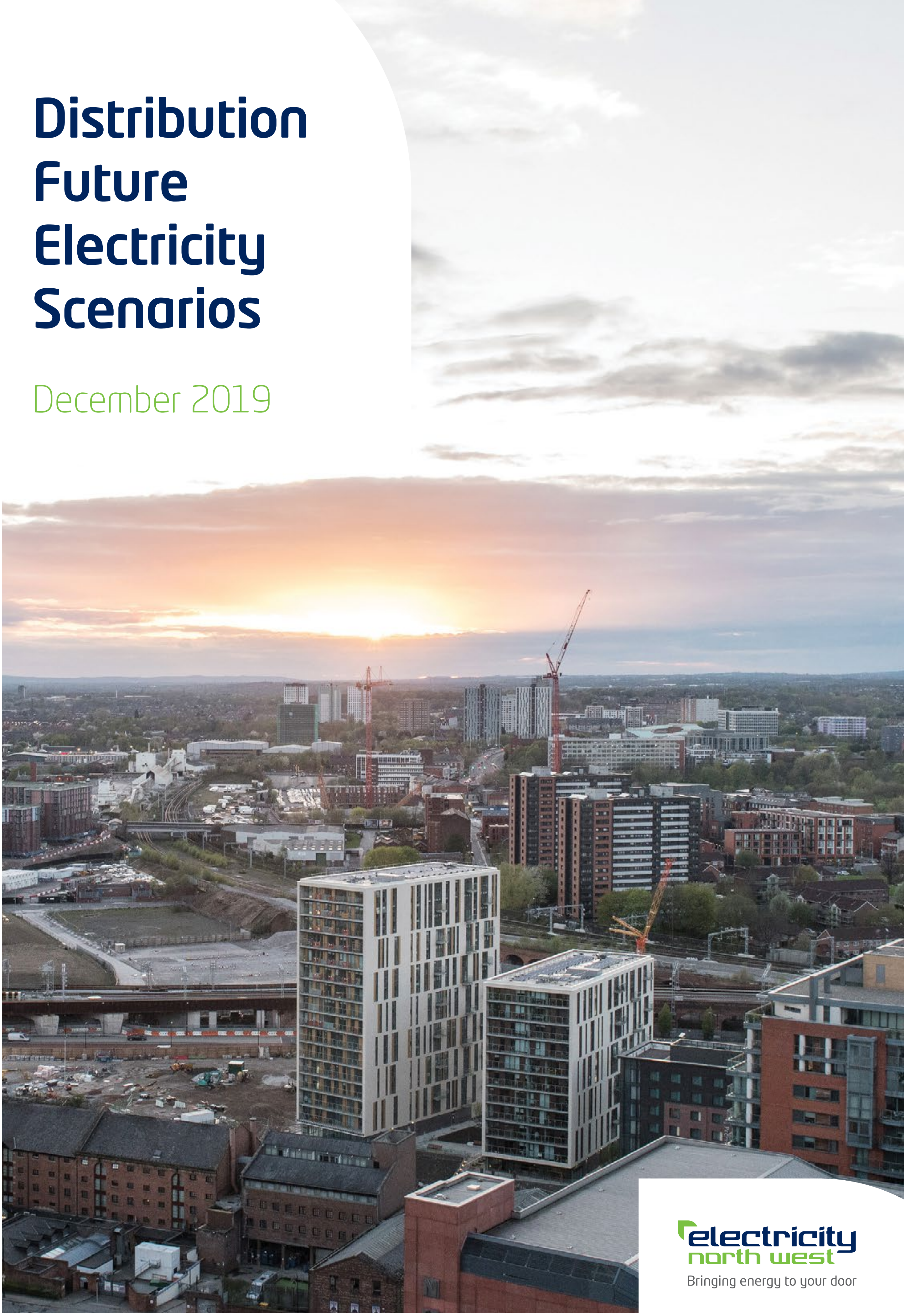
Distribution Future Electricity Scenarios

December 2019



electricity north west
Bringing energy to your door

Contents

This year has seen significant developments in key areas that influence our views on future growth and the potential requirements of our regional electricity network. There has been increased attention and commitment to climate action. In June 2019, the UK became the first major economy to legally commit to the target of net zero greenhouse gas emissions by 2050.

In the North West, Greater Manchester Combined Authority (GMCA) and numerous other local councils in our region declared climate emergencies. In economic terms, modest growth across the UK was reflected in the North West's own performance overall, however, it is notable that construction output in the region significantly outperformed the national average. The changing national generation mix was demonstrated in renewable sources providing a third of the UK's power generation in 2018 and no coal was used to generate electricity for two weeks in May 2019. A national power incident causing disruption across Great Britain on 9th August 2019 demonstrated the societal impact of such events and the growing reliance on electricity in our day-to-day lives.

Electricity North West is committed to leading the region, our communities and customers as we move to a developed and decarbonised future. We are a trusted strategic partner helping facilitate the North West's growth and low carbon ambitions by providing investment in innovation and infrastructure. Although we know the energy system is facing a period of unprecedented change, exactly how our future will actually manifest is uncertain, and so it is critical that we have the foresight and understanding to enable us to adapt quickly. We achieve this by defining potential pathways for when and how our region will grow and how it can support a reduced carbon future.

Building on our first Distribution Future Electricity Scenarios (DFES) in 2018, this year's annual update of our scenarios and forecasts presented here reflects our latest views on influences that are expected to affect the ways electricity is generated and used in our region. The results of our forecasts show significant implications and challenges for the North West's future electricity network. All our scenarios indicate significantly higher peak demand levels and energy usage across the region as our customers adopt more electric vehicles and electric heating, and also reflect strong growth in distributed generation. To increase stakeholder utility and facilitate further analysis, a data workbook of detailed modelling outputs for all scenarios including tables and charts accompanies our 2019 DFES.

We are also presenting a carbon compliant scenario this year in recognition of the increased focus and stakeholder commitment to a low carbon future. The carbon compliant scenario provides an understanding of the steps that must be taken for our region to become carbon compliant and how our electrical distribution network is affected.

Following stakeholder feedback, we have distilled the magnitude of some of these opportunities and challenges by producing tangible metrics and an accessible narrative to explain what our future means in practical terms.

The Regional Insights resulting from analysis using our forecasts presented in last year's DFES remain valid and highlight future network issues which we are monitoring and may resolve through strategic investment as we have done in South Manchester. Other such projects have arisen directly from stakeholder engagement including network enhancements for the Salmesbury Enterprise Zone.

As the regional distribution network owner and operator we are best positioned to know our locality, working closely with our customers to anticipate their needs and reflect them in our planning. We are grateful to local stakeholders, our engagement with who continues to provide valuable information allowing us to improve our forecasting whilst better supporting their development plans. Our DFES is a starting point for identifying and communicating future network specific constraints and informing our mitigation plans.

It is certain that our scenarios and forecasts have already proven to be an invaluable tool in our planning when faced with uncertain future electrical demands and supplies, and we are making continuous improvements in anticipation of their increasing importance.

Steve Cox

Engineering and technical director

Electricity North West 2019 Distribution Future Electricity Scenarios

Future network considerations

Peak demand

Peak demand is forecast to increase by half by 2050 and in some places nearly double

Distributed generation

Distributed generation capacity is forecast to nearly double in our central forecast

Increased electrical energy

Up to 25% more electrical energy by 2030 and 50% by 2050 shows a greater reliance on electrical energy

Network investment

Our electricity network will need to accommodate electric vehicles and heat pumps so we must invest at the right time and in the right places

Network innovation

Doubling of peak demand and distributed generation even in our central scenario requires us to innovate to develop ways of using our network better to deliver an efficient and economic network

Network resilience

Increasing reliance of our customers on electricity needs to be reflected in the resilience of our distribution network

Steps for meeting the carbon target

Act now

Changes must start happening now to meet the 2050 target immediate action is required

Wide participation

Meeting the carbon target will require all businesses and customers to change to alternative low carbon transport and heating before 2050

Electric vehicles

Half of vehicles will need to be electric by the early 2030s and all vehicles will need to be low carbon by 2050

Heat pumps

60% of buildings will be warmed by heat pumps by 2050, with one in six buildings adopting heat pumps within the next ten years

Renewable distributed generation

Over 4GW of additional solar and wind generation capacity to be connected to the Electricity North West network by 2050 (half by 2030)

Presently, only approximately one in fifty of our customers have solar generation installed on their roofs, but a ten-fold increase is needed by 2050

Low carbon future

Consideration of how electricity will be consumed and generated in the future is key to the way Electricity North West plan the affordable development of a safe and reliable electrical distribution network that continues to meet the needs of more than 5 million customers in the North West.

Our network investment decisions on how to best serve our customers in an efficient manner are informed by the results of our examination of the range of potential outcomes for which accurate up to date forecasts are essential.

Stakeholder engagement enhances our forecasting by providing knowledge for each locality.

This year has seen some significant changes to the central government policies, national trends and local developments that influence our views of the future. Among others, the UK's 2050 net zero emission target became law, plans for UK's exit from the European Union have provoked economic uncertainty and numerous renewable energy records were broken.

This second DFES document presents our updated forecasts of electricity for our region up to 2050 for five scenarios that together define a range of outcomes based on our latest view of countrywide and regional stimuli. Different levels of renewable distributed generation (DG) and the uptake of low carbon technologies including electric vehicles (EVs) and heat pumps are modelled in response to different technological advancements and future behaviours. Our five scenarios describe credible routes in that they do not consider the extremes of all uncertainties, but correlate various assumptions on demand and generation based on future levels of prosperity and the focus on a green ambition for a decarbonised future.

Document objectives

The main objective of this DFES document is for Electricity North West to share our forecasts for a range of credible future electricity scenarios. Our intention is to communicate the range of future pathways and to empower stakeholder involvement through the provision of information and data.

The DFES provides transparency and visibility of the scale of future challenges and opportunities from a local and regional perspective. It also allows customers to further analyse and target decarbonisation and development opportunities, plus participate in network services.

Industrial and commercial customers are an important audience for our DFES; although accounting for only 8% of our customers, they consume two thirds of the total energy distributed through the Electricity North West network. With potential carbon reduction benefits being large due to current levels of carbon emissions, it is vital that businesses lead the way in decarbonisation by making changes such as the installation of renewable generation and the electrification of heat and transport. Electricity North West is already advising key companies in our region on the size of the impact as they adopt innovative low carbon technology solutions. This engagement is serving as useful feedback for the scale and phasing of any necessary interventions on our network.

We present details of the timing and extent of low carbon transition that will be useful to local authorities and communities in their consideration of the support they can offer in their locality. Through their promotion of low carbon initiatives, support for businesses, planning approaches and the provision of EV charging infrastructure, local authorities play a key part in the region's transition to a low carbon future. Our DFES provides information that should help to inform how and when they use their influence to fulfil this role.

The DFES is part of how we are making data accessible to help inform decisions in inter-related systems such as transport and gas, as we strive to increase whole system co-ordination and collaboration.

Sharing our forecasts provides regional visibility to empower stakeholders.

1 Introduction

Document structure

This document comprises two further main sections:

- Section 2 outlines our five scenarios, differentiating them in terms of the future usage and supply of electricity; it also provides an explanation of what influences have changed recently along with their drivers.
- Section 3 presents the comparison between a scenario compliant with a carbon reduction target and our core scenarios. This is a new addition to our DFES document, and aims to demonstrate the target's ambitious requirements.

To increase stakeholder utility and facilitate further analysis, a data workbook of detailed modelling outputs for all scenarios including tables and charts accompanies our 2019 DFES. Trends detailed in our DFES workbook include peak demand forecasts across all scenarios, minimum demand, EV and heat pump uptakes, distributed generation and storage capacities.

