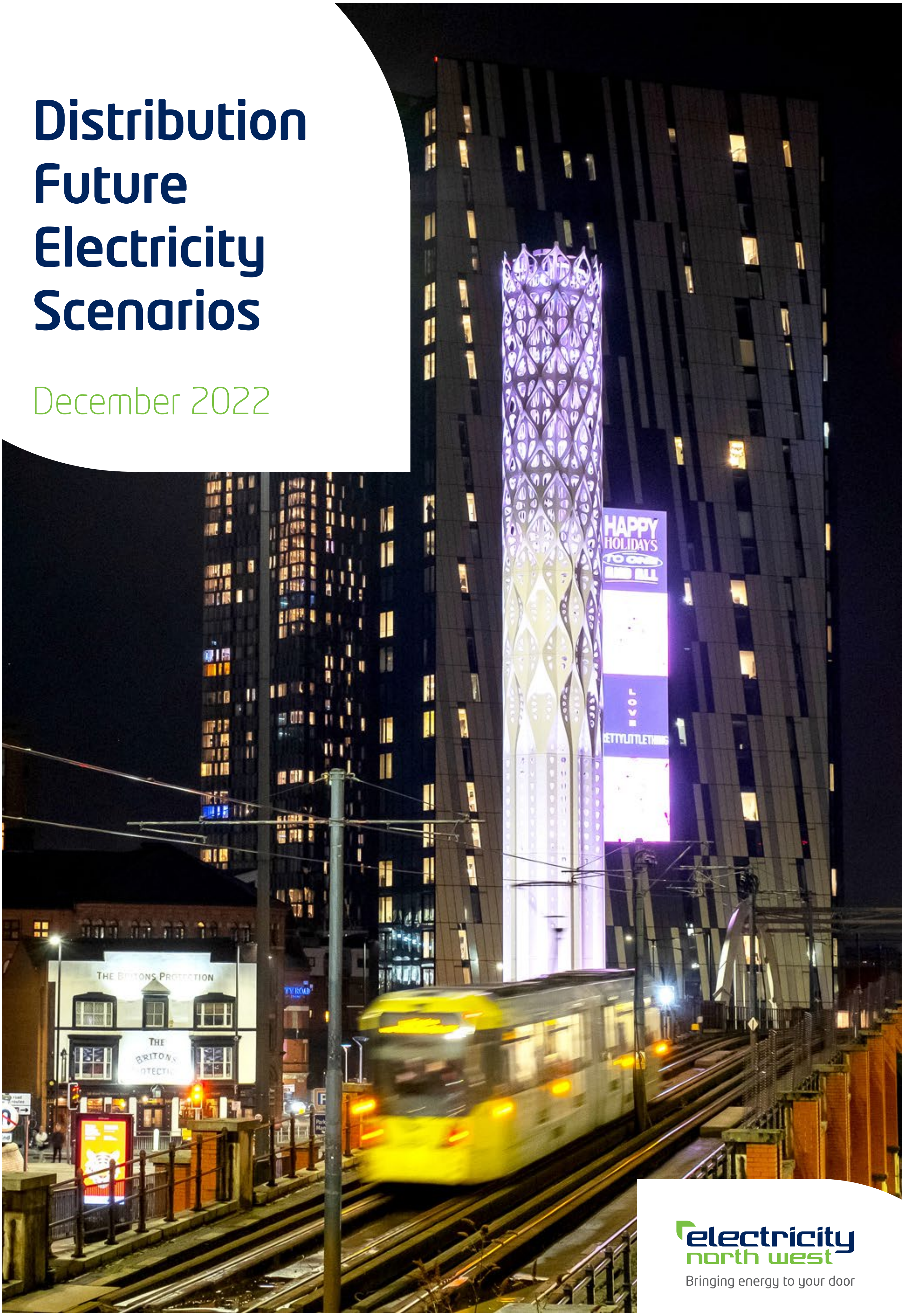
Distribution Future Electricity Scenarios

December 2022



electricity north west

Bringing energy to your door

Contents

Welcome to our fifth annual Distribution Future Electricity Scenarios (DFES) document, in which we set out our understanding of the way we expect the use of the electricity network to change in our region up to the year 2050.

These forecasts for demand, distributed generation (DG) and battery storage are used to develop our investment strategies, support our stakeholders' plans and have informed our business plan for our next regulatory price control (RIIO-ED2) which runs from April 2023 – March 2028.

Our communities are currently facing the combined impact of a significant cost-of-living crisis and the long-term effects of the COVID-19 pandemic.

To support our stakeholders, our proposed investment in network capacity (load-related expenditure) for RIIO-ED2 has the lowest impact on customer energy bills across all Great Britain's (GB) distribution network operators (DNOs). We have also identified any additional investment requirements that could be funded through 'uncertainty mechanisms' in the event that a large part of our region decarbonises more quickly to meet Net Zero before 2040.

Our scenarios take into account the impact of advances in technology, fuel costs and changing government policies. Even though technology costs reduce quickly, this year's forecasts show that decelerated economic growth combined with short-term supply chain issues could result in a delay in the uptake of electric vehicles (EVs) and heat pumps before they return to the levels predicted in last year's forecasts.

We continue to follow the same high-level assumptions as the rest of the GB electricity industry with four of our five scenarios. This allows us to support whole system thinking and deliver a consistent approach for our stakeholders. 'Steady Progression' has been renamed 'Falling Short' as this is the only scenario that fails to meet Net Zero by 2050. Our unique 'Best View' scenario captures the highest certainty trends for the next ten years.

A key focus area in the development of our forecasts is stakeholder engagement. We work with local government and other stakeholders to understand where capacity is needed and we provide them with load-related investment data that can be used to inform Local Area Energy Plans (LEAPs) which consider the most effective route to meet Net Zero.

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 in the future. This will include an important transition in our role as a DNO. We will develop new 'distribution system operation' (DSO) activities such as the use of flexibility to facilitate Net Zero transition at lower cost and the establishment of a local flexibility market.

This year we have enhanced the DFES workbook to include long-term forecasts of our flexibility service requirements which build on the requirements published in our autumn 2022 tender.

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 Operation Director
December 2022

Cost of living crisis

Uncertainties from the cost of living crisis
The impact of the cost-of-living crisis on the communities we serve and the uncertainty it brings is discussed in this report and is reflected in our forecasts.

The transition to net zero needs to be aligned with a focus on reducing energy costs
Our customers and stakeholders are currently focused on reducing their energy costs, so policies and incentives are needed to encourage the adoption of energy efficiency measures and low carbon technologies. After a period of uncertainly surrounding the cost-of-living crisis we expect our customers to adopt more EVs, heat pumps and renewable generation as technologies mature and their costs continue to fall.

SCENARIOS AT A GLANCE

2022	Scenario		2030	2040	2050
25 TWh Annual Electricity	Falling Short		29 TWh	32 TWh	34 TWh
			0.8 million	1.6 million	1.8 million
			0.17 million	0.39 million	0.55 million
			1.5 GW	1.9 GW	2.2 GW
			0.5 GW	0.6 GW	0.7 GW
25,000 EVs	System Transformation		33 TWh	40 TWh	41 TWh
			1.3 million	2.6 million	2.8 million
			0.23 million	0.6 million	0.76 million
			2.0 GW	2.6 GW	3.2 GW
			0.9 GW	1.4 GW	1.9 GW
22,000 Heat Pumps	Best View		33 TWh	41 TWh	42 TWh
			1.3 million	2.7 million	2.9 million
			0.23 million	0.6 million	0.8 million
			2.0 GW	2.6 GW	3.2 GW
			0.9 GW	1.4 GW	1.9 GW
1.48 GW of Zero Carbon DG	Consumer Transformation		34 TWh	47 TWh	53 TWh
			1.3 million	2.7 million	2.9 million
			0.4 million	1.4 million	2.6 million
			2.8 GW	3.8 GW	4.7 GW
			0.9 GW	1.5 GW	2.1 GW
167 MW of Battery Storage	Leading the Way		35 TWh	49 TWh	50 TWh
			1.4 million	2.7 million	2.5 million
			0.5 million	1.4 million	2.6 million
			2.1 GW	2.9 GW	3.6 GW
			2.1 GW	2.6 GW	2.9 GW

OUR LATEST FORECASTS

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 heating

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

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.

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 are critical to define effects on network loading.

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.

WHAT IS NEW IN DFES 2022?

Local Area Energy Plans (LAEPs)

We explain our role as a supporter and facilitator of LAEPs, their interactions with DFES and the benefits for our customers and stakeholders from the use of data we share, including information on the recent changes in connection charges to our networks.

More data and insights

Additional datasets on flexibility services requirement forecasts are now included in the DFES workbook. Our analysis shows that electrification of transport in North West has been accelerated, but much slower than national average.

DSO ROLE IN LOCAL AREA ENERGY PLANNING (LAEP)

Local area energy planning (LAEP)

Our role as LAEP facilitator

LAEP action plans are a direct input to DFES and vice versa in a continuous cycle. We expect that local authorities will be LAEP coordinators and our role is to assess network impact and release capacity where and when needed to facilitate LAEPs and other stakeholder plans.

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. Our flexibility service requirements published in DFES and shared in flexibility tenders support local energy markets (LEMs).

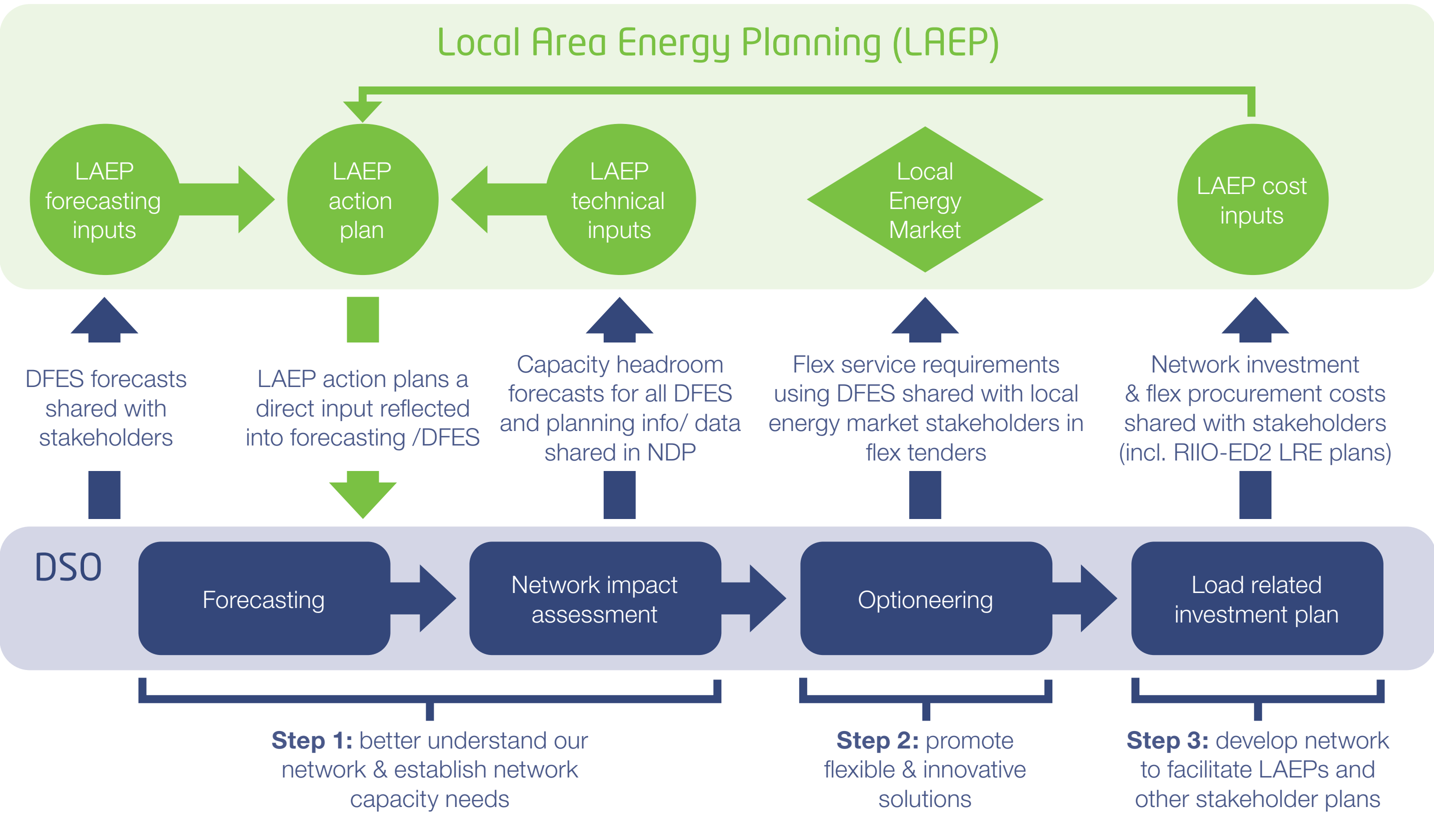
Network planning data as inputs for LAEP action plans

Our DFES and associated capacity headroom forecasts are published following stakeholder engagement and can be used to produce well informed LAEP action plans.

