north west

Bringing energy to your door

Contents

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

The 2021 DFES builds on the previous year's publication but with the introduction of a high certainty Best View scenario for the next 10 years. The other four scenarios remain the same and follow the same high-level assumptions as the rest of the GB electricity industry, allowing us to support whole system thinking and deliver a consistent approach for our stakeholders. Importantly for our stakeholders we have developed an enhanced DFES workbook; which presents demand and generation forecasts at a local authority level as well as new carbon assessments.

As the communities we serve bounce back from the unprecedented global pandemic, our aim is to help them build back better using innovation, deployment of flexibility first and investment in key infrastructure. We also continue to lead the North West to Net Zero carbon emissions. There are two parts to this role in leading the North West. Firstly, we are responsible for the affordable development of a safe and reliable system in the North West which must continue to meet our customers' needs as they transition to a Net Zero carbon future. Also, we have committed to lead by example by reducing emissions from our own buildings, transport and supply chain. In August 2021 we joined a growing movement with 3,000 other leading businesses as part of the United Nations' Race to Zero campaign.

Just two years since the UK became the first major economy to legally commit to cut its greenhouse gas emissions and achieve Net Zero by 2050, the UK government announced in 2021 an ambitious target to achieve 78% reduction in emissions from 1990 levels by 2035. This year we have seen a growing awareness and ambition both nationally and internationally as we move towards Net Zero; with the UK government's first Net Zero Strategy published in October in advance of the internationally significant COP26 event. Here in the North West local stakeholders' ambitions are to deliver Net Zero even sooner than the national target. We are supporting Cumbria County Council, Greater Manchester Combined Authority (GMCA) and Lancashire County Council to reach Net Zero carbon before 2040.

Our DFES analysis continues to inform our future network needs and the efficient development of the North West's distribution networks. Earlier this month (December 2021) we submitted to Ofgem, our regulator, our final business plan for the next regulatory price control (RIIO-ED2) from 2023 to 2028. Our proposed investment in network capacity (Load Related Expenditure) within the RIIO-ED2 business plan is informed by our DFES and will ensure the network can accommodate the demand and generation growth from low carbon technologies and stakeholder developments.

RIIO-ED2 will see significant change in the way electricity is generated, consumed and stored, driving innovation across the whole energy system both now and into the future. This will include an important transition in our role, from DNO to distribution system operation (DSO). The transition to DSO is not one activity but rather the delivery and co-ordination of a range of functions.

Our 2021 DFES considers the latest updates on technology and fuel costs, developing central and local government policies and stakeholder engagement inputs. As a result, we present the latest forecasts around electricity demand, distributed generation and battery storage in our networks. New areas in this year's scenarios are forecasts for electric heavy duty vehicles, and forecasts on the electrification of industrial processes that currently use alternative fuels. As technology costs reduce faster than previously forecasted and latest UK government policies support decarbonisation, this year's forecasts show that we should be expecting more electric vehicles and heat pumps in our license area before 2030.

An essential tool to facilitate the Net Zero transition whilst keeping low energy bills for our customers is the use of flexibility services. In this publication we explain how we use our scenarios to help define flexible service requirements and for the first time we provide forecasts of the potential for flexibility services in our networks. We have set out our flexible service requirements for the following two years in our Autumn 2021 Requirements. Our longer term flexible service requirements will be presented in our first Network Development Plan (NDP) to be published in May 2022.

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.

Development Plan (NDP)
Regular
NDP (from 2022), part of Clean Energy Package, details future distribution network requirements for one to ten years beyond publication.

Steve Cox
Distribution System Operator Director
December 2021

What is new in DFES 2021?

Introduction to "Best View" scenario

A high certainty trajectory for next 1 to 10 years which replaces Central Outlook from 2020.

New forecasting components

Electric heavy duty vehicles and electrification of industrial processes that currently use alternative fuels.

Enhanced DFES Data workbook

Additional datasets on her local authority demand and generation. Carbon saving assessments and granular information for more demand elements.

2021	Scenario		2030	2040	2050
23 TWh Annual Electricity	Steady Progression		29 TWh	33 TWh	35 TWh
			0.8 million	1.7 million	2.0 million
			0.16 million	0.38 million	0.55 million
			1.7 GW	2.0 GW	2.4 GW
			0.43 GW	0.5 GW	0.6 GW
13,000 EVs	System Transformation		30 TWh	38 TWh	39 TWh
			1.2 million	2.6 million	2.8 million
			0.2 million	0.58 million	0.75 million
			2.2 GW	2.9 GW	3.7 GW
			0.98 GW	1.2 GW	1.5 GW
22,000 Heat Pumps	Best View		30 TWh	38 TWh	41 TWh
			1.2 million	2.7 million	2.9 million
			0.2 million	0.58 million	0.75 million
			2.2 GW	2.9 GW	3.7 GW
			1.08 GW	1.2 GW	1.5 GW
1.48 GW of Zero Carbon DG	Consumer Transformation		31 TWh	44 TWh	52 TWh
			1.2 million	2.7 million	2.9 million
			0.31 million	1.3 million	2.6 million
			2.4 GW	3.6 GW	4.7 GW
			1.0 GW	1.3 GW	1.7 GW
167 MW of Battery Storage	Leading the Way		31 TWh	46 TWh	49 TWh
			1.3 million	2.7 million	2.6 million
			0.34 million	1.9 million	2.6 million
			2.3 GW	3.2 GW	4.1 GW
			1.09 GW	1.6 GW	2.0 GW

Future of electricity

Decarbonisation through electrification

Our updated best view considers faster decarbonisation of transport and heating in North West compared to last year's DFES. This is not only driven by updates on national policies, but also from reduced technology costs.

Electrification of transport

Up to 1.2 million electric cars and vans before 2030. Higher certainty that a significant proportion of heavy duty vehicles will be plug in electric. Location and rate of charging critical to define effects on network loading.

Storage and zero carbon renewables

Double capacity and volumes of grid scale batteries in the pipeline compared to last year. PV capacity up to four times higher and wind generation up to double by 2050.

Flexibility services

Increased requirements for flexibility services, across more locations and down to low voltage. More opportunities for our customers and stakeholders to participate in local energy market.

Electrification of heating

Over 1 million heat pumps before 2040 could accelerate decarbonisation and support an early zero carbon transition before 2050.

Action required

Public and business engagement

Successful public and business engagement is key to deliver the behavioural and societal changes needed for the adoption of low carbon technologies.

Act now to decarbonise supply

Connection of renewable generation and storage is required to meet the UK Net Zero strategy to provide a clean and reliable power system as the foundation of a productive Net Zero economy.

DSO transition

Our transition to Distribution System Operation (DSO) will allow us deploy 'flexibility first' and active network management to facilitate Net Zero at minimum cost for our region.

Electricity North West business plan

Our RIIO-ED2 business plan for 2023-2028 keeps the customer energy bills low whilst facilitating Net Zero in North West by 2050 at latest. Additional investment proposed to be funded if our region accelerates decarbonisation before 2040.

Domestic low carbon technologies for all

We will provide the capacity required to charge EVs and run heat pumps at home. We will continue supporting rapid EV charging at strategic locations.

1 Introduction

As part of our region's transition to Net Zero carbon we need to consider the future ways we consume, generate and store electricity to ensure we can maintain an affordable, safe and resilient electricity distribution network.

In this, our fourth annual DFES document, we present updated forecasts up to the year 2050 and what they mean in terms of our longer term flexibility service requirements.

Our DFES will help us to continue to meet the growing needs of our 2.5 million customers by facilitating the electrification of transport, heating and industrial processes, as well as the growth of renewable DG and battery storage and the wider decarbonisation plans of our stakeholders.

Transition to Net Zero and the role of the DSO

Two years after the UK became the first major economy to announce a 2050 Net Zero target, we have first seen an increased participation of renewable generation that during the first year of the pandemic in 2020 supplied around 1/3 of the annual electricity consumption. As commercial activity bounces back we see in 2021 an increase in sales of purely battery electric vehicles (EVs) that now meet the total existing volumes of plug ins and reach a total aggregated level of over 2/3 of a million EVs across the UK.

To support the UK transition to Net Zero, 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 very recently in October 2021 its first Net Zero Strategy that sets out policies and proposals to decarbonise all UK economy sectors to meet Net Zero by 2050.

To support the Net Zero transition in the North West, we will evolve as a business part of our transition to Distribution System Operation (DSO).

DSO is not one activity but rather the delivery and co-ordination of a range of functions covering planning and network development, network operation and market development. When it comes to planning the network of the future, forecasting requirements is important to enable us to develop a smart and flexible distribution system. We will need to be able to adapt to changing customer behaviour and delivering network capacity for use by customers at the most efficient price. The importance of delivering these DSO functions must not be understated as they are vital to facilitate the energy transition to Net Zero in the North West. We will ensure that the North West electricity distribution network transition is accessible and cost efficient.

Distribution System Operation (DSO) is a range of functions that we adopt as a business to facilitate Net Zero in the North West. These functions include forecasting and will allow us use flexibility and energy efficiency to meet Net Zero at the lowest energy bill costs for our customers.

To facilitate Net Zero in North West we submitted earlier this month (December 2021) to Ofgem, our regulator, our final business plan for the next regulatory price control (RIIO-ED2) from 2023 to 2028. Our proposed baseline load related expenditure of £28 million per year is informed by last year's DFES and allows us develop the network to meet Net Zero by 2050 at the latest, whilst keeping consumers electricity bills as low as possible. In our proposed business plan we have also estimated additional expenditure up to £172 million per year that would be required to be funded under uncertainty mechanisms in case that our customer behaviours change as they adopt low carbon technologies or the region accelerates decarbonisation to meet the earlier net zero targets announced by local authorities in our license area.

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 May 2022, setting out how we plan to develop our network over the next one to ten years, based on our latest DFES. The NDP will be a new publication and will present forecasts of identified network issues, associated flexible service requirements and plans for network developments based on the DFES scenarios. Together with our DFES document and Long Term Development Statement (LTDS), the NDP will provide a comprehensive overview of our future needs and developing plans for the region's electricity network.

Interaction between DFES and FES

Through the Open Networks project run by the Energy Networks Association (ENA), networks have been working closely to align process and provide clarity on the purpose of the Distribution Future Electricity Scenarios (DFES) and Future Energy Scenarios (FES) activities to stakeholders.

DFES is used for strategic planning of the distribution system and network. FES is used for transmission network planning and national system operability.

DFES is an annual forecasting activity undertaken by Distribution Network Operators across Great Britain. They provide granular scenario projections that incorporate regional factors and can be used at a local level for strategic planning of distribution networks. These projections are informed by local stakeholder engagement to understand the needs, plans and delivery progress of local authorities and other stakeholders. The DFES provides an evidence base for DNOs to develop the business case necessary to support future investment, including regulated business plans.

FES is an annual process undertaken by National Grid ESO. It provides a set of scenario projections for Great Britain and focuses on the whole energy system, through the lens of how the energy system can be decarbonised. FES utilises information, insight and data from all sectors of the energy industry and is used as a fundamental part of the annual transmission network planning and national system operability analysis. It also provides insight to members of the energy industry and beyond.

The use of a common scenario framework between DFES and FES allows our stakeholders understand how granular local trends compare with the national and regional picture.

Both DFES and FES use a common scenario framework and definition of technologies, to allow for comparison of datasets for all network and system operators. Whilst a common scenario framework is used, regional variations in projections mean that the summation of DFES forecast ranges may not have identical alignment to the GB FES forecast range.

From 2021 all DNOs will follow Electricity North West's proposal and present a Best View scenario in DFES that aims to remove the complexity of multiple scenarios and provide the highest certainty in a 1 to 10 years horizon.

Electricity North West's DFES are produced by our bottom-up ATLAS forecasting approach using sophisticated tools and methodologies and key data and information from our stakeholder engagement and local characteristics. This allows us to present local granular forecasts to our stakeholders who can use the common scenario framework and compare them up to the national trends from the FES.

In 2021 all DNOs have accepted Electricity North West's proposal that defines a Best View scenario to be included in their DFES and used in their Network Development Plans (NDP). This fifth scenario aims to remove the complexity of multiple scenarios for our stakeholders and provides the highest certainty in a 1 to 10 years horizon. Even though this scenario extends to 2050, longer term uncertainties can be only captured by the full range of scenarios.

Document objectives

The main objective of this document is to present our forecasting scenarios for electricity demand, DG and battery storage that inform 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).

This year we share more data in our DFES workbook that can help our stakeholders inform their decarbonisation plans and understand how we plan our networks.

1 Introduction

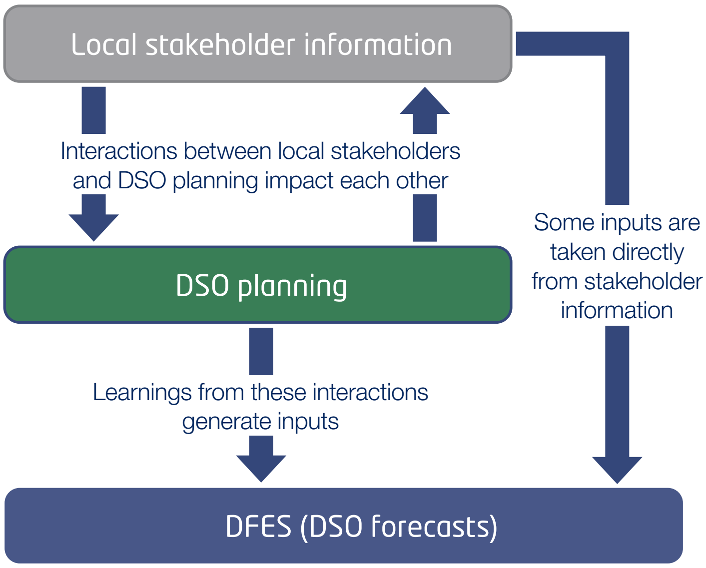
The future levels of electricity demand, DG and battery storage are expected to be significantly affected by the level of societal change, the progress of decarbonisation plans and by uncertainties around the future role of hydrogen and its interaction with electricity in a Net Zero carbon future.

As part of our network planning process, we use these scenarios to determine future network requirements and help inform 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 (EVs) charge points, heat pumps and sources of renewable generation.

Stakeholder Engagement

Our engagement with local stakeholders including local authorities (LAs), customers, energy communities and investors provides valuable inputs to our ATLAS forecasting methodology used to produce the DFES. These inputs include both data provided directly by stakeholders but importantly also how implications of our network development affect stakeholder decisions and connection behaviour.