We are aware that many stakeholders are also keen to understand what our scenarios specifically mean to them; therefore, our interactive workbook allows users 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 distributed generation capacities in their region, along with the associated electricity demand.

Continuing DFES improvements

We are looking for your feedback as we seek further inputs from regional stakeholders and strive to improve the utility of our DFES. It is important that our DFES evolves as it is one of our key decision making tools in a continually changing energy landscape.

We would like to get your input on the future of electricity in the North West to continue the conversation on our DFES, its improvement and its utility in particular with regards carbon reduction and reaching net zero.

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

Our distribution future electricity scenarios

Active Economy	High prosperity, but weak green policies
Green Ambition	High prosperity partnered with strong green policies
Focus on Efficiency	Strong green policies, but low prosperity
Slow Progression	Weak green policies and low prosperity
Central Outlook	Average assumptions across the other scenarios

2.1 Why and how we forecast

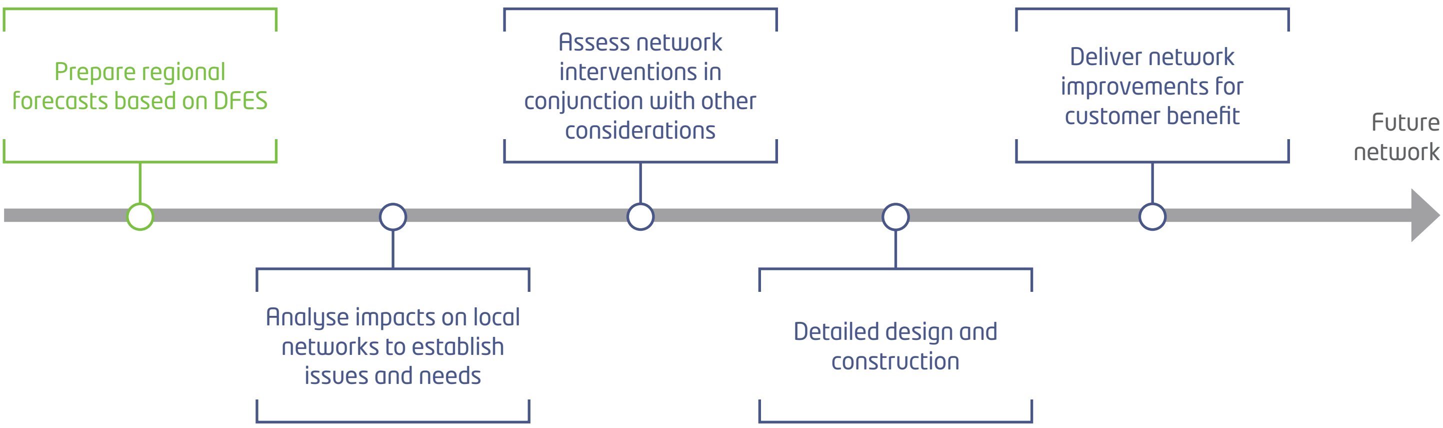
The DFES is one of the first steps in the development of our network investment strategy, informing the next steps by defining the inputs to detailed network analysis. We are able to study regional differences in the uptake of low carbon technologies and associated growths in demand and generation affecting power flows in our network by taking a bottom up approach to develop our forecasts, starting at postcode sector granularity. Forecasts specific to each area allow us to assess the localised impact on the thermal loading, voltage profile and fault levels of our network to determine the range of network requirements and ensure that we make optimum decisions in regards to what we need to do, where and when.

Regional variation and characteristics of the DFES forecasts not only provide local insights into the future effects on networks, but also:

- reveal the opportunities and challenges for decarbonisation; and
- incorporate credible regional trends in order to develop a whole system approach that can include the new interactions and services between customers, distribution and transmission networks.

An uncertain future means that we develop forecasts for a number of scenarios to frame a range of potential eventualities.

DFES in relation to planning the future of our distribution network



In order to produce well-informed forecasts for the North West that can reflect future uncertainties in demand and generation, we look back at the past and to the future, both locally and nationally.

Our starting point is internal information on the current capacity requirements of proposed and accepted domestic, industrial and commercial demand developments, as well as generation and battery storage connections. Engagement with our local stakeholders plays a key role in our foresight of what is likely to be coming next. It can help us both understand and support their planned developments and low carbon ambitions. Therefore, this year we have engaged in multiple ways with a wide variety of stakeholders. These include local authorities, universities, major business and commercial customers. We have learnt about their plans through published development plans, bilateral meetings, via workshops and group discussions and considered them to deliver accurate locally focussed forecasts. The scale and locations of GMCA's plans for EV charging at car parks and the expansion of the Metrolink tram network are examples of the insight we have gained. The impacts of nationwide stimuli including central government policies are also considered in both the short and long term.

Our expert partner, Element Energy, undertake consumer choice modelling to differentiate regional uptake trends of EVs, heat pumps and renewables based on regional factors. Bottom-up modelling using big data analytics is used to take into account local characteristics such as the types of building stock, socioeconomics, feasibility of renewables, existing patterns and potentials.

The numbers of EVs and heat pumps, as well as efficiency measures, distributed generation and storage capacity that we forecast our customers' will be using in the future have discrete electrical requirements which we translate into an overall diversified requirement by combining the half hourly profiles for each individual component. We continue to use a range of scenarios that we believe can frame the uncertainties of future levels of electricity demand and distributed generation across the Electricity North West distribution network.

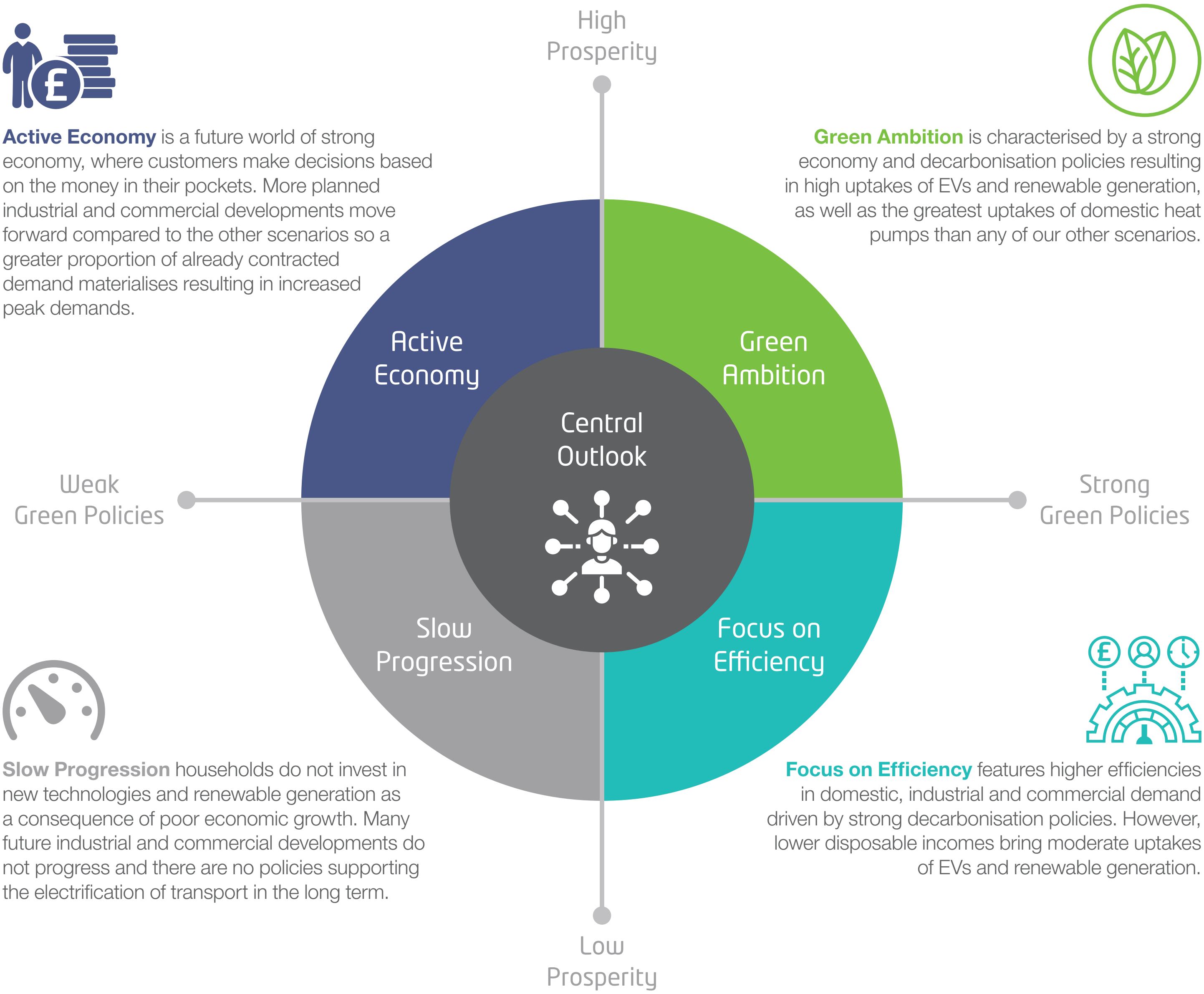
2.2 Our Distribution Future Electricity Scenarios

The names and rationale of our 2019 scenarios are the same as used in our 2018 DFES, namely Active Economy, Green Ambition, Focus on Efficiency, Slow Progression and Central Outlook. There are two main dependencies, specifically:

- Financial conditions - the scenarios consider different levels of future prosperity with more or less money available not only for both domestic and industrial and commercial (I&C) customers, but also for investment in the energy sector and local communities, and
- Future decarbonisation - the scenarios consider an increasingly decarbonised and sustainable world reflected by the uptake of more low carbon technologies influenced by policies supporting a green future.

Active Economy is a future world of strong economy, where customers make decisions based on the money in their pockets. More planned industrial and commercial developments move forward compared to the other scenarios so a greater proportion of already contracted demand materialises resulting in increased peak demands.

Green Ambition is characterised by a strong economy and decarbonisation policies resulting in high uptakes of EVs and renewable generation, as well as the greatest uptakes of domestic heat pumps than any of our other scenarios.



Slow Progression households do not invest in new technologies and renewable generation as a consequence of poor economic growth. Many future industrial and commercial developments do not progress and there are no policies supporting the electrification of transport in the long term.

Focus on Efficiency features higher efficiencies in domestic, industrial and commercial demand driven by strong decarbonisation policies. However, lower disposable incomes bring moderate uptakes of EVs and renewable generation.

The **Central Outlook** scenario assumes average / central assumptions across the other scenarios around both future prosperity and decarbonisation policies and behaviours. More low carbon technologies (EVs, heat pumps, renewable generation) can be found in this scenario compared to the low prosperity scenarios, whereas fewer developments bring slightly lower demand growth than the high prosperity scenarios.

2.3 Updates in our 2019 DFES

Latest thinking and expectations are reflected in this year's definitions of our scenarios meaning that the associated forecasts are different than last years. Updated financial forecasts are now used to assess future growth of industrial and commercial demand. During the last year, there have been indications of stronger future green policies, including the recommendations from the Committee on Climate Change (CCC) for the government to bring forward the ban on sales of internal combustion engine (ICE) vehicles to 2035 at the latest. Also in the government's Spring Statement, it was announced that all new homes built after 2025 would have low carbon heating.

