SP Manweb

2023 Distribution Future Energy Scenarios

March 2024

Aligned with FES 2023 scenario framework

Contents

Commissioned partners:

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Welcome to our DFES

Welcome to our Distribution Future Energy Scenarios (DFES). This document sets out our forecasts for how electricity generation and consumption may evolve in North Wales, Merseyside, Cheshire and North Shropshire out to 2050.

This document presents our annual update to these DFES forecasts following the publication of the Electricity System Operator's Future Energy Scenarios in July 2023.

Scott Mathieson
Director, Network Planning & Regulation

If you have an idea you would like to discuss with my forecasting team, or if you'd like more information on a particular subject, please get in touch via:
dfes@spenergynetworks.co.uk

Electricity networks are at the heart of the Net Zero transition. The scale of decarbonisation means that by 2050 the peak demand on our distribution networks is forecast to double, and we could likely see a five-fold increase in connected generation and storage. Over recent years we have seen a steady increase in connection rates of domestic, low carbon technologies. These trends are expected to accelerate, and we forecast that our customers are likely to connect up to eight million electric vehicles and heat-pumps by 2050.

We know from detailed modelling that this new demand, generation, and storage will increasingly push the distribution network beyond what it is designed for, meaning that our network needs to evolve to enable our customers' Net Zero transition. This evolution will affect every area of our business. For example, changing the way that we plan and develop the network – requiring granular forecasts to establish where, when, and how much network capacity we need to add to accommodate customer growth, and to determine the tools, interventions and solutions we need to best deliver that capacity.

The role of network operations – managing the network in real time, keeping the lights on, and keeping our customers and staff safe – will soon involve the dispatching and settling thousands of flexibility service contracts. These are actions taken by our customers who have agreed to operate in ways that free up network capacity and avoid network constraints. Information, visibility, data, and automation will all be essential to enable us to develop and operate this more active distribution system.

It is important that we understand the likely uptake of these new demand and generation technologies, so we know how best to respond. That is the purpose of our DFES – to show the possible decarbonisation routes to Net Zero so that we can develop our network accordingly.

While the overall direction of travel towards Net Zero is clear, there are some areas where detailed local authority and community action plans are still under development. There are also broader factors at play – continuing high energy prices have changed decarbonisation business models; the Ukraine war has promoted the importance of energy security; supply chain issues have delayed some projects. Whilst these are hopefully short-term factors, these uncertainties and the ever-changing energy landscape illustrate that creating a single forecast risks being misleading.

Instead, we set out four forecast scenarios which cover a range of credible pathways to describe the potential decarbonisation routes which our customers may follow.

Our main role is to provide the safe, efficient, and reliable network capacity needed to enable the decarbonisation route that our customers and communities choose. To achieve this, these DFES forecasts are used to assess future network capacity requirements and plan the delivery of this capacity. These DFES forecasts are also valuable to the two transmission operators that supply our distribution networks, as they start to assess what investment they need to make in the 2026-31 RIIO-T3 period.

Given the important role of these forecasts, we need to ensure that we have correctly forecast our customers' requirements. That is why stakeholder feedback has been a vital component of every DFES publication. We welcome the feedback we have already received, which has been used in these latest forecasts and previous versions. Whilst we do incorporate and carry forward feedback from previous years, a lot can change in 12 months. Therefore, we thank those who continue to give up their time to share their views with us every year – it is important and valued – and we look forward to continuing to engage with all stakeholders..

1. Introduction

We are SP Energy Networks. We own and operate the electricity distribution network in the SP Manweb licence area covering North Wales, Merseyside, Cheshire, and North Shropshire. It is through this network of underground cables, overhead lines, and substations that 1.5 million homes, businesses, and public services are provided with a safe, economical, and reliable supply of electricity.

A safe and reliable electricity supply is key to most people's lives – we depend on it to light our homes, keep our food fresh, power our businesses, and enable our connected lifestyle. In the future, we will also increasingly rely on it to heat our homes and power our transport as we decarbonise our society.

SP Energy Networks must ensure our network has sufficient capacity to meet our customers' changing electricity needs, and that our networks are equipped to facilitate the reaching of Net Zero legislated targets. To do this, we need to understand what our customers' electricity requirements are going to be into the future. This includes how much electricity both existing and new customers might consume (demand) and how much they might produce (generation).

Our DFES

The DFES comprises forecasts of the following key areas:

1. Growth in the volume of Low Carbon Technologies (LCTs), such as heat pumps, district heating and Electric Vehicles (EVs).
2. Changes to demand and consumption as a result of technology and behaviour changes, not least due to the growth in LCTs.
3. Growth in and changes to electricity generation and storage[1]. This is generation connected to our distribution network as opposed to the transmission network; we call this Distributed Generation (DG) or embedded generation.

There are multiple pathways that GB could take to meet Net Zero, influenced by a range of external factors. These external factors – political, economic, social and technological – will all affect the way our customers' needs evolve over time. Therefore, we develop Distribution Future Energy Scenarios (DFES).

Figure 1 | DFES is the first step in our investment planning process

These scenarios provide a range of alternative electricity requirements out to Net Zero. For each scenario we model the impact on our distribution networks.

We use our DFES forecasts to help us understand where and when we might see constrained network capacity. This informs procurement of flexibility services, as well as where and when we need to increase network capacity through conventional or innovative network reinforcement. Ultimately, DFES is the cornerstone of our investment planning as represented by Figure 1.

This document

Section 2 explains what our DFES is and how it is created.

Sections 3-4 give an overview of demand and generation results, respectively.

Section 5 gives comparisons back to industry GB forecasts.

Section 6 shows how the Climate Change Committee forecasts are incorporated.

Section 7 presents the Net Zero compliant range used for network planning and development.

Section 8 gives a history of stakeholder feedback gathered in the production of this and previous DFES cycles.

Incorporating your views

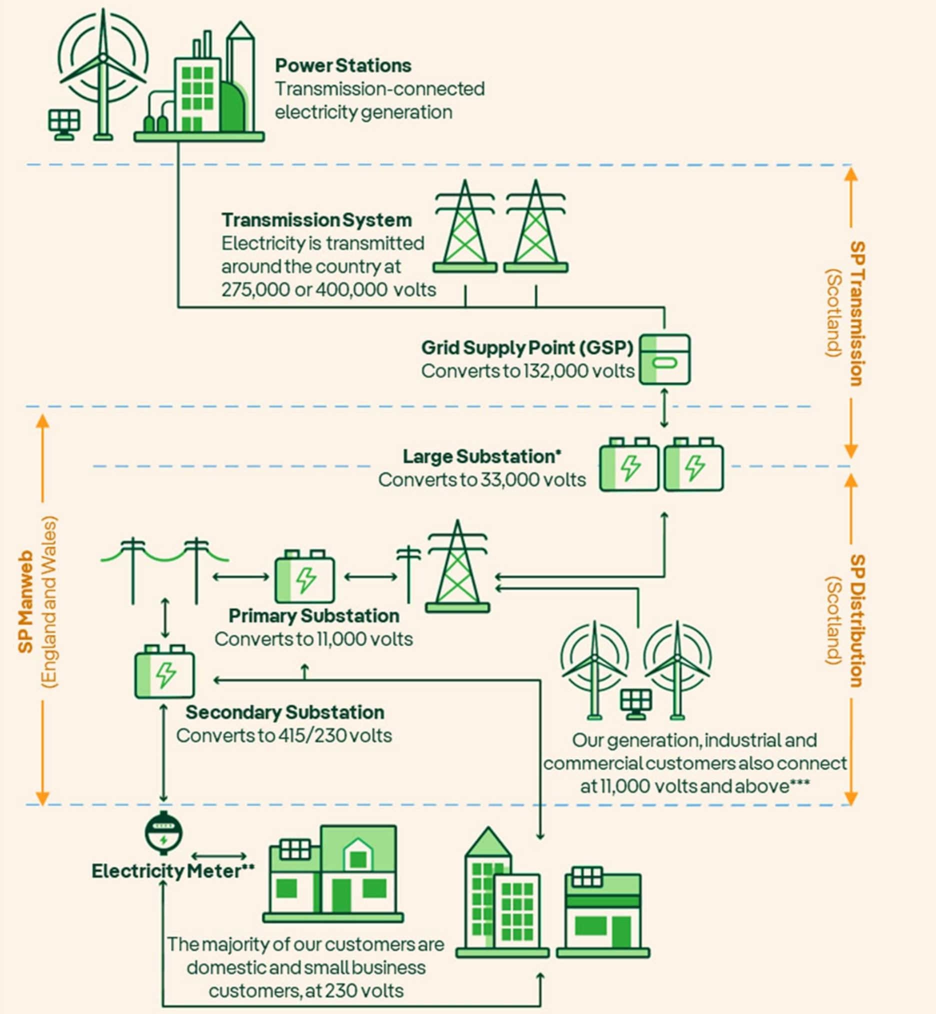
We update our forecasts on an annual basis in line with national and regional projections. As part of this annual process, we engage with a wide representation of our stakeholders to test the forecasts' data, methodology, and outputs.

However, we encourage you to engage with us and shape our forecasts throughout the year, to support the continuous improvement of our DFES. If you have any questions or feedback on our forecasts, they would be gratefully received.

Please provide your feedback via email to dfes@spenergynetworks.co.uk.

[1] From a technical perspective, storage increases both demand (when it imports electricity) and generation (when it exports), so it could have been included in either group. However it is legally deemed to be generation, so is included within the generation forecasts.

Figure 2 | Diagrammatic view of transmission and distribution system



**These are GSPs in SPD.*
***We are responsible for the cables and equipment down to the electricity meter. The energy supplier owns the meter, and wiring and equipment beyond-the-meter is customer-owned.*
****These customers have different metering arrangements to domestic customers and sometimes there are dedicated SPEN substations at their site.*

[2] https://www.spenergynetworks.co.uk/userfiles/file/DFES_SP_Distribution_2023.pdf

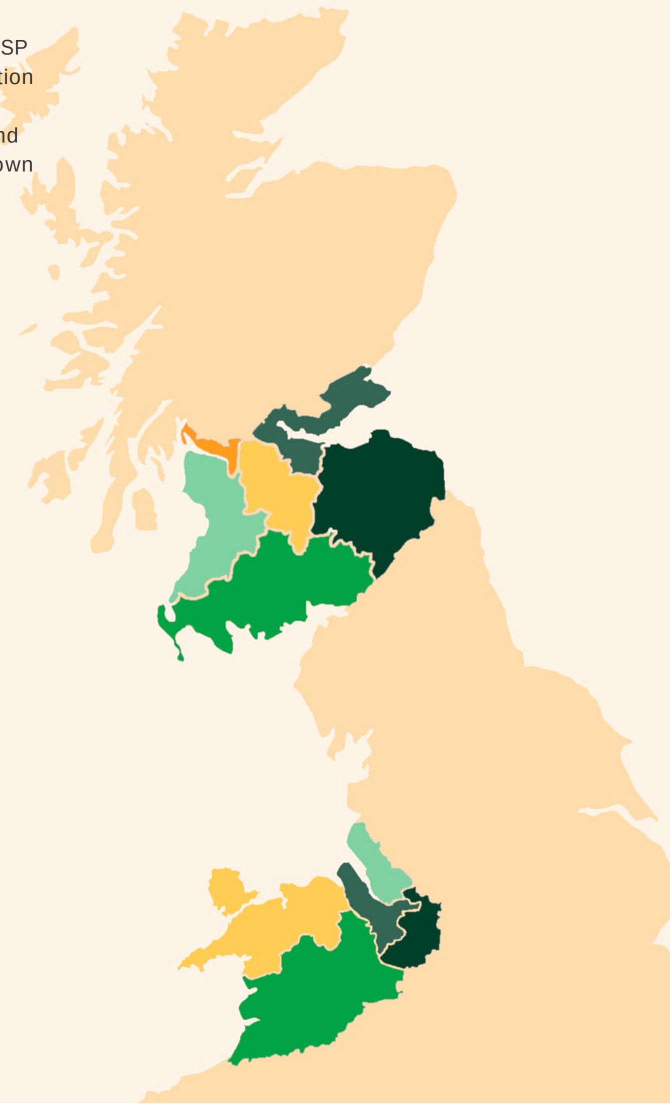
Our network areas

SP Manweb owns and operates the electricity distribution network – the network at 132 thousand volts and below – across North Wales, Merseyside, Cheshire, and North Shropshire It has six operating regions: Merseyside, Wirral, Mid-Cheshire, North Wales, and Dee Valley & Mid Wales. Across these regions, we transport electricity to and from circa 1.5 million homes and business.