Local stakeholder inputs in DFES



Our forecasts are 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 stakeholder 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 worked with local gas distribution companies to produce decarbonisation pathways for Greater Manchester, Lancashire and Cumbria.

In our cycle of engagement with local stakeholders and customers we both consider their inputs to produce DFES and we share information and data through DFES that helps them produce well informed plans.

Both DFES and the regional decarbonisation pathways are an important component of our stakeholder engagement as they provide useful insights to inform decarbonisation plans for local authorities and other stakeholders. Also when combined our local stakeholders can benefit from further insights into future whole energy system requirements.

Document structure

This document comprises five further main sections:

- Section 2 introduces our Best View scenario for the region and outlines the other four 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, electricity consumption and information/forecasts on the electrification of transport, heating and industrial processes.
- Section 4 presents electricity generation and storage forecasts for all scenarios. These include photovoltaics (PV) and wind capacities, which are the most dominant Net Zero types of DG, as well as battery storage.
- Section 5 describes how we forecast our requirements for flexibility services that will be presented in our first NDP. It also presents our forecasts on the potential for flexibility services in our license area.
- Section 6 presents the per County Council trends for electricity demand and renewable generation, focusing on what actions need to be taken in our region to meet Net Zero.

In line with our Distribution System Operation (DSO) data strategy and Ofgem's best practice guidance, we continue to publish alongside the DFES a data workbook of detailed forecasting outputs for all scenarios, which can be viewed in tabular and chart formats. Following the feedback received from our local stakeholders, in addition to maximum and minimum electricity demand per substation across the whole region, this year we also share annual electricity consumption data per substation feeding area and per local authority. Data for EV and heat pump uptakes extend to heavy duty vehicles this year, whereas the DG and battery storage capacity data are shown not only per substation feeding area but also per local authority. Carbon assessment results are also included in the DFES workbook for first time.

We are aware that many stakeholders are keen to understand what our scenarios specifically mean to them. Therefore, our interactive workbook will continue allowing you to examine what the scenarios forecast 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.

What differentiates our DFES from other Net Zero carbon transition scenarios is that the DFES should be viewed as long-term forecasts, rather than any specific type of pathway to Net Zero carbon. Energy pathways to Net Zero typically illustrate a range of interventions to achieve a specific outcome. Our electricity DFES uses models that show the impact of customer choice and societal change whilst we consider granular data on local characteristics and plans of our local stakeholders and customers.

The 2021 scenarios

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

The first four scenarios reflect the same high level assumptions and are defined using a common agreed framework 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 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.

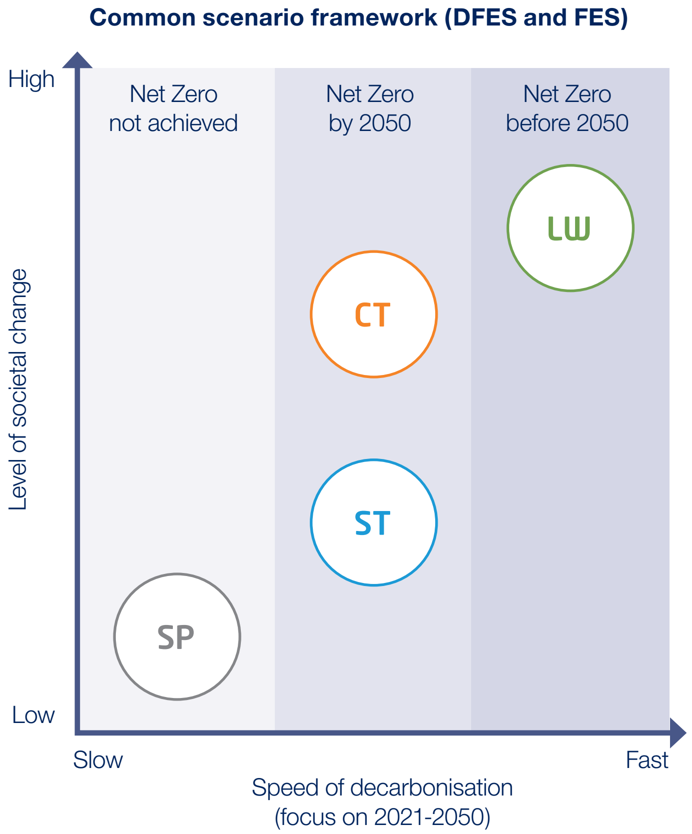
However, this does not mean that these trends follow the same pattern or volume across all regions or between regions within the same license area. Engagement with local stakeholders and the influence of distribution network planning on stakeholder decisions allows us to improve the accuracy of regional forecasts.

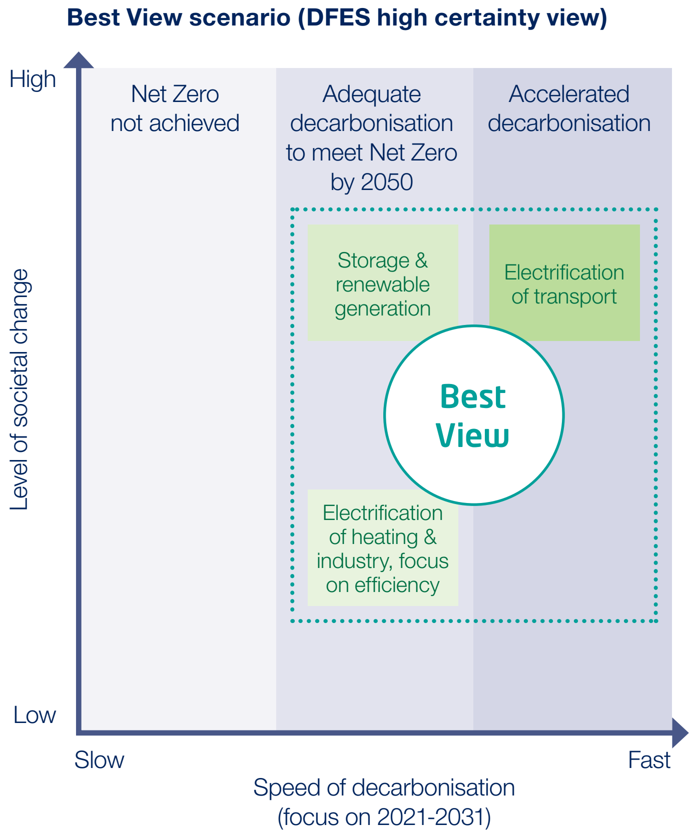
Our 2021 DFES consider four scenarios that follow the common framework with all DNOs and the ESO. A fifth Best View scenario is introduced for first time this year focusing on the most likely forecast in our region.

Best View is an additional scenario that replaces Central Outlook from our previous DFES publications. Unlike Central Outlook that adopted central and average assumptions, the **Best View** is the region's highest certainty scenario that focuses on high certainty in the next 1 to 10 years.

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 2021





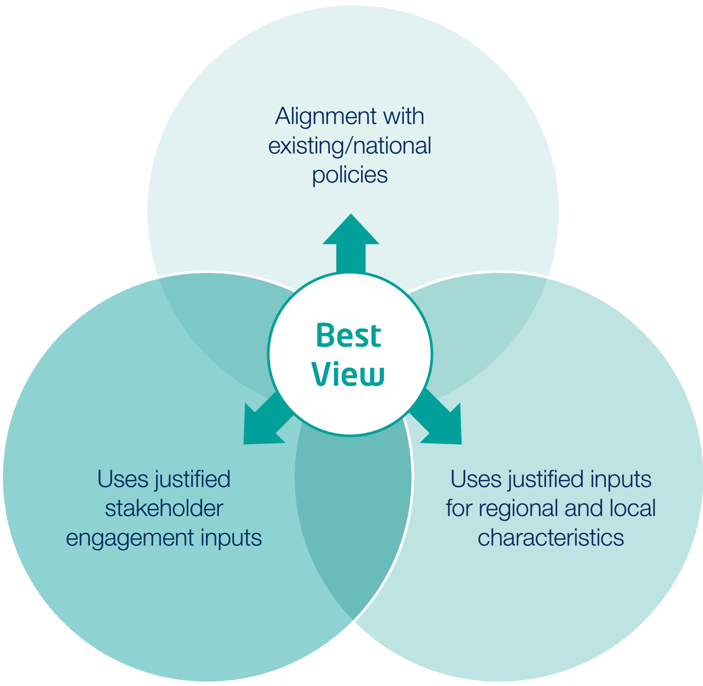
Best View scenario

Our **Best View** scenario aims to provide clarity and remove the complexity of multiple scenarios for our stakeholders. As the region's highest certainty scenario when compared to three key criteria, **Best View** can help stakeholders understand local demand and generation trends over the short-term.

Our Best View scenario removes the complexity of multiple scenarios and provides the highest certainty trend for our region for the next 1 to 10 years. Using Best View in conjunction with our full set of scenarios provides the range of uncertainties for this period and importantly beyond 2030 towards 2050.

The **Best View** scenario can provide the highest certainty basis for assessing network impact and the need for interventions in the next 10 years. Therefore it will be used as the basis to present asset and flexibility options in our first Network Development Plan. Beyond this 10 year time horizon presenting Best View with all other DFES scenarios can importantly provide insight into the range of uncertainty in the longer term.

The three categories of justification criteria that define the Best View scenario



To produce the **Best View** scenario each forecasting component ("building block") needs to be checked against three categories of justification criteria. These are:

i. **alignment with existing / announced policies – Best View** models national policies which are currently to meet net zero by 2050. Local policies can be used only if justified they will prevail over national, eg to accelerate decarbonisation.

ii. **use of justification criteria for stakeholder engagement inputs – Best View** considers the connections pipeline and supporting evidence from local stakeholders. It also models regional strategic developments only if specific justification criteria presented, such as local authority or UK government backing and secure funding.

iii. **uses justification criteria for regional and local characteristics inputs –** local trends in **Best View** are justified based on how regional and local characteristics can influence local customer/stakeholder actions differently from a national average. For example, trends affected by access to gas grid, planning permission requirements, socioeconomic conditions, housing stock and other local factors.

Inputs from Stakeholder Engagement

The ambitious regional Net Zero carbon targets from LAs across our region are supported by their actions to accelerate decarbonisation. During the last year we have reviewed and actively engaged with GMCA and Energy Systems Catapult that produced local area energy planning studies for Bury, Salford and Manchester councils. These studies inform GMCA's action plans such as the Retrofit Accelerator that aims to reduce heat demand from existing homes in order to reach Greater Manchester's zero carbon by 2038 target.

From smaller to major strategic developments, our engagement with local stakeholders and customers helps us produce accurate local granular forecasts.

Further to our engagement with the local gas distributor to produce decarbonisation pathways for GMCA, Lancashire and Cumbria, we have also engaged with Lancashire this year to review their decarbonisation pathway study and with Cumbria councils to discuss their decarbonisation plans.

Local authority (LA) and local enterprise partnership (LEP) plans, as well as actions from I&C customers are key to help decarbonise the North West. Our continuous engagement with local stakeholders across our region allows us to consider not only developments and decarbonisation plans where customers have applied to us for electrical connection, but also for development hot spots that are currently in planning stage and we have robust evidence they will go ahead.

Decarbonisation plans and other planned developments from local stakeholders are modelled in our DFES to improve the accuracy of regional demand forecasts. Using our well established confidence factors that follow our ATLAS methodology we consider the connections pipeline taking into account historical performance and per project information to accurately reflect their effect on network loading. We also model longer term major strategic developments from our local stakeholders. Demand growth for these developments is phased out during our next price control until post 2030. Even though connection applications have not yet been received for all of these developments, there is however evidence they will be energised given that there is strong backing from UK and local government, secure funding and ongoing developments progress.

DFES 2021 assumptions on electricity demand components

Demand components	Steady Progression	System Transformation	Best View	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	Medium	High	Early high
Electric vehicles (cars & vans)	Low	Medium	High	High	Early high
Smart EV charging & V2G	Low	Medium	Medium	High	High
Electric Heavy Duty Vehicles	Low	Low	Medium	High	Early 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
Electrification of Industrial Processes	Low	Medium	Medium	High	Early high

DFES 2021 assumptions on distributed generation and battery storage

DG and storage components	Steady Progression	System Transformation	Best View	Consumer Transformation	Leading the Way
Photovoltaics - small (<1MW)	Low	Medium	Medium	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	High	Medium	High
Generation and battery connections	Only limited from accepted	Only accepted	Only accepted	Only accepted	Only accepted

3.1 Peak demand and electricity consumption

As the electrification of transport and heating goes ahead in our region's transition to Net Zero, we need to make sure that there is capacity in our network to accommodate the future electricity demand. Our key DSO responsibility is to use well informed granular forecasts of peak demand to plan where, when and what additional capacity we need to release in our network.

Our peak demand forecasts inform our network plans on where, when and how much additional network capacity we need.

As a DSO we need to quantify in our forecasts the peak true (underlying) electricity demand, for example, in the dark when there is no solar generation or on calm days when wind generation is low. Knowing this peak true demand we can then provide the necessary network capacity using our "flexibility first" approach that prioritises the use of flexible services and we also consider strategic conventional reinforcement to avoid inefficient piecemeal network expansion.

Beyond peak demand it is critical to understand electricity consumption and half-hourly profiles to quantify the flexibility requirements.

Beyond peak demand, as a DSO we need to understand the annual electricity consumption and the detailed through year half-hourly electricity demand. This can help us not only understand whether we have cyclic or continuous thermal stress on network assets that defines the asset ratings, but importantly define our future requirements for flexibility services. These requirements are expected to increase and establish a viable long term local energy market as both the electricity demand increases and we enhance our forecasts and expand them to lower voltages using our proposed RIIO-ED2 LV monitoring programme and smart meter data.

The increased electricity demand and our enhanced DSO forecasting and monitoring capabilities will result in increased flexibility requirements in the long-term. This can establish a viable local energy market to meet Net Zero through low energy bills for our customers.

The last section of this DFES document discusses the role of flexibility to meet Net Zero and how it relates with our forecasts. It also provides forecasts for all DFES scenarios on how much flexibility is made available across the North West.