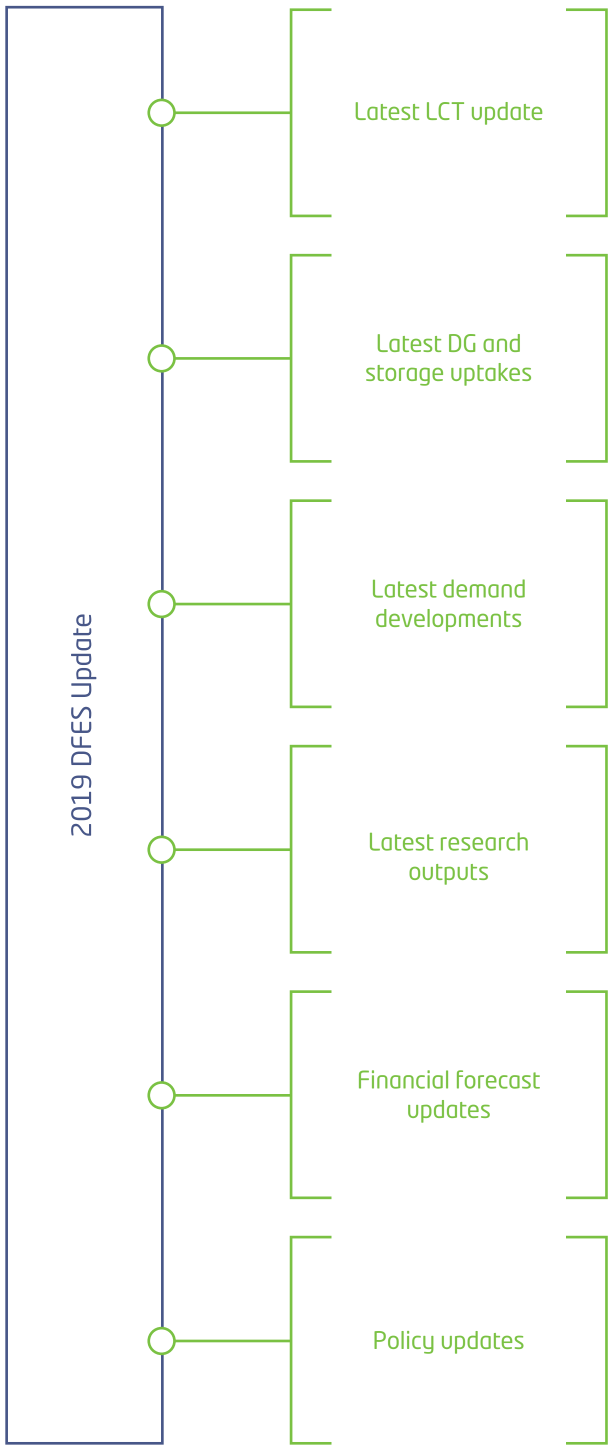
Revised policy expectations together with other parameters such as capital cost and fuel prices were used as inputs to the consumer choice model resulting in higher volumes of EVs forecasted for some of our scenarios.

Generation uptake forecasts have been affected not only by this year's developments in the government's mechanisms for supporting renewable generation, such as the end of the Feed-in Tariffs (FiT) scheme and completion of the Contract for Difference (CfD) allocation round 3, but also non-policy factors. More specifically, expectations for future onshore wind generation have reduced due to the difficulties developers have recently experienced when applying for planning permission. Conversely, large generators could gain additional revenues in the future from their participation in the reinstated capacity market, whilst there is further support for small generation in the new Smart Export Guarantee.

Changes in our local customers' demand, generation and storage development plans from last year are also reflected in this year's DFES forecasts. Regional trends have particularly been affected by projects installing larger capacities or the cancellation of accepted projects.

Planned demand developments are treated differently than generation when we create our forecasts because some demand customers estimate their capacity requirements and how quickly they will reach this capacity more cautiously. This year we have used the latest evidence resulting from the analysis of a larger sample of historical demand connections on our EHV and HV networks to understand how much demand they actually take compared to their contracted capacity and the proportion of accepted connections that are actually energised. Following our observations of developments slowing down in the pipeline, we have reduced our confidence factors resulting in lower demand growth for planned developments.

Finally, we have also included the latest research outputs in this year's DFES. The half hourly daily demand profiles we use for EVs have been updated based on over 8 million recent real charging events recorded across the UK as part of an National Grid ESO funded project. We have also updated our reactive power forecasting tools to reflect the physical effects of the distribution network below primary substations more accurately.



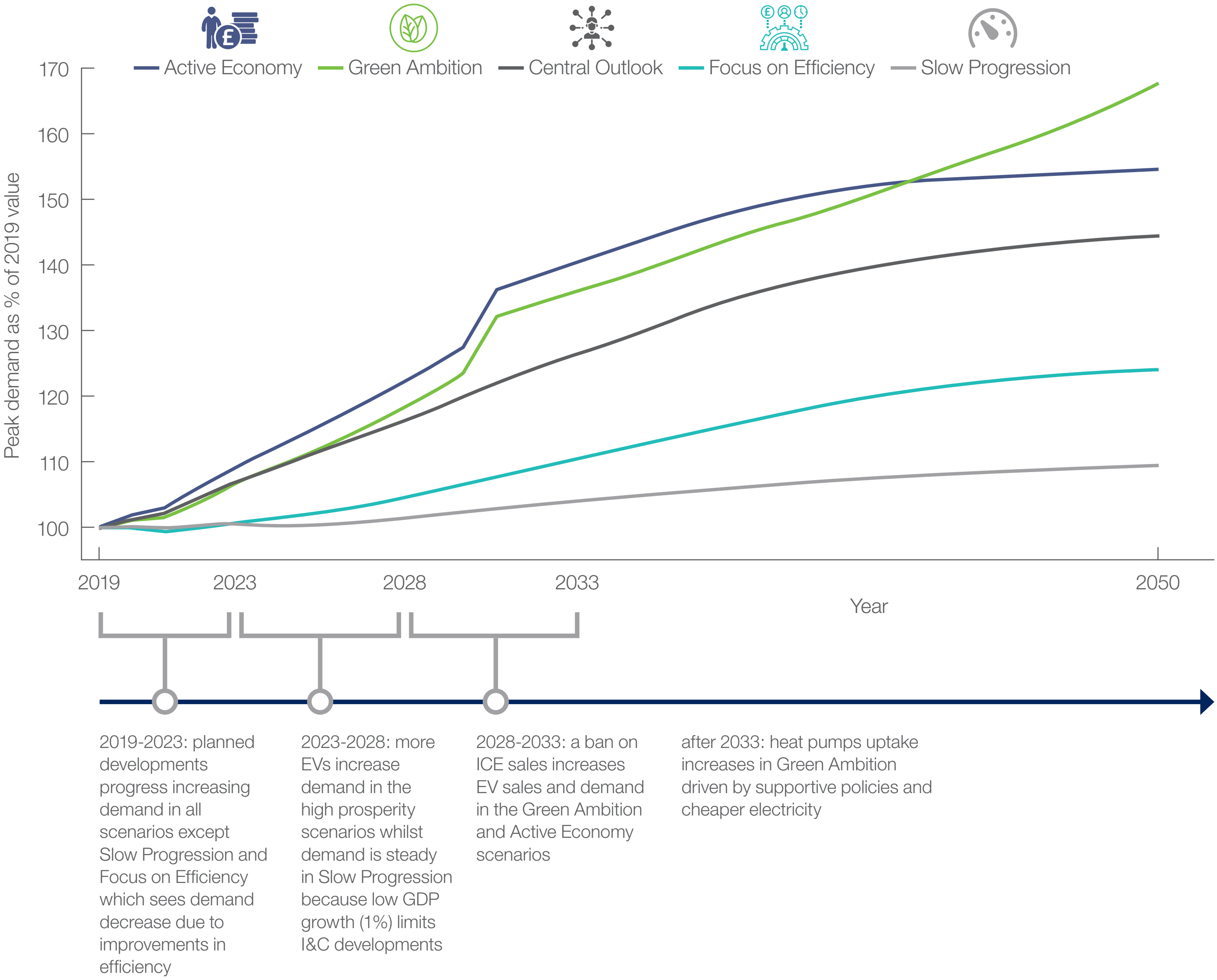
2.4 Electricity demand forecast

Sufficient distribution network capacity to accommodate future levels of peak demand is necessary to assure security of supply for our domestic, commercial and industrial customers.

EVs and heat pumps may double peak demand in the long term.

Electricity North West forecast peak true demand without any offsetting from distributed generation. The diversified effect of distributed generation is not fully accounted for in distribution networks as it is at the interface between the distribution and transmission network. We forecast true demand for our system studies because our network needs to be capable of supplying our customers when distributed generators are not operational, for example in the dark when there is no solar generation and on calm days when wind generation is low.

Peak demand forecasts for all Electricity North West scenarios



Future peak demand (true demand with no offsetting from distributed generation) for the entire Electricity North West network is expected to change dramatically. In the short-term until 2023, corresponding to the end of the current regulatory period ED1 for GB distribution network licensees, our demand is driven by planned developments for our Central Outlook and the high prosperity scenarios, i.e. the Active Economy and Green Ambition. Within the same period, the effects from the uptake of low carbon technologies (EVs and heat pumps) are less significant and efficiency measures by domestic and I&C customers combined with low GDP growth (1.4%) reduce peak demand until 2021 in our Focus on Efficiency scenario.

During the next regulatory period ED2, from 2023 to 2028, the Active Economy and Green Ambition scenarios see a significant demand growth driven by their high EV uptakes and growth in industrial and commercial demand due to more jobs and floor space arising from an average 1.8% GDP growth per year. Efficiency measures keep peak demand growth in the Green Ambition scenario less than the Active Economy scenario and closer to the Central Outlook level, whereas the low prosperity scenarios, i.e. Focus on Efficiency and Slow Progression, exhibit limited growth in peak demand during this period.