Electricity North West’s load related investment

Our RIIO-ED2 business plan for 2023-2028 keeps the customer energy bills low whilst facilitating Net Zero in North West by 2050 at the latest. Additional investment quantified to be funded through Ofgem’s uncertainty mechanisms if our region accelerates, through LAEPs, the decarbonisation to meet Net Zero before 2040.

INTERACTIONS OF LAEP WITH DFES AND DSO PLANNING



The way the five million customers across our region will consume, generate and store electricity is forecasted in our Distribution Future Electricity Scenarios (DFES).

As part of our region's transition to Net Zero, our DFES allow us to understand the requirements to facilitate across North West:

- the electrification of transport and heating
- the penetration of local renewable generation and battery storage
- Local Area Energy Plans (LAEPs)
- other decarbonisation plans or any planned developments by our stakeholders and customers.

We are the first DNO in Great Britain to publish a fifth annual DFES document, where we present updated forecasts up to 2050 and how these inform the future of the North West's electricity network.

Our DFES should not be seen as any pathway to Net Zero, but as long-term forecasts of electricity demand, DG and battery storage. They are produced using our bottom-up ATLAS methodology and reflect the short- and long-term best view and uncertainties in demand and generation across 500 of the largest electricity substations supplying the North West.

Transition to Net Zero during a period of high uncertainty – the role of DSO

Following a two-year pandemic that has affected not only our economy, but also the way we live and work, we are now facing a cost-of-living crisis. We understand the impact of this on our customers, especially the most vulnerable. Our business plan for the next regulatory period (RIIO-ED2 from 2023 to 2028) will help by reducing the part of their energy bills associated with the local electricity distribution network and is the lowest cost per customer across all GB DNOs.

In June 2022, the Committee on Climate Change (CCC) Progress Report to Parliament highlighted that Net Zero solutions should align with tackling the fuel crisis. In fact, Net Zero options for renewable generation and the electrification of transport and heating are not only getting technology mature but are also becoming more cost- and energy-efficient. This makes them more attractive and 'low regret' Net Zero options that allow our stakeholders and customers to proceed with their decarbonisation plans.

In July 2022 the UK government Energy Security Bill was introduced. This builds on the ambitious commitments of the British Energy Security Strategy to invest in homegrown energy and maintain the diversity and resilience of the UK's energy supply.

We are in a period of high uncertainty where the cost-of-living crisis is affecting the energy and decarbonisation decisions of our customers, especially the most vulnerable members of our society.

Uncertainty over the adoption of low carbon technologies and the decarbonisation plans of our stakeholders and customers is not only due to the cost-of-living crisis. The CCC Progress Report to Parliament also noted that even though the UK has a Net Zero strategy, policy gaps remain. This is demonstrated by the difference we have seen in our progress towards the adoption of EVs. Over the last four years, even though we have seen an exponential growth of EV volumes in the North West, this growth is only half the national pace which is driven by local policies such as the Greater London congestion charge to improve air quality.

Our DSO load-related investment planning uses the DFES, a 'flex first' approach and extensive optioneering of network reinforcement options to identify the most cost-efficient interventions to facilitate the North West's transition to Net Zero.

1 INTRODUCTION

Our DFES forecasts are used to inform our DSO load-related investment plan, aiming to release capacity where and when required to facilitate the decarbonisation and other plans of our stakeholders while facilitating the North West's transition to Net Zero by 2050 at the latest. Using a 'flexibility first' approach we procure flexibility services in cases where their use is more cost-efficient compared to conventional or innovative network reinforcement. We also adopt an extensive optioneering process to identify conventional reinforcement and innovative options that release only the required capacity based on DFES.

In our RIIO-ED2 business plan we have proposed an investment of £28 million per year to facilitate the North West's transition to Net Zero by 2050. We have also quantified that up to a five-fold investment plan may be required and would be funded through the RIIO-ED2 regulatory uncertainty mechanisms. Among others, uncertainty funding applies in the following circumstances:

- the majority of our region fully decarbonises before 2040, especially through the electrification of heating
- reduced network connection charges incentivise our stakeholders to proceed with more local developments including renewable generation and grid-scale battery storage connections.

Document objectives

In line with the requirements specified by Ofgem, our regulator, the main purpose of our DFES forecasts is to inform network planning by presenting our long-term forecasting scenarios for electricity demand, DG and battery storage.

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 Future Energy Scenarios (FES).

Another key objective of this report is to support our local stakeholders and customers by presenting how their decarbonisation and other plans – including any LAEPs – are reflected in the scenarios that inform the future of their local electricity network. More granular data down to primary substation feeding areas can be found in the DFES 2022 workbook.

Document structure

This document comprises five further main sections:

- **Section 2** outlines this year's scenarios and explains how the DFES data is linked with data we publish in our Network Development Plan (NDP) and Long-Term Development Statement (LTDS). It also presents the framework of our load-related investment process and highlights the importance of local stakeholders informing us of their plans in advance so that we can facilitate any plans at any location.
- **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 the most dominant Net Zero renewables, ie photovoltaics (PV) and wind farms, as well as battery storage.
- **Section 5** presents our forecasts of flexibility service requirements for all scenarios.
- **Section 6** presents how Local Area Energy Plans (LAEPs) are not only a key component of our load-related investment planning, but also how our DFES and DSO proactive engagement and data can support LAEPs in the North West.

Continuous improvement

This is the fifth and final annual DFES publication for the current regulatory period. Next year we will publish our first DFES for the RIIO-ED2 period, so this is the perfect time for you to let us know what you expect to see in next year's DFES.

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.

The DFES are long-term forecasts of electricity demand supplied by our distribution networks, as well as forecasts of DG and battery storage connected to our networks. Our DFES use models that show the impact of customer choice and societal change. We also consider granular data on local characteristics and the plans of our local stakeholders and customers.

The 2022 scenarios

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

As in DFES 2021, the first four 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. However, this year the Steady Progression scenario has been renamed as **Falling Short** to highlight that this scenario does not meet the UK's Net Zero target of 2050.

Our 2022 DFES consider four scenarios that follow the common framework with all DNOs and the ESO. A fifth Best View scenario is also presented focusing on the most likely forecast in our region.

Best View is the region's highest certainty scenario that focuses on high certainty in the next one to ten years. The high level assumptions in our **Best View** scenario have not changed, ie we still expect that the electrification of transport will accelerate in our area as we approach 2030, whereas a slow electrification of heating is not expected to change until after 2026 and the UK government's decision on the future of hydrogen for domestic heating following the hydrogen village trials.

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.

DFES data

Our updated DFES workbook contains forecasts down to primary substation feeding areas for electricity demand, DG, battery storage and low carbon technologies including EVs and heat pumps.

In last year's workbook we included per council data on forecasts of electricity demand, renewable generation, EVs, heat pumps and others. We also provided more granular per primary substation feeding area forecasts of annual electricity demand.

This year we have updated all forecasts and we have added forecasts for flexibility service requirements across all DFES scenarios and down to primary substation feeding areas. The forecasts extend to 2028 and are representative of the longer-term requirements for flexibility services.

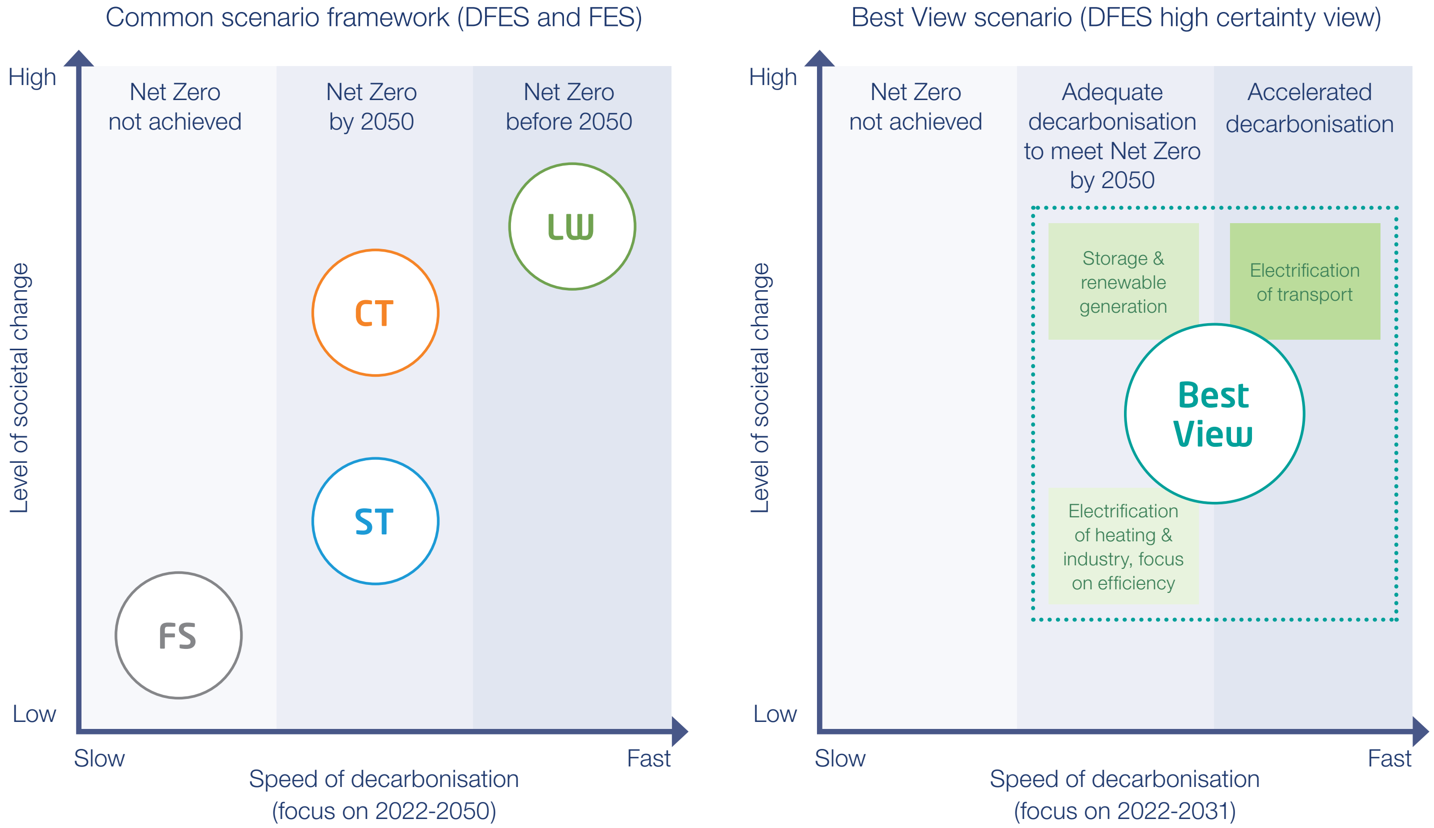
The flexibility forecasts consider planned reinforcement work and the associated capacity release. The longer-term flexibility requirements should be seen as the amount of flexibility that we expect to put out to tender under the different DFES scenarios. Following our 'flex first' approach, we will procure flexibility whenever and wherever it is a more cost-efficient option and reduces customers' bills, compared to conventional or innovative network reinforcement.