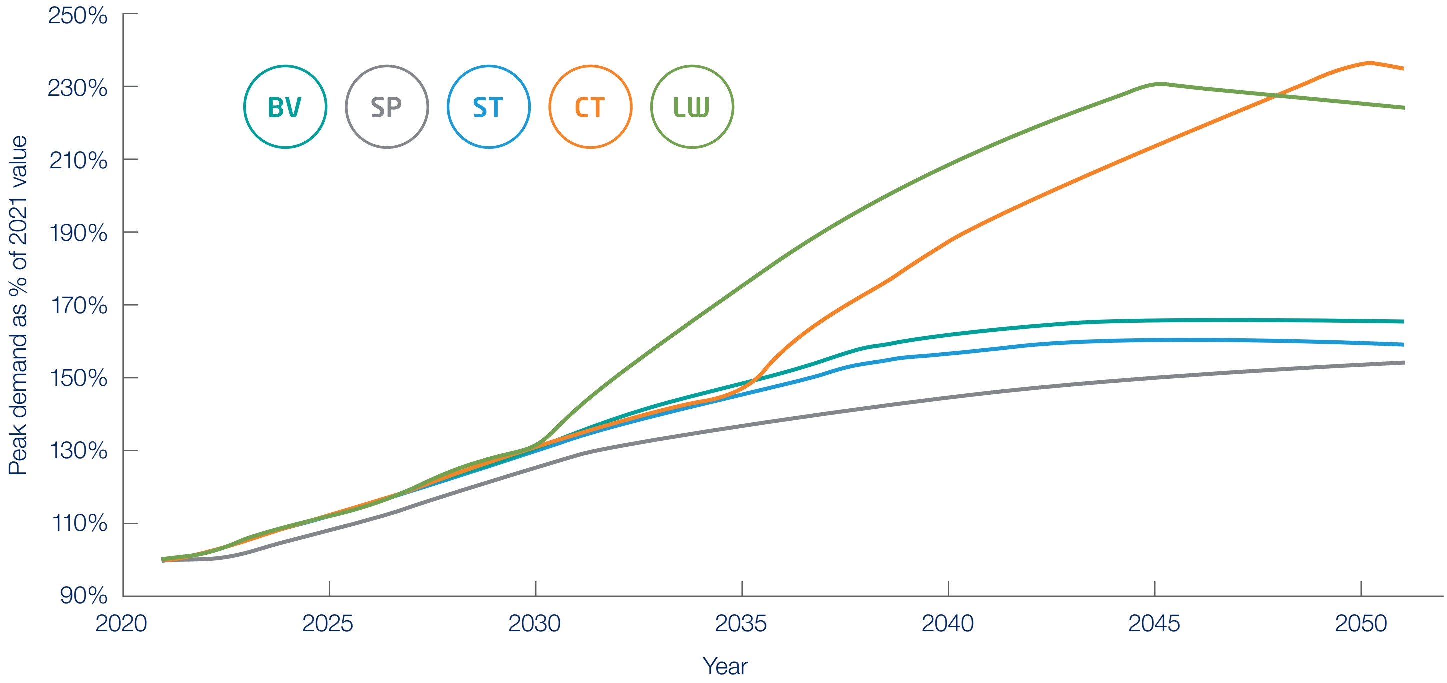
Demand growth up to 2030

This is the period when our **Best View** scenario can provide the highest certainty trend based on justified assumptions. Following a short period of demand reduction due to the effects of COVID-19, peak demand is expected to grow slowly until 2023 as effects of efficiencies balance the relatively low uptake of EVs and heat pumps.

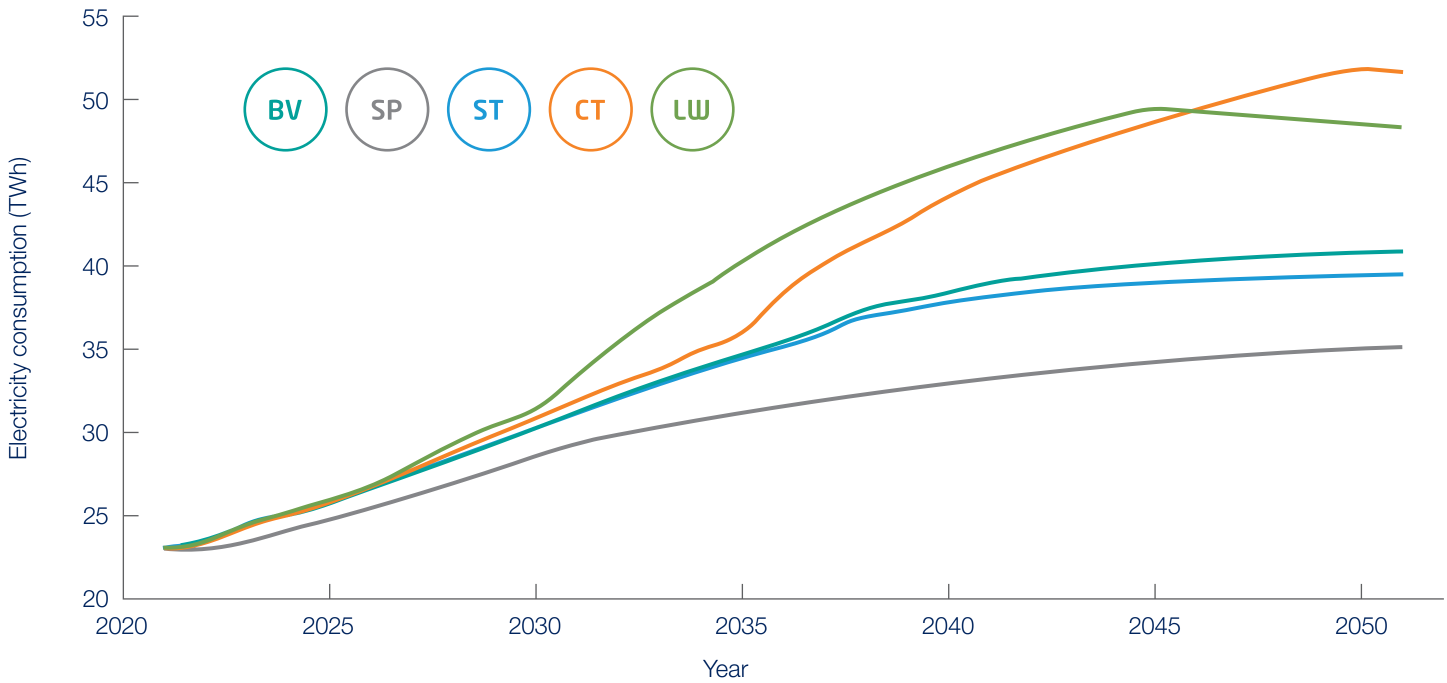
Our Best View scenario shows higher demand growth within 2023-2030 compared to last year's DFES. This is due to the accelerated decarbonisation of transport driven by lower battery prices and the stronger support for electric heating following UK government's 2021 'Heat and Building Strategy and grants to achieve the interim 2035 carbon target.

After 2023 and up to 2030, growth in demand is mainly driven by planned developments and EV charging. With the exception of Steady Progression that uses lower confidence factors for planned developments, all other scenarios that meet the Net Zero target consider the historical performance to predict the demand growth from 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 the local authority spatial framework plans.

Future trends of annual peak true demand



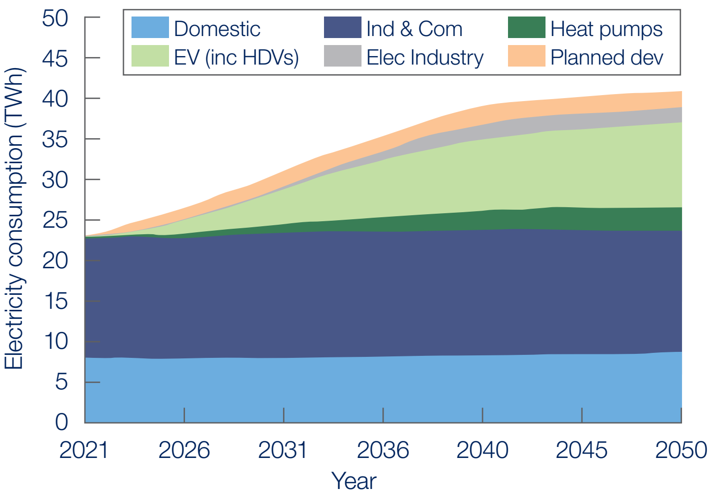
Future trends of annual electricity (energy) consumption



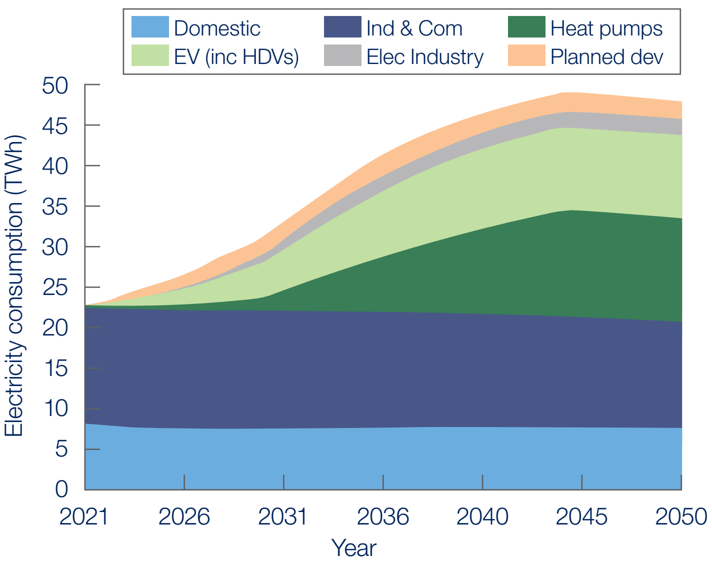
The **Best View** scenario shows relatively high demand growth that is very close to **Consumer Transformation** and **Leading the Way** which are in the top of the scenario range within this period. High levels of efficiencies result in significant reductions for both domestic and I&C demand in these two scenarios, but the highest levels of EV charging and heat pumps modelled are driving the overall demand growth higher than all other scenarios.

Best View also considers high EV uptakes, modelling UK government's announcement to ban the sales of new internal combustion engine vehicles by 2030 and the Department for Transport (DfT) projection of the total vehicle stock. As explained in the electrification of transport section in this document, in this year's DFES we are seeing an accelerated decarbonisation of transport compared to last year's DFES following the higher reductions in battery costs from what was forecasted last year.

Future annual demand for Best View



Future annual demand for Leading the Way



Unlike **Consumer Transformation** and **Leading the Way**, **Best View** shows an average reduction in demand from all types of efficiencies, eg from building retrofits to improve heating insulation to white appliances. This is due to the use of central rather than ambitious assumptions for efficiencies, which is in line with the fact that our region has some of the highest poverty levels across the whole of GB.

The heat pump uptakes in our region are also lower than the national average, mainly due to the high access of our customers to the gas grid. However, we expect an accelerated heat pump uptake before 2030 following the UK government's Heat and Building Strategy that aims for 600,000 heat pump installations across GB by 2028 and multiple incentives for heat pumps uptake, eg the Green Homes and Clean Heat Grants. Using central assumptions in our **Best View** scenario we expect higher heat pump uptakes from last year with increased penetration of hybrid heat pumps before 2030 which have cost benefits for customers and can help meet UK government's interim 2035 carbon reduction targets.

System Transformation shows lower demand growth from **Best View** scenario as it considers lower EV uptakes. **Steady Progression** is the only scenario that 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 partly accomplished, and lower 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.

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 2038, whereas **Consumer Transformation** meets similar levels closer to 2043. The effects of the highest efficiencies in **Leading the Way** are mitigated by the fastest decarbonisation achieved by customers incentivised to adopt more purely battery EVs rather than plug in hybrids compared to all other scenarios.

Best View is in the middle of the range and it should be considered more as a central outlook rather than a high certainty scenario during this period. 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 the annual electricity consumption trend for shows higher growth than the corresponding peak demand trend.

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 zero carbon scenarios, and below **Steady Progression**, which exhibits the highest penetration of air conditioning in the long term.

3.2 Electrification of transport

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.

Reduced battery prices combined with announced UK government policies can drive an accelerated decarbonisation of transport across our region. But this requires easy access to public charging and it is critical that our local stakeholders act now to achieve that.

Our updated forecasts consider the latest technology updates and learnings around consumer choice and show an accelerated penetration of electric cars and vans. This is mainly driven by the significant reduction in battery prices that was beyond what was previously forecasted. The reduced battery prices are expected to increase the attractiveness of both plug in hybrids (PHEV) and pure battery EVs (BEV) for our customers. The accelerated decarbonisation of the transport sector is also supported by the UK government's decisions to bring forward the ban on sales of new petrol and diesel vehicles to 2030 and require EV chargers for new and refurbished buildings.

In this year's DFES we also include for first time forecasts of electric heavy duty vehicles (HDVs) including buses, coaches and heavy good vehicles (HGVs).

Recent information from vehicle manufacturers suggests that there could be supply constraints to meet the demand in the short term. Even though this has not been reflected in our current forecasts, it is expected to affect the EV uptakes only in the early 2020s.