SP Manweb is part of SP Energy Networks. SP Energy Networks includes another distribution network company: SP Distribution, the distribution network operator for Central and Southern Scotland. SP Distribution has its own forecasts, which are available separately[2].

SP Energy Networks also comprises SP Transmission, the transmission network owner for Central and Southern Scotland.

The forecasts in this document are for the SP Manweb network only; they are not forecasts for the whole of the UK, or the transmission network. The relationship between the distribution system and the transmission system is shown in Figure 2.



2. About our DFES

The DFES are long-term forecasts of electricity demand and generation connected across our networks, which we update and publish annually. This year's DFES 2023 publication is an incremental update to the DFES 2022 publication. This section describes how we created our DFES and what it contains.

The scenarios are aligned to the National Grid Electricity System Operator's (ESO's) Future Energy Scenarios (FES)[3]. These are four GB-wide holistic energy scenarios out to 2050, considering gas and electricity supply and consumption. These four scenarios are designed to represent a range of credible energy scenarios, representing differing levels of consumer ambition, government/policy support, economic growth and technology development. The scenarios are developed through extensive engagement with stakeholders and are widely recognised as being an industry reference point.

To illustrate their different representations, Figure 3 maps the four scenarios against two metrics: the speed of decarbonisation (how fast low carbon technologies are adopted) and the level of societal change.

Creating our DFES

We start the process by looking at medium- and long-term growth patterns at a regional- and licence-level. For these we gather evidence from the ESO's FES, UK and Welsh governments' legislation and proposals (including the incorporation of Net Zero), and regional ambitions and development plans.

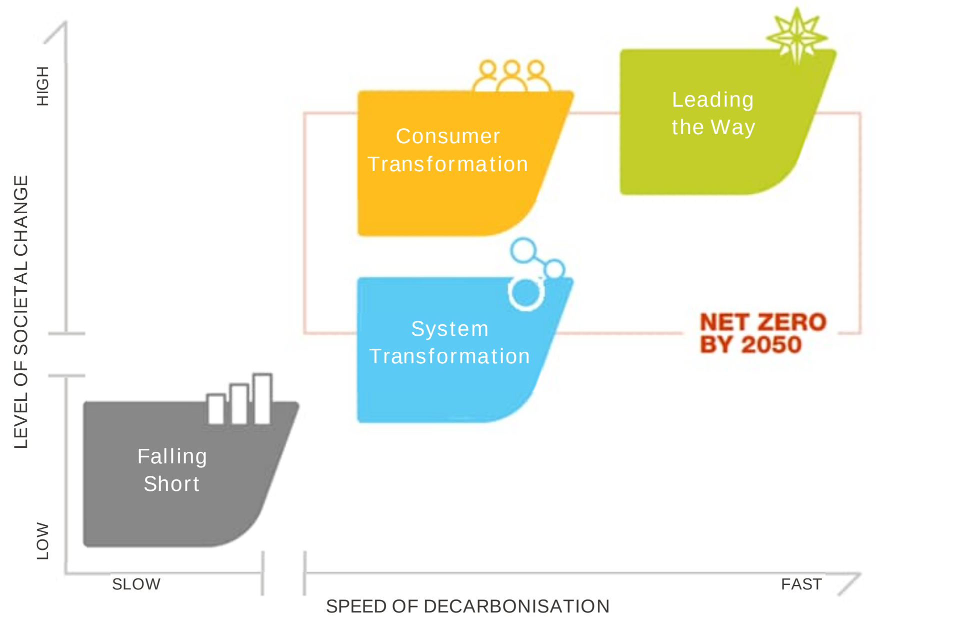
We then ensure these forecasts align with and are underpinned by the detailed information we already have on our networks. For example, incorporating the pipeline of near-term connections of large demand and distributed generation projects.

The forecasts are then spatially disaggregated to two levels of detail:

1. Grid supply point (GSP) level. There are 13 GSP areas across North Wales, Merseyside, Cheshire, and North Shropshire.
2. Primary substation level. There are 335 primary substation network areas across North Wales, Merseyside, Cheshire, and North Shropshire. These geographic areas cover, on average, approximately 38km^2.

We also provide key metrics disaggregated by Local Authority region.

Figure 3 | Overview of the ESO's Future Energy Scenarios



To create these geographically granular forecasts, we use outputs from SP Energy Networks' EV-Up, PACE and Heat-Up projects, as well as other highly spatially disaggregated sources of data (e.g. number of, type of and footprint of buildings in an area).

We also gather stakeholder evidence and feedback at all levels of the DFES. Feedback from customers and stakeholders is vital to ensure that our DFES forecasts reflect the plans and ambitions of the communities we serve.

In Section 6, we present the feedback we have received from this engagement and discuss how this has been assessed and used to update the forecasts. This update incorporates feedback received since our first publication in May 2020.

The resulting DFES forecasts are regionally reflective, geographically granular forecasts out to 2050 for four scenarios.

The creation of this DFES was undertaken with the support of Baringa, an expert consultancy. For further details on the methodology to create the forecasts, please refer to the "SPEN Distribution Future Energy Scenarios – Summary of Methodology" document, developed in conjunction with Baringa[4].

[3] https://www.nationalgrideso.com/future-energy/future-energy-scenarios-fes

[4] https://www.spenergynetworks.co.uk/userfiles/file/Annex%204A.6%20-%20DFES%20Methodology.pdf

External challenges

Forecasting electricity demand and generation in the short term has been challenging in recent years. Since the COVID-19 pandemic, in which we saw peak demand fall by almost 9% in one year, we have had a period of high energy prices and a cost of living crisis that continues in the short term. The triggers include the Russian war on Ukraine and various external levers, including Brexit.

These triggers have limited both electricity peak demand growth and energy efficiency improvements, having the overall effect of relatively little change to electricity peak demand in the short term. They have also had a knock-on impact to the uptake of LCTs, with supply issues of new electric vehicles being a key concern in recent years. Furthermore, the UK government announced in September that the ban on the sale of new petrol and diesel cars and vans would be pushed out from 2030 to 2035.

Nevertheless, these pressures are beginning to settle down. Vehicle manufacturers have already set in place plans for the transition to electric power by 2030 so, even if the original target is missed, market factors may act to accelerate this transition. Furthermore, long term strategic visions with regard to Net Zero have remained unchanged. More is discussed in the next section.

ANOTHER DISRUPTOR HAS BEEN THE SIZE OF THE GENERATION AND STORAGE 'PIPELINE' – THE QUEUE OF PROJECTS CONTRACTED TO CONNECT TO OUR NETWORKS IN THE FUTURE.

A key challenge faced across GB at present is the time being quoted to connect renewable generation to the network due to rapid expansion of the GB connections queue. At the end of 2023, about 500GW of generation was contracted to connect across GB transmission and distribution networks. For comparison, this is over eight times the GB electricity peak demand. Notably, there has been a particular boom in battery storage applications. This has led industry to work together to develop an action plan to accelerate grid connections.

Whilst growth in generation and storage will be central to a decarbonised energy system, we do not expect that all projects in the current transmission and distribution pipeline will progress through to delivery

However, because this volume of pipeline is unprecedented, exactly where, how quickly and by how much it will reduce are considerable unknowns – and ones that we have to tackle in our energy forecasts.

Our forecasts consider these external challenges, and we have discussed the impact on our forecasts in the results sections of this report.

Legislative context

The UK and Welsh governments have committed to a significant change to the energy system in order to reduce greenhouse gas emissions.

In response to the global climate change challenge, the UK Government introduced a legally binding target for the UK to become Net Zero (greenhouse gas emissions), reducing 100% of greenhouse gas emissions by 2050, with interim targets for reductions of at least 68% by 2030 and 78% by 2035[5] compared to 1990 levels.

The Welsh Government has also committed to reach Net Zero by 2050 at the latest, with interim targets of 63% by 2030 and 89% by 2040[6]. There are no separate interim targets for England – progress is assessed against the UK-targets.

IN MARCH 2023, THE UK GOVERNMENT'S CARBON BUDGET DELIVERY PLAN[7] ANNOUNCED THAT DELIVERY OF CURRENT POLICIES WOULD ONLY MEET 92% OF THE INTERIM 2030 TARGET.

The government has continued to express confidence in its delivery of emissions savings by its wider proposals, and by bringing forward further measures to ensure that the UK will meet its international commitments.

This confidence is not matched by the Committee on Climate Change (CCC), which has expressed particular concerns about a policy gap to the 2030 target, calling for more transparency on the effect of how recent policy announcements will affect future emissions.

THE LAST TWELVE MONTHS HAS BEEN A BUSY TIME FOR ENERGY LEGISLATION, WITH LOTS OF CHANGES TO PROPOSALS AND POLICIES SINCE THE PUBLICATION OF OUR 2022 DFES – SOME THAT MAY SPEED UP DECARBONISATION PROGRESS, AND SOME THAT MAY SLOW IT DOWN.

These changes have not significantly impacted our 2023 DFES forecasts – but nevertheless we have considered them carefully in developing our scenarios.

A summary of some key legislative context is below.

The timeline of recent UK policy is summarised as follows:

- The UK Government's main climate change policy is the Net Zero Strategy (Build Back Greener)[8], published in 2021. This is a long-term plan for a transition that will take place over the next three decades, and builds upon the November 2020 Ten-Point Plan for a Green Industrial Revolution and the Energy White Paper, which lay the foundations for a Green recovery.
- The Net Zero Strategy aligns to several sector and technology specific strategies such as the Transport Decarbonisation Plan[9], published July 2021, the Industrial Decarbonisation Strategy[10], updated April 2021, and the Heat and Buildings Strategy[11],. published October 2021.

[5] https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035
[6] https://senedd.wales/media/0kalampz/cr-ld14183-e.pdf
[7] https://assets.publishing.service.gov.uk/media/6424b2d760a35e000c0cb135/carbon-budget-delivery-plan.pdf
[8] https://www.gov.uk/government/publications/net-zero-strategy
[9] https://www.gov.uk/government/publications/transport-decarbonisation-plan
[10] https://www.gov.uk/government/publications/industrial-decarbonisation-strategy
[11] https://www.gov.uk/government/publications/heat-and-buildings-strategy

- Government commitments were updated and published in March 2023 in the Powering Up Britain[12] strategy document. A series of other policy documents were also released in March 2023, notably the Carbon Budget Delivery Plan[13] that set out policies and proposals designed to meet the next carbon budgets.
- Several of these policies and proposals changed, however, in September 2023, when the Prime Minister gave a speech on Net Zero[14] setting out a new approach.

The policies and proposals of relevance to our 2023 DFES are summarised below.