DFES as part of our load-related investment strategy

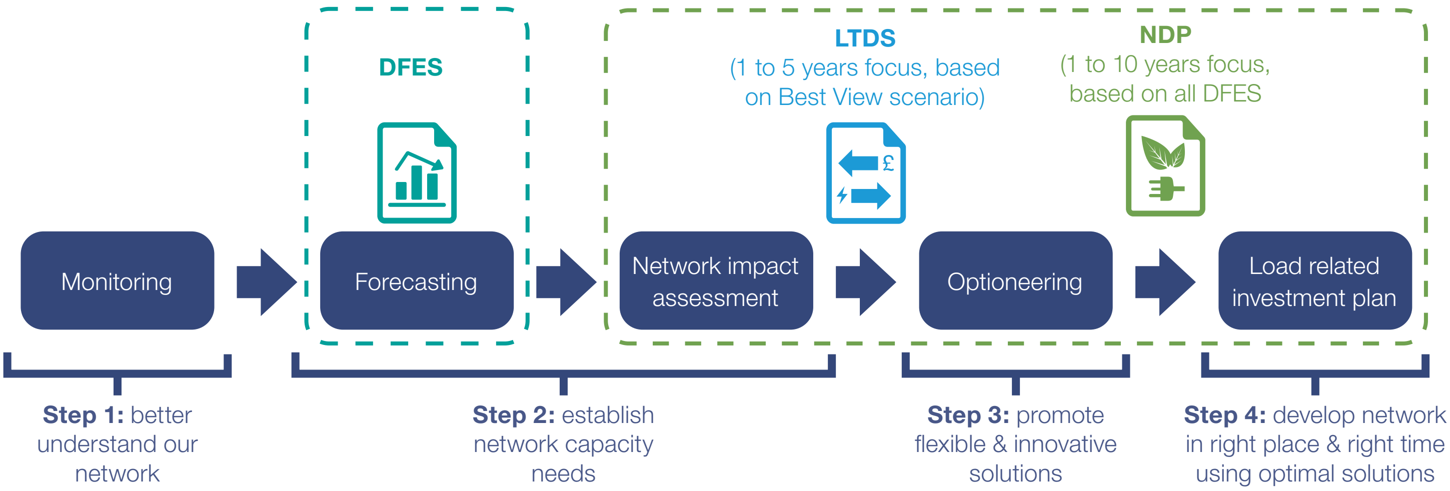
Our DFES forecasts are used to inform our load-related investment plan, which aims to release network capacity in a cost-efficient and risk averse way to facilitate the decarbonisation and other plans of our stakeholders and customers. Ofgem has adopted our framework for load-related investment planning for the RIIO-ED2 business plan submissions.

In this framework as a first step, we start from the monitoring of load and generation (measurements) to better understand our network. The second step is to produce our long-term forecasts of demand and generation that are presented in our DFES report and workbook using our ATLAS methodology. The DFES forecasts are used in network studies and other impact assessments to establish our capacity needs. More on the network impact assessment can be found in our NDP, which details future distribution network requirements for one to ten years beyond publication. The NDP workbook provides forecasts of capacity headroom across all DFES scenarios. Our first NDP was published in May 2022 and will be updated on an annual basis.

Our Distribution Future Electricity Scenarios 2022



The framework for load-related investment and associated DSO publications



Network data together with network requirements for the next five years are presented in our LTDS. The LTDS is published in November every year and contains capacity headroom forecasts for the **Best View** scenario.

Having identified the network needs following the network impact assessments, the next step is to promote flexible and innovative solutions to release the required capacity to meet future needs based on our DFES forecasts.

Our 'flexibility first' approach requires the selection of flexible services over conventional network reinforcement options where this is more cost-efficient. This approach allows us to reduce customer energy bills and develop a local energy market. More information on our long-term flexibility service requirements based on DFES can be found in our latest autumn 2022 flexibility tender.

We optimise our load-related investment through extensive optioneering which considers flexibility services and conventional reinforcement options. The optimisation process allows investment only when and where it's needed, at minimum cost and in ways that reduce the risk of exceeding network capacity.

To release capacity and facilitate local stakeholder decarbonisation and other plans it is critical that our stakeholders and customers inform us well in advance about their plans, even before their application to connect to our networks.

In our RIIO-ED2 business plan for the 2023-2028 period you can find more on how we have used DFES previously to inform our load-related investment (see Annexes 2, 3a and 3b on this link). Our load-related investment is informed by DFES and releases capacity to facilitate local stakeholder plans, the electrification of transport and heating, as well as the penetration of renewable generation in the North West. It should be noted that it is more critical for our stakeholders to inform us about their planned developments well in advance, even before their connection application. This allows us to inform our DFES and procure flexibility or carry out reinforcement work to release capacity and facilitate their plans.

DFES 2022 assumptions on electricity demand components

Demand components	Falling Short	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 2022 assumptions on distributed generation and battery storage

DG and storage components	Falling Short	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 Uncertainties in forecasts due to the current landscape

Peak demand is a key parameter that we forecast to inform our network plans on where, when and how much additional network capacity we need.

Over the last couple of years we have observed a reduction in peak demand and electricity consumption across various parts of our networks due to the impact of the pandemic. This reduction was driven by less industrial and commercial activity, which was more evident in areas where electricity demand was predominantly non-domestic.

During the first year of the pandemic we observed a reduction in peak demand across most of our networks. During the second year a third of this reduction was recovered as our economies started to bounce back.

During the first year of the pandemic, ie from 2020-2021, we saw on average a 3.5% reduction in peak demand across primary substations that supply the lower voltages on our networks (downstream 11 and 6.6kV). This reduction is associated with the reduced activity of medium sized and smaller industrial and commercial customers. In the same period we saw almost a 5% reduction in peak demand across the higher voltage networks (132kV) that also supply very large industrial and commercial customers, as well as the largest grid-scale batteries connected to our networks.

The cost-of-living crisis and the effects of the pandemic on the ways we live and work are key uncertainties in our forecasts of electricity demand.

At the same time there were parts of the network where demand increased. This increase was driven by local planned developments, an increase in EV volumes and, at higher voltages, the charging of new grid-scale batteries.

During the second year of the pandemic (from 2021 to 2022), nearly a third of the peak demand reduction in the previous year across primary substations was recovered as the economy bounced back from the first year of the pandemic.

This highlights that the pandemic has potentially changed our behaviours and the ways we live and work. It also underpins the significant levels of uncertainty that affect our long-term forecasts, which currently include the cost-of-living crisis and how it affects the behaviours of our customers.

In the same period peak demand across the higher voltage networks, ie 132kV, increased beyond the pre-pandemic levels by 3.5% from 2019 to 2022 (or nearly 9% from 2021 to 2022). This was driven by some major local developments, especially around Greater Manchester, and a significant number of new grid-scale battery connections.

As more Net Zero options for the electrification of transport and heating become mature technologies and more cost-efficient, it is still uncertain how the cost-of-living crisis will affect our customers' decisions to adopt them in the short term.

During the last four years we have seen an accelerated growth of EV volumes in the North West, which is further explained in the electrification of transport section. We have also seen more heat pump connections, due to their high energy and cost efficiency when combined with building retrofits. These highlight that more customers are adopting Net Zero options as more of them now understand their benefits in terms of increasing cost efficiency and technology maturity, which make them low regret options.

Demand growth up to 2030

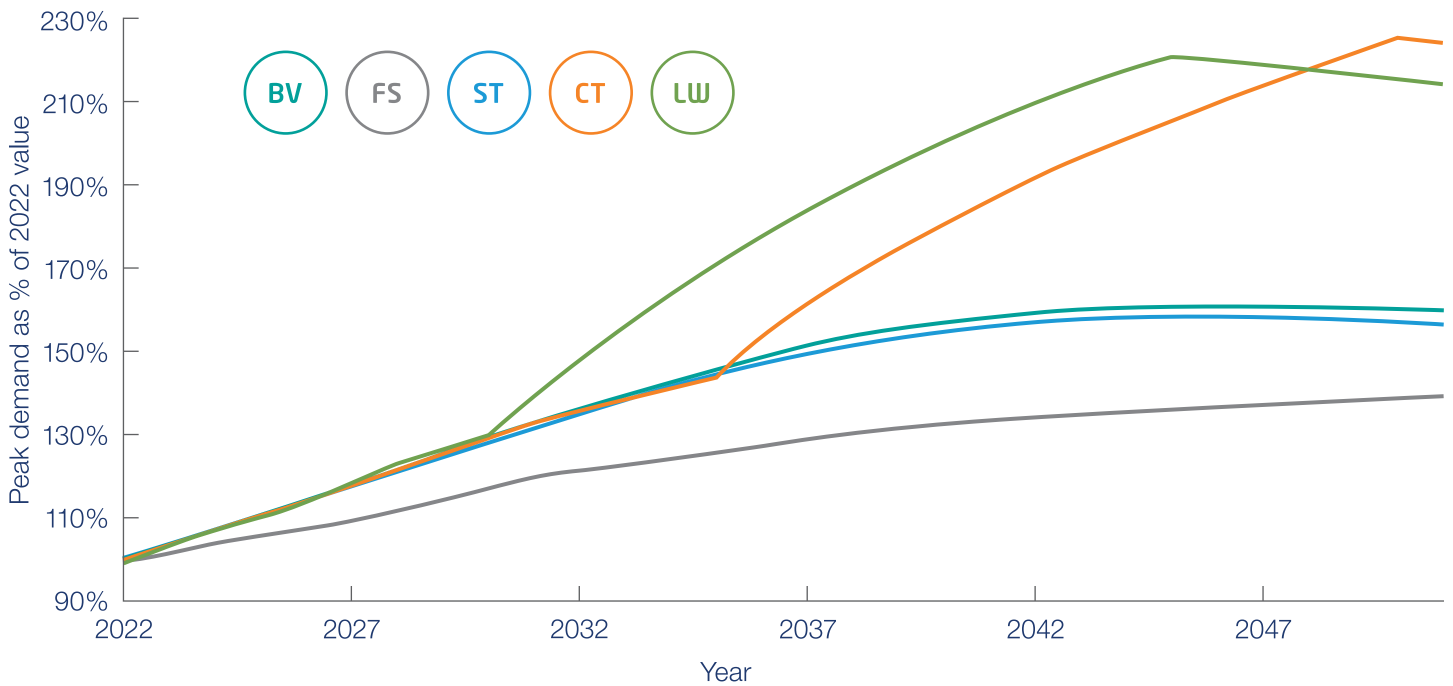
As noted in last year's DFES report, the 2023 to 2030 period is within the ten years' forecasting horizon when our **Best View** scenario provides the highest certainty trend based on justified assumptions.

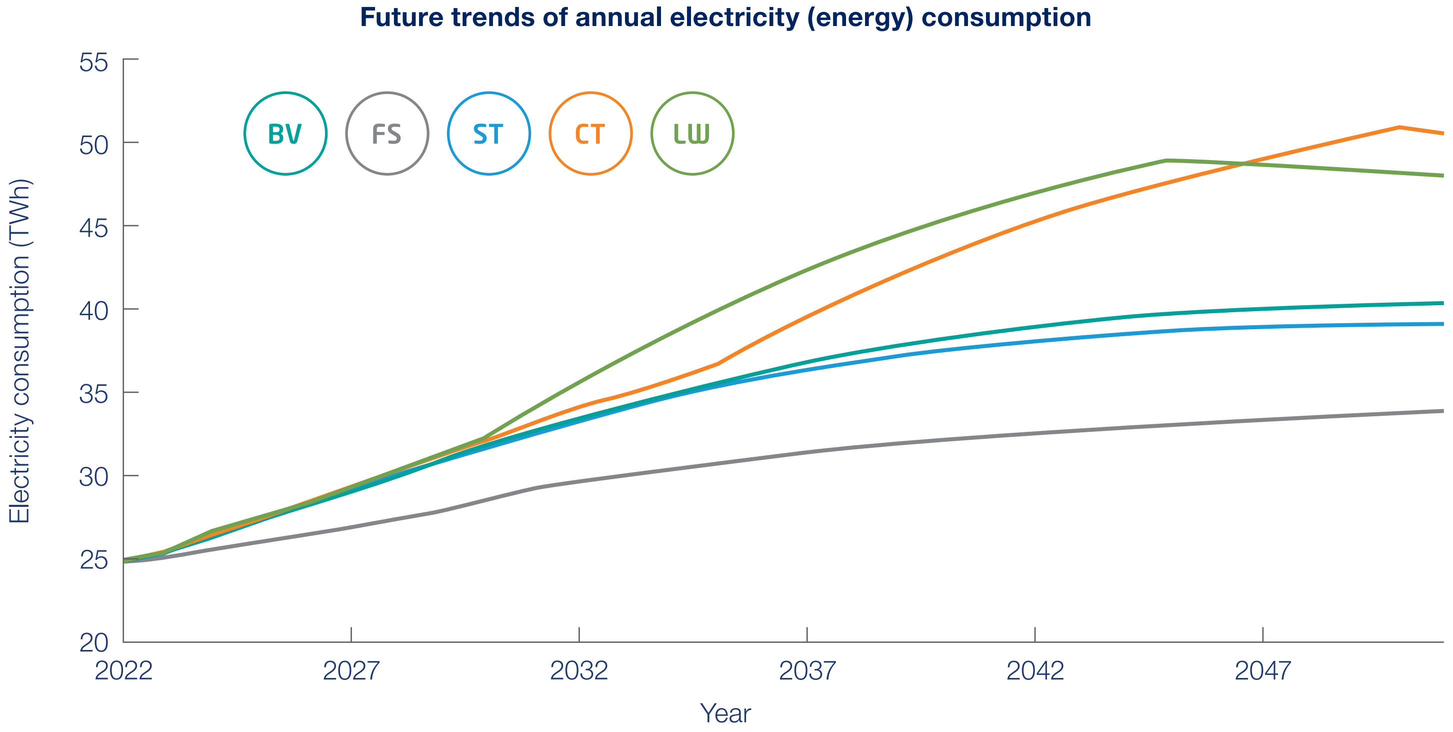
Following a short period of demand reduction due to the effects of the cost-of-living crisis, peak demand is expected to grow slowly until 2024 as the effects of efficiencies balance the relatively low uptake of EVs and heat pumps. This year we have reflected the latest conditions of the EV supply chain so the uptake of EVs over the next two years is lower than last year's forecasts.