Electric cars and vans

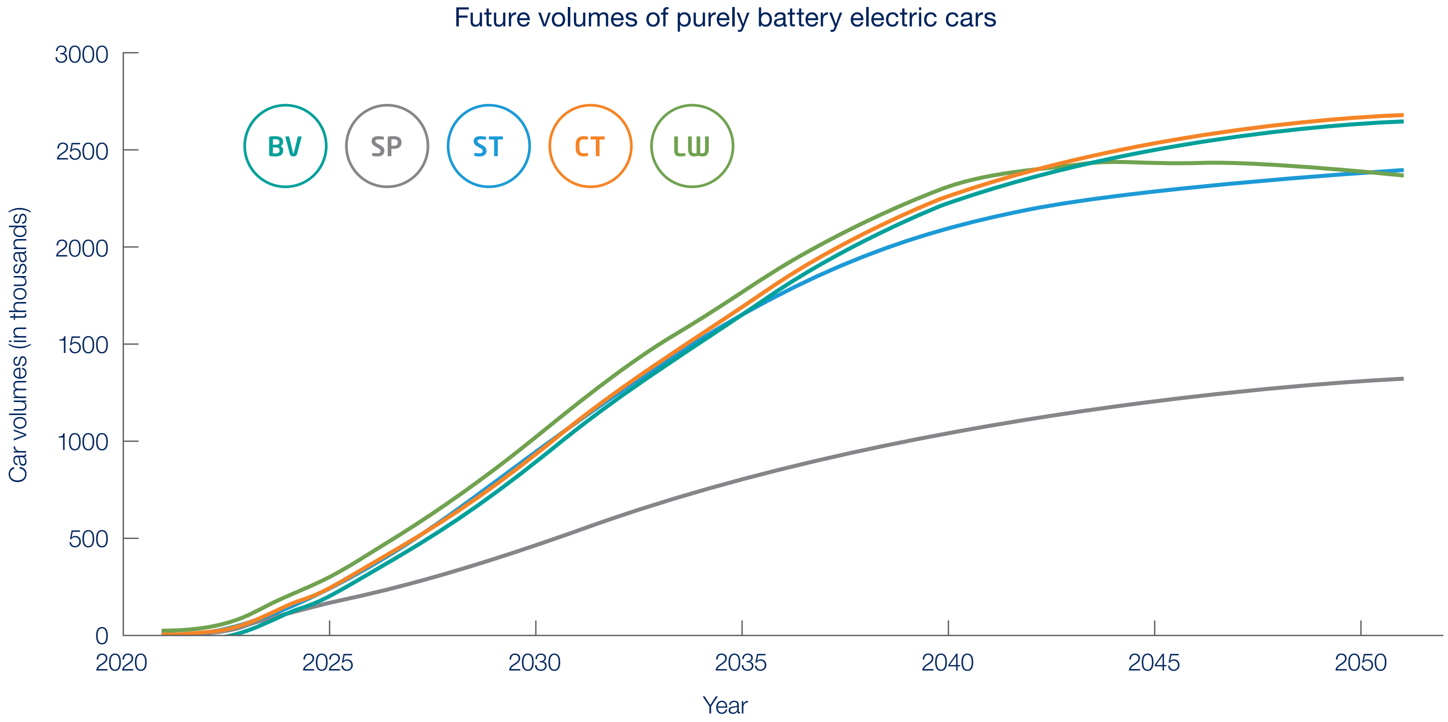
We have worked with Element Energy to update the forecasts of the volumes of EVs in our license area. The most recent learnings on customer choice suggest that the willingness of our customers to adopt a BEV or PHEV instead of other vehicle types are highly dependent on how easy it is to access rapid charging. As battery prices are also forecasted to reduce faster than previously anticipated, we expect that more of our customers are going to buy an electric car or van.

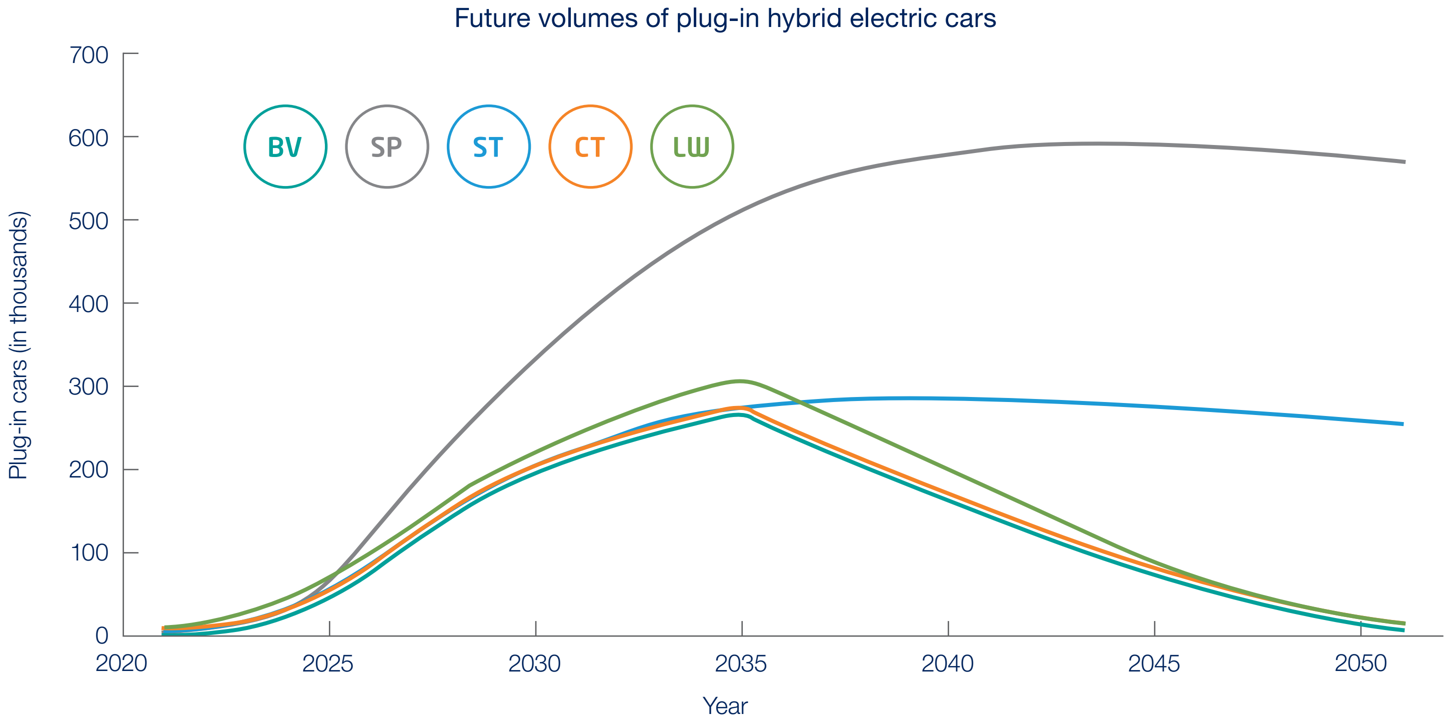
As the only scenario that does not meet Net Zero by 2050, our **Steady Progression** represents a feasible minimum level of EV uptake. In this scenario consumers are more sceptical to adopt EVs in the absence of sufficient public charging. Also a change in current policy position not mandating the ban of diesel and petrol fuelled vehicle sales is assumed. In addition, battery developments are delayed more than currently expected.

In **System Transformation** we assume that charging infrastructure develops sufficiently for customer acceptance in 2030. However, we make the same assumption as **Steady Progression** in that a change in current policy position not mandating the ban of diesel and petrol fuelled vehicle sales is assumed.

Best View and **Consumer Transformation** consider the same EV uptake trends which are in line with the 2021 UK government's Transport Decarbonisation Plan. The future BEV volumes in the two scenarios are driven high by the ban on new ICE and plug-in hybrids by 2030, which is also in line with Committee for Climate Change's (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 the **Best View** assumptions to consider the highest levels of societal change. These include an aggressive reduction in vehicle mileage travelled and the development of the car sharing market. Unlike all other scenarios, **Leading the Way** does not follow the DfT forecasts of the total vehicle stock, but the vehicle stock is in line with the CCC's balanced net zero pathway.


Future volumes of purely battery electric cars
BV
SP
ST
CT
LW
Car volumes (in thousands)
3000
2500
2000
1500
1000
500
0
2020
2025
2030
2035
2040
2045
2050
Year


Future volumes of plug-in hybrid electric cars
BV
SP
ST
CT
LW
Plug-in cars (in thousands)
700
600
500
400
300
200
100
0
2020
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2035
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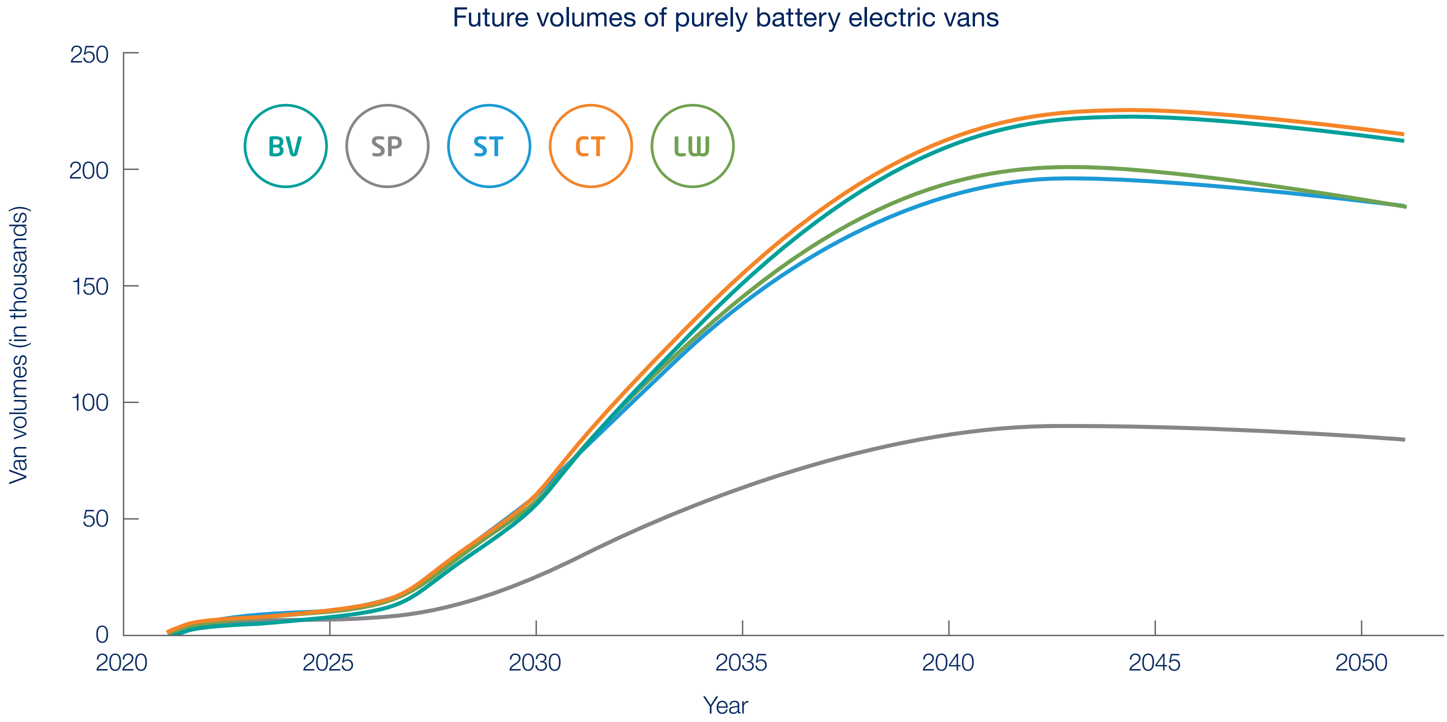
2050
Year



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 forecasts consider where, when and how fast EVs could be charging across the North West in the future.

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) . The 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 times of peak demand.

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 (33 and 132kV), as well as provide valuable insights to the ESO and the transmission operator on the effects expected at the different interfaces with transmission.

Electric heavy duty vehicles

This is the first year that our DFES consider and present forecasts of electric heavy duty vehicles (HDVs). Similarly to cars and vans, the requirements for the charging of electric HDVs are included in our forecasts of electricity demand supplied by our network.

As battery costs fall and energy density of batteries improves, we expect that more customers will adopt electric heavy duty vehicles.

Unlike cars and vans where EVs are expected to be the dominant technology to drive decarbonisation, there are higher uncertainties for HDVs. For hydrogen fuelled HDVs these include uncertainties around the future availability of hydrogen production at scale and the future costs of fuel cells. For electric HDVs these are more related with the energy density of batteries.

However, as battery costs fall and the energy density of batteries improve, electric HDVs are increasingly seen as cost effective and suitable for daily operation, especially for vehicles that are not over 25 tonnes. The penetration of electric HDVs and light vans is also supported by local policies, where the Clean Air for Greater Manchester in our license area is expected to incentivise commercial customers to electrify their fleets.

Our DFES consider the effects on electricity demand from the charging of electric buses, coaches and heavy good vehicles in the North West.

In this year's DFES we forecast the uptakes of electric buses, coaches and heavy good vehicles in our region. Our forecasts present only the purely battery electric HDVs that plug in to charge. However, hydrogen fuelled vehicle types have been considered in the consumer choice models of our Element Energy consultants.

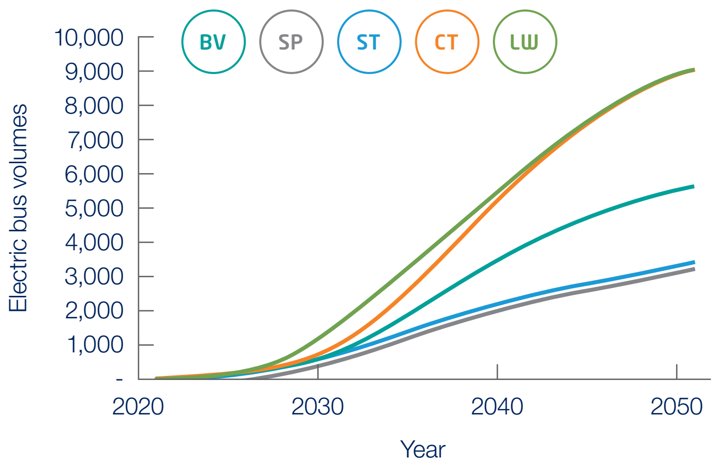
In **Steady Progression**, where no action is taken to meet Net Zero, we adopt a low certainty assumption to capture the minimum demand growth in the very unlikely case where the electrification of transport does not go beyond vans.

In **Best View** and **System Transformation** we acknowledge that the lack of policies to support the uptakes of electric HDVs maintains the uncertainties around the future role of hydrogen and will postpone the uptakes of electric and hydrogen (fuel cells) fuelled HDVs. However, post 2040 the majority of zero emission HDV sales correspond to battery electric fuelled.

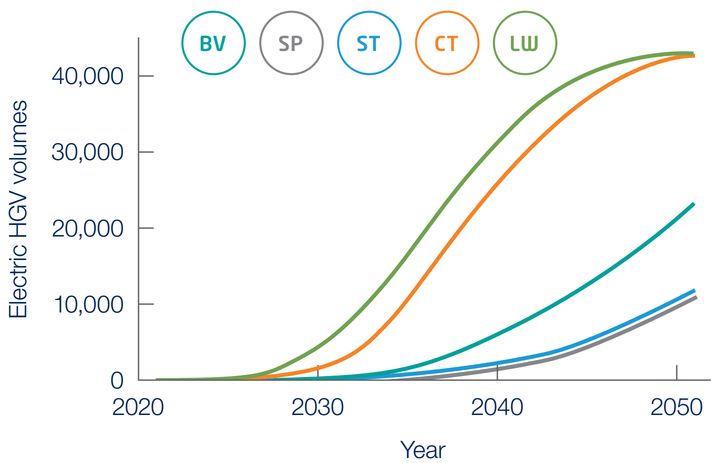
A significant amount of hydrogen fuelled HDVs (using fuel cells) are present, but the majority of HDVs sold are battery electric.