On generation, plans include:

- 24GW of nuclear power by 2050 and 50GW of offshore wind by 2030. We would expect most of this to connect to the transmission system, which is outside of the scope of DFES, but it is still helpful to understand the breakdown of where and how electricity is likely to be generated.
- A five-fold increase in solar power (up to 70GW) by 2035. This is supported by the removal of VAT on residential solar panels, easing permitted development to remove barriers to flat-roof installations, and removing the 1MW limit on non-domestic applications.
- By 2035 the UK to be powered entirely by clean electricity, subject to security of supply. Investment announced in the Spring Budget 2023 for Carbon Capture, Usage and Storage (CCUS) and hydrogen will support this ambition, technologies that will be particularly important to decarbonisation the North West.

On heating and electricity demand linked to buildings, plans have moved both forward and back over the course of 2023.

- By 2030 there will be a 15% energy demand reduction target. Energy efficiency improvements will be key to meeting this target, and the government will continue with their plan to spend £6 billion capital funding for households, businesses and the public sector between 2025-8 to make energy efficiency and clean heat improvements.
- In March 2023, government announced that all rental properties had to have an EPC rating of C or better by 2028 with penalties for non-compliance. In September, this proposal was scrapped: landlords will be encouraged to upgrade the energy efficiency of their properties where possible. This may stymie the uptake of heat pumps for these properties, but on the other hand would increase the amount of electricity they consume.
- The plan to phase out oil heating systems by 2026 has been pushed back to 2035, and similarly, the plan to phase out gas boilers by 2030 has also been pushed back five years to 2035. The aim is for an 80% phase-out rather than a 100% ban.
- The aim to install 600,000 heat pumps per year by 2028 is still in the plan, and the Boiler Upgrade Scheme (BUS) grant level for air source heat pumps and ground source heat pumps has been increased from £5,000 to £7,500 (though the total size of the 'pot' has not increased).

On transport:

- The ban of new petrol and diesel cars and vans by 2030 has been pushed back to 2035. However, this will have a reduced impact due to continuation of the Zero Emission Vehicle (ZEV) mandate will still require all new cars and vans to be fully zero emission at the tailpipe by 2035.
- The second phases of HS2 have been cancelled, which temporarily releases some of the demand capacity earmarked within the SP Manweb area. Some of the budget recouped from scrapping this scheme will be redirected into electrifying rail lines, and improve Manchester to Liverpool links.
- Investment still planned to accelerate the rollout of charge points for electric vehicles.

THE WELSH GOVERNMENT'S NET ZERO WALES PLAN[15] SETS OUT THE FOUNDATIONS TO ACHIEVE NET ZERO.

They include:

- By 2025, 10% of car passenger travel and 48% of new car sales to be zero emission.
- Increasing the proportion of heat that is electrified by 3% by 2025.
- By 2025, 1GW of additional renewable energy capacity will be installed.
- By 2030, Wales to generate 70% of its electricity consumption from renewable energy.
- By 2030, 1GW of locally owned renewable electricity I Wales.

THESE PLANS INCLUDE AMBITIOUS RENEWABLE ELECTRICITY GENERATION TARGETS, THAT ARE ALSO REFLECTED STRONGLY IN LOCAL PLANS. WALES IS SIGNIFICANT NET EXPORTER OF RENEWABLE GENERATION.

Delivering a widespread and reliable charging network will be a key enabler to the uptake of electric vehicles in Wales. The Electric Vehicle Charging Strategy for Wales[16].has an action plan that sets out the following:

- All new homes with an associated car parking space will be ready to have electric vehicle charging installed.
- Measures to introduce up to 55,000 fast chargers and up to 4,000 rapid/ultra chargers by 2030.
- New non-residential buildings with more than 10 parking spaces will have a charge point provided by 2025.
- View to installing on average one fast-charge point for one in every three electric vehicles that cannot charge at home.

[12] https://www.gov.uk/government/publications/powering-up-britain

[13] https://www.gov.uk/government/publications/carbon-budget-delivery-plan

[14] https://www.gov.uk/government/speeches/pm-speech-on-net-zero-20-september-2023

[15] https://www.gov.wales/net-zero-wales

[16] https://www.gov.wales/sites/default/files/publications/2021-03/electric-vehicle-charging-strategy-wales.pdf

- By 2025, a rapid charging network will be provided across the strategic trunk road network of Wales.

The Welsh Government also published its draft Heat Strategy[17] for consultation in August 2023, which sets out its objectives for 2050 and proposals for how to meet them:

- Homes to be served in the main by heat pumps.
- By the late 2020s, heat pump installations to reach 30,000 per year, and 60,000 installations before 2035.
- All new social housing to achieve EPC A or an equivalent standard, and existing social housing must have a Target Energy Pathway in place to achieve EPC A by 2033 or by a date that Welsh Government has authorised.
- From 2025, fit 80,000 easy insulation measures for 10 years and 50,000 more extensive insulation measures per year for five years.
- By 2033, phase out the installation of all new gas boilers for commercial properties.
- Support for hydrogen innovation and commitment to publish clear statement on the role of hydrogen for industrial heat demand.

This strategy also clearly highlights the need to work closely with the network operators, such as SP Energy Networks, to ensure the necessary infrastructure is in place to effectively support electrified heat. We have also fed into the Welsh Government's Future Energy Grids for Wales[18] project, which seeks to understand in detail how the changing energy needs of Wales will place new requirements on the electricity and gas networks.

THE WELSH GOVERNMENT HAS DRIVEN A MAJOR PROGRAMME OF LOCAL AREA ENERGY PLANS (LAEPS) THAT IS TARGETED FOR COMPLETION IN MARCH 2024.

These plans will be enormously beneficial in setting out the effect of national action plans and strategies at a local level. This will aid our planning of the electricity network required across Wales. We have followed and supported the development of these LAEPs closely, and are setting plans in place for how the information provided in the LAEPs will feed into the modelling our future DFES.

FINALLY, IT IS IMPORTANT TO NOTE THE RECENT PUBLICATION OF THE UK ENERGY ACT 2023, WHICH BECAME LAW IN OCTOBER 2023.

This sets out new legislation for energy production, energy security and the regulation of the UK energy sector. Among its aims are strengthening energy security, supporting the delivery of Net Zero and ensuring household bills are affordable in the long-term.

The Act has not had time yet to impact these 2023 DFES forecasts – there is much secondary legislation still to be implemented, and this will be key to understanding how the Act will shape the long-term future of electricity networks. But it does signal stronger desire to support and unlock the investments in infrastructure that are required to meet the ambitious forecasts such as those set out in this document for the SP Manweb region.

The distribution network is key to realising these targets and ambitions – regardless of forecast scenario, the distribution network will need to accommodate significantly more demand through the electrification of heat and transport, and more renewable generation to decarbonise our electricity supply. Given this key Net Zero enabling role, the importance of these DFES forecasts has never been greater.

[17] https://www.gov.wales/sites/default/files/consultations/2023-08/draft-heat-strategy-for-wales.pdf

[18] https://www.gov.wales/sites/default/files/publications/2023-07/future-energy-grids-for-wales-insights-report.pdf

Developments in industry scenario planning

Over the course of 2023, Ofgem have been working on the role and responsibilities of the Future System Operator, that will be launched in summer 2024. This role, undertaken by the NG ESO, will be responsible for planning Britain's electricity and gas networks as well as continuing to operating the electricity system.

Part of the role is development of the Centralised Strategic Network Plan (CSNP) which will set out how the system should develop to decarbonise the electricity system by 2035. It will identify a firm delivery pipeline of work for transmission network development for the first 12 years, and a longer-term pathway covering a 25-year horizon that will identify future strategic options.

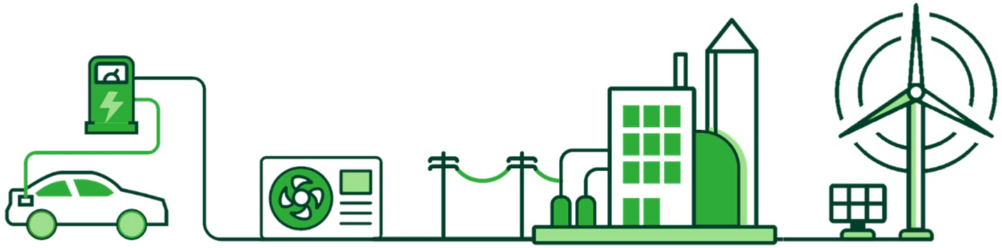
In August 2023, the new Electricity Networks Commissioner published his recommendations[19] for accelerating the rollout of electricity transmission infrastructure. One of his key recommendations with significant impacts on network planning is the proposal for a Strategic Spatial Energy Plan (SSEP). The SSEP will coordinate the timing, mix and location of generation and storage to meet forecast demand and net zero targets. In November 2023, government confirmed that the SSEP should indeed be developed by the FSO, and that it should inform the longer-term CSNP.

Whilst the SSEP and CSNP will focus on the strategic planning of transmission networks, this work will influence our distribution scenario planning.

Not least, NG ESO have indicated that the FES will undergo key changes – such as a move from a wide scenario range towards a framework of pathways, with a narrower range of future decarbonisation options. Additionally, the FES will seek to include near-term transmission constraints.

We do not yet know the full extent of the impact that these changes to GB system-level future planning will mean for DFES 2024 and beyond, but we are working closely with the NG ESO and other Distribution Network Operators (DNOs) to ensure we maintain a holistic approach.

[19]https://www.gov.uk/government/publications/accelerating-electricity-transmission-network-deployment-electricity-network-commissioners-recommendations



Regional Energy Strategic Planner (RESP)

Ofgem have announced it will create regional energy planning roles across Great Britain. Regional Energy Strategic Planners (RESPs) will aim to ensure there is appropriate accountability and effective coordination for whole system strategic planning at a subnational level. RESPs will be responsible for the development of strategic energy pathways at the regional level that are cross-vector and fully consider regional priorities. This is intended to provide critical planning assumptions to inform system and network needs.

In developing a strategic plan, the RESPs are expected to develop a cross-vector, regional view using a wide range of inputs – including national forecasts, electricity and gas network operator data, heat networks and local plans (e.g. the LAEPs).

We think the RESP role presents a significant opportunity to support our customers' ambitions to decarbonise and to enable true cross-vector coordination. We recognise the advantages of defining regional Net Zero pathways that lead to a common understanding of what different actors need to deliver.

The RESP will need to build on industry best practice, avoid duplication and maintain clear accountability. For example, the interplay between RESP pathways and DNO responsibilities will need to be defined in detail.

RESP boundaries are still to be finalised, but they will total between 10 and 13 across Great Britain (GB) – one in Wales, one or two in Scotland, and between eight and ten in England. SP Energy Networks operates in England, Wales and Scotland and will likely overlap with three or more individual RESPs.

More will be known on the future interactions between DFES and the RESP strategic plans as progress the detailed design for RESP progressing throughout 2024. Ofgem intend to consult on their plans in summer 2024.

Scenario overview

Key assumptions characterising each of the scenarios are described as follows.

In SPM Falling Short (FS) decarbonisation progress is the slowest of all scenarios. While home insulation improves, there is still heavy reliance on natural gas, particularly for domestic heating. Electric vehicle uptake grows more slowly than in other sectors, displacing petrol and diesel vehicles for domestic use. However, decarbonisation of other vehicles is slower with continued reliance on diesel for heavy goods vehicles. In 2050 this scenario still has significant annual carbon emissions, some way short of the 2050 Net Zero target in UK legislation

In SPM Consumer Transformation (CT) the 2050 Net Zero target is met with measures that have a greater impact on consumers and is driven by greater levels of consumer engagement in the energy transition. For example, a typical domestic consumer will use an electric heat pump with a low temperature heating system and an electric vehicle, they will have had extensive changes to their home to improve its energy efficiency and most of their electricity demand will be smartly controlled to provide flexibility to the system. Domestic heating is almost fully electrified by 2050. The system will have higher peak electricity demands that will be managed with flexible technologies including energy storage, demand side response and smart energy management.