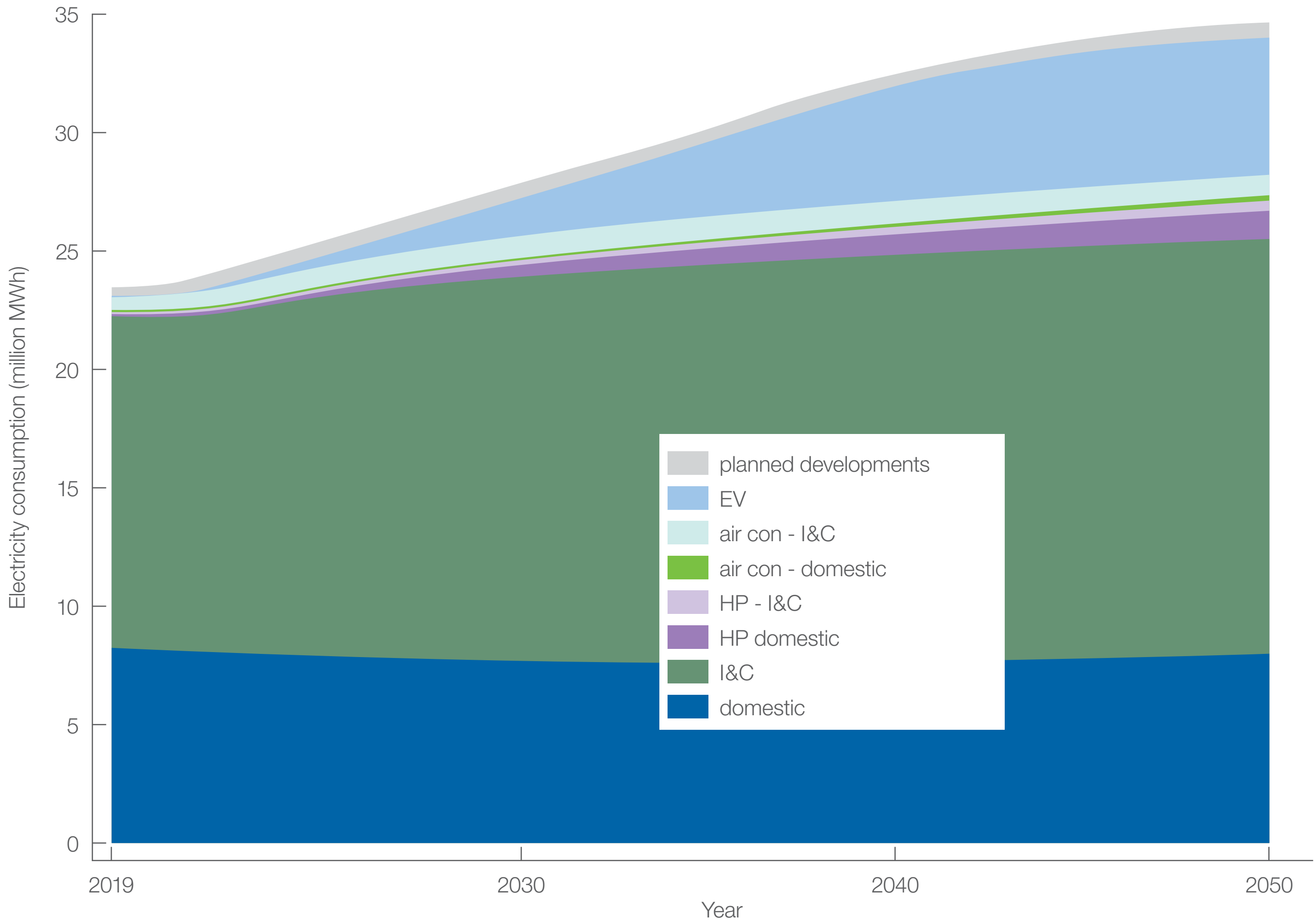
Increases in peak demand will impact our network as we look for more efficient methods to operate it including flexibility services.

From 2028 to 2033 the deployment of more air conditioning increases peak demand for both the Active Economy and Green Ambition scenarios. Green Ambition peak demand continues to grow slower than Active Economy due to improved domestic and industrial efficiency measures, demand side response and shifts in demand due to the roll-out of smart-meters. These two scenarios also see the highest uptake in EV charging as they consider the more ambitious CCC desire for a 2030 ban on ICE vehicle sales.

The greatest heat pump uptakes in our Green Ambition scenario result in the largest peak demand growth across all scenarios after 2033. Heat pumps, just like air conditioning units, are expected to continue to increase peak demand in the long term because they are less flexible and will always tend to be used during the early evening at the traditional time of peak electricity demand. Domestic heat pumps are expected to have a more pronounced effect on winter peak demand, whereas air conditioning used mainly by industrial and commercial customers is expected to affect summer peak demand.

EV uptakes continue to increase demand levels across all scenarios although at different paces; EVs even have an impact under our Slow Progression scenario that doesn't consider a ban on ICE vehicle sales. When there are significant numbers of EVs in our region, the time that people choose to charge their vehicles will greatly alter the amount of electricity flowing through the distribution network throughout the day. We have assumed smart charging behaviours in which customers are incentivised to manage when they charge their vehicles and charging occurs across the day rather than just at the end of a day when people return home from work. This assumption is validated by the recent change in the Government's Electric Vehicle Home Charge Scheme that now only supports the installation of smart charge points. The capacity of our network will need to be much greater to accommodate much larger peak demands if EVs do not use smart chargers and instead more vehicles all charge at the same time.

Whole Electricity North West forecast annual electrical energy consumption (Central Outlook scenario)



Growth in peak demand is not consistent across our region due to different effects being expected in different areas. For example, future heating options are based on existing building types and their ability to retrofit alternative technologies along with their access to gas networks. Bottom-up modelling using high spatial resolution data down to postcode level has been applied to understand local potentials and assess regional trends, which are presented in both data tables and graphs per Bulk Supply Point (BSP) and primary substation in this year's DFES workbook.

Half-hourly through year modelling of the various components of electricity demand enables us to understand how their use together affects daily and seasonal variations, allowing us to consider network impacts at different times of the day and year. It also allows us to understand the annual electricity consumption of the individual demand components.

EVs are the most significant contributor to the future rise in electrical energy consumption, although the electrification of heating and cooling (heat pumps and air-conditioning) also contributes significantly in this rise.

Future domestic and I&C electrical energy consumption is forecast to remain similar to present levels, with currently planned developments expected to increase annual energy consumption by approximately 1.9% after 5 years.

2.5 Electrification of transport and heating forecasts

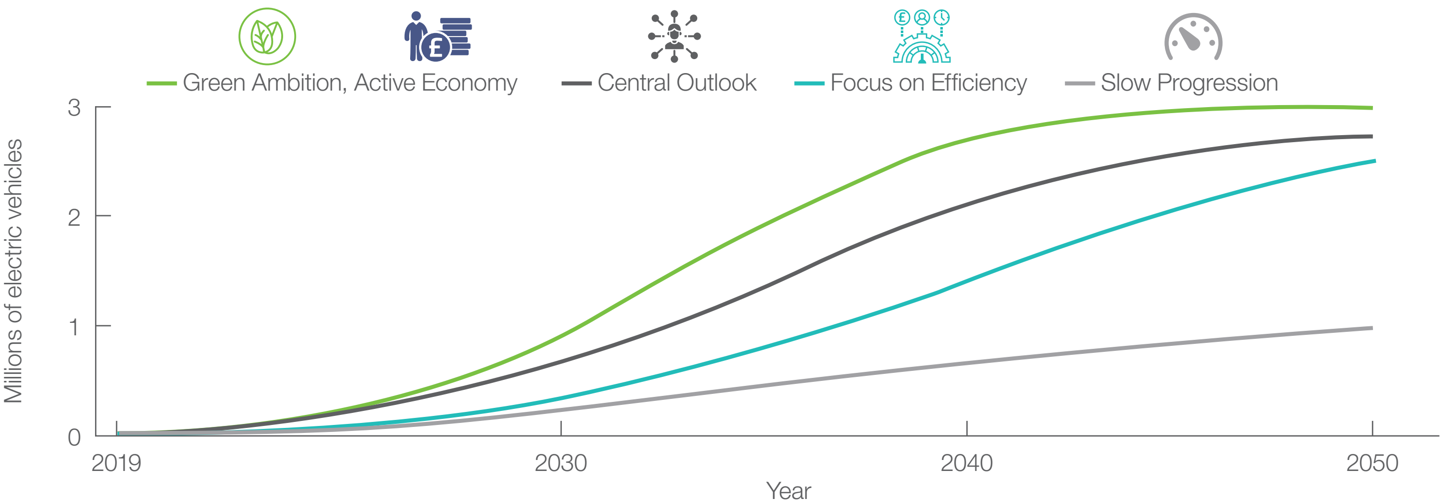
Latest advances in EV and battery technologies and manufacturing, along with expressed policy ambitions, support the view that electrification of transport will continue at an even higher pace during the following decades. The uptake trend for EV (mainly cars and vans) registrations across the UK is considered to be highly dependent on government policies and battery costs. Our scenarios make a range of assumptions around these factors and the dates that new policies become effective.

- This year's Focus on Efficiency scenario models a 2040 ban on sales of ICE vehicles based on the government's ambition expressed last year and also assumes baseline battery costs and petrol/diesel prices.
- Our Central Outlook scenario assumes low battery costs and baseline fuel prices, along with a ban on sales of ICE vehicles by 2035 based on the recent CCC recommendation.
- Green Ambition and Active Economy scenarios assume low battery costs and high petrol/fuel prices, whilst modelling a 2030 cessation on ICE sales in line with the CCC's view of the benefits that advancing the ban would bring.

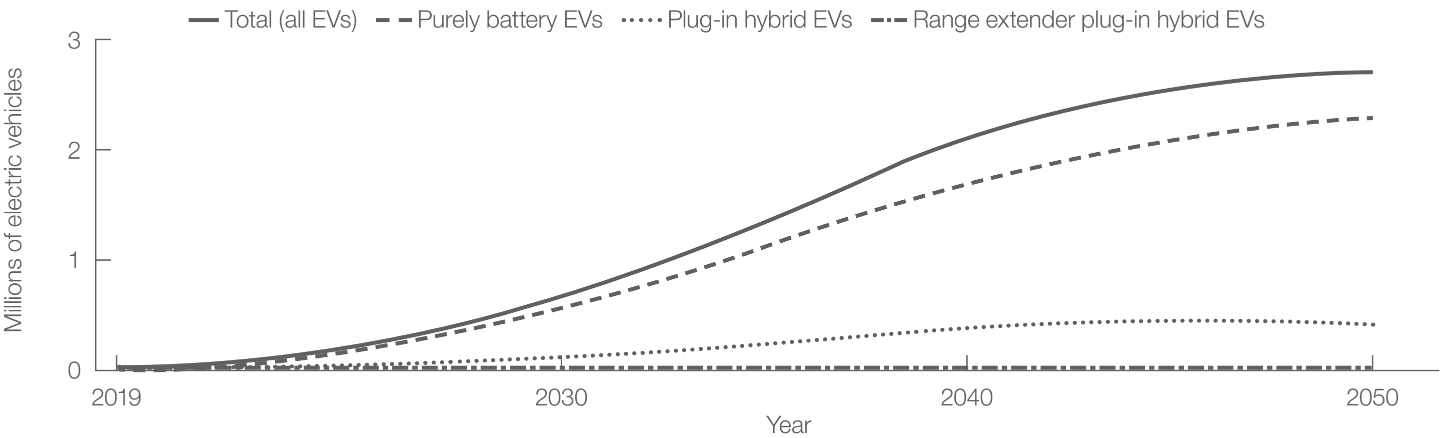
EV forecasts show tipping points around the year that the ban of ICE sales has been modelled in each scenario.

The split between different types of EVs reveals that purely EVs are expected to be the dominant type after 2023 with the volumes of plug in hybrid EVs (PHEVs) and range extenders PHEVs remaining below a quarter of the total EV fleet after 2023.