In **Consumer Transformation** we assume that the large scale supply of zero emission HDVs, including battery electric will be available by mid 2030s. This combined with reduced battery costs, improved energy density of batteries and limited availability of green hydrogen for transport will accelerate the penetration of electric HDVs.

Future volumes of electric buses



Future volumes of electric HGVs



Leading the Way assumes that the public concern about climate change accelerates the technology advances through government to improve batteries for HDV applications and ramping up of supply. Large scale supply of battery fuelled HDVs is available from 2030, resulting in the fastest uptake of electric HDVs across all scenarios.

The location of depots and existing volumes per depot have been considered to allocate the forecasted HDVs across our region. To calculate the electricity demand for the HDV charging, we have followed our ATLAS methodology using half-hourly through year profiles. Bus and coach charging is modelled to occur mainly at depots overnight and therefore increases the minimum load across our network. The HGV charging profile is flatter and represents an average for different operations, from small trucks that deliver goods during the day to larger trucks that move goods to distribution centres at night.

3.3 Electrification of heating

Similarly to transport, heating is a sector with significant carbon footprint and accounts for over a third of the UK's total carbon emissions. Consequently, the decarbonisation of heating requires immediate action to not lose track in the country's transition to Net Zero.

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 dominant role.

Interactions with hydrogen

Our DFES 2021 considers the significant 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 beyond 2030. In practice, this wide range means that we need to monitor any advances in the use of hydrogen, for example future replacement of natural gas boilers with hydrogen fuelled boilers, as this could significantly affect load-related investment in our networks.

> 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.

The UK government's Heat and Building Strategy aims to 600,000 heat pumps installed per year by 2028. To support this target and reduce the cost of clean heat, in 2021 the government announced the grants for the Boiler Upgrade Scheme that can be used for heat pumps, which are a mature, highly efficient and net zero technology for heating.

The uncertainties on the use of hydrogen for domestic heating will remain at least until 2025 when the conclusions from Village Trials using 100% hydrogen fuelled boilers are expected to be reached.

More information on how the future range of heat pumps and associated interactions with the future role of hydrogen can affect investment in our network can be found in the load related expenditure annexes of our RIIO-ED2 business plan that was proposed recently in December 2021.

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.

> Our Best View scenario forecasts higher volumes of heat pumps until 2030 compared to Central Outlook scenario in last year's DFES. This is in line with the recent UK government's grants for new installations and the government's interim 2035 carbon target.

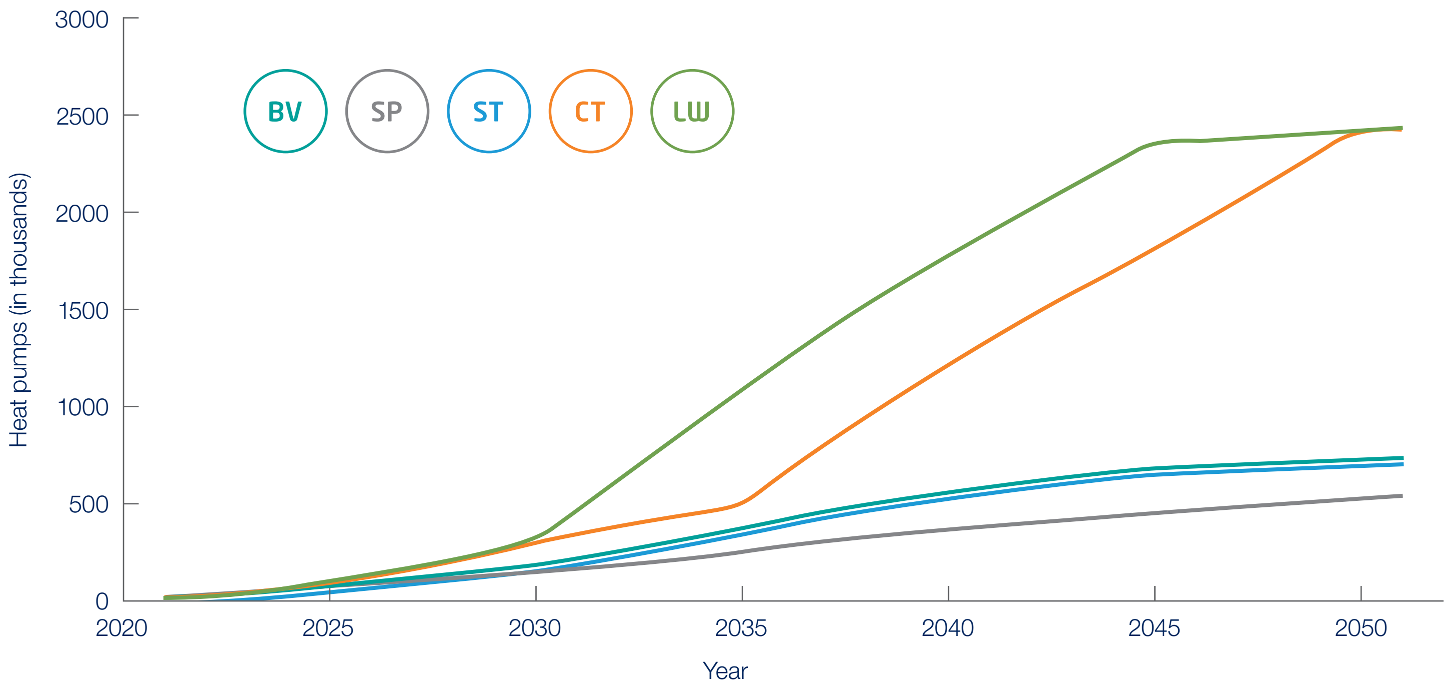
In **Steady Progression** the heating sector does not achieve Net Zero carbon. Gas networks continue to supply local customers mainly with natural gas with a lower amount of biogas. Even though the installation of gas boilers in new buildings will be banned from 2025, existing buildings can still use 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 **Best View** and **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. The proportion of hybrid heat pumps is higher in this scenario, acknowledging that hybrids can be attractive cost efficient options for customers that support both the interim and Net Zero transition targets of the government. In specific, installing a hybrid heat pump now does not foreclose a highly efficient Net Zero option in the longer term, given that they can easily switch to either purely electric heat pumps or hybrids with hydrogen boilers.

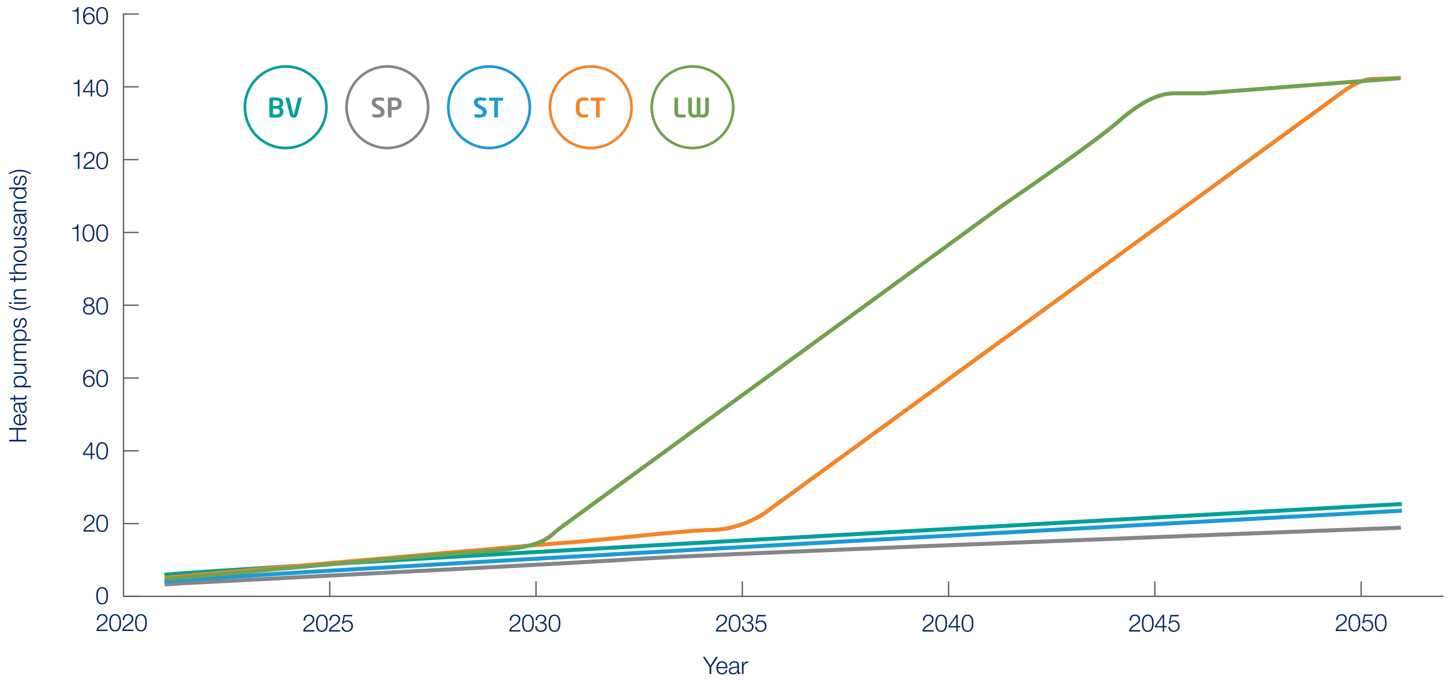
In **Consumer Transformation**, electrification is the main path to decarbonisation of the heating sector. We assume that the UK government's ambition for 600,000 heat pump installations per year is met and the North West contributes its share to meeting this target. In the longer term, gas boilers in existing buildings cannot be chosen by 2035, whereas the banning of oil and coal boilers is assumed to be already applied by 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.

Leading the Way differentiates from **Consumer Transformation** in that the electrification of heating is accelerated 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.

Future volumes of domestic heat pumps



Future volumes of industrial and commercial heat pumps



Electricity generation is the first sector that is expected to fully decarbonise by mid 2030s. To meet this target, new zero carbon renewable sources will be required to be installed across Great Britain. The UK government's Net Zero Strategy sets out the ambition to decarbonise the power system by 2035 and further investment in the offshore wind sector to achieve the target of 40GW by 2030.

PV and wind farms will play a key role in the decarbonisation of generation in the North West and meeting the long-term growth in demand, resulting from the electrification of transport and heating.

The offshore wind generation will be mainly connected to the transmission network. However, distribution connected zero carbon renewables such as PV and wind farms are critical to meet Net Zero, especially in case there are very high levels of electricity demand or delays in the offshore wind generation programme.

In distribution networks, the Contracts for Difference (CfD) scheme and reducing capital costs should accelerate the deployment of zero carbon renewable generation, meaning we expect to see significant growth in PV and wind farms.

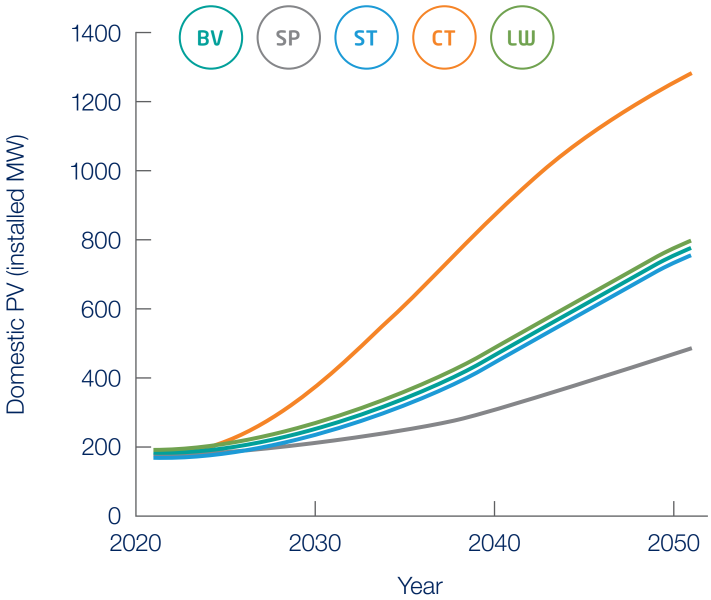
The intermittent nature of PV and wind farms connected at transmission and distribution levels requires flexible assets that are connected to distribution networks and can provide whole system services. Over the last five years we have seen a significant penetration of gas-fuelled flexible generators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

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

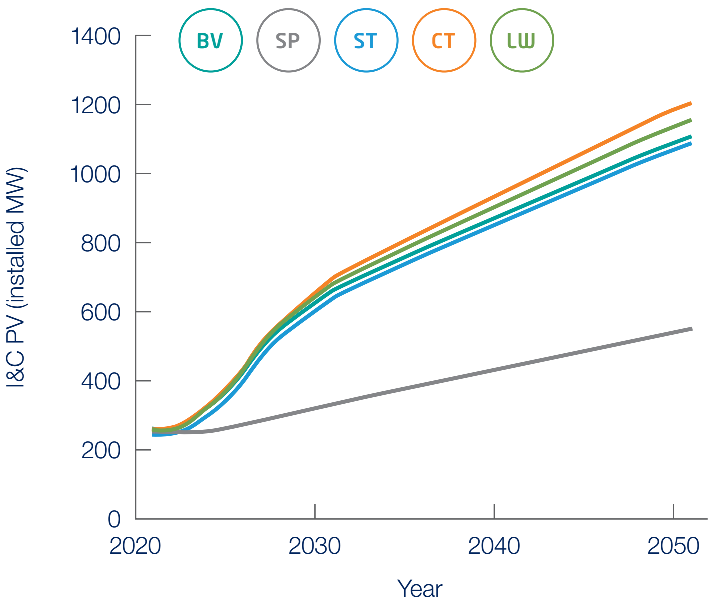
4.1 Distributed generation

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 CfD, but the reduced capital cost will allow the long-term penetration of onshore wind farms and larger PV rather than depend only on subsidies.

Future total installed capacity of domestic PV



Future total installed capacity of non-domestic PV



Our approach to modelling DG connections has been updated from last year to reflect the delays from acceptance to energisation. So, even though only accepted projects are still considered, there is a 5-year linear capacity growth modelled to reflect these delays.

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.