In SPM System Transformation (ST) the 2050 Net Zero target is met, following a pathway that has the least consumer impact to do so. The typical domestic consumer will experience less disruption than in Consumer Transformation as more of the significant changes in the energy system happen on the supply side, away from the consumer. For example, a typical consumer will use a hydrogen boiler with a mostly unchanged heating system and an electric vehicle or a fuel cell vehicle, they will have had fewer energy efficiency improvements to their home and will have lower engagement with opportunities to use their demand to provide flexibility to the system. Total hydrogen demand is high, and it is produced using a combination of natural gas with carbon capture and storage, electrolysis, and biomass gasification.

In SPM Leading the Way (LW) rapid decarbonisation occurs with high levels of investment in world-leading decarbonisation technologies. Consumers are highly engaged in acting to reduce and manage their own energy consumption. This scenario includes the highest and fastest improvements in energy efficiency to drive down energy demand, with homes retrofitted with insulation such as triple glazing and external wall insulation, and a steep increase in consumer participation in smart energy services. Hydrogen is used to decarbonise some of the most challenging areas of society such as some industrial processes, with this hydrogen produced mostly from electrolysis powered by renewable electricity. Net Zero is achieved before the 2050 target date.

	Falling Short	System Transformation	Consumer Transformation	Leading the Way
Residential electrical energy efficiency	Low	Medium	Medium	High
Residential consumer engagement	Low	Medium	High	High
Battery electric vehicles (BEVs)	Medium	Medium	High	High
Home EV charging	Medium (High by 2050)	Medium	High	High
Home thermal efficiency levels	Low	Medium	High	High
Heat pumps	Low	Medium	High	High
District heating	Low	Medium	High	High
Solar PV generation (<1MW)	Low	Medium	High	High
Solar PV generation (>1MW)	Low	Medium	Medium	High
Onshore wind	Low	Medium	High	High
Medium duration electricity storage	Low	Medium	Medium	High

DFES outputs:

1. Demand

Outputs which affect electricity demand. The main drivers here are electric vehicles and heat pumps, so we show disaggregated forecasts for these. These are set out in Section 3.

2. Flexibility

For demand components, we also consider the potential for flexibility. This is also set out in Section 3.

3. Generation

Outputs which affect electricity generation and storage. These are set out in Section 4.

For each metric we have forecast we include, where possible, both a measure of the absolute number (e.g. number of electric vehicles); and its impact on electricity demand or generation capacity (shown in MW). Demand forecasts are shown as ‘peak demand’. This is because the additional demand at peak demand periods will have the most network impact – we have to plan and design our network to accommodate peak demand. Generation forecasts are shown as ‘capacity’; this represents the total installed generation capacity.

Flexibility is the measure of the capability of that component to operate at different times of day. For example, a factory process which always has to operate at the same time is not flexible, whereas an electric vehicle that can be charged at different times of the day has some flexibility. Flexibility is relevant as it means electricity consumption can be moved from peak demand times to less busy times of the day, or to periods of high generation output, which in turn reduces the network impact and the requirement for network interventions – this will be to the benefit of customers.

Only large-scale offshore and onshore generation, and very large individual demand customers, are likely to be directly connected to the transmission network. This means that the DFES forecasts will capture nearly all demand and medium-scale, smaller-scale and domestic-scale generation in North Wales, Merseyside, Cheshire, and North Shropshire.

3. Electricity demand

This section sets out the forecasts for demand, which is forecast to increase significantly in the UK's journey to Net Zero, through the electrification of transport, heat and industrial processes.

Peak demand

Each part of our network is designed to safely and reliably transport the maximum flow of electricity through it. Understanding how electricity demand will evolve on our network is key to informing the need for network intervention to manage network capacity.

Electricity demand out to 2050 will be affected by:

1. Energy efficiency and underlying demand trends;
2. The extent of new sources of demand, i.e. how much heating and transport is electrified, and the speed of this uptake;
3. The degree to which both existing and new load can be shifted or reduced at times of system peak demand (flexibility).

Figure 4 shows how the SP Manweb total peak demand will vary for the four scenarios, assuming that none of the demand is flexible (i.e. it can't be shifted away from the peak to less busy periods, which would have the effect of reducing peak demand). This is shown as the sum of the GSP forecast maximum half-hourly averaged demands, in MW, that are forecast at each GSP across the network over the course of each year[20]. It shows the 'true demand', which is the total demand used by our customers. In other words, this includes the gross power provided by both the transmission system, and that provided by embedded generation connected directly to our distribution network.

For comparison, the grey area of Figure 4 shows the forecasted range (i.e. the difference between the lowest and highest scenario) from our 2022 DFES. The sum of GSP peak demands is lower than last year: this is a combination of observed reduction at some GSPs, as well as gradual reversal of a previous Covid correction applied to recorded peak demands. However, the peak demand forecasts have generally increased slightly in later years – driven by an increased growth in industrial and commercial underlying demand. This, in turn, driven by both our pipeline of connections, expected growth from industrial clusters such as Net Zero North West (as discussed in Section 2) and the application of a slightly higher growth factor[21].

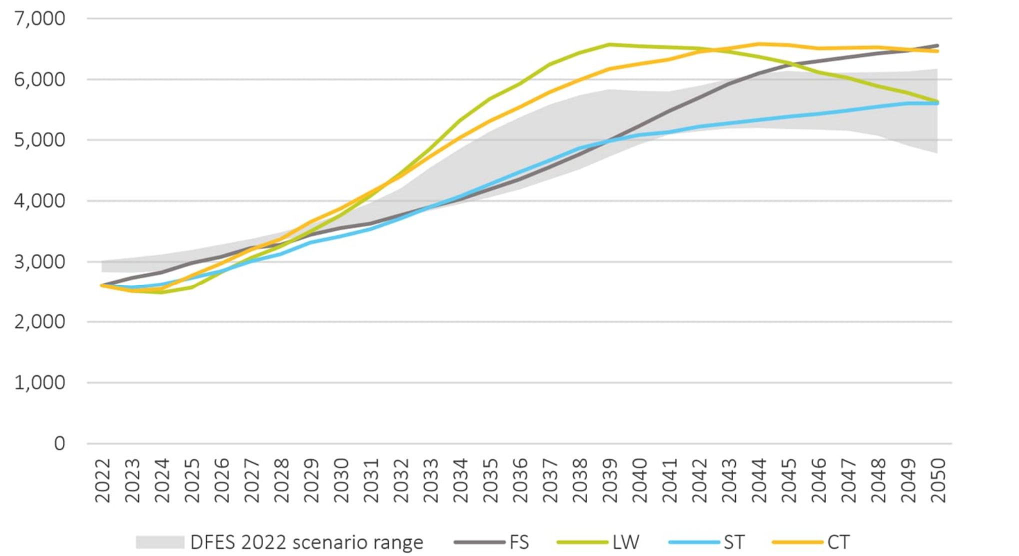
There is a material split between the scenarios. Even though SPM System Transformation, SPM Consumer Transformation and SPM Leading the Way all achieve the Net Zero targets, this is achieved through differing levels of electrification. Both SPM Consumer Transformation and SPM Leading the Way involve a near total shift to the electrification of cars and light goods vehicles, and increasing levels of electric heating. These factors significantly increase the peak demand. In comparison, SPM System Transformation and Falling Short involve less electrification of heat and transport, with more reliance on other energy vectors (e.g. petrol, diesel, natural gas, hydrogen) for these two activities. As a result, these two scenarios do not increase electricity peak demand to the same extent.

Historically, our most ambitious decarbonisation scenarios forecasted that, before demand begins to significantly increase as we transition to Net Zero, we would observe a demand decrease in the early 2020s. This was driven by more ambitious energy efficiency measures in these scenarios (e.g. low-emissions lighting and home insulation), which reduced both overall consumption and also the power requirements at peak times.

Due to the COVID-19 pandemic, we observed a step decrease in peak demand across our network in the year 2020/21, beyond what we had previously forecast even in our SPM Leading the Way scenario. In the last two years we have seen marginal recovery, but peak demand is still not at the levels forecast pre-pandemic. We believe this observed reduction is less likely due to deliberate measures to be 'green', and instead more closely linked to the sustained period of high energy prices that coincided with the end of the pandemic.

Without flexibility, demand could increase by as much as 49% by 2030 and more than double by 2050.

Figure 4 | Electricity peak demand without flexibility



[20] Note that this is different to the 'SP Distribution system peak', which is the maximum demand across all GSPs in any one, single half-hourly period. We use the per-GSP peak demand forecasts to calculate a 5-year system peak forecast in our Long Term Development Statement.

[21] In DFES22, we forecast that energy efficiency measures would outweigh electrification of industrial processes. In this year's DFES, we have applied a less severe reduction.

Figure 5 | Electricity peak demand with and without flexibility *Peak demand (MW)*

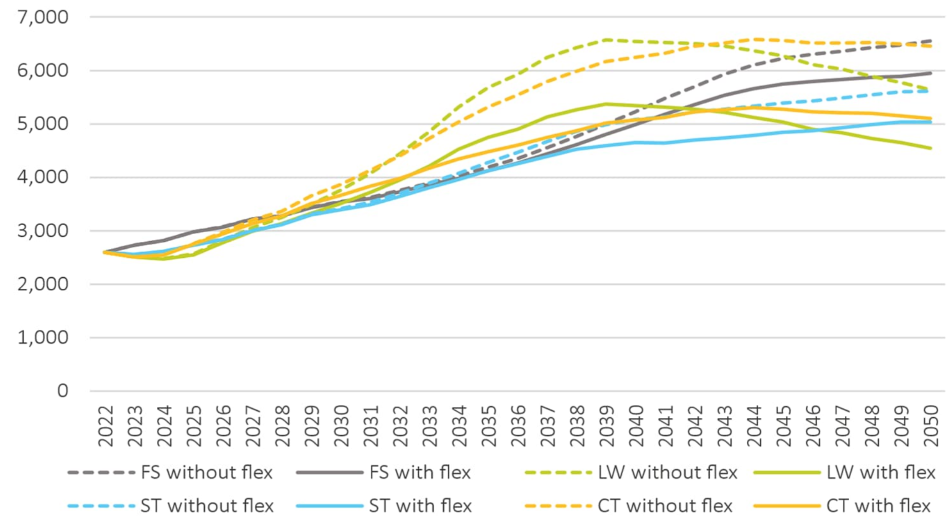
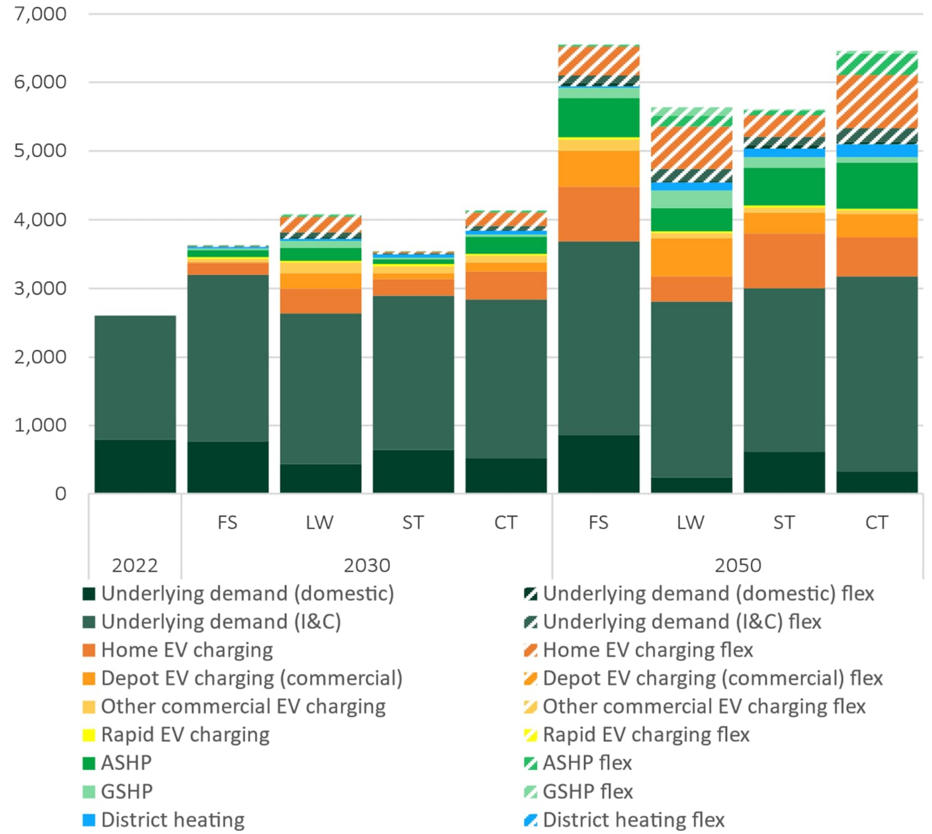


Figure 6 | Electricity peak demand breakdown for 2030 and 2050 *Peak demand (MW)*



We therefore forecast that further demand reductions could occur in the short term due to postponed energy efficiency measures. On the other hand, with energy prices still higher than pre-pandemic levels, this may continue to limit both energy efficiency investment and energy consumption.