Demand growth in 2023-2030 is driven by the electrification of transport and some planned major developments, mostly around Greater Manchester.

After 2023 and up to 2030, growth in demand is mainly driven by planned developments and EV charging. With the exception of Falling Short, that uses lower confidence factors for planned developments, all other scenarios that meet the Net Zero target consider historical performance to predict demand growth from decarbonisation plans and other projects from industrial and commercial (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.

Future trends of annual peak true demand





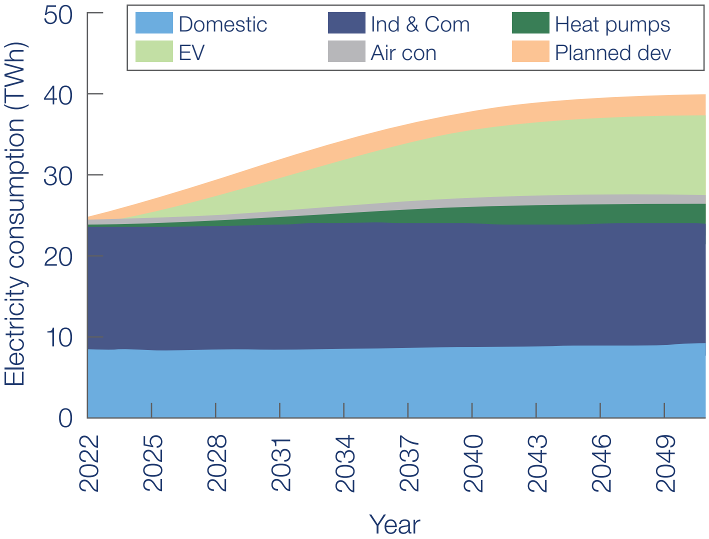
In the last four years we have seen an exponential growth of EV volumes in our license area, as explained in the electrification of transport section in this report. We understand that there is high uncertainty in the uptake of EVs and other low carbon technologies over the next few years due to the impact of the cost-of-living crisis on customer decisions. Our **Best View** considers a high EV uptake derived from the modelling of UK government's announcement to ban the sales of new internal combustion engine (ICE) vehicles after 2030, the Department for Transport (DfT) projection of the total vehicle stock and the expectation that by the mid-2020s the whole life cost of an EV will be equal to the corresponding cost of an ICE vehicle.

As in last year's DFES, 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 for 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 overall demand growth higher than all other scenarios.

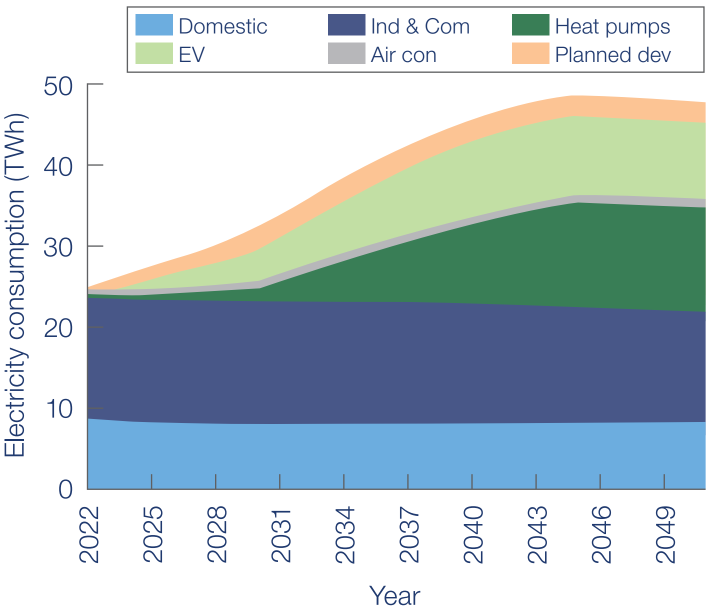
Unlike **Consumer Transformation** and **Leading the Way**, **Best View** shows an average reduction in demand from all types of efficiencies, eg from building retrofits to improved heating insulation to white goods. This is due to the use of central rather than ambitious assumptions for efficiencies,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

System Transformation shows lower demand growth than our **Best View** scenario as it considers lower EV uptakes. **Falling Short** 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 **Falling Short** showing the lowest peak demand growth by 2030.

Future annual demand for Best View



Future annual demand for Leading the Way



Demand growth after 2030

The range of demand growth increases in the longer term. This is mainly due to the significant uncertainties around the role of hydrogen for heating. We are currently at the early stage of the hydrogen village trials, which will provide crucial evidence to the UK government and the public to inform decisions on the role of hydrogen in heat decarbonisation by 2026.

In a future **System Transformation** world, the use of hydrogen goes beyond energy intensive industrial use and is widely available for domestic heating. This world is aligned with the lowest electricity demand growth in the long term across all scenarios as it exhibits the lowest uptake of heat pumps.

In a future where village trials have not been successful and hydrogen is mainly used for industrial processes, heat pumps will be the dominant technology as their reduced cost and greater efficiency will make them more attractive to customers. 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 2044.

Beyond 2030 **Best View** should be seen as a central outlook of demand growth rather than a high certainty scenario. 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 **Best View** shows higher growth than the corresponding peak demand trend.

Falling Short is the only scenario that does not meet Net Zero by 2050. However, it exhibits higher demand than **System Transformation** as it assumes the highest penetration of air conditioning and because customers would adopt similar levels of heat pumps due to their anticipated low cost and increased efficiency.

3.2 Electrification of transport

The transport sector accounts for around a third of the UK's carbon emissions. This means that the transition to Net Zero requires immediate action to speed up decarbonisation.

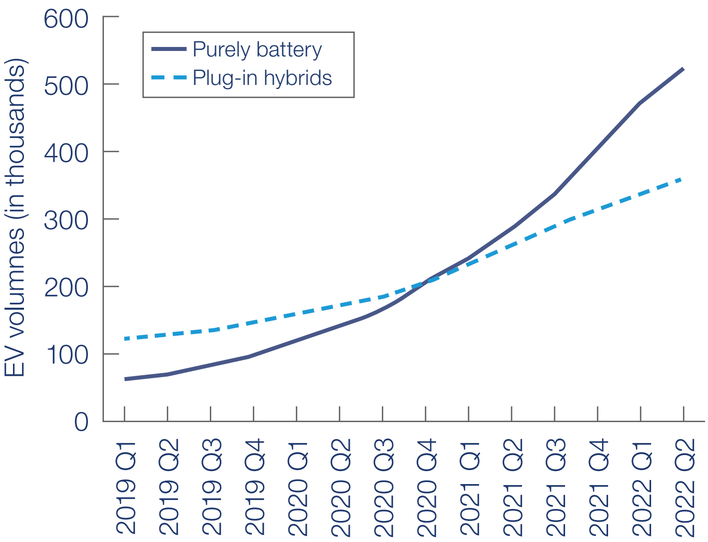
Electrification is the main and highest certainty path to decarbonise the transport sector, especially for lighter duty vehicles such as cars and vans. However, we expect that a significant number of heavy duty vehicles (HDVs), especially buses and trucks up to 25 tonnes, will charge their batteries through electricity distribution networks.

Historical trends

Over the last four years we have observed an accelerated growth in the volumes of electric cars and vans in our region and nationwide.

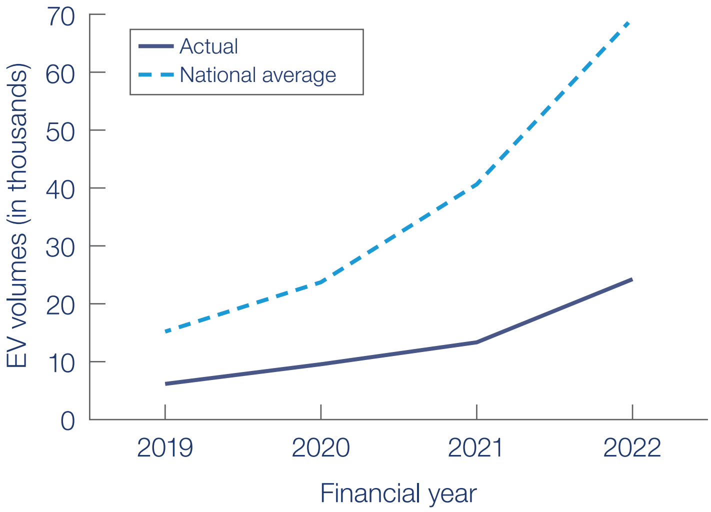
Volumes of electric cars and vans in the North West have doubled from last year, but the pace of electrification of transport in our region is less than half of the national average.

Historical volumes of electric vehicles across Great Britain (source: DVLA)



However, by comparing our region to the national average, we can see that the pace of EV uptake in our license area is less than half of the nationwide trend. This is partly explained by the higher poverty rates in our region compared to the national average. It can be also related to the lack of local policies incentivising the decarbonisation of the transport sector compared to other regions. More specifically, the use of the congestion charge, as part of Greater London's air quality policy framework, has accelerated the electrification of transport and the nationwide average trend.

Historical volumes of electric vehicles in the North West compared with the national average normalised for the same region



Future trends

We have worked with Element Energy to update the forecasts for EV volumes in our license area. The most recent findings 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. We have reflected in our forecasts the latest findings on battery prices (2021 Battery Price Survey from Bloomberg NEF projections). The findings reflect a slight increase in the price of related materials from 2021 to 2022 and the impact of supply chain issues.

Supply chain issues for battery materials combined with the current cost-of-living crisis are expected to slow down EV uptake in the short term. However, the accelerated decarbonisation of transport is expected across our region once the whole life cost of EVs equals internal combustion engines in the mid-2020s.

Our forecasts show that following a short period of uncertainty we should see an accelerated penetration especially for electric cars and vans. This is mainly driven by the significant reduction in battery prices and the expectation that by the mid-2020s the whole life cost of electric cars and vans will be equal to conventional ICE vehicles. The accelerated decarbonisation of the transport sector is also supported by the UK government's decisions to keep the ban on sales of new petrol and diesel vehicles to 2030 and mandate the installation of EV chargers in new and refurbished buildings.

Last year we included forecasts for electric HDVs in our ATLAS forecasting methodology and presented them in our DFES report for the first time. This year we have updated the consumer choice modelling for HDVs and we have also considered local plans. For example, we have included Transport for Greater Manchester's plans for taxi chargers and bus depot chargers.

This year we have used the latest consumer choice views for electric car, van and HDV uptakes as well as local plans for electric taxi and bus depot chargers.