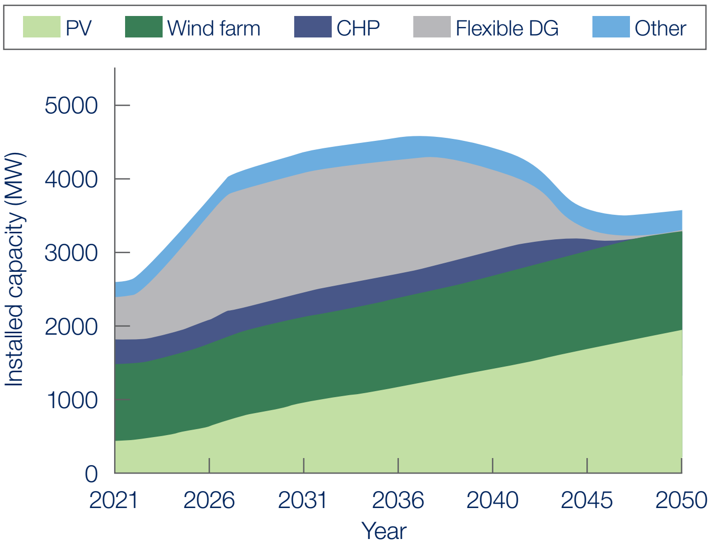
Best View and **System Transformation** show a moderate uptake for all DG technologies including PV and wind farms. Average assumptions have been considered for the technology capex, the electricity price for larger renewable DG units and the CfD strike-prices. In the short-term horizon (1 to 5 years) the DG uptake trends is driven by the connections pipeline, where flexible generators are the dominant technology. 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 1,600 MW of PV and over 400 MW of wind generation before 2040.

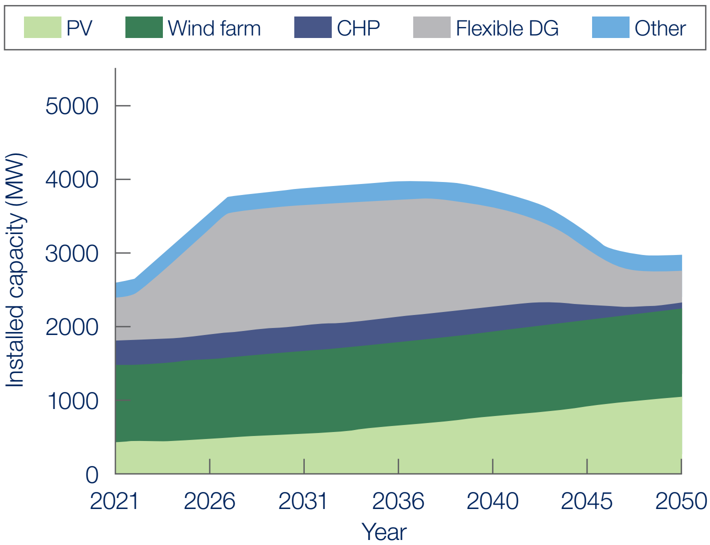
In **Consumer Transformation** over 1,600 MW of additional PV and 400 MW of wind farms before 2040 help to decarbonise local generation across the North West faster than any other scenario. Within a whole electricity context this scenario considers the highest contribution of DG to decarbonise the UK's 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.

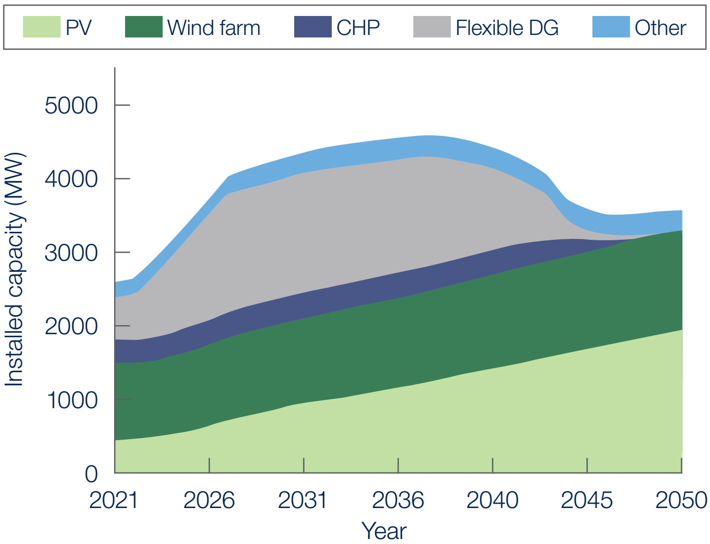
Best View forecasts for distributed generation



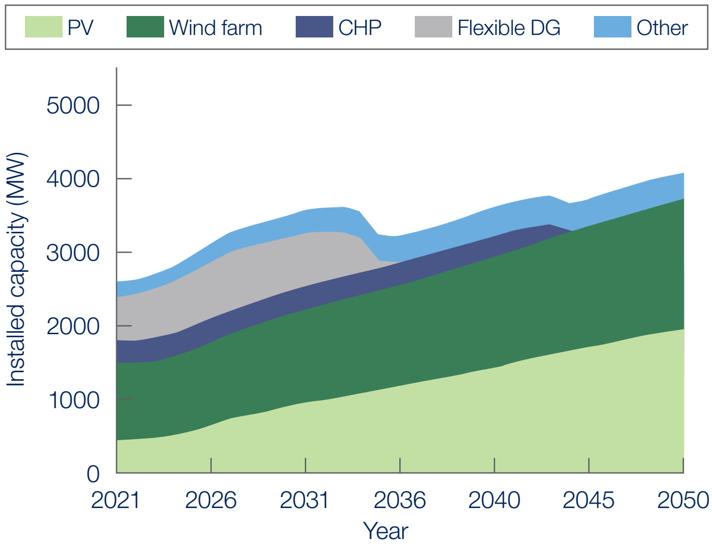
Steady Progression forecasts for distributed generation



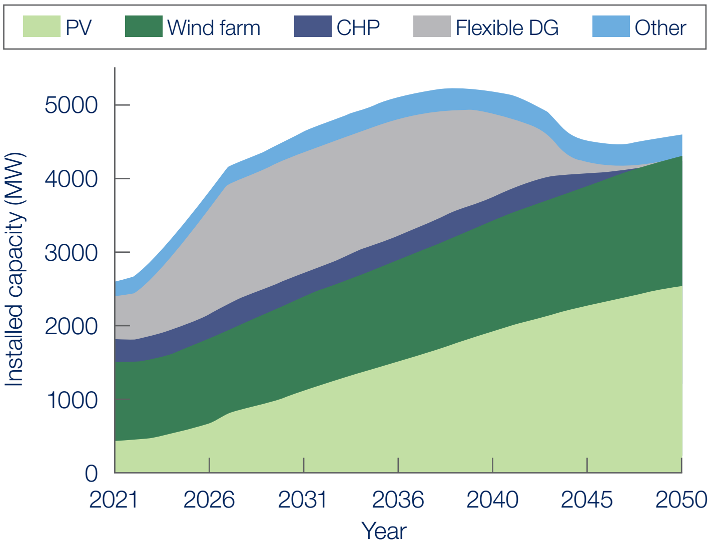
System Transformation forecasts
for distributed generation



Leading the Way forecasts
for distributed generation



Consumer Transformation forecasts
for distributed generation



4.2 Battery storage

Battery storage is a key technology which can allow customers connected to our networks to benefit from behind-the-meter services and to provide flexibility services to us and the transmission operator. These services can facilitate the transition to Net Zero by both avoiding costs for distribution network reinforcement and allowing more renewable generation connect both at transmission and distribution level.

Compared to 2020, in 2021 we have seen in over double the capacity of grid scale batteries accepted for connection to our network.

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 the smart control of the electricity network which will allow them to use more electricity from the network when it is cheaper and export more 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.

Compared to last year's DFES, in 2021 we have seen a significant rise in the number of connection applications for grid scale batteries. The associated installed capacity for the accepted to connect projects is over double and the most recent figures can be accessed from our Embedded Capacity Register (ECR) dataset that is updated on a monthly basis and includes all accepted connections above 1 MW installed capacity.

In **Steady Progression** only a limited number of accepted battery connections for projects that have already made significant progress are energised. 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.

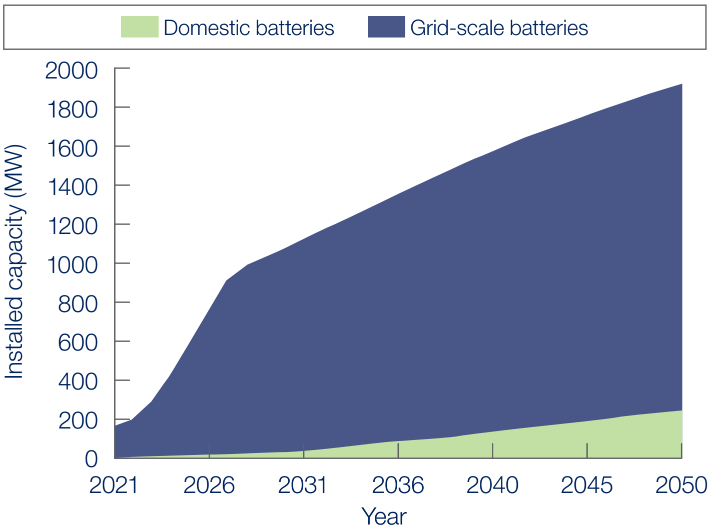
Consumer Transformation also shows that all accepted large battery connections are moving forward and are responsible for the linear growth in storage capacity between 2022 and 2027. In the longer term, this scenario shows higher total battery capacity compared to **System Transformation** due to the 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 connected to the distribution and transmission networks. This is the main driver for the higher uptake of both grid-scale and domestic batteries.

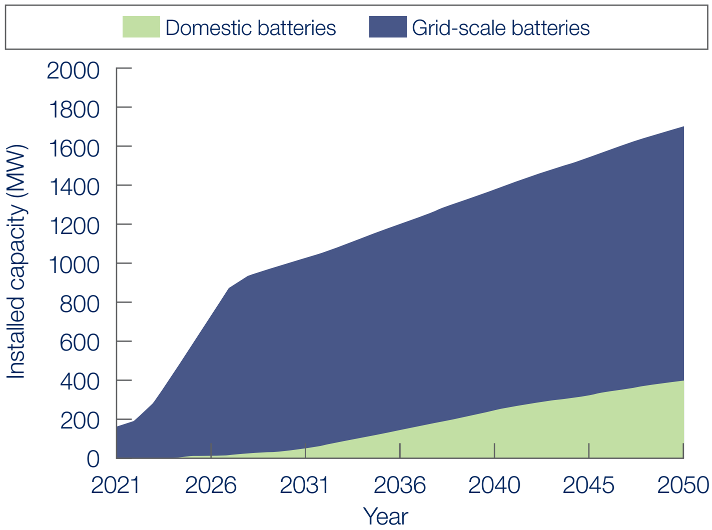
Our **Best View** scenario considers average uptake trends for domestic batteries, which are driven by the corresponding average uptake of domestic PV adopted in this scenario. However, for grid scale batteries **Best View** uses the high uptake trends adopted in **Leading the Way**. There are two reasons that justify this assumption for grid scale batteries:

- the UK government's commitment on offshore renewable generation to decarbonise the electricity generation sector and
- importantly over double the capacity of accepted connections in the pipeline observed this year compared to last year. The capacity in the pipeline is continuously growing and is already over 50% of the battery capacity allocated to our region to meet the Net Zero target.

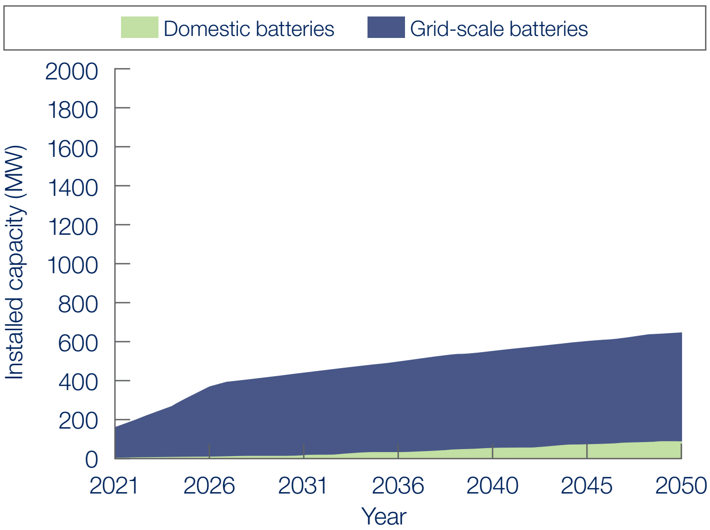
Best View forecasts for battery storage



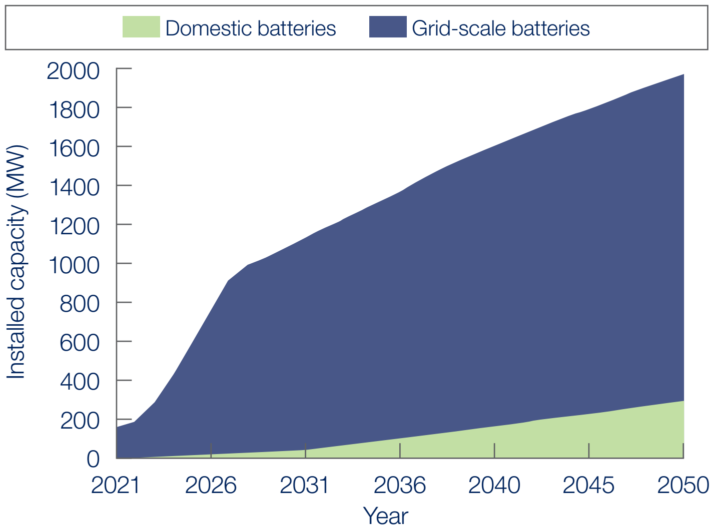
Consumer Transformation forecasts for battery storage



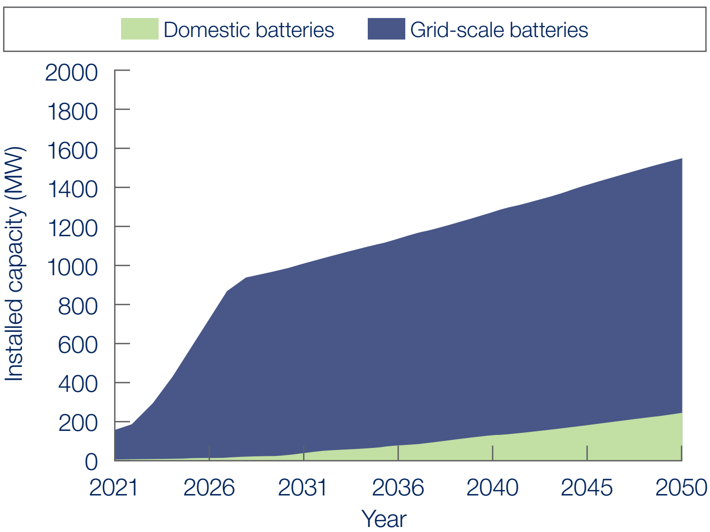
Steady Progression forecasts for battery storage



Leading the Way forecasts for battery storage



System Transformation forecasts for battery storage



5 Flexibility

As the electrification of transport and heating increases the loading across our network, the use of flexibility services is a key tool to help expand network capacity in an economic and efficient way. Moving towards Distribution System Operation (DSO) with increased network management capability, flexibility services will be an essential resource for balancing supply and demand and reducing the cost for electricity distribution networks in customer energy bills. Flexibility will also help us decarbonise our electricity supply while ensuring that our networks remain resilient, reliable and meet our customers' needs.