The overall effects of these competing drivers on our scenario range are as follows:

1. The starting point is slightly lower in all scenarios, and demand growth is lower in the first three-five years.
2. We now see a more pronounced dip in the Net Zero compliant scenarios, arising from further energy efficiency measures. This is aligned to the trend in the NG ESO's 2023 FES.

The SPM Falling Short scenario, which does not have such ambitious energy efficiency actions, remains a credible scenario in the short term due to energy prices.

The forecast scenario range realigns with previously forecast levels by 2027/28. This is mainly driven by accelerated industrial process electrification towards the end of the decade, in effect 'making up for lost time' to meet decarbonisation strategies. This pushes up underlying industrial and commercial demand. This remains, however, sensitive to energy prices.

In presenting the case without flexibility, Figure 4 shows what the forecast 'worse case' peak demand, as it assumes that no existing or new demand has any flexibility. In reality: we expect that some existing demand could shift to other times of the day and some new demand could be controlled in a smart way to avoid certain hours of the day when the distribution network is seeing more demand, for example when charging electric vehicles.

Figure 5 shows how demand flexibility (excluding vehicle to grid) could reduce the SP Manweb total peak demand. This reduction will directly deliver benefits for consumers as it will require less investment in the network, resulting in lower electricity bills. SPM Consumer Transformation and SPM Leading the Way involve greater levels of heat and transport electrification. . it is important that we utilise flexibility as far as possible where we can, to better enable demand growth whilst reducing network impact.

To better illustrate what is driving the changes in demand out to 2050, and to show where the demand flexibility is coming from, Figure 6 shows a breakdown of the components of peak demand. The solid bars show the non-flexible demand, and the dashed bars show how much peak demand is forecast to be avoided through flexibility in each scenario.

With flexibility, demand could increase by as much as 41% by 2030 and double by 2050.

Figure 7 | Electricity peak demand changes from 2020 by primary substation area *Peak demand growth (MW)*

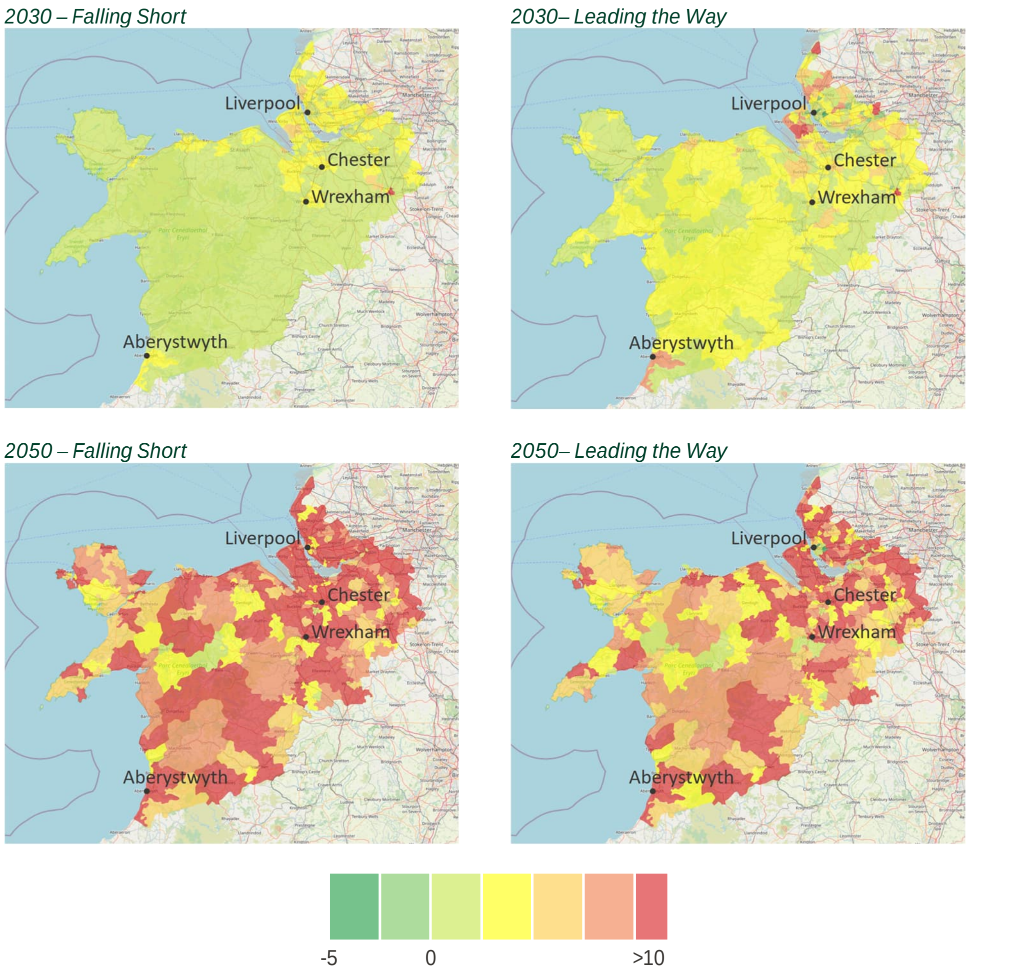


Figure 5 and Figure 6 show increasing electricity demand for all scenarios in the medium to long term. These forecasts and trends are the total values for all SP Manweb districts across England and Wales. However, different regions will see different increases in demand at different times, based on a range of factors. Figure 7 shows the geographical breakdown for how the demand could change from current levels for the highest and lowest forecast scenarios. Figure 7 shows there is clear variance in the demand changes seen in different regions. This may well present the industry with a challenge, as these focussed regions of particularly high growth could develop into hot spots of required reinforcement.

Overall peak demand trends:

1. All scenarios show increasing demand by 2030 and more so by 2050. This means that the distribution network will certainly need intervention to facilitate Net Zero.

2. Demand flexibility can reduce peak demand, and we should utilise this as far as possible. However, even with the most ambitious forecasts of flexibility, networks will still need to expand significantly to meet a growing need.

3. The increase in demand is not geographically uniform – some areas of the network will be impacted earlier, and to a greater extent, than others.

Electric vehicles

One of the key contributors to growth in both electricity consumption, and therefore the size of the peak electricity demand our networks must provide, is the electrification of road transport.

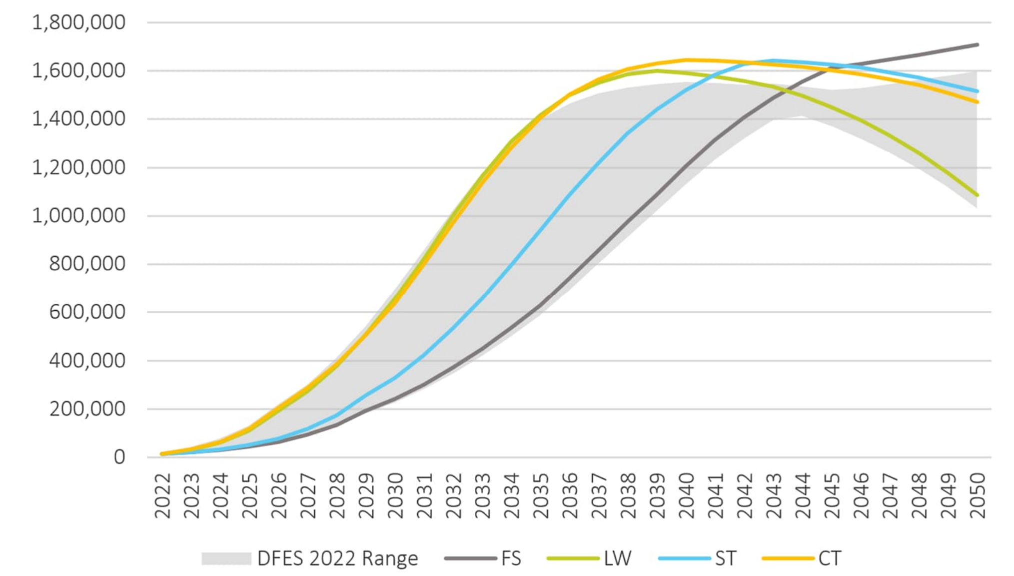
By the end of 2022/23, we estimate the number of electric vehicles (EVs) – both plug-in electric hybrid vehicles (PHEVs) and battery electric vehicles (BEVs) – registered within the SP Manweb area was around 30,000.

Figure 8 shows the forecast numbers of residential BEVs[22] in the SP Manweb region. For comparison, the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our 2022 DFES: this year is only an incremental update to the EV results. There has been only a small change in the longer-term to the forecast numbers of vehicles across all scenarios out to 2050 and assumptions have remained constant.

Figure 8 shows that all scenarios forecast there will be over 1.6 million domestic BEVs within the SP Manweb network area, but the scenarios reach this value at different rates.

Across the scenarios, the share of residential BEVs rises from around 15,000 now to between 243,000-657,000 in 2030. The reason for this high level of variance in the 2030s is the differing levels of ambition between scenarios for phasing out the sale of new petrol and diesel cars and vans.

Figure 8 | Residential battery electric vehicle uptake



The SPM Leading the Way scenario has the fastest uptake: it forecasts that compared to today, there could be over 40 times more BEVs by 2030, and over 100 times more by 2040. SPM Leading the Way and SPM Consumer Transformation both assume that the sale of new internal combustion engine vehicles ends in 2030, in line with the UK government's original target date. Volumes reach more than 1.6 million by the end of the 2030s.

Our SPM Falling Short and SPM System Transformation scenarios contain a much slower uptake of residential battery electric vehicles up to 2030. The SPM Falling Short scenario doesn't meet Net Zero targets, and the SPM System Transformation scenario assumes that the UK Government's previous 2030 target for a ban on new internal combustion engine vehicles is only met in 2035. Growth rates pick up in the early 2030s for SPD System Transformation and in the mid-2030s for SPD Falling Short, reaching more than 1.6 million by 2042 and 2045, respectively.