Future numbers of electric vehicles in the Electricity North West region

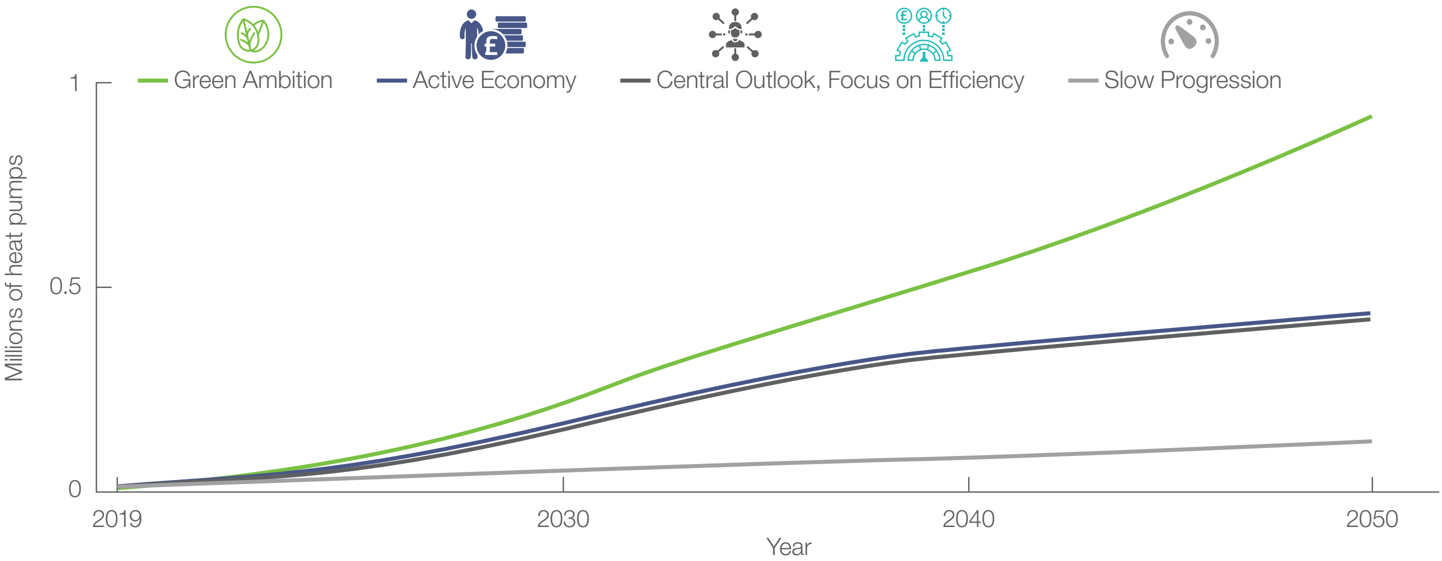


Breakdown of Central Outlook electric vehicle forecast values

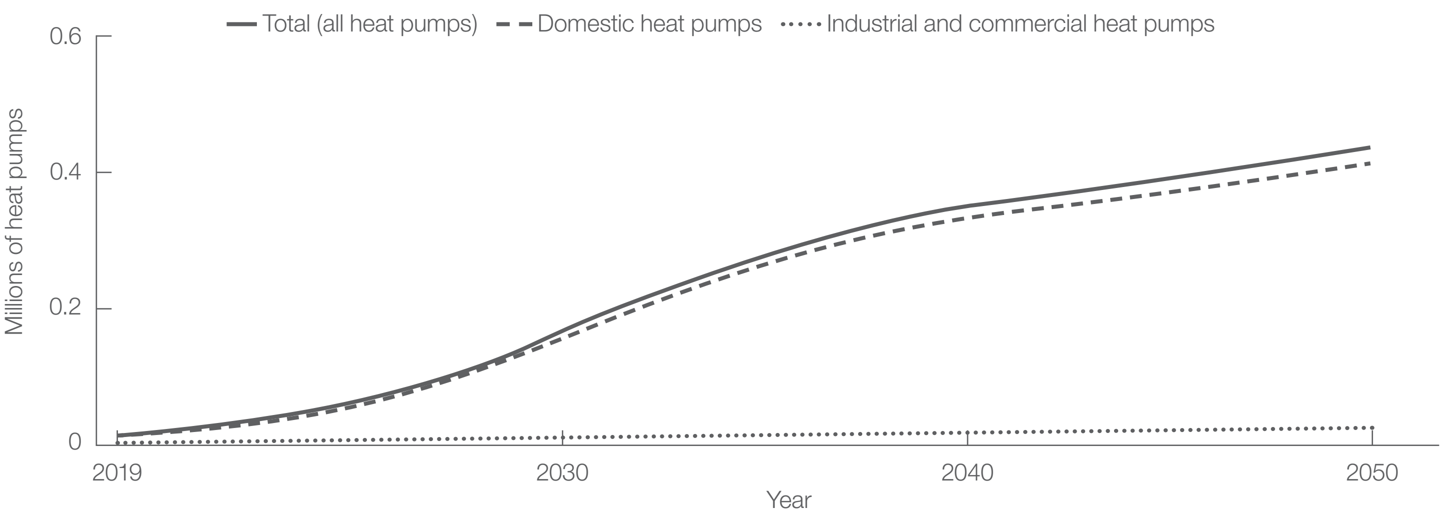


Future trends in heat pump volumes for the different scenarios result from the analysis of local uptakes based on regional characteristics including access to the gas grid and the existing building stock. Even though our Active Economy and Green Ambition scenarios consider the same uptakes for domestic heat pumps, there is a small difference between the total uptake due to a higher growth in the volumes of industrial and commercial (I&C) heat pumps in the Green Ambition scenario. The split of heat pumps installed at domestic and I&C locations reflects that the latter comprise less than 10% of the total number of our customers.

Future numbers of heat pumps in the Electricity North West region



Breakdown of Central Outlook heat pump forecast values



2.6 Distributed generation and battery storage forecasts

A significant penetration of distributed generation has been seen in the UK within the last decade. Currently, solar PV and wind farms are seen as the key renewable generation types that are expected to continue growing as part of the transition to net zero. Connecting to distribution networks, solar PV can be deployed on the roofs of domestic customers and on large commercial customers' premises in urban areas, alongside larger solar and wind farm installations in more rural areas.

The large renewables connected at transmission level (mainly offshore wind generation) are also triggering the requirement for significant amounts of gas fuelled flexible generators that are connected in distribution networks and provide grid services to the transmission system operator (NGESO).

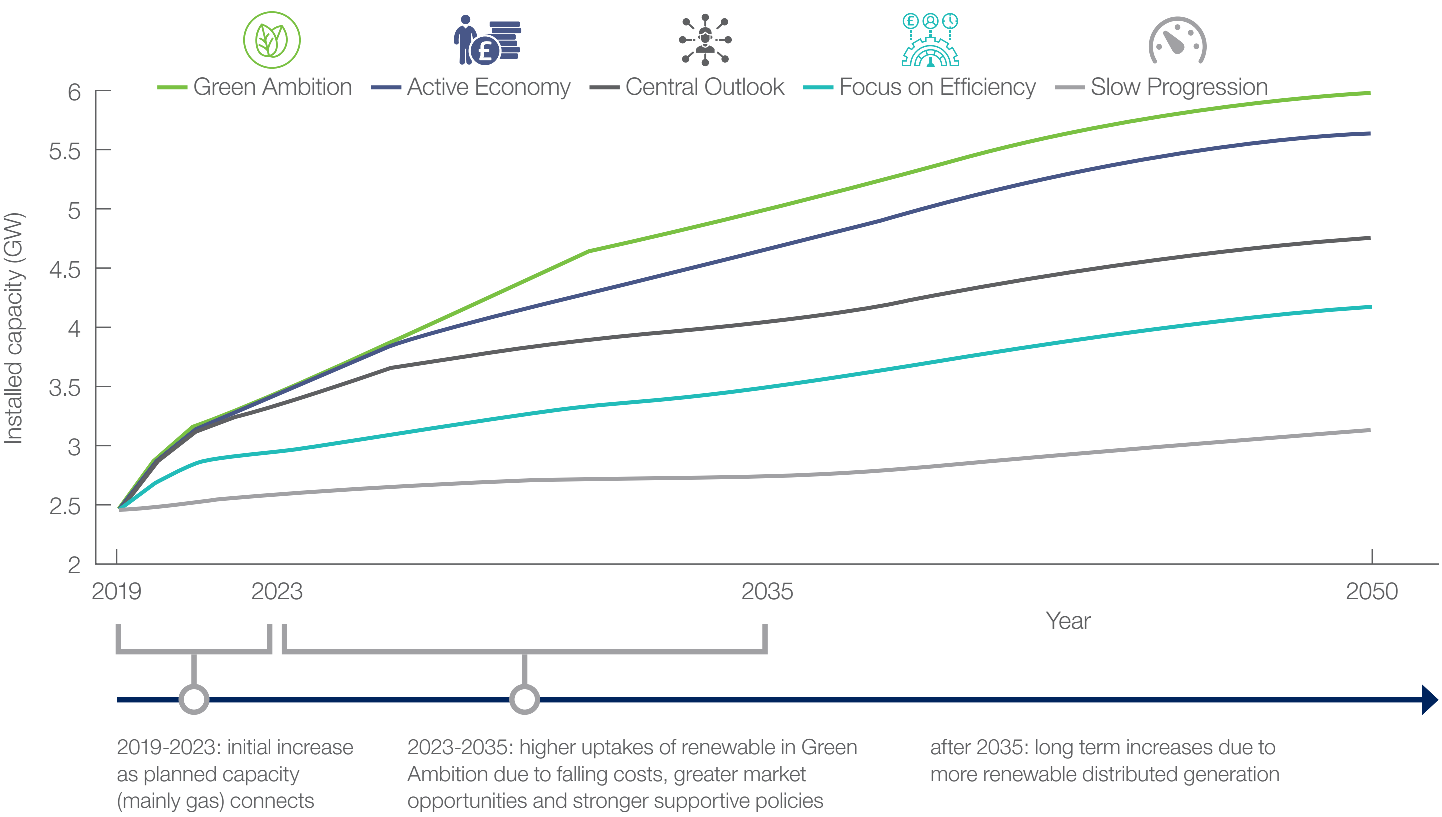
Installed DG capacity is expected to increase by between 25% and 75% of current levels within the next decade and potentially more than double the current level by 2050.

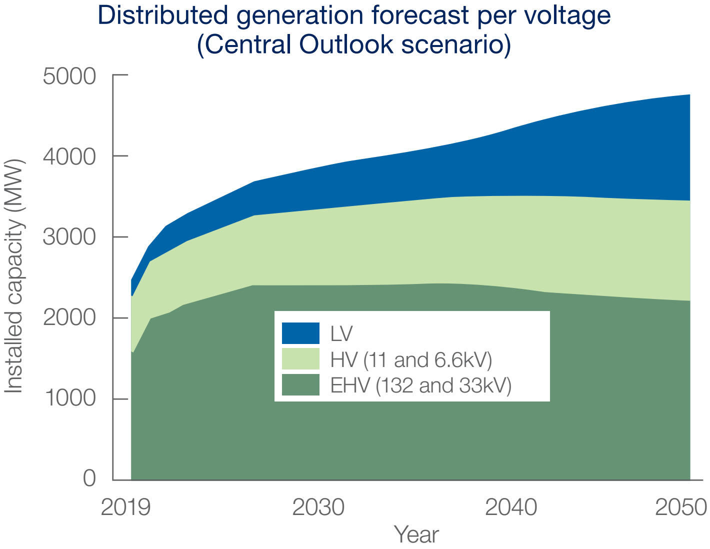
The range of future DG capacity across the scenarios is less than the corresponding value in last year's forecasts, mainly due to reduced volumes of planned developments.

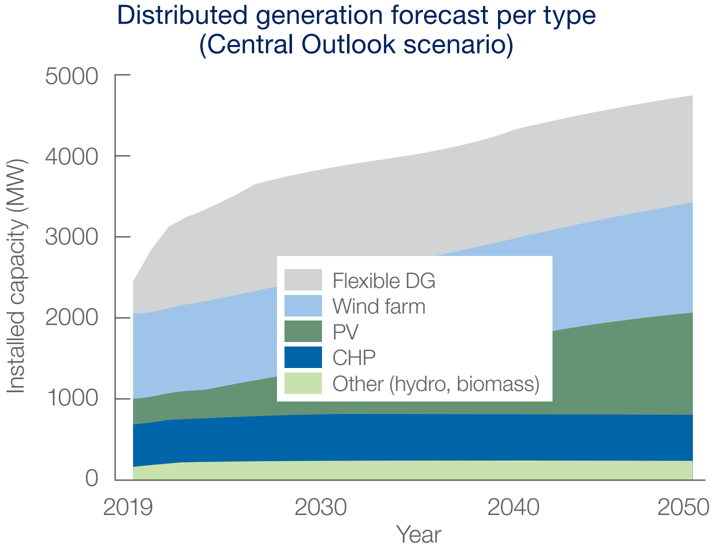
There are different trends in future DG capacity dependant on voltage level and DG type. Similar to last year's forecasts, but at a different overall capacity, planned developments show an abrupt rise in the following three years for gas/diesel fuelled flexible DG units, whereas limited use of combined heat and power generators (CHPs) is expected in the longer term as policies for decarbonisation and reduced capital cost lead to renewable generation being more attractive than CHPs.