5.1 Role of flexibility to meet net zero

The transition to Net Zero is going to be achieved with significant levels of electrification of the transport and heating sectors, as well as more local renewable generation and battery storage to decarbonise the electricity generation sector.

Flexibility services can help us meet the Net Zero target with reduced energy bills for customers and reduce the risk associated with expanding the network.

As customers adopt more LCTs, there are two key challenges in optimising our network planning and continuing to operate a secure and reliable network:

a) reduce the cost for customers whilst providing network capacity to facilitate LCTs; and,

b) reduce any risks from the uncertainties around future LCT uptakes and customer behaviours in their use of electricity.

Flexibility services help us deal with both of these challenges and minimise both costs and risks during the transition to net zero.

In our RIIO-ED2 business plan that we submitted on December 2021 we used Cost Benefit Analysis (CBA) to present how the use of flexibility services can be cost efficient for our customers. Using flexibility, we can have cost savings not only when we avoid conventional reinforcement now, but also when we postpone reinforcement work. Our plans also include the deployment of flexibility services at some sites to mitigate against predicted short term overloads at peak times LCT uptake increases across the region to deliver Net Zero.

Regarding the risks in network planning, with the use of flexibility services we can make sure that network capacity will be available for the highest possible demand growth. This in practice means that not only demand growth across all DFES scenarios is considered, but also additional short-term uncertainties in demand growth from planned developments. Using flexibility services to manage uncertainty, and only installing new assets when there is high certainty of the needs avoids the risk of costly underutilised assets.

5.2 Our future requirements of flexibility services

In our Autumn 2021 requirement we have asked for 259MW of flexibility across 37 locations in our region. In our final RIIO-ED2 business plan submitted to Ofgem, our regulator, we explained how flexibility services will expand to lower voltages and cover more locations for our next price control that ends in financial year 2028.

Our future requirements for flexibility services will cover more locations, expand to lower voltages and will in general increase as we move towards net zero.

Importantly flexibility services are forecasted to increase through time as together with energy efficiency they become key tools to reduce costs and the risks associated with network planning, including:

- postponing or avoiding conventional reinforcement for multiple years or even decades if flexible capacity can increase;
- providing capacity during the construction lead time of conventional reinforcement (2+ years)
- providing capacity for pre- and post-fault cases
- providing capacity under uncertainty in demand growth, ie flexibility requirements based on all DFES scenarios and for even higher demand due to extreme weather and higher loading of planned developments than historical performance of similar projects.

In our first Network Development Plan in 2022 we will share requirements for flexibility services based on each DFES scenario up to 2050.

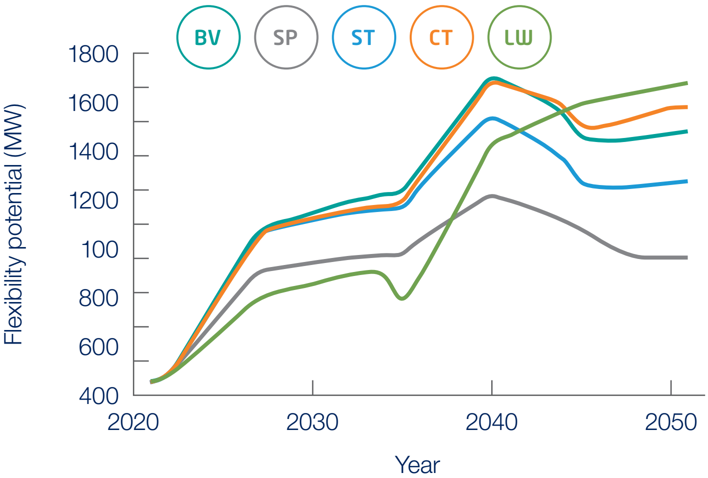
5.3 Forecasting the potential of flexibility services

Our "flexibility first" approach presented in our final RIIO-ED2 business plan shows our intention to procure flexibility wherever possible to avoid conventional network reinforcement. Therefore a key question is how much flexibility can we expect to be available in our region in the future.

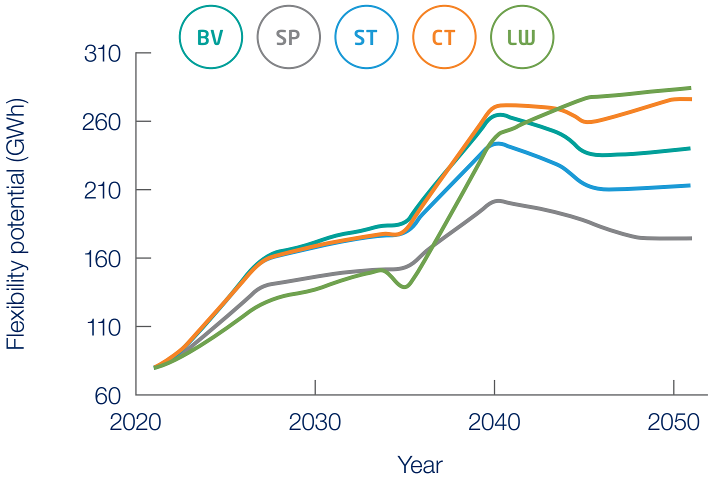
Our stakeholder engagement helps us inform our forecasts and improve our understanding of the future potential for flexibility and what it means for uncertainties in our planning and future business plans.

The demand, generation and battery storage forecasts from our DFES scenarios can be used to estimate the future potential for the provision of flexibility services in our area. This highlights the importance of our cycle of engagement with our stakeholders, given that information and feedback on our forecasts can help us make informed assumptions on the extent that flexibility can reduce costs and risks in our network in the longer term.

Future potential of active power available for flexibility services



Future potential of electricity available for flexibility services



Our forecasts of active power (MW) at time of peak load and annual electricity (MWh) that could be provided through flexibility correspond to capacity release and associated energy potential for:

- Demand Side Response (DSR) from load shifting away from times of peak demand;
- generation from flexible DG units; and,
- discharging of grid scale and domestic battery storage.

Our **Best View** scenario shows a continued increase of the available MW and MWh for DSO flexibility services until mid 2030s. This is due to the continuous growth of flexible generators, batteries and electricity consumption driven by the electrification of transport and heating. However, towards 2040 and beyond there is a decline as we expect that most distribution connected flexible generators will be disconnected, given that they are not Net Zero technologies fuelled mainly by gas and diesel.

Our **Leading the Way** scenario shows the potential for flexibility in the case that gas fuelled flexible generators are disconnected earlier, we have higher opportunities for DSR driven by the accelerated decarbonisation of transport & heating and more flexibility can be provided from domestic batteries.

6 Appendix – per county trends in our region

Our license area supplies the counties of Cumbria, Greater Manchester and Lancashire, as well as councils shared with neighbour DNOs including Cheshire, Derbyshire, Merseyside and North Yorkshire.

Our **Best View** scenario shows the highest certainty trends in our region by 2030 including the anticipated high levels of electrification of transport. But local authorities and stakeholders should also consider our **Leading the Way** scenario to understand the level of electrification of heating required to accelerate decarbonisation and our **Consumer Transformation** scenario to understand the amount of local zero carbon renewables required to fully decarbonise electricity supply.

This section presents forecasting trends per county focusing on three scenarios. Our **Best View** scenario shows the highest certainty trends in our region for the next 10 years including the anticipated high levels of electrification of transport. The three main County Councils in our area have ambitions to decarbonise before 2040 and therefore our **Leading the Way** scenario should be considered for accelerated decarbonisation and the electrification of heating. To meet the decarbonisation of the power system in mid 2030s, further distribution connected zero carbon generation will be required to connect. Use of our **Consumer Transformation** scenario sets out zero carbon renewable generation uptake requirements.

6.1 Electricity Demand – focus on electrification of transport and heating

Across all counties and councils in our license area we expect, based on all DFES scenarios, that electrification of transport will be the main driver of the increase in electricity consumption. The uncertainties around the electrification of heating do not allow us to assume that hydrogen is not going to have a dominant role in domestic heating to decarbonise the sector. Therefore in our **Best View** scenario all three major counties in our license area have as a secondary demand growth driver the penetration of domestic and commercial heat pumps. This is not the case in **Leading the Way** scenario, where the early electrification of heating allows our region to accelerate decarbonisation.

Even though electrification of transport and heating are the main drivers of electricity demand growth across the different counties, there are differences based on the characteristics of each county. Our **Best View** scenario shows that the increase of electricity consumption from planned developments within the following 15 years can be double in Greater Manchester as a percentage (over 10% of existing energy consumption) compared to Cumbria and Lancashire (less than 6% for each).

Accelerating the decarbonisation of heating through electrification would require at least over 200 thousand heat pumps in Greater Manchester, 50 thousand in Cumbria and 100 thousand in Lancashire. However, meeting Net Zero before 2040 could require five times (5x) these volumes per county.

Forecasts of EV cars and vans per county in thousands for Best View

County	Year			
	2021	2030	2040	2050
Cumbria	1	162	309	339
GMCA	7	716	1,348	1,486
Lancashire	4	424	800	880

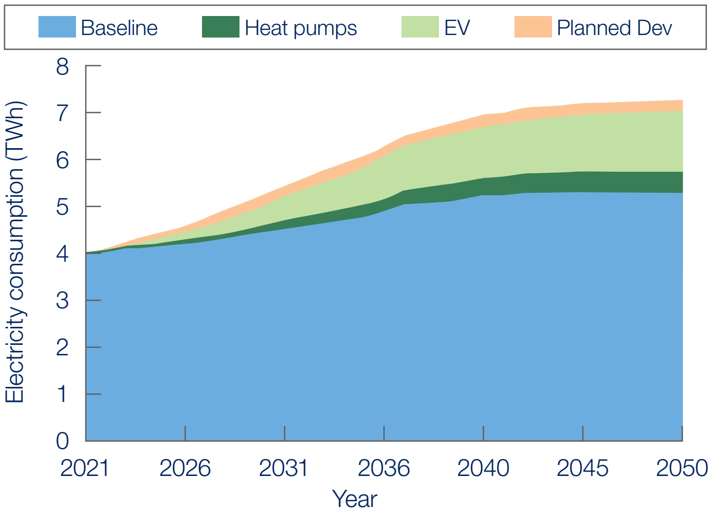
Forecasts of heat pumps per county in thousands for Leading the Way

County	Year			
	2021	2030	2040	2050
Cumbria	2	48	215	285
GMCA	13	174	995	1,375
Lancashire	5	98	542	744

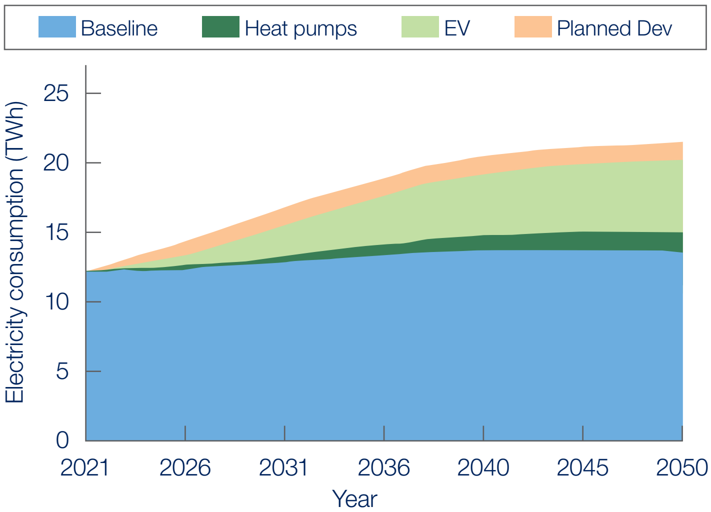
The electrification of transport, taking into account all vehicle types from cars and vans to buses and heavy good vehicles, is expected to increase demand by almost half of the existing (2021) baseline demand in Lancashire. This is more than the corresponding effects in the other two counties, ie just over 40% for GM and just over 30% for Cumbria. This difference is explained by the higher volumes of domestic customers and HDV depots for both buses and HGVs in Lancashire compared to Cumbria, as well as the lower non-domestic demand compared to GM.

Our **Leading the Way** scenario differentiates from our best view in assuming higher levels of societal change (eg, focus on efficiencies, less EV mileage) and electrification of heating as the main decarbonisation pathway for this sector. To accelerate the decarbonisation of heating through electrification would require at least over 200 thousand heat pumps in Greater Manchester, 50 thousand in Cumbria and 100 thousand in Lancashire. However, meeting Net Zero before 2040 could require five times these volumes per county.