As the only scenario that does not meet Net Zero by 2050, **Falling Short** represents a feasible minimum level of EV uptake. In this scenario consumers are more sceptical about adopting EVs in the absence of sufficient public charging. We have also assumed a change in current policy where the ban on diesel and petrol fuelled vehicle sales is not enforced. 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 **Falling Short** in that a change in current policy where the ban of diesel and petrol fuelled vehicle sales is not enforced. For HDVs, in **Best View** and **System Transformation** we acknowledge that the lack of policies to support the uptake of electric HDVs maintains the uncertainty around the future role of hydrogen and will postpone the uptake of electric and hydrogen (fuel cells) fuelled HDVs. However, post 2040 the majority of zero emission HDV sales are fuelled by electric batteries.

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

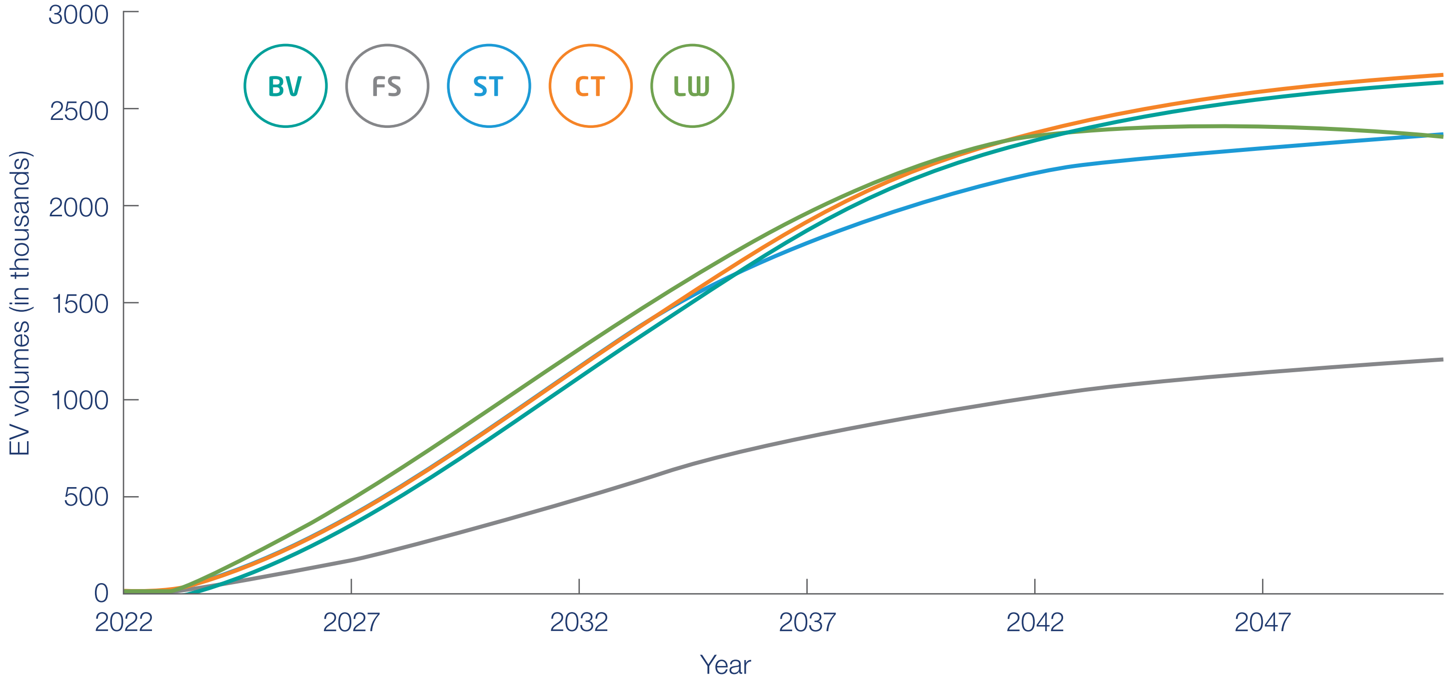
Best View and **Consumer Transformation** consider the same EV uptake trends for cars and vans. The future BEV volumes in the two scenarios are driven high by the ban on new ICE and plug-in hybrids by 2030, which is also in line with the CCC's more ambitious recommendations. New PHEVs are also banned after 2035, which has the consequent effect of increasing the volumes of BEVs in the long term with a more evident effect on vans.

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

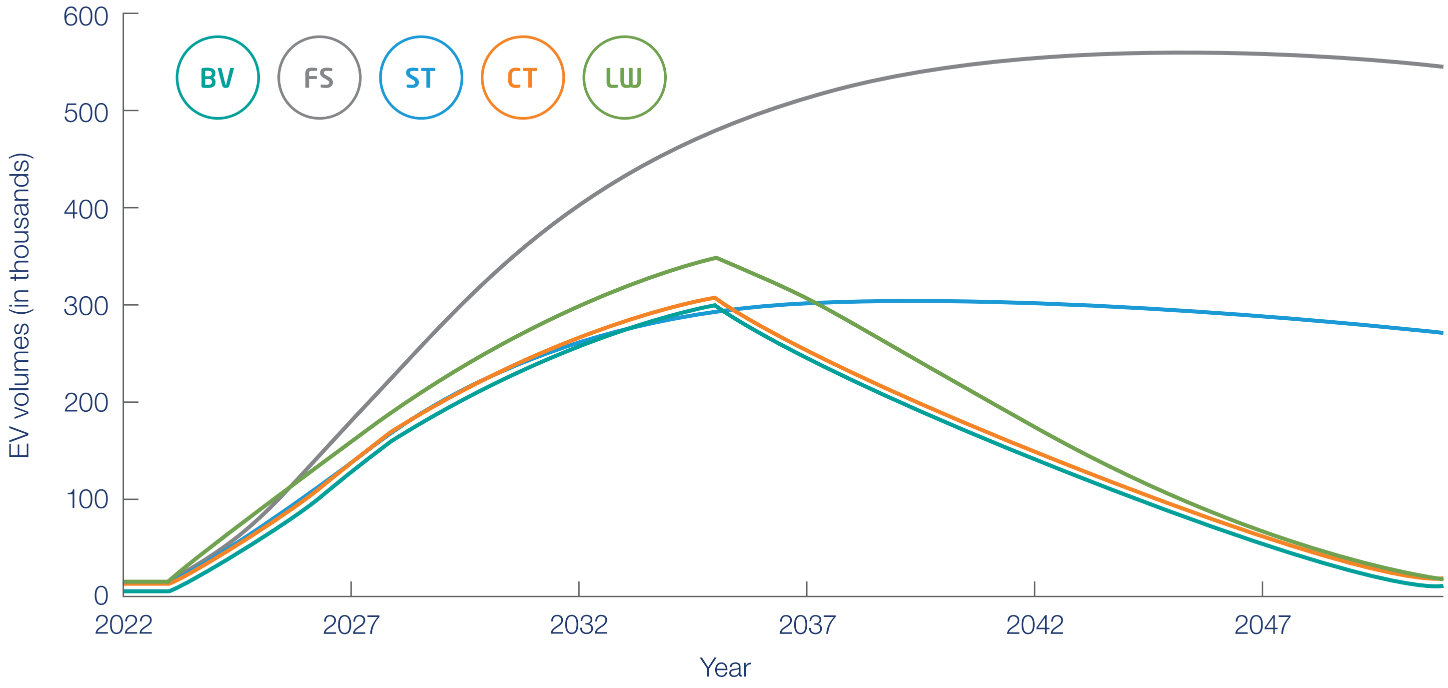
For HDVs, in **Consumer Transformation** we assume that the large-scale supply of zero emission HDVs, including battery electric, will be available by the mid-2030s. This, combined with reduced battery costs, improved energy density of batteries and limited availability of green hydrogen for transport,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

Leading the Way goes beyond the **Best View** assumptions for cars and vans 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. For HDVs, this scenario 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. The large-scale supply of battery-fuelled HDVs is available from 2030, resulting in the fastest uptake of electric HDVs across all scenarios.

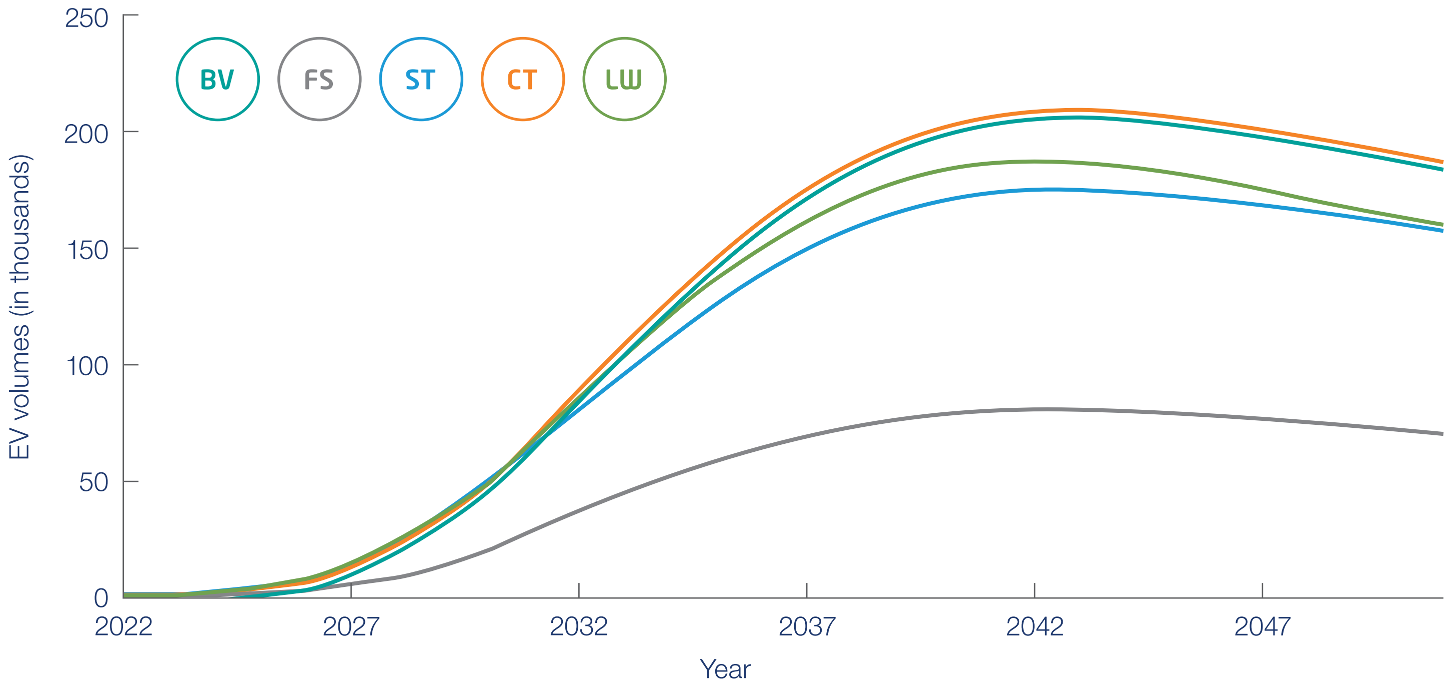
Future volumes of pure battery electric cars