Although the removal of strong subsidies for renewable generation (FiTs and CfD) is limiting uptake before 2023, capacity is expected to grow at higher pace in the longer term due to falling costs and revenue from participation in wholesale and local future electricity markets. Growth rates are higher for solar PV that is easy to fit on residential and commercial rooftops and fields (mainly HV and LV), whereas planning permission issues are expected to limit the development of onshore wind farms (mainly EHV and HV). The distributed generation capacity forecast in 2050 for each scenario depends on capital cost, wholesale electricity price and planning success rate of planning permission applications for onshore wind farms. All scenarios assume no new flexible generation (open cycle gas turbines and diesel generators providing a service to meet demand during peak periods) after 2030. The Green Ambition scenario forecasts more distributed generation than the other scenarios in particular due to support for small PV from the Smart Export Guarantee scheme and larger generators benefitting more from direct access to capacity markets or through aggregators.

Distributed generation forecasts for all Electricity North West scenarios

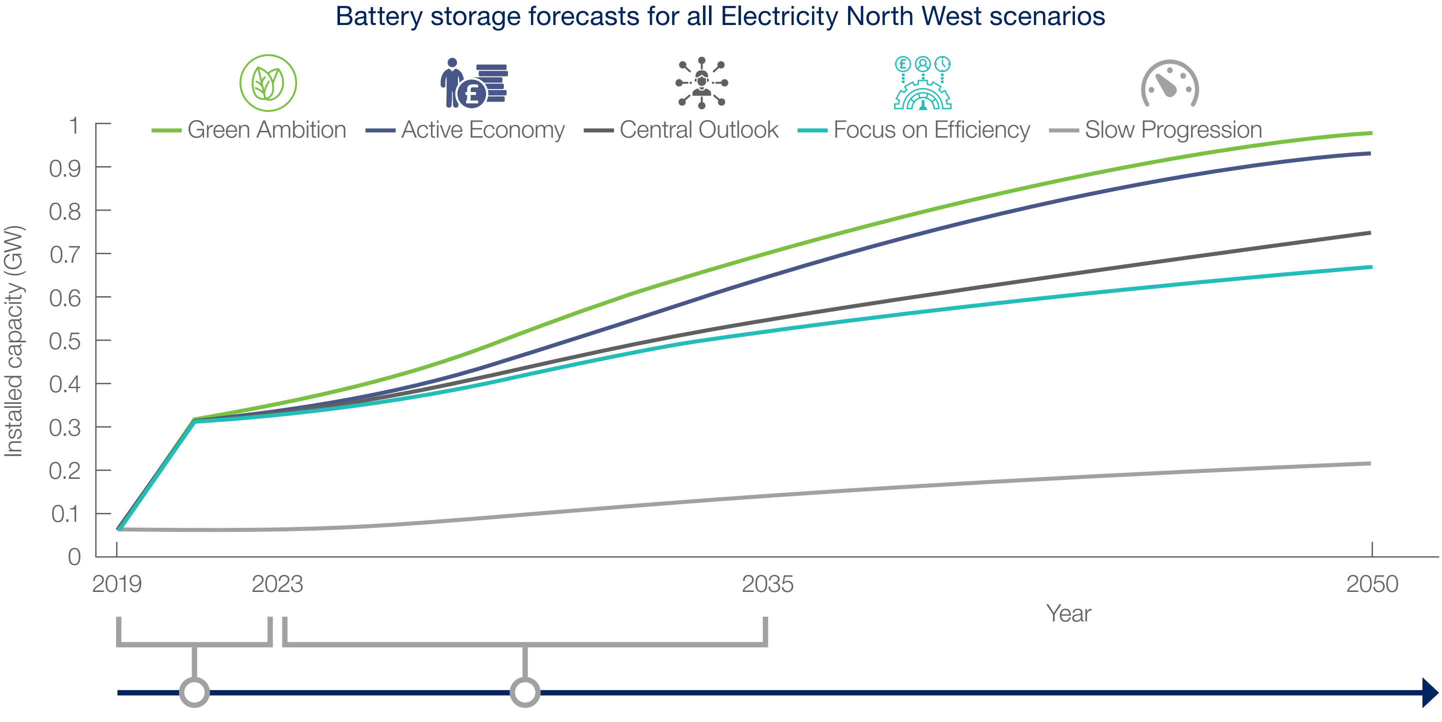






Similar to the generation uptakes, battery storage is expected to be driven until 2022 by planned developments, mainly from investments aiming to provide frequency response services to the ESO. Currently accepted battery storage project connections are considered within all scenarios with the exception of Slow Progression, as this scenario demonstrates the significant effects of the withdrawal of large battery storage projects on the overall capacity across the network.

Behind the meter storage is expected to be used by industrial and commercial customers with existing connections to our network and who will target revenues from multiple services (e.g. STOR, TRIADs and RAG DUoS charge avoidance). However, it is expected that such customers will aim to bring in revenues by participating in different markets including grid services to the ESO. Domestic customers are also expected to benefit from future reductions in the capital cost to purchase and install integrated PV and batteries to primarily reduce electricity consumption and potentially provide flexibility services via aggregators.



2019-2023: planned developments progress increasing storage capacity in all scenarios except Slow Progression

2023-2035: increase in storage is driven by larger installations at industrial and commercial sites

after 2035: batteries installed alongside PV at residential properties drive strong growth

2.7 Reactive power forecast

Electricity North West forecasts reactive power due to its importance in maintaining our network performance through acceptable voltages. Our ATLAS project (2015-2017) introduced a new business as usual approach for DNOs to forecast reactive power considering the interactions between demand, generation and the network by modelling the whole of our 132 to 33kV networks for each half hour throughout a year. We have now further improved our reactive power forecasting by considering the practical effects of our HV and LV networks.

There is a greater need for reactive power forecasting due to the UK implementation of the European Demand Connection Code, which could mean that DNOs face the technical challenge of complying with potential regulatory requirements to limit reactive power exchanges (both imports & exports) across the boundaries between the distribution and transmission networks.

These policy recommendations were introduced mainly due to the effects of the acute declining trends for reactive power across UK and other European countries on transmission voltage levels during periods of minimum demand.

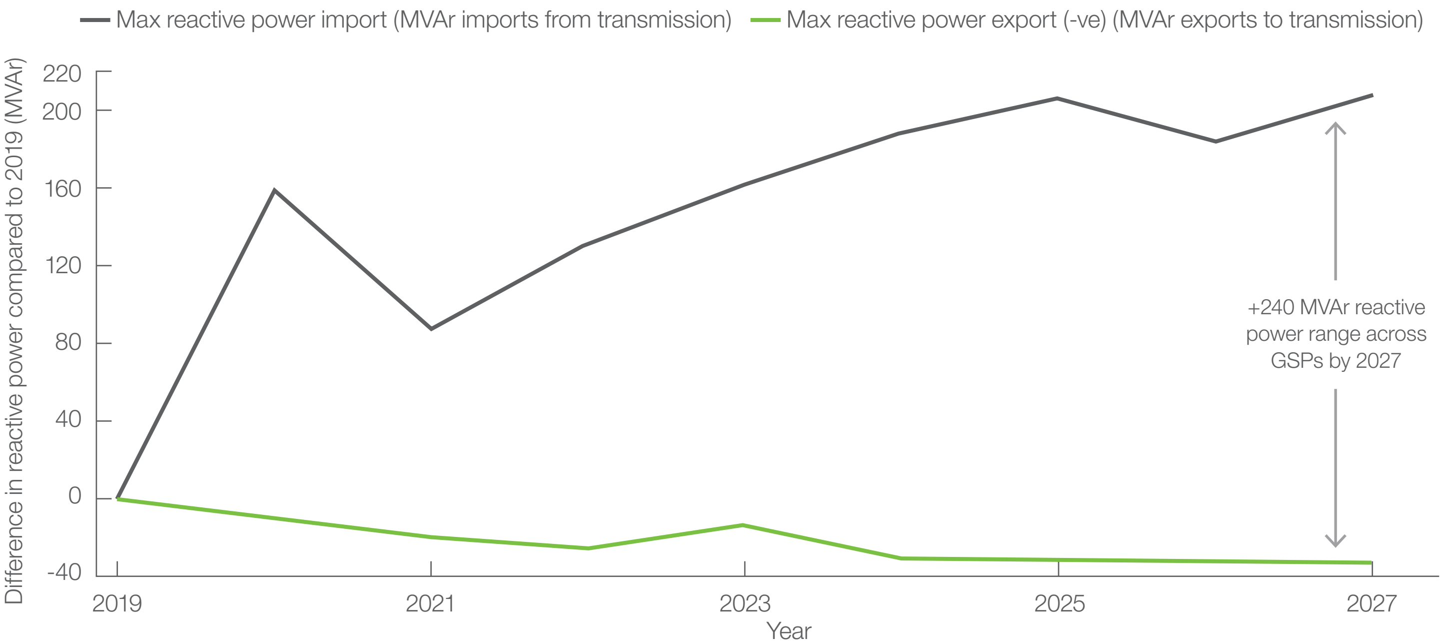
We discussed in our 2018 DFES report that declining reactive power absorption across Electricity North West networks is:

- increasing the reactive power exports from our distribution network to the transmission network; and
- leading to the voltage control provided by transformer tap changers at BSPs and primary substations reaching the limits of their capabilities meaning that DNOs could face real voltage containment challenges.

2019 reactive power forecasts for our distribution network indicate a significant rise in both the reactive power imported from and exported to the transmission network.

Our Central Outlook reactive power forecasts show a widening difference between maximum import and export across the Electricity North West transmission and distribution network interfaces. Our analysis considered the annual maximum reactive power imports expected at the same time across all of our GSPs and the annual maximum reactive power exports over eight years. The increased future range of reactive power at 125% of the present range (circa 900 MVAr) combined with an expected broader range of active power requirements associated with peak demand growth and increased levels of variable distributed generation are expected to affect transmission voltage levels in both periods of peak and minimum demand.

Forecast annual maximum reactive power consumed and produced by Electricity North West's distribution network (Central Outlook scenario)



Electricity usage today contributes a lot less to climate change than it did ten years ago due to the use of renewable power. However, further drastic changes are required if UK is to reach the legally binding target of being net zero by 2050.

In June 2019, an amendment to the 2008 Climate Change Act was approved, seeing the previous target of an 80% reduction to 1990 levels of greenhouse gas emissions (GHG) change to a 100% reduction (net zero) by 2050.

It is important to understand the steps that must be taken for our region to become carbon compliant and how our electrical distribution network is affected.

This recent change to a more ambitious target is expected to exacerbate impacts on electrical networks as the power sector could account for a large proportion of the reduction in carbon emissions. The recent more stringent governmental policies, increasing national focus on decarbonisation and greater regional stakeholder commitment to a low carbon future have led Electricity North West to consider a carbon compliant scenario.