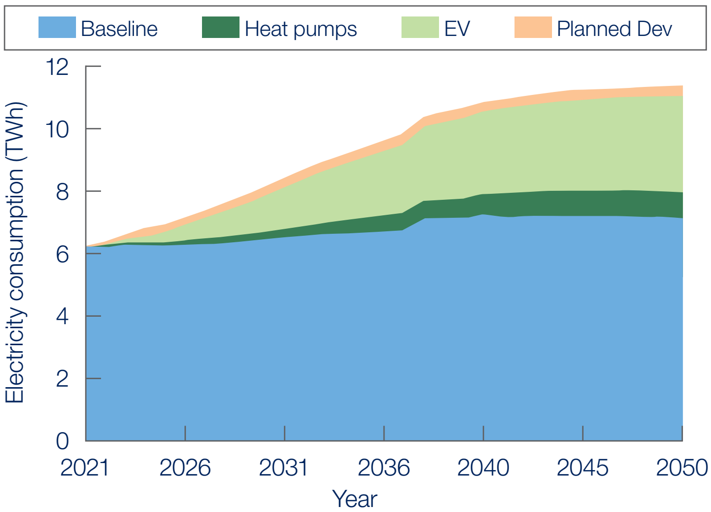
Future annual demand for Cumbria for Best View



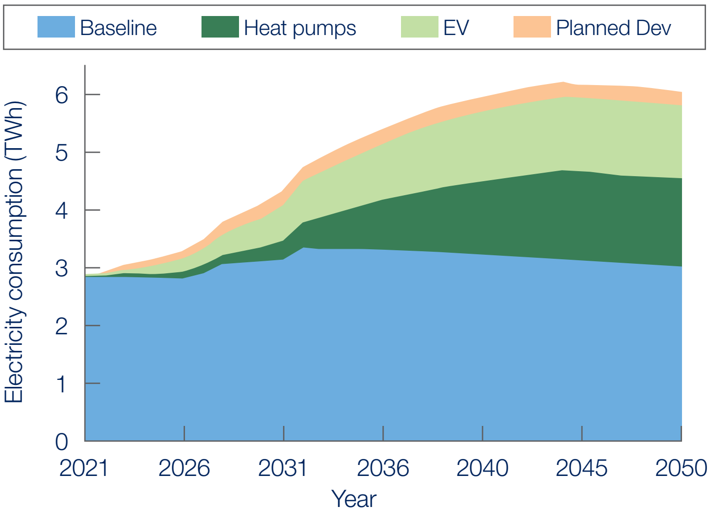
Future annual demand for Greater Manchester for Best View



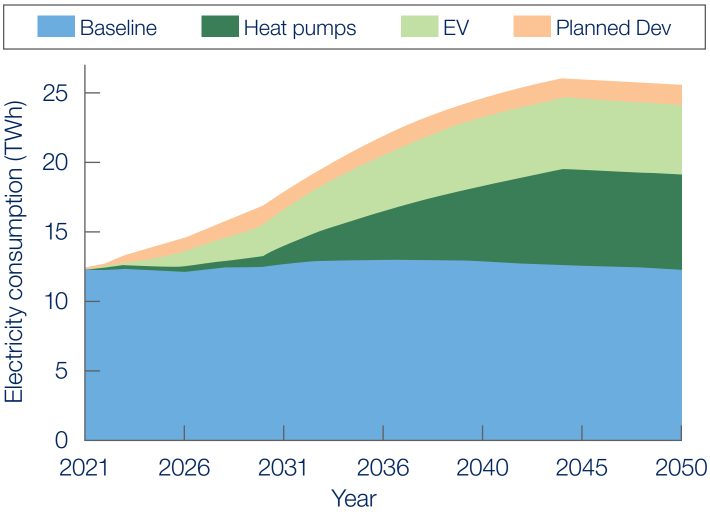
Future annual demand for Lancashire for Best View



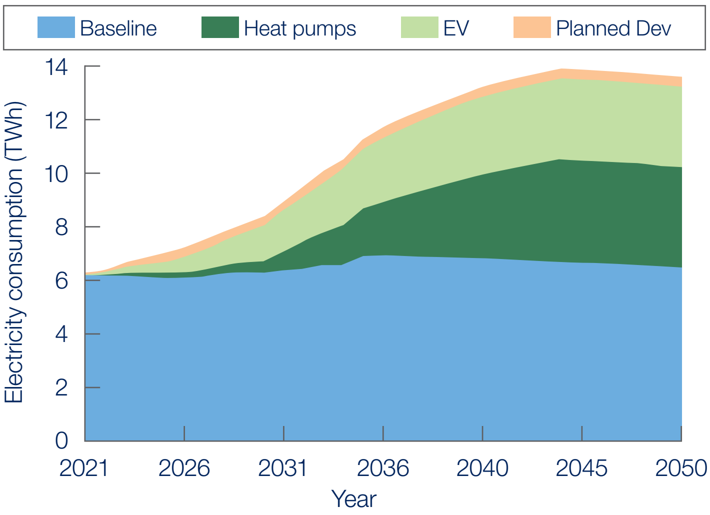
Future annual demand for Cumbria for Leading the Way



Future annual demand for Greater Manchester for Leading the Way



Future annual demand for Lancashire for Leading the Way



Forecasts of the electricity demand and LCT volumes for each of the 40 councils that we supply in our license area can be found for first time in our DFES workbook. The forecasts cover all five DFES scenarios and include the total electricity consumption, as well as the demand for EV charging, heat pumps and planned developments per council. Forecasts for EV and heat pump volumes are also included.

6.2 Renewable Generation

As highlighted in the distribution generation section of this document, distribution connected renewable sources are expected to play a critical role to fully decarbonise the electricity generation sector by mid 2030s. Any delays in the offshore wind generation programme or uncertainties around the electricity demand growth will require higher levels of zero carbon generation connected at distribution.

Local characteristics drive higher levels of wind generation uptake in Cumbria and higher levels of PV in Greater Manchester. By 2030 our **Consumer Transformation** shows an additional 300MW of PV in Greater Manchester, an additional 300MW of combined wind farms and PV in Cumbria and an additional 230MW of PV and 50MW of wind farms in Lancashire.

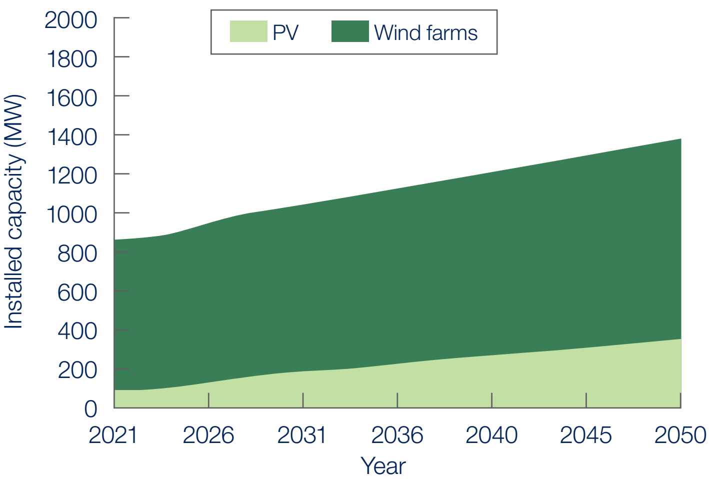
Even though our forecasts consider biomass and biogas fuelled generation, wind farms and PV are the two major, mature and cost efficient in the long term zero carbon technologies that can support decarbonisation of supply in our region. The local characteristics of each county are taken into account in our forecasts. This results in higher uptake of wind generation in Cumbria compared to the rest of the region due to land availability, whereas PV penetration in the area is lower due to the lower customer volumes. The opposite characteristics can be observed in Greater Manchester, where higher volumes of customers and commercial activity drive higher regional PV penetration and limited land availability limits the corresponding wind farm installations.

To reflect the UK government's growing ambition to fully decarbonise the electricity power system we may need to refine the amount of distribution connected renewable generation. This could mean that requirements for the next 10 years are higher than our latest thinking within the **Consumer Transformation scenario**.

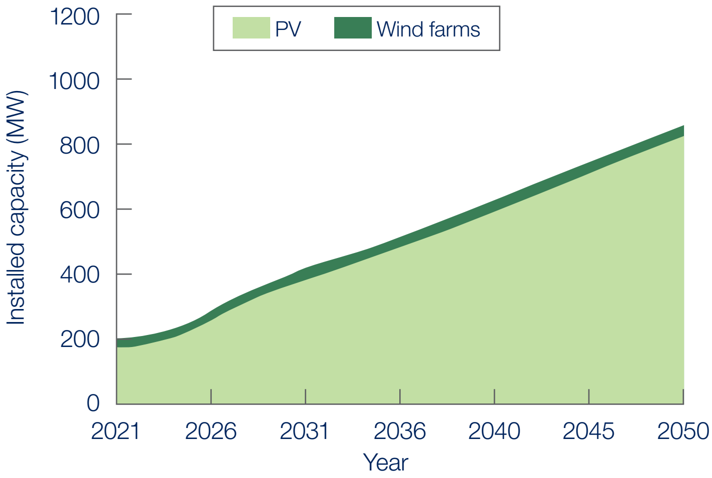
Our **Best View** scenario shows that in the following 1 to 10 years all three major counties in our license area will increase their PV and wind farm capacity. However, this increase will not exceed even half of the installed capacity of PV and wind farms currently connected, which was mainly installed during the past decade. This is justified by the limited amount of accepted connections for PV and wind farms at the moment, as well as the limited incentives for our customers compared to the recent past.

Our **Consumer Transformation** scenario shows the highest uptake of wind generation, given that the accelerated decarbonisation in **Leading the Way** is achieved through transmission connected offshore wind generation. Following the consistent assumptions with the other GB DNOs and National Grid's ESO, our **Consumer Transformation** scenario considers medium uptakes for non-domestic PV. These assumptions are in line with the future world that this scenario represents, ie a world with high levels of societal change and adequate decarbonisation to meet Net Zero by 2050. Therefore this scenario should be seen as a minimum requirement for PV and wind generation to decarbonise the local electricity supply.

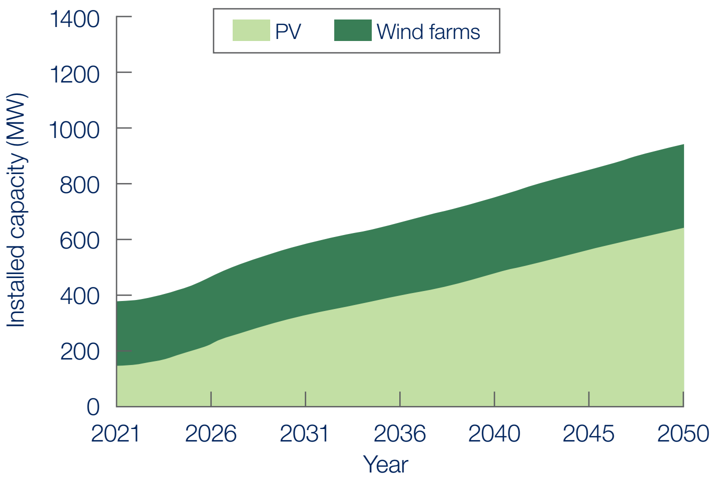
Future installed PV and wind generation capacity for Cumbria for Best View



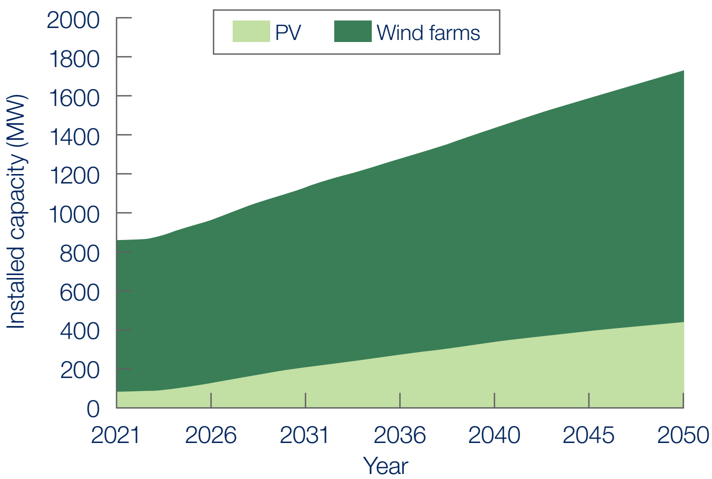
Future installed PV and wind generation capacity for Greater Manchester for Best View



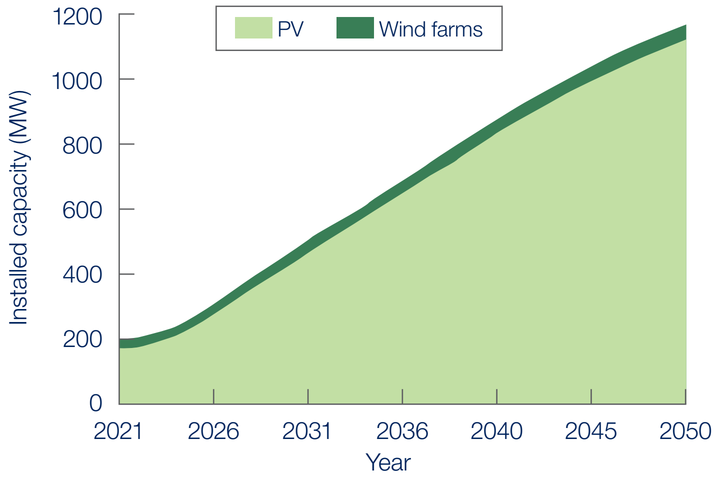
Future installed PV and wind generation capacity for Lancashire for Best View



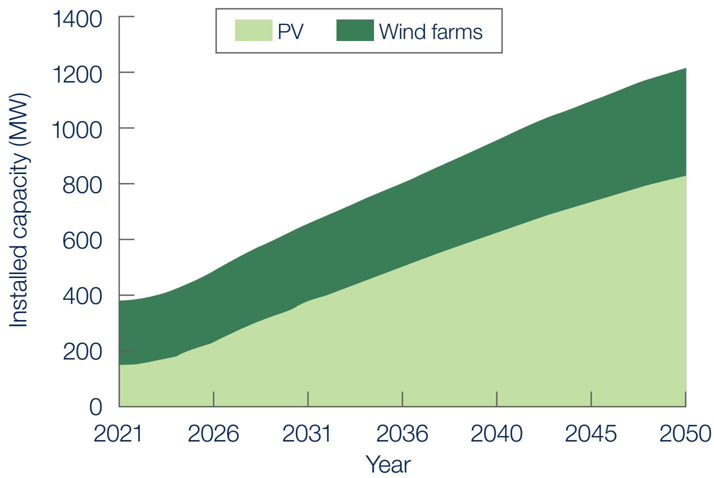
Future installed PV and wind generation capacity for Cumbria for Consumer Transformation



Future installed PV and wind generation capacity for Greater Manchester for Consumer Transformation



Future installed PV and wind generation capacity for Lancashire for Consumer Transformation



Forecasts for PV and wind farms for each of the 40 councils that we supply in our license area can be found for first time in our DFES workbook. The forecasts cover all five DFES scenarios and include not only the installed capacities, but also the total electricity generated per council.

High levels of national and local zero carbon renewables need to be connected, followed by actions to accelerate the installation of domestic and non-domestic battery storage.

In order to fully utilise the electricity generated by transmission and distribution connected renewables and meet Net Zero, action is required to increase the installed battery storage capacity. In this year's DFES workbook we also include forecasts of battery storage for each of the 40 councils that we supply in our license area.

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