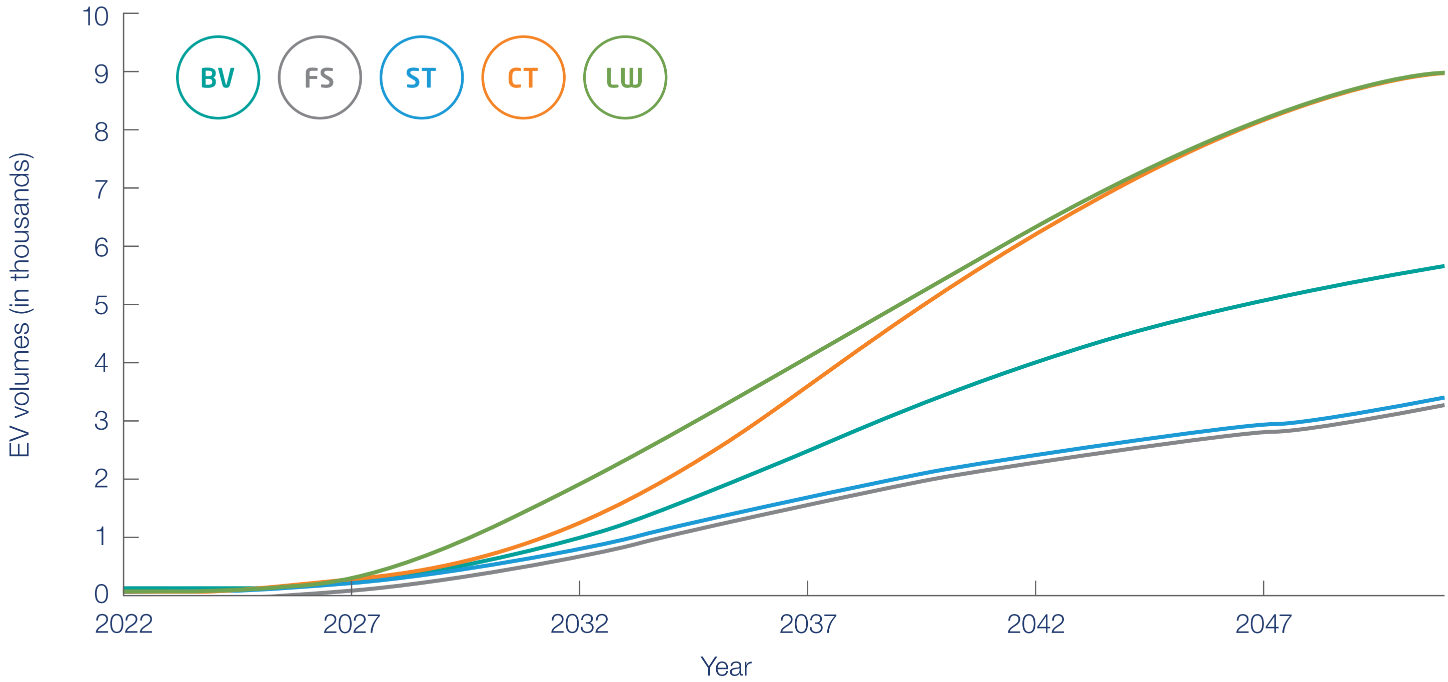
Future volumes of plug-in hybrid cars



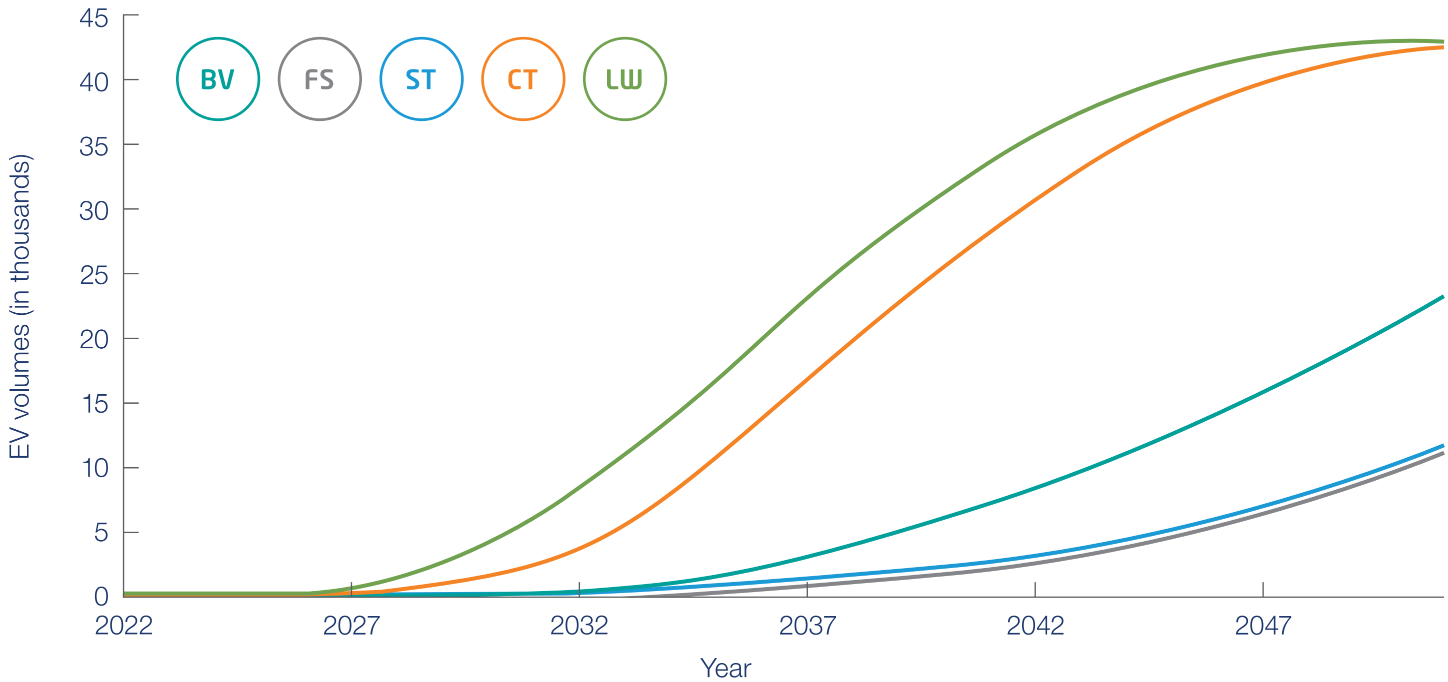
Future volumes of pure battery electric vans



Future volumes of electric buses



Future volumes of electric heavy goods vehicles (HGVs)



The way that our customers are likely to charge their EVs is not only differentiated by 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 customers, we will need to adopt smart EV charging to shift demand away from times of peak load.

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

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 for 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.

3.3 Electrification of heating

Over a third of the UK's total carbon emissions come from heating, which highlights that immediate action to decarbonise the sector is required to avoid losing track of the country's transition to Net Zero.

In last year's DFES report we explained the long-term uncertainties around the role of hydrogen to decarbonise the heating sector and the interactions with electrification. A more or less dominant role for hydrogen in heating could directly influence the level of penetration for electric heat pumps.

More certainty on this interaction is expected by 2026, when the UK government will decide on the future of hydrogen for domestic and commercial heating following the conclusions of the hydrogen village trials.

The increased attractiveness of heat pumps

Earlier this year the department for Business, Energy and Industrial Strategy (BEIS) announced five reasons to get a heat pump, highlighting that this is a no regret option for customers. These reasons include £5,000 off the cost of installation, the reduction of energy bills, the removal of VAT from installation and the contribution towards Net Zero.

Energy Systems Catapult have also previously highlighted through their government funded Electrification of Heat project that all housing types, from Victorian mid-terraces to pre WW-II semis and 1960s blocks of flats, are suitable for heat pumps.

Focusing more on the reduction of energy bills, it should be noted that heat pumps are among the most energy-efficient devices across all energy vectors. An average air source heat pump (ASHP) produces over double and up to over three times the thermal energy for every kWh of electricity it consumes. As explained in previous DFES publications, this is relevant to the co-efficient of performance (COP) and our DFES forecasts consider typical values for each heat pump technology and for average seasonal conditions that do not overestimate the impact of these technologies on peak demand.

Energy efficiency can increase for ground source heat pumps (GSHPs) where water is pre-heated naturally from the underground soil. As the installation costs of heat pumps decrease, their efficiency benefits make them more attractive, especially when combined with retrofit building measures.

The attractiveness of heat pumps is not only increased by reduced installation costs and UK government grants, but also by their unique energy efficiency advantages and suitability to all building types.

In a Net Zero landscape both heat pumps and hydrogen boilers will be predominantly fuelled by wind and solar renewable generation. Hydrogen boilers will use green hydrogen produced through electrolysis. Even though through electrolysis there are 20 to 30% electricity losses and further losses for transportation and all other end-to-end processes, electrolysis has significant advantages in reducing curtailments of wind and solar generation connected to electricity networks.

For heat pumps, there is less than 10% end-to-end network losses from the connection point of renewables to the end devices. Distribution losses in our networks are typically around 5%. The fact that a heat pump multiplies the consumed electricity to produce multiple kWh of thermal energy means that we should refer to energy gains instead of energy losses for the whole energy cycle from renewables to heat pumps.

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 lower volumes of heat pumps in the next couple of years (over a 5% difference) compared to last year's forecast. However, in the longer term we expect similar levels to last year's forecasts as the impact of the current cost-of-living crisis is mitigated by the increased attractiveness of the heat pump options.

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

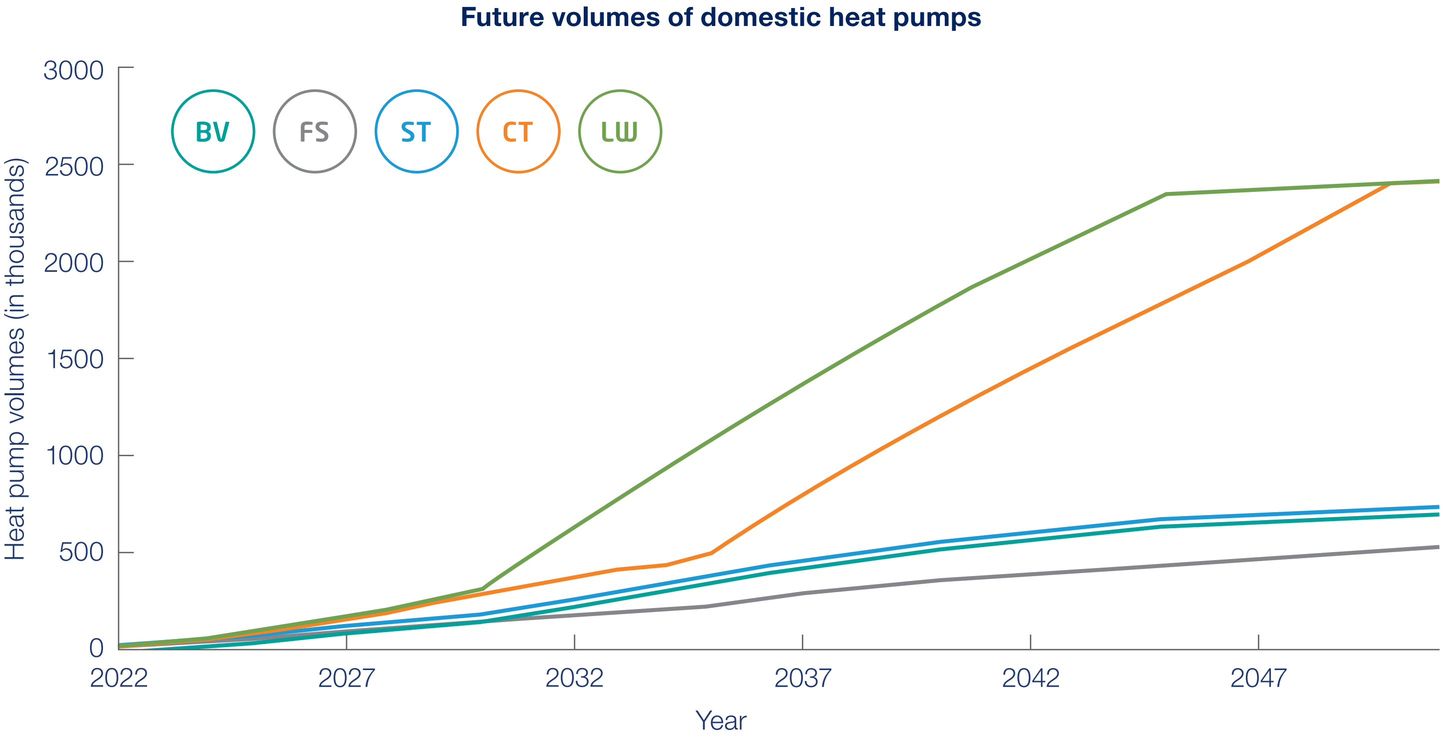
In **Falling Short** the heating sector does not achieve Net Zero carbon. Gas networks continue to supply local customers mainly with natural gas with a lower amount of biogas. Even though the installation of gas boilers in new buildings will be banned from 2025, existing buildings can still use gas 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.