All scenarios except Falling Short see a reduction in residential electric vehicles in the 2040s due to a reduction in car ownership and a move towards methods of transport with a lower environmental impact. This reduction is earliest and most pronounced in the SPD Leading the Way scenario.

It has been reported across various media that EV sales have plateaued; however, according to our estimates based on DVLA statistics[23], the number of newly registered BEVs and PHEVs in the 2022/23 financial year[24] as a percentage of total new registrations GB has continued to grow compared to the 12 months prior.

However, BEV growth remains in the bottom of the scenario range. Additionally, PHEVs continue to be a large part of the market – indicating that the switch to pure electric has not happened as quickly as expected in the more ambitious decarbonisation scenarios.

In September 2023, the government goal to end the sale of petrol, diesel and hybrid vehicles was indeed pushed back to 2035. This could support the findings that volumes will be towards the bottom of the scenario range in the short term.

All scenarios forecast that the SP Manweb network will have to accommodate over 1.6 million domestic, battery electric vehicles by or before 2045.

[22] *For the purposes of demand-modelling, we assume that PHEVs have a very limited contribution to peak demand and therefore the analysis in this chapter focusses on BEVs.*

[23] *UK Government Vehicles statistics published by the Department for Transport (DfT) and Driver and Vehicle Licensing Agency (DVLA: https://www.gov.uk/government/collections/vehicles-statistics*

[24] *April 2022 to March 2023,or Q2 2022 to Q1 2023 inclusive. BEV and PHEV sales in the 12 months up to and including Q3 2023 (which is the latest available data at the time of writing) have also increased compared to the previous 12 months, as a percentage of total registrations. Source: VEH1153.*

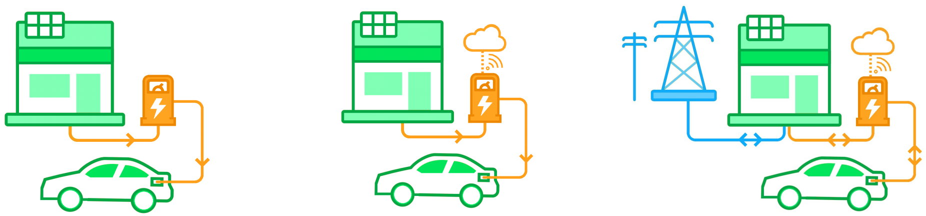
Widespread adoption of electric vehicles is expected to provide a significant challenge to the electricity sector due to the resultant large increases in peak demand.

Electric vehicle charging could have a significant impact on the SP Manweb peak demand if left unmanaged. Smart charging and vehicle to grid (V2G) are two ways to add flexibility to electric vehicle demand; respectively they help reduce this peak demand impact by shifting electric vehicle charging to a different time of day, and enabling electric vehicles to release electricity back to the network.

Figure 9 shows the expected contribution from domestic electric vehicle charging at the time of peak with and without smart charging and V2G.

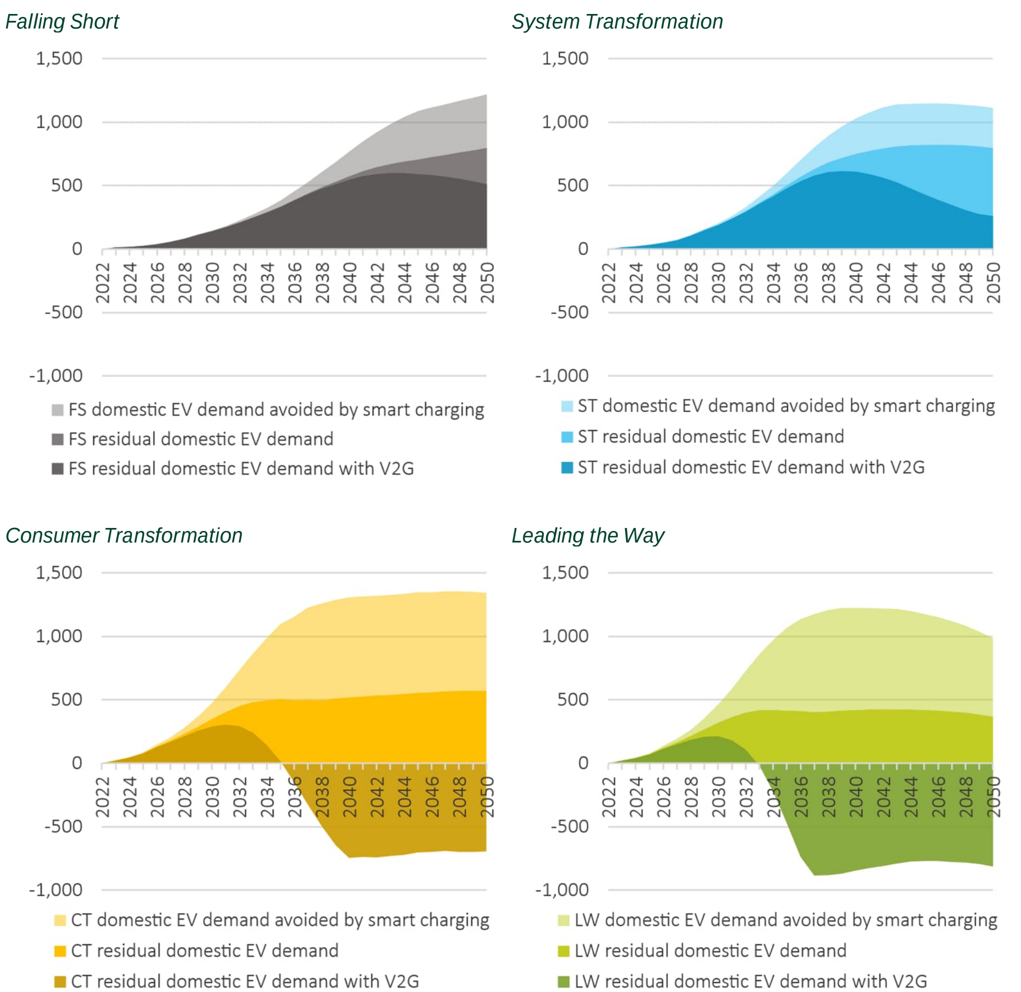
It shows the development of these capabilities could considerably reduce peak demand, delivering significant benefits for our customers by avoiding required network reinforcement.

However, the scenario range shows significant variance, reflecting a large degree of uncertainty in the impact of these technologies, particularly V2G[25]. This is because customers have concerns about technology capability, impact on battery life and the ability to use their EV on full charge on demand. There is also uncertainty in the market; it is unknown what smart charging and V2G products and services will ultimately be available to consumers, and how much networks will be able to rely upon these services.



By 2030	EV charging could add to SPM's peak demand between 147-472MW	Smart charging could reduce this contribution by 4-31%	V2G could reduce this contribution to as low as 288MW
By 2050	EV charging could add to SPM's peak demand between 984-1,344MW	Smart charging could reduce this contribution by 28-63%	V2G could reduce overall peak demand by as much as 812MW*

Figure 9 | Home EV contribution to peak demand *Peak demand contribution (MW)*



[25] V2G could reduce peak demand by up to 183% in 2050. A total peak demand reduction above 100% means vehicle to grid has gone beyond offsetting the peak demand contribution from electric vehicles.

* V2G more than offsets the peak demand contribution of domestic EV charging in the SPM Consumer Transformation and SPM Leading the Way scenarios.

The degree of geographical clustering of electric vehicle adoption will also be a key determining factor of the impact on the network – if there are high concentrations of electric vehicles in certain areas then there may be insufficient network capacity in those areas. We have used our EV-Up project to provide a highly spatially disaggregated view of where the uptake of electric vehicles is likely to occur. The model combines detailed spatial analysis to determine off-street parking availability at an individual property level, and sociodemographic information to understand the probability of specific areas to transition to electric vehicles.

We have aggregated the results to show residential battery electric vehicle roll-out forecast by local authority area (Figure 10) and primary substation area (Figure 11). For all local authorities, we only provide forecasts for the area of that local authority which we serve. The values shown in Figure 10 represent the range between the low and high forecasts.

Figure 11 shows that for the English local authorities within the SP Manweb distribution network area, residential BEV numbers are highest in the larger and fairly densely populated local authorities that are interspersed with pockets of more rural areas – such as Cheshire West and Chester, and Cheshire East, where each could see 70,000 or more electric vehicles by 2030; more than 60 BEVs per 100 customers. Warrington is also hotspot for BEV growth.

In the Welsh local authorities within the SP Manweb distribution network area, there is slightly less variation and numbers have a stronger correlation with the numbers of customers in each area. However, the most residential BEVs are found in the most densely populated area of Flintshire, which could see over 50,000 electric vehicles by 2030, increasing to over 115,000 by 2050. We also account for and observe increased volumes caused by specific local geography even in more sparsely populated areas, such as the influence of tourism and local community projects in Gwynedd.

Figure 10 | Potential range of residential battery EV uptake by Local Authority *Number of vehicles*

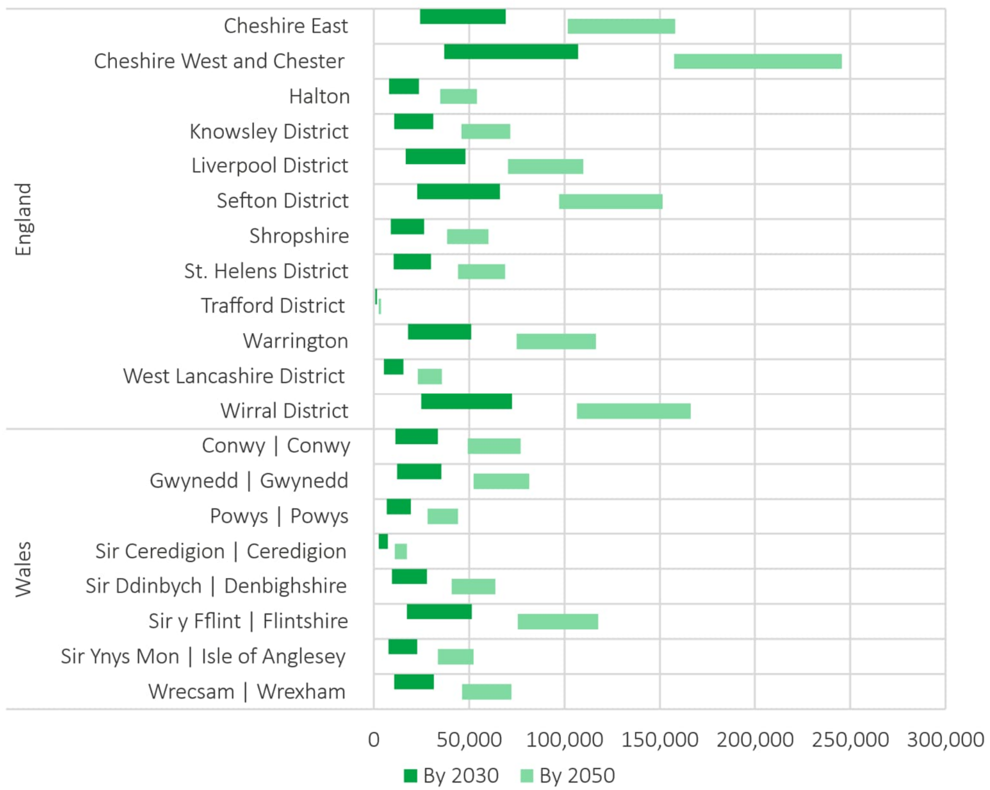
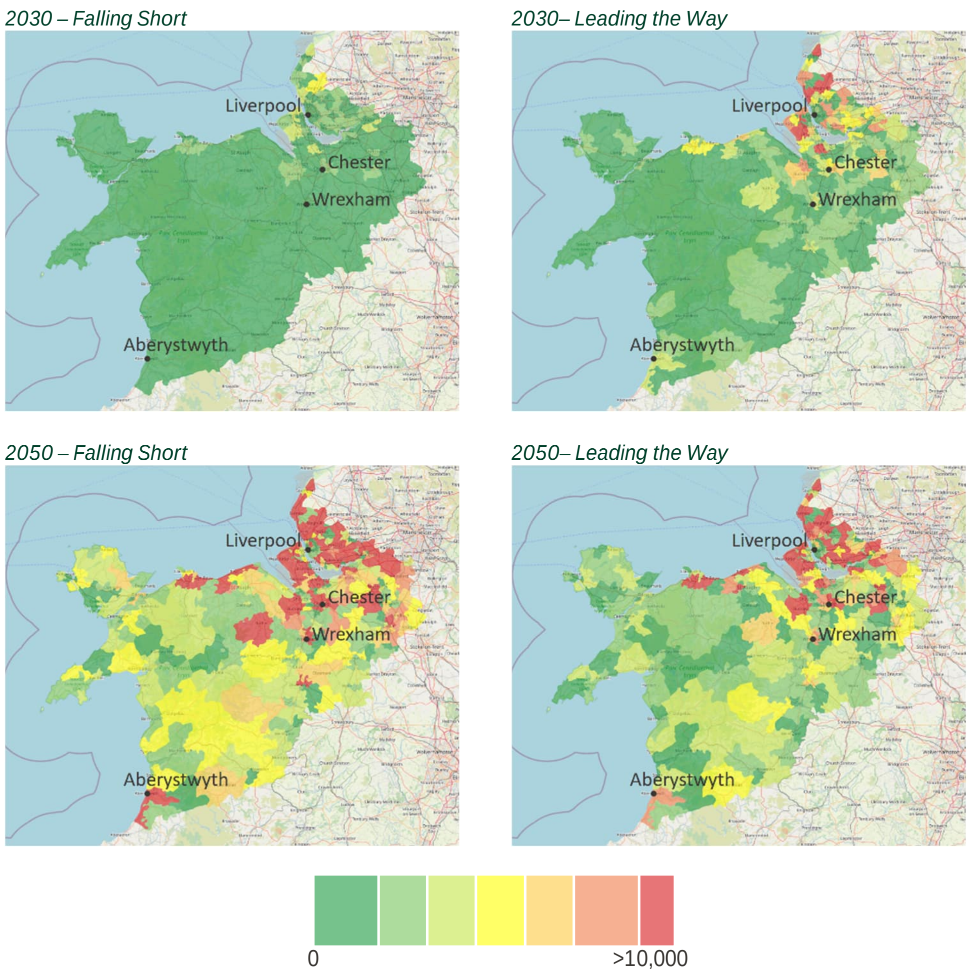