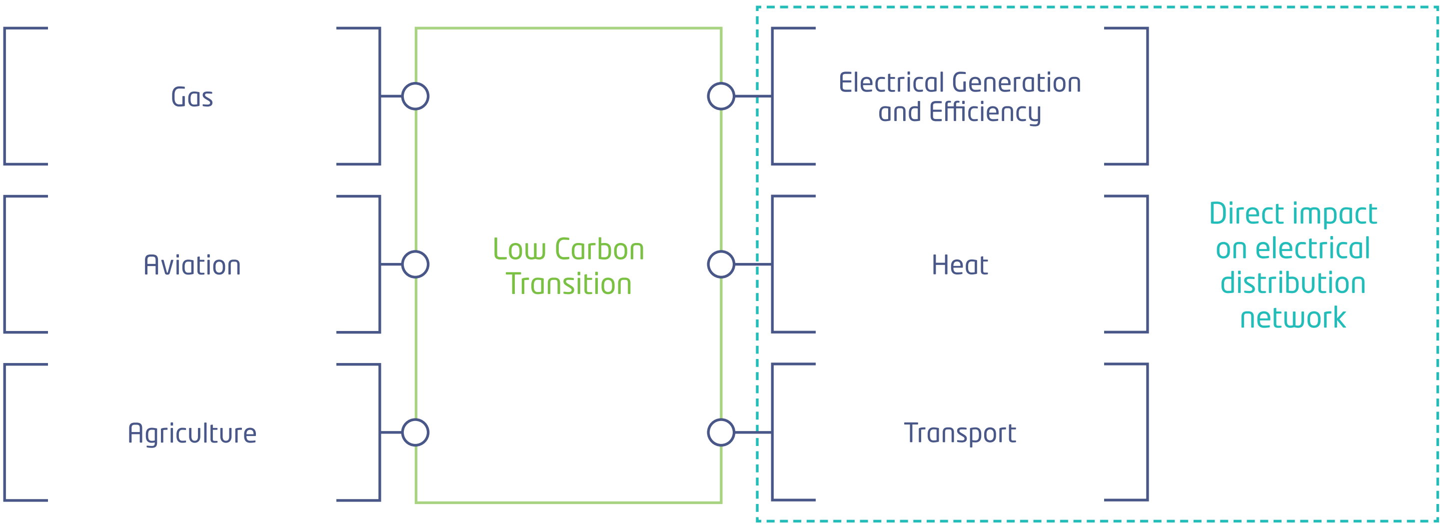
The carbon compliant scenario provides an understanding of the steps that must be taken in our region and how becoming carbon compliant affects our electrical distribution network.

The additional scenario reflects the requirements for compliance with the government's previous carbon target (80% reduction).We intend to share more information on what the recent net zero target will mean to electricity in our region next year when more research will have been undertaken and when we expect that detailed and regional data will be available.

Our core scenarios concentrate on the likelihood of future changes in demand and generation influenced by economic prosperity and the policies supporting a green future. They consider how electricity is generated and utilised, including increased usage by new low carbon technologies and reduced usage through increased appliance and building energy efficiencies. Although the use of more renewable power sources and the adoption of alternative electrical heat and transport will provide corresponding carbon benefits for each of our core scenarios, they were not formulated to explicitly meet long-term climate change goals.

It is appropriate to consider a carbon compliant scenario separately from our core forecasts because achieving the carbon target depends on much more than electricity; it requires changes in other energy sectors including gas, modifications to our buildings and societal changes such as how we get around, like walking or using public transport. Also, reaching the national carbon target involves the whole of UK and goes beyond our region. The carbon compliant scenario is just one of the many methods for reaching the carbon target as it could be achieved through countless combinations of the varied and wide-ranging actions to reduce carbon.

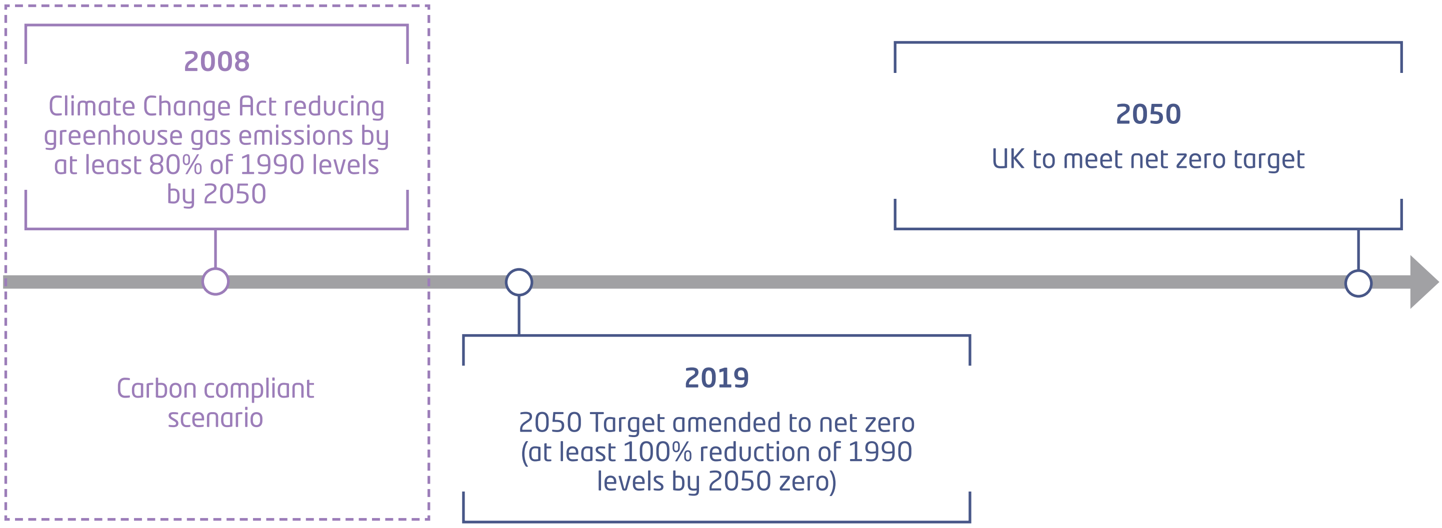
We compare our Green Ambition scenarios uptake levels of low carbon technologies with the carbon compliant scenario in order to highlight how far we expect that our current view of policies supporting a green future in our area can reach the carbon targets.



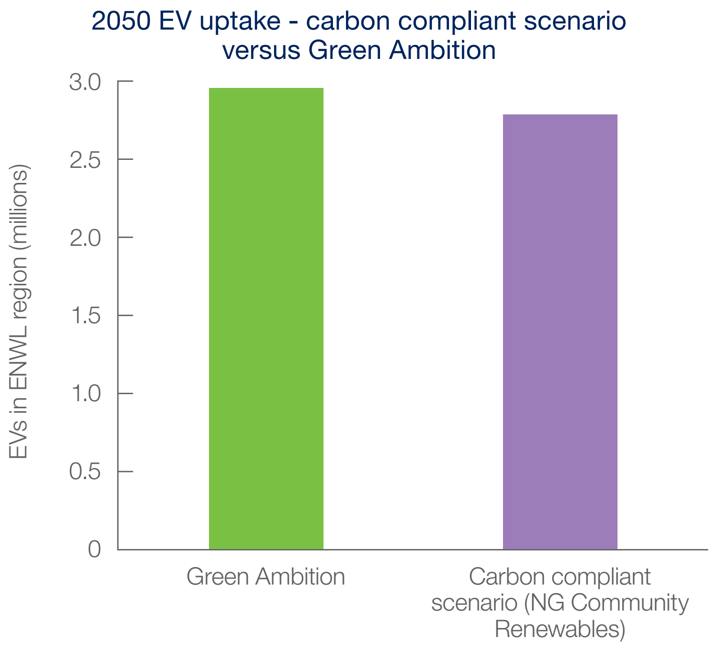
The carbon compliant scenario that we present complies with the target to reduce greenhouse gas emissions by 80% of 1990 levels by 2050. In this scenario compliance is achieved through more stringent and influencing policies than those of our Green Ambition scenario. It is based on National Grid ESO's Community Renewables FES scenario which we have interpreted for our region in terms of the connection of renewable generation, the installation of heat pumps (decarbonisation of heat) and the uptake of EVs (decarbonisation of transport).

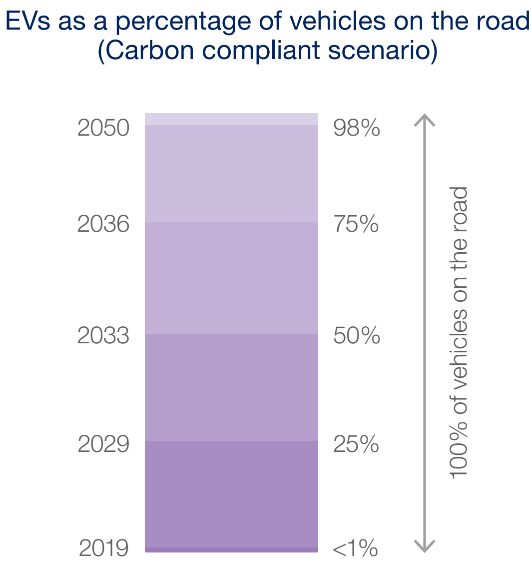
National research continues to establish how net zero can be achieved including the use of yet unknown technologies, but the ultimate impact on electricity is expected to be even greater than currently expected. Early indications are that greater application of Carbon Capture, Usage and Storage (CCUS) may be required to reduce carbon levels and that the generation of electricity effectively will need to produce negative levels of carbon using CCUS partnered with bioenergy. Initial forecasts of electrical implications predict even higher peak demands despite the application of smart technologies to smooth electrical consumption during the day and night by managing heating and EV charging.

Some local authorities within our region have even more ambitious goals. Manchester, for example, plans to become a carbon neutral city by 2038. This requires greater and immediate steps across all types of measures that reduce carbon. A five year environment plan was launched by the GMCA in March 2019 defining the urgent action needed to put Greater Manchester on a path to carbon neutrality, including commitments to increase local renewable electricity generation and the decarbonisation of heat and transport. We have compared the Manchester's ambitious targets to the carbon compliant scenario forecasts to highlight the local challenges facing our customers.



3.1 Electric Vehicles uptake meeting carbon target





The number of EVs on the roads of our region by 2050 forecast by the carbon compliant scenario closely matches the corresponding results from our Green Ambition scenario with very few petrol or diesel cars remaining by 2050.

The carbon compliant scenario forecasts that the vast majority of vehicles will be powered by electricity by 2050, although there will be a small number of vehicles powered by other alternative low carbon fuels, for example hydrogen.

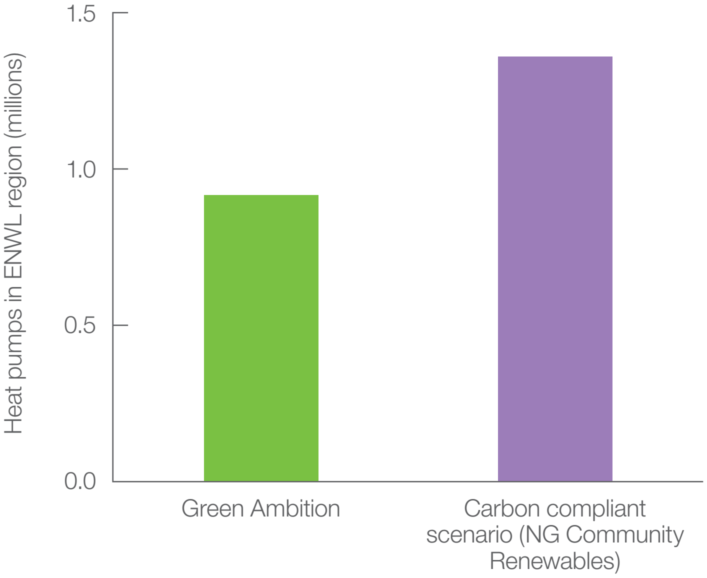
Half of vehicles will need to be electric by the early 2030s and all vehicles will need to be low carbon by 2050 to meet the carbon target.