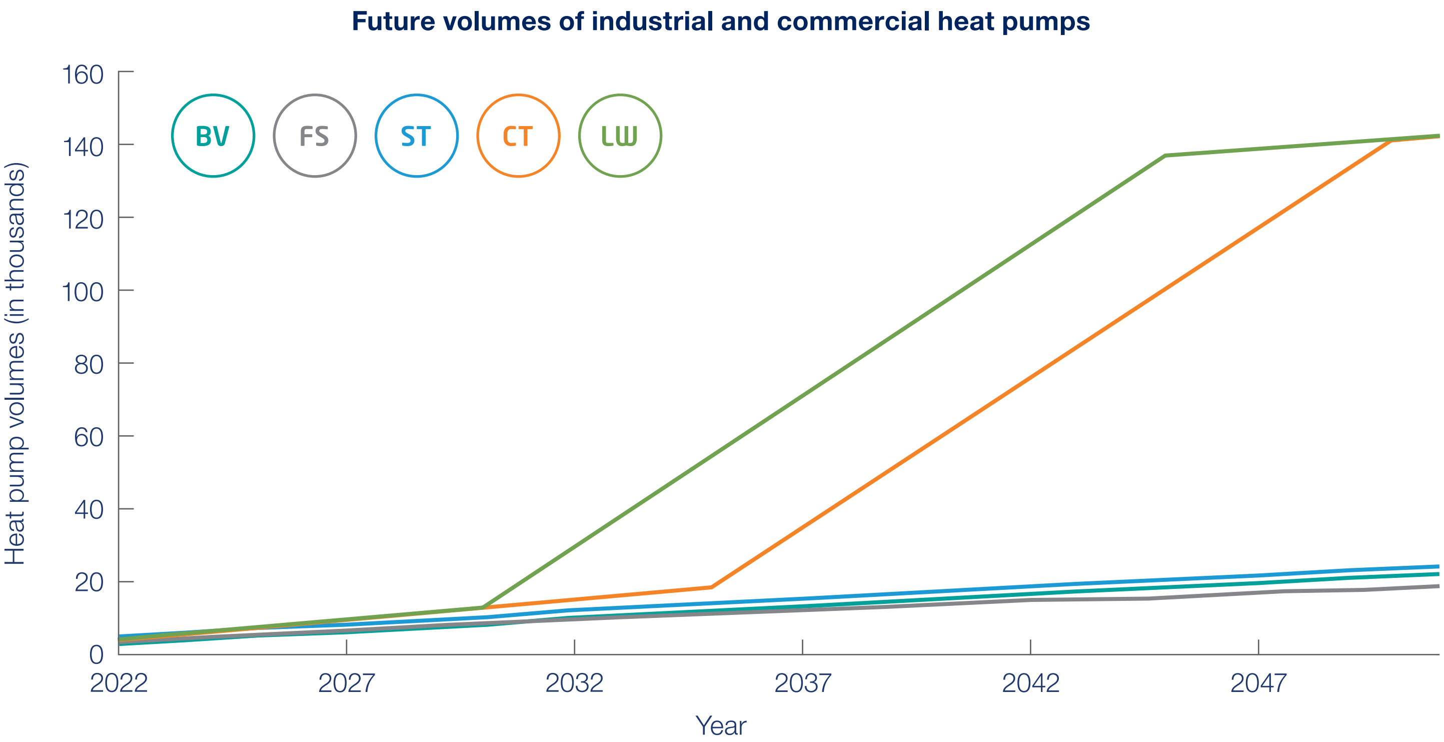
In **Best View** and **System Transformation** the future role of hydrogen is key to the decarbonisation of the heating sector. After 2040 all existing gas boilers switch to hydrogen. The proportion of hybrid heat pumps is higher in this scenario, acknowledging that hybrids can be attractive cost-efficient options for customers who support both the interim and Net Zero transition targets of the government. This means, installing a hybrid heat pump now does not preclude a highly efficient Net Zero option in the longer term, given that they can easily switch to either pure electric heat pumps or hybrids with hydrogen boilers.

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 before 2040.

In **Consumer Transformation**, electrification is the main path to the 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 of this. In the longer term, gas boilers will be banned in all buildings by 2035, and we assume that oil and coal boilers are already banned by 2027. These policies will incentivise customers to install heat pumps with the tipping point for the 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
BV
FS
ST
CT
LW
Heat pump volumes (in thousands)
3000
2500
2000
1500
1000
500
0
2022
2027
2032
2037
2042
2047
Year


Future volumes of industrial and commercial heat pumps
BV
FS
ST
CT
LW
Heat pump volumes (in thousands)
160
140
120
100
80
60
40
20
0
2022
2027
2032
2037
2042
2047
Year

In last year's DFES we highlighted that we expect electricity generation to be the first sector to fully decarbonise by the mid-2030s. To meet this target, new zero carbon renewable sources will need to be installed across Great Britain. Given the intermittent (stochastic) nature of renewable generation, there will be increased requirements for batteries to store renewable energy until it is needed on the network, ie at times when renewable generation levels are low.

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

The UK government's Net Zero strategy sets out further investment in the offshore wind sector to achieve the target of 40GW by 2030. Offshore wind generation will be mainly connected to the transmission network. The other two key technologies for the transition of the electricity supply sector to Net Zero are PV and onshore wind farms. Both are mature technologies with reduced installation costs. Together with offshore wind generation they are among the most cost-efficient types of generation.

Given that PV and wind generation are intermittent sources with stochastic outputs, their penetration needs to be supported by a significant amount of energy storage. Batteries ranging from domestic use to grid-scale are expected to be the most dominant technology for energy storage and currently account for the majority of capacity in our connections pipeline.

Uncertainties due to change in connection charges

Our stakeholders consider a range of parameters to inform their decisions to invest in DG and batteries, eg technology costs, national and local energy market opportunities, land availability for renewables etc. Depending on the location of a planned development, our stakeholders receive as part of their network connection process a quote that specifies the connection cost. The cost assessment (charging) methodology for both demand and generation is defined by Ofgem, our regulator. It requires customers to pay not only for the use of assets bespoke to their needs but also for a contribution towards network reinforcement work at the same and higher voltage levels.

By engaging with stakeholders during their network connection process we have identified cases where connection costs have been a barrier to their plans. We expect that in many cases stakeholders did not even apply to connect believing that they could not afford the network connection costs.

From April 2023 network connection costs will be reduced across GB to accelerate the electrification of transport and heating and the penetration of renewable generation. This introduces uncertainty in our forecasts as we do not know how it will influence customer behaviour.

In May 2022, to enable higher penetration of low carbon technologies including renewable DG and battery storage, Ofgem published its final decision on the access and forward-looking charges Significant Code Review (SCR). From April 2023 customer contributions will be reduced for all reinforcement costs for demand connections (eg EV chargers) and for reinforcement costs for one voltage above the point of connection for DG and battery storage projects. The reduced network connection charges are combined with flexible connection opportunities. More specifically, customers wishing to connect DG or a battery unit could be offered a contractual agreement with agreed curtailment for a limited number of years before distribution or transmission network capacity is released through conventional network reinforcement work.

4 DISTRIBUTED GENERATION AND BATTERY STORAGE

At the moment our forecasts for DG and grid-scale storage take into account stakeholder engagement information from our 2022 connections pipeline. This means that from Q2 2023 we are not able to estimate the impact of the access SCR charges on our customers' behaviours to connect more renewable DG and/or battery storage to our networks.

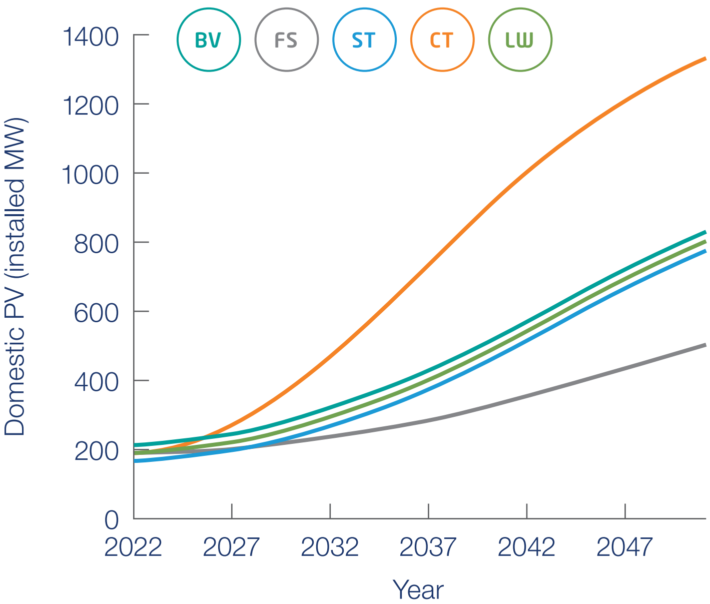
In view of this uncertainty for demand and generation connections, Ofgem will allow DNOs to access additional funding through uncertainty mechanisms to release capacity. This will facilitate the accelerated electrification of transport and heating and encourage higher uptakes of renewable generation and battery storage.

Distributed generation

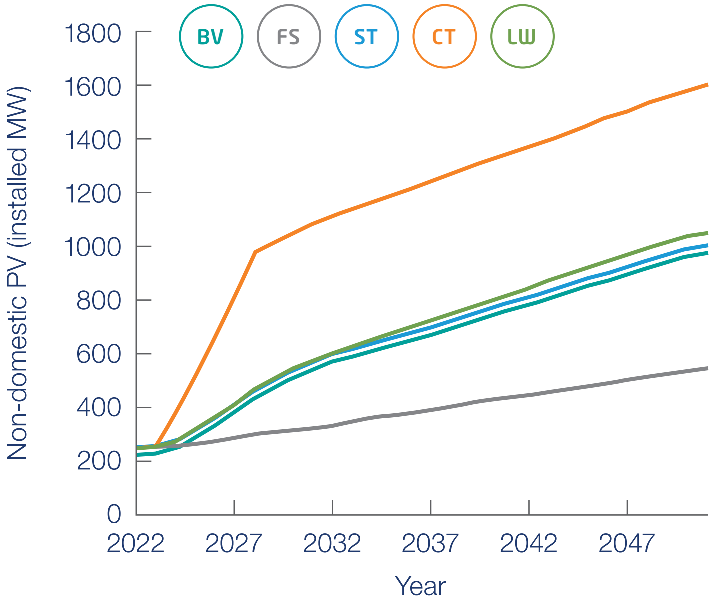
All of our scenarios show continuous growth in PV and wind farms. Small PV installations were supported by the Feed-In Tariff until early 2019 and future installations are likely to continue receiving Smart Export Guarantee payments. Larger PV and wind installations can earn revenue in the capacity market and through a 'contract for difference' (CfD), but reduced capital costs will encourage the long-term penetration of onshore wind farms and larger PV rather than relying on subsidies.

As with last year's approach to modelling DG and battery connections, we have modelled a five-year linear capacity growth to reflect the delays from project acceptance to energisation. In **Falling Short** we have the highest uptake of flexible generators, the majority of which are gas-fuelled.

Future total installed capacity of domestic PV



Future total installed capacity of non-domestic PV



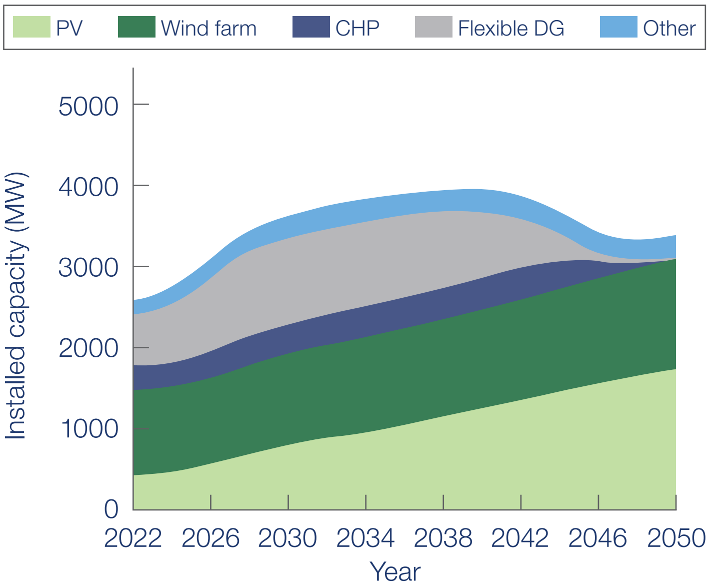
This scenario also considers the highest levels of combined heat and power (CHP) generation. As with the other scenarios, gas-fuelled generation (mainly flexible DG and CHPs) is reduced in the long term, but this scenario includes the highest level of gas-fuelled generation by 2050.