Figure 11 | Residential battery EV uptake numbers by primary substation area *Number of vehicles*



Heat pumps

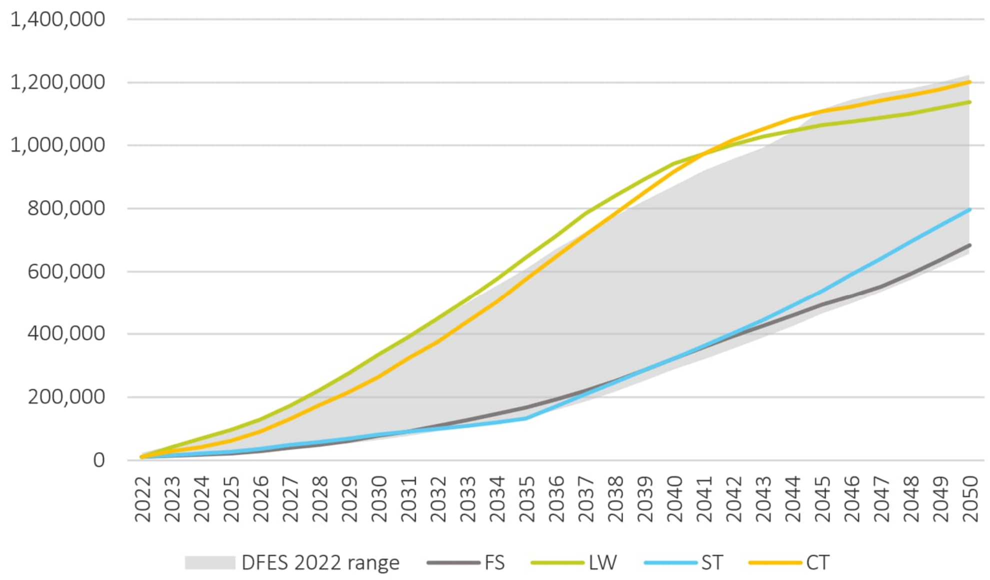
Heat pumps use electricity to heat buildings and provide hot water. Heat pumps – both air source and ground source – represent another change to the future electricity demand.

Heat pumps can also take the form of hybrid systems where an alternative heating system (such as a methane or hydrogen boiler) is used at times of peak demand, as well as larger scale heat pumps used for district heating.

Deployment is still currently low, estimated at about 0.7% of total households within a total stock of circa 1.5 million households in the SP Manweb area. This is in the range we forecast in our 2022 DFES. Although towards the lower end, we are now observing a faster connection of heat pump technologies than in previous years. Under the Future Homes Standard that comes into effect in 2025, changes to building regulations will mean new homes will not be allowed to use polluting heating systems, such as oil and gas boilers. We have observed the switch towards heat pumps in new housing developments across our region has already started.

Figure 12 shows the forecast uptake for each of the four scenarios. For comparison the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our 2022 DFES.

Figure 12 | Electric heat pump uptake *Number of heat pumps*



There is significant variance between the heat pump forecasts as follows:

- SPM Consumer Transformation assumes that the decarbonisation of heat will predominantly be met by electricity – either via heat pumps, or district heat networks. The growth in heat pumps is initially expected to be in-line with new housing growth, but the rates of new installations increase to over 60,000 per year by the mid-2030s as more of our customers begin to retrofit old heating systems with heat pumps.
- SPM Leading the Way, being the most ambitious decarbonisation scenario, has a slightly faster uptake, assuming a quicker switch to retrofitted heat pump systems, even in the short term. Installation rates of over 50,000 are reached as early as 2029. The end-points is lower than Consumer Transformation as the Leading the Way scenario assumes hydrogen will be used to decarbonise domestic heating systems in some areas.
- The SPM Falling Short scenario, which does not meet Net Zero by 2050, has low installation rates, possibly below even the rate of new build houses.
- SPM System Transformation also has very low installation rates, as this scenario assumes hydrogen will play a key role in the decarbonisation of space heating. As a result, in System Transformation, homes and business will continue to use gas for heat into the mid-2030s before switching to hydrogen, at which point hybrid heat pumps become a very popular technology. The sharp uptake in 2035 is due to a significant increase in hybrid heating systems. As a result, more heat pumps are installed in the 2040s in System Transformation than in any other scenario.

The total proportion of homes with a heat pump could reach 22% by 2030.

Figure 13 shows the impact on peak demand. It show that by 2050, all scenarios broadly have the same impact at the time of peak, but the scenarios get there in different ways.

The SPM Falling Short and SPM System Transformation scenarios steadily increase out to 2050 as heat pump numbers are still increasing; notably, they do not meet all Net Zero by 2045 targets.

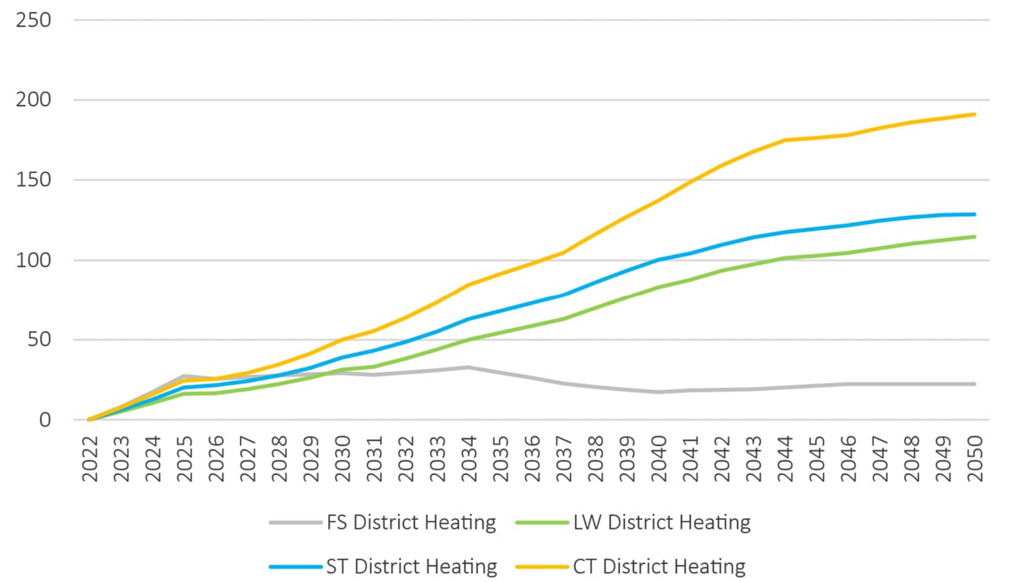
SPM Consumer Transformation has a much earlier impact on peak demand given the greater volume of heat pumps, but the potential impact is reduced from 2030 onwards due to a notable shift towards demand flexibility – i.e. avoiding some heat pump demand at the times of day when the electricity network is busiest. SPM Leading the Way is very similar but the impact of flexibility is greater, and efficiency is slightly higher.

The development of effective heat pump flexibility could reduce their associated peak demand contribution by up to 32% by 2045. This volume is significant, although there is a limit to how much flexibility can be delivered by heating technologies alone. Electricity peak demand is most likely to occur in the early evening on a cold, winter weekday – this is when it is dark, workplaces are still open and functioning, but many people are also simultaneously getting back home to houses that have been empty all day. It is unlikely this pattern of behaviour will shift completely, and so there will always be a demand for a boost of heat around this time.

Some heat demand in SP Manweb is likely to be met by district heating, or heat networks. These are likely to be larger-scale, and therefore connect into higher voltage levels. We forecast this will contribute slightly to peak demand in all scenarios, though much less so in SPM Falling Short (again, due to its latent dependence on methane gas for heating), as shown in Figure 14.