Corresponding with potential dates for the ban on the sale of ICE vehicles, the greatest uptake rates are seen between 2025 and 2036. Achieving the ultimate 2050 carbon target requires immediate action to meet the intermediate milestones of half of us in our region driving electric cars by 2033, and three quarters of us soon after in 2036. Understanding this level of transition and its timing is useful to our stakeholders making the low carbon transition and developing the charging infrastructure that will be required to support these EVs, but is also useful to Electricity North West as we plan sufficient network capacity.

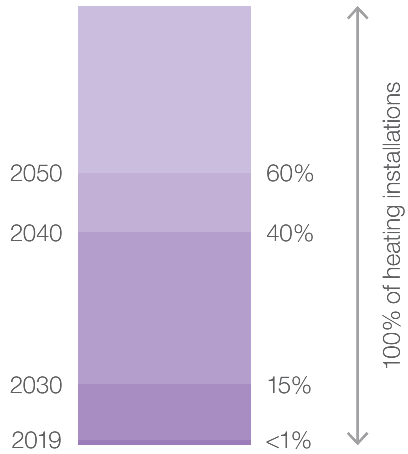
The challenge of the GMCA's five year environment plan for 200,000 EVs in the Greater Manchester area alone within the next five years is evident from comparison with our forecasts which shows approximately the same number of EVs across the whole of our region by 2024. We recognise that GMCA's target is ambitious and are therefore already working closely with them to ensure that our network is ready to accommodate the earlier adoption of EVs there.

3.2 Heating technologies uptake meeting carbon target

2050 heat pump uptake - carbon compliant scenario versus Green Ambition



Heat pumps as a percentage of all heating installations (Carbon compliant scenario)



Changes in how we warm buildings and reductions in the amount of energy needed to heat our homes through improved insulation and increased efficiencies are critical for meeting carbon targets. The Greater Manchester five year Environmental Plan is seeking to reduce carbon in the short-term by reducing heat demand from existing homes by retrofitting wall, loft and floor insulation, replacing single glazed windows and draught proofing doors.

Meeting the carbon target will require the majority of us with existing natural gas boilers to adopt low carbon options like electric heat pumps, electric resistive heating in well insulated buildings or using hydrogen by 2050.

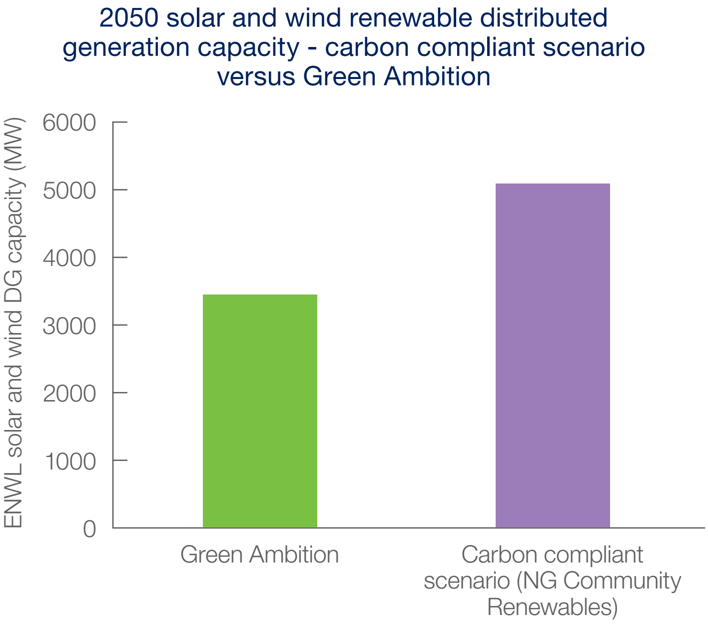
More heat pumps are required and heating energy must reduce to meet the carbon target by 2050.

Supportive legislation is already in place, including a ban on gas boilers in new domestic properties after 2025 and requirements for greater boiler efficiencies, compulsory timers and room thermostats.

It is forecast that 60% of households will be heated by electric heat pumps including hybrids by 2050 under the carbon compliant scenario, compared to 40% under our Green Ambition scenario. Fewer electric heat pumps in our Green Ambition scenario could mean that other low carbon alternatives are used to heat our buildings instead. However, it is likely that stronger policies or market forces will be required to drive more households and businesses to move away from gas. Greater use of heat pumps in the carbon complaint scenario will increase our forecast maximum electrical demands and the amount of energy that needs to be supplied through the Electricity North West distribution system. It is important that we are aware of this so that we can contemplate the impact on our network, with the additional half a million heat pumps forecast to account for an increase in demand of approximately 1,500MW.

Again, Greater Manchester's goal is even more ambitious targeting 60% of all heating (domestic and commercial) supplied by low carbon heating by 2040. Heavily urbanised areas may utilise heat networks, but otherwise there could be approximately 800,000 heat pumps just in the GMCA area by 2040 with a corresponding increase in the energy supplied via our network and increase in peak demand.

3.3 Renewable distributed generation uptake meeting carbon target



Decarbonisation of electrical generation is a critical element of meeting the climate change target, not only due to the direct carbon benefit but also because it underpins the benefits gained from the decarbonisation of heat and transport by switching to electrical methods.

The carbon compliant scenario forecasts a combined total of nearly 5.1GW of solar PV and wind generation connected to the Electricity North West distribution network by 2050, corresponding to approximately twice the present total embedded capacity of all types.

Solar PV and wind generators are expected to play a major role in decarbonising future supply of electricity.

The additional 4.1GW of new renewable generation capacity on top of the existing capacity corresponds to at least 550 additional large wind turbines, approximately 140km^2 of solar PV and another 500,000 customers fitting domestic solar panels corresponding to a ten-fold increase in the current number of installations.

Reaching the 2050 carbon compliant target will require approximately 140MW of solar and wind generation to be connected to our network per year every year for the next thirty years, which corresponds to more than twice the average annual capacity of solar PV and wind DG capacity connected to our network over the past five years.

Although the 3.5GW of distributed generation forecast by our Green Ambition scenario by 2050 is less than the corresponding value in the carbon compliant scenario, it is possible that the uptakes indicated by Green Ambition forecasts could meet the carbon target. The balance of the generation could be low carbon generation connected to the transmission network such as nuclear, storage or interconnectors.

Again, stronger policies and possibly incentives will be required for more households and businesses to install renewable generation. Greater capacity of distributed generation above our Green Ambition levels will have a bigger impact on our network, especially as the popular areas for generation already export at times of minimum demand. Harker and Golborne between Wigan and Warrington are examples of where the connection of additional generators would require network reinforcement or alternative network management solutions.

GMCA's 2050 target for 50% of households in the area to install solar PV generation and increases in the number of wind turbines and large PV capacity is likely to add nearly 3.8GW of DG exceeding our Green Ambition forecast for the whole Electricity North West region.

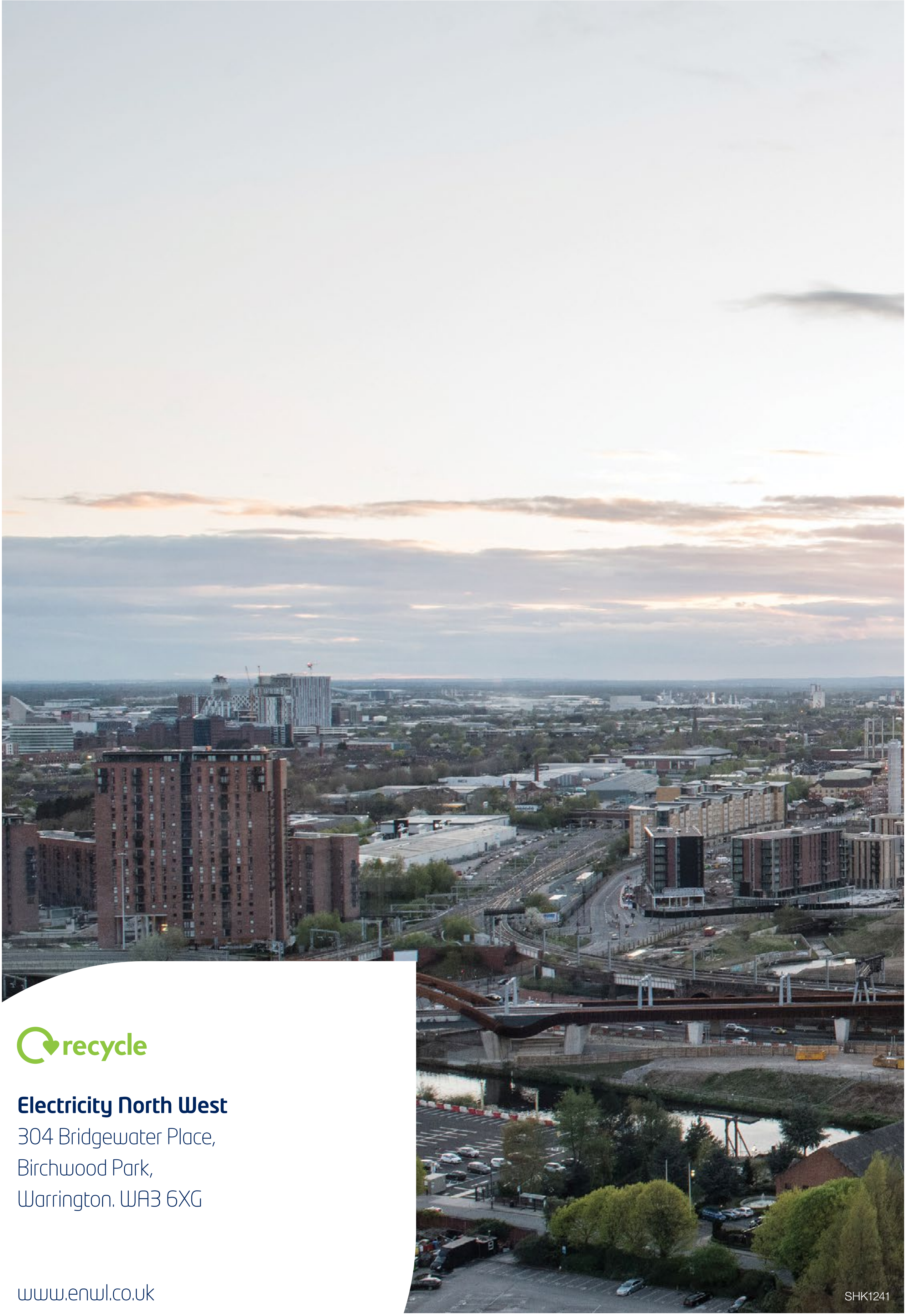
Distributed generation can be helpful to our network when it offsets local demand. However, high penetration levels can mean that not all of the generated power is consumed locally and power must flow back up the network contrary to its design for delivering power to customers. It is important that we understand where distributed generation will be clustered so that we can plan to mitigate any associated network issue.

It is important that our DFES evolves as it is one of our key decision making tools in a continually changing energy landscape. We need to ensure that our forecasts are increasingly accurate to better inform our planning to develop an adaptable network matching the range of future requirements. Also, we are making our scenarios and forecasting more accessible and useful to our communities and customers as they transition to a low carbon future.

The future success of the DFES requires us to work closely with our stakeholders as they have the most intimate foresight of the potential developments in our region, understanding the scale and timing of new projects. Together, we can provide mutual benefits; we can tailor our reporting to deliver more valuable information to customers whilst ensuring that our network develops to match their requirements in an efficient and timely manner based on their detailed insight.

We would like to get your input on the future of electricity in the North West to continue the conversation on our DFES, its improvement and its utility in particular with regards carbon reduction and reaching net zero.

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



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