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 and the electricity price for larger renewable DG units. In the short-term (one to five years) DG uptake 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 **Falling Short**.

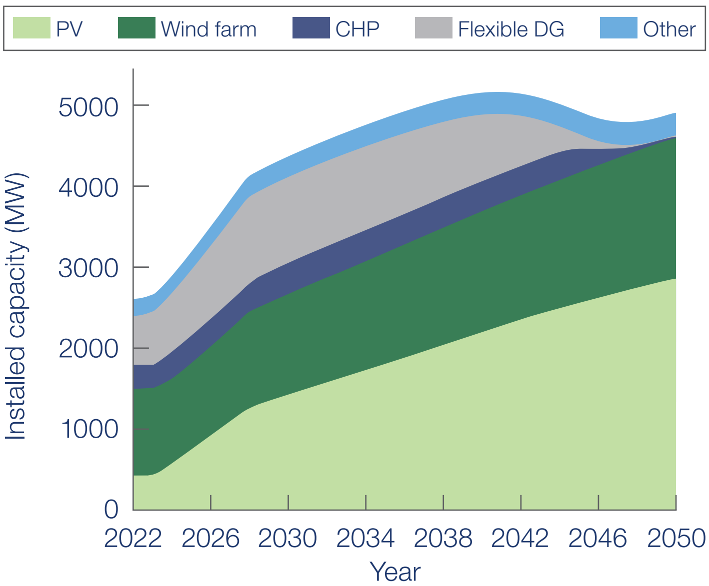
Speeding up the North West's transition to Net Zero carbon would require over 1,800 MW of additional PV and over 440 MW of wind generation before 2040.

In **Consumer Transformation** the installation of over 1,800 MW of additional PV and 440 MW of additional wind generation 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.

Best View forecasts for distributed generation



Consumer Transformation forecasts for distributed generation



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

Battery storage

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.

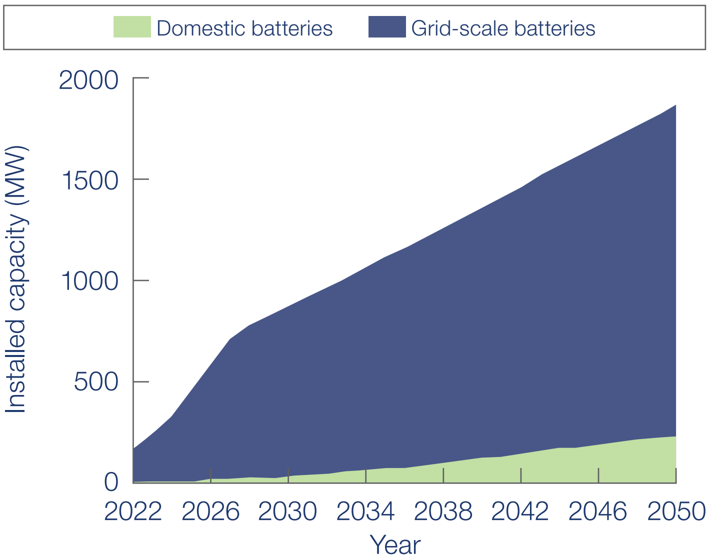
There are more commercial drivers for the uptake of larger, grid-scale batteries. Currently most large size batteries are installed to provide balancing services to the ESO or behind-the-meter services to I&C customers. In many cases they can also provide DSO flexible services. However, in the long term,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

As in last year's report our **Best View** scenario considers average uptake trends for domestic batteries, which are driven by the corresponding average uptake of domestic PV in this scenario.

However, unlike last year, **Best View** no longer uses the high uptake trends for grid-scale batteries adopted in **Leading the Way**. This is because the latest information from our stakeholder engagement during the network connection process shows that some accepted battery projects, especially when planned to connect at 132 and 33kV, are unlikely to proceed to energisation. As with DG and demand connections, it should be noted that our stakeholders are provided with flexible connection offers with minimum curtailment requirements while distribution or (for larger projects) transmission reinforcement work is carried out to release the full capacity required.

In the longer-term (beyond 2030) we forecast that battery uptake in **Best View** will meet the corresponding levels of last year's scenario, ie just over 1,900MW by 2050. This trend was taken from a series of recent studies that estimate the higher levels of battery storage required for a 2050 Net Zero UK. The full range of battery forecasts across all scenarios can be found in the DFES workbook, which shows peak battery capacity of 2.8GW installed by 2050 for **Leading the Way**. However, this scenario is less likely than **Best View** as all grid-scale batteries in our connections pipeline, including those identified as less likely to proceed from acceptance to energisation, are assumed to be connected within the next five years.

Best View forecasts for battery storage



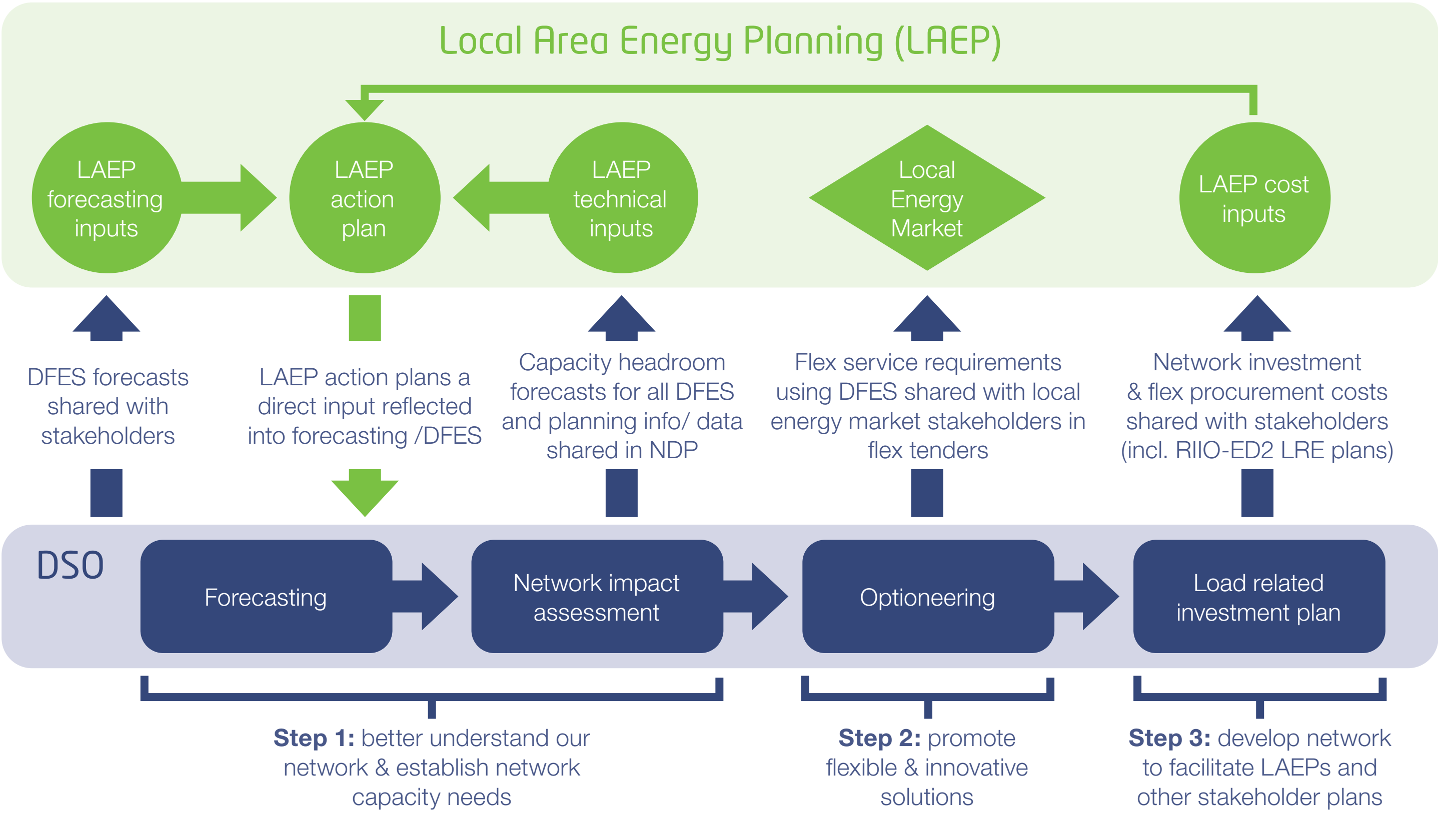
The transition to Net Zero for the UK and every local area requires the adoption of the most cost-efficient measures across all sectors. In the energy sector, plans must be made on a local level as every area has its own unique characteristics and associated opportunities for location-specific decarbonisation actions.

We expect that all local authorities (LAs) will act as creators of LAEPs liaising with stakeholders to create, review and approve Net Zero action plans, secure funding for these action plans and establish a wider framework that incentivises stakeholders to adopt measures that fit into an optimal mix of Net Zero options.

We expect local authorities to act as developers of LAEPs. Our main role is to assist the LAEP development by sharing data and technical insights to help local stakeholders produce well informed action plans.

Our key role in the development of LAEPs is to act as the facilitator of all action plans related to electricity, ie the electrification of transport, heating and the further penetration of renewable distributed generation.

Local Area Energy Planning interactions with DSO



5 LOCAL AREA ENERGY PLANS (LAEP) AND LOCAL ENERGY MARKETS

5.1 LAEP interactions with DSO

We engage with local authorities and other local stakeholders at all stages of our DSO planning process to support the development of their LAEPs.

Our annual DSO planning cycle starts with demand and generation forecasting. All LAEP action plans are a direct input to our forecasting. It should be noted that these action plans include only mature planned developments where high certainty of completion can be evidenced, eg plans with strong local/central government backing with secure funding.

The forecasts are then used in network impact assessments This allows us to better understand our network and establish the associated capacity needs. The next step is to apply extensive optioneering which includes flexibility services and strategic reinforcement options to identify the most cost-efficient solution to release network capacity for our customers. The outputs of this optioneering process inform our load-related investment plan to develop our network in the right place and time to facilitate LAEPs.

Our DSO planning process also produces data and information that can be useful to LAs and other local stakeholders to inform their LAEPs. Starting with our forecasting, the DFES report and datasets are published following engagement with stakeholders. The DFES forecasts are also used in our NDP publication, where forecasts for network capacity headroom and other network planning information and data are published for all scenarios. These datasets are important inputs for LAs/stakeholders to inform LAEP action plans. Information provided by DNOs for load-related investment, eg through our submitted RIIO-ED2 load-related expenditure plans, also allow LAs to understand our network investment plans to facilitate the LAEPs and any other decarbonisation plan detailed in DFES.

5.2 Local energy markets

Beyond the facilitation of LAEP action plans, our DSO planning supports the development of local energy markets (LEMs). LEMs can be part of LAEPs, where local stakeholders can benefit from the provision of flexibility services to the local DSO. Datasets on the operation and management of the local electricity network, as well as our short- and long-term flexibility service requirements, are important to support the efficient operation of a local energy market.

We support the development of local energy markets by sharing data on the operation and management of the local electricity network, as well as sharing our existing and future flexibility service requirements. 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 we move towards distribution system operation (DSO) with increased network management capability, flexibility services will be an essential resource for balancing supply and demand with network capacity and reducing electricity distribution costs for customers. Flexibility will also help us decarbonise our electricity supply while ensuring that our networks remain resilient, reliable and meet our customers' needs.

Over the next five years we expect flexibility services to help us meet our Net Zero target while reducing energy bills for customers by over £3.5 million per year.

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 deliver over £3.5 million of cost savings per year between 2023 to 2028 by avoiding or deferring conventional reinforcement.

In autumn 2022 we tendered 1,025 MW of flexibility across 30 locations.

Moving forwards to meet Net Zero we expect more flexibility requirements at more locations, and at lower voltages. In our autumn 2022 requirement we have asked for 1,025 MW of flexibility across 30 locations in our region.

In our final RIIO-ED2 business plan submitted to Ofgem, we explained how flexibility services will be expanded to lower voltages and cover more locations for our next price control period between April 2023 – March 2028.

6 GET IN TOUCH

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