Figure 13 | Heat pump contribution to peak demand *Peak demand contribution (MW)*

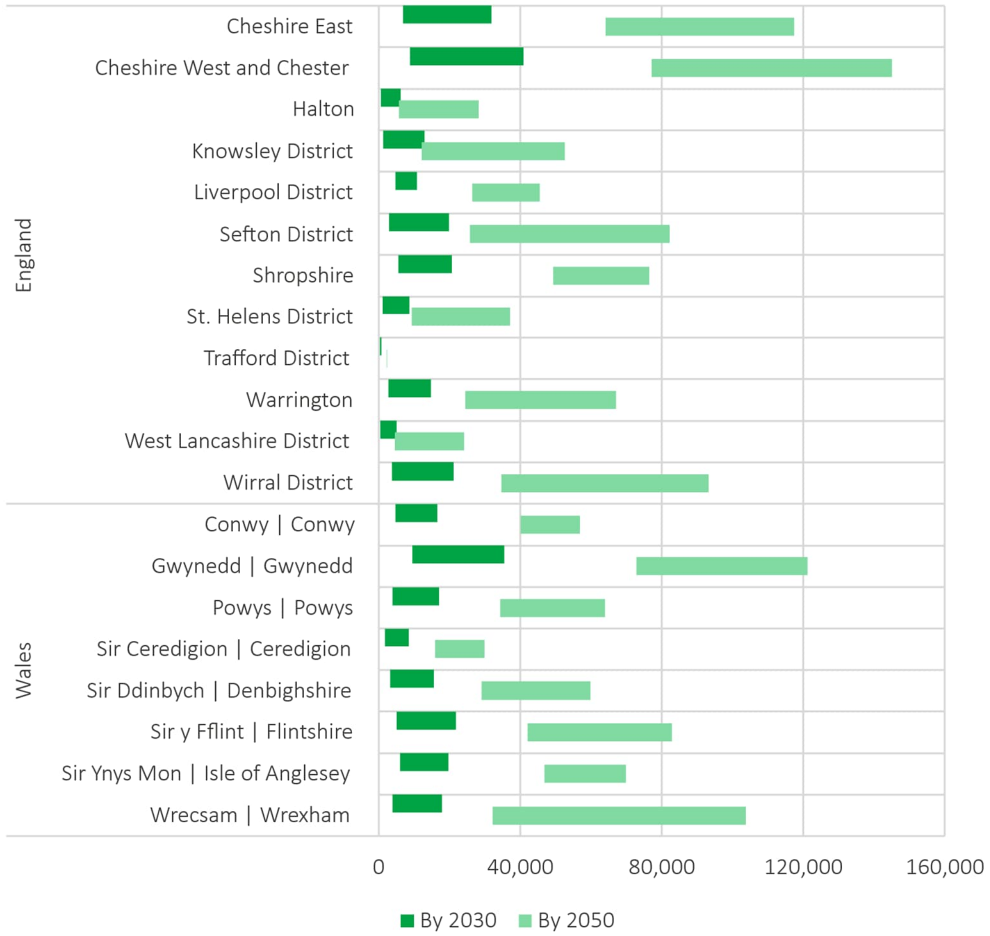
Figure 14 | District heat contribution to peak demand *Peak demand contribution (MW)*



We have disaggregated the results to show heat pump roll-out forecast across the region.

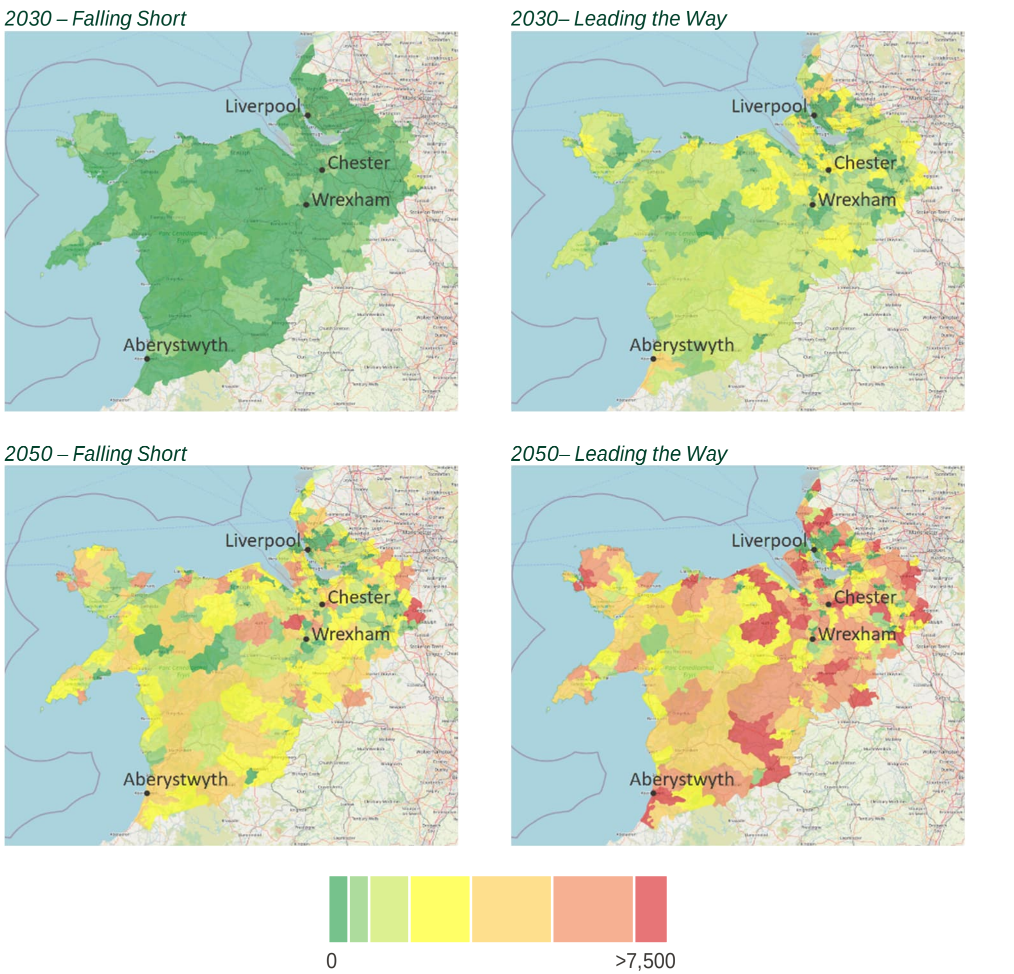
Figure 15 shows the roll-out forecast by primary substation area, and Figure 16 gives the approximated per-Local Authority numbers. The values shown in Figure 16 represent the range between the low and high forecasts. We have estimated the Local Authority numbers by looking at the overlap of our primary substation supply areas with the Local Authority boundaries. For all local authorities, we only provide forecasts for the area of that local authority which we serve.

Figure 15 | Potential range of heat pump uptake by Local Authority — *Number of heat pumps*



The degree of geographical clustering of heat pump adoption is less than for EVs, but it is still key to determining the local impact on the network. Although the most populated areas do have larger numbers of heat pumps by nature of there being more properties, we see a higher density of properties with heat pumps in some of the more rural areas – particularly, in England, across Cheshire and North Shropshire. These areas are associated with high areas of off-gas-grid properties. In our model, heat networks would be least suitable for many of the properties on these areas. Per customer, we forecast that the Welsh local authorities overall have generally notably higher uptake by 2030.

Figure 16 | Heat pump numbers by primary substation area — *Number of heat pumps*



4. Electricity generation and storage

This section sets out the forecasts for generation and storage. The main drivers are increased solar PV generation, wind generation, and storage, so we provide disaggregated forecasts for each.

Understanding how electricity generation and storage could evolve on the SP Manweb network is the second key factor informing the need for more network capacity.

THE VOLUME OF ELECTRICITY GENERATION CONNECTED TO THE DISTRIBUTION NETWORK IN NORTH WALES, MERSEYSIDE, CHESHIRE, AND NORTH SHROPSHIRE OUT TO 2050 WILL BE AFFECTED BY:

1. The overall requirement for more generation, i.e. how much additional generation capacity is required to supply the increase in demand.

2. The decentralisation effect – how much of that generation will be smaller-scale (and so connected to the distribution network) versus larger-scale (and so connected to the transmission network). This is driven by generation technology, economics and government policy.

These two factors, along with the type of generation, will determine the extent to which distributed generation and behind the meter generation may help offset increases in demand (which would reduce the need for more network capacity), or may lead to greater power flows across the distribution network (which would increase the need for more network capacity).

Generation and Storage Overview

Figure 17 shows the geographic location of our baseline and pipeline. Our baseline position outlines the scale of generation and storage technologies connected to our SP Manweb licence area - the starting point for our forecasts. Our pipeline outlines the scale of our contracted generation and storage projects which are a key driver of our short-term forecasts.

Our baseline contains circa 3.2GW of connected generation and storage of which a relatively high proportion – over 30% – is non-renewable technologies such as non-renewable Combined Heat and Power (CHP) or non-renewable engines.

Wind and solar are the next most prominent technology, each with over 24% of connected generation and storage – a notable increase in small scale solar since December 2022 DFES.

Our generation and storage pipeline has continued to grow to 2.6GW. A high proportion of the pipeline – 45% - is driven by contracted storage projects.

Figure 17 | Geographic view of generation and storage baseline (top) & pipeline (bottom)

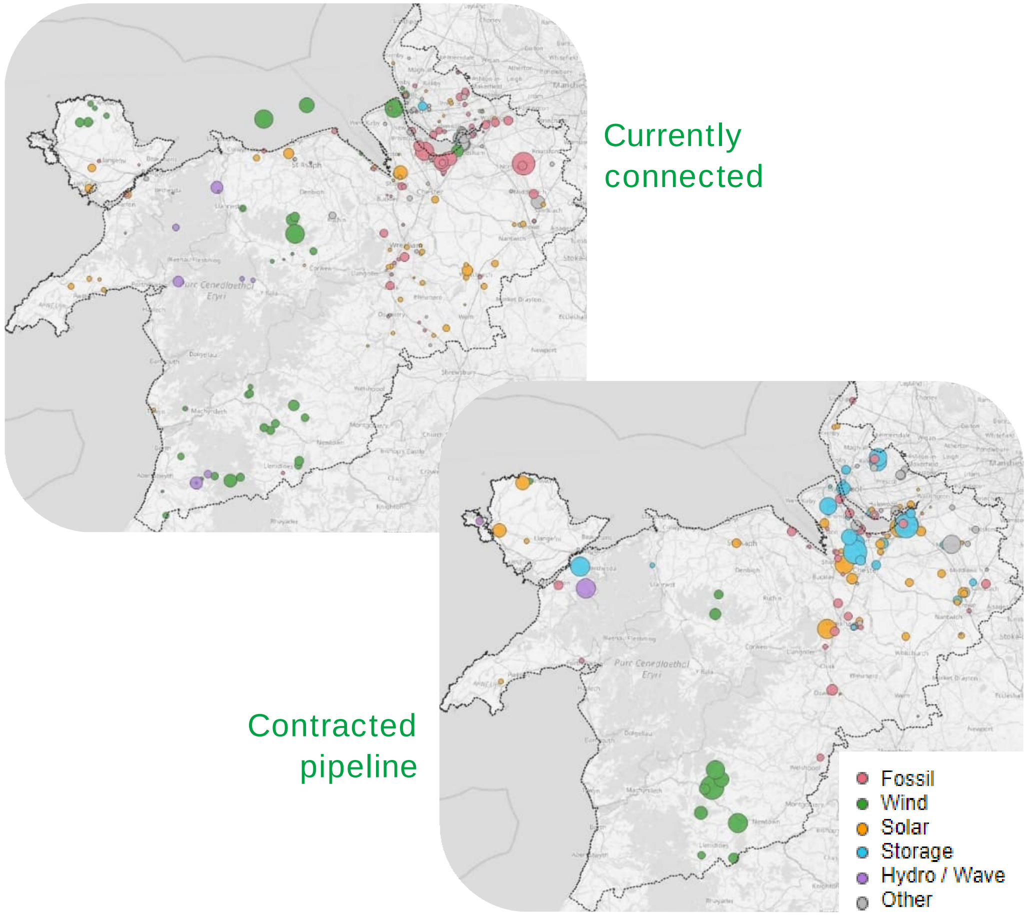


Figure 17 highlights that a high percentage of these planned storage projects are closely located to demand centres or other generation technologies. As expected, our pipeline indicates minimal growth in non-renewable technology during the short term with continued growth in both solar and wind.

Figure 18 shows how the total generation and storage capacity connected to the North Wales, Merseyside, Cheshire and North Shropshire distribution network will vary for the four scenarios. For comparison, the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our December 2022 DFES. Our generation forecast updates have been incremental, this is highlight by the small shift from our December 2022 DFES range. The driver for the medium-term growth is the growth of our generation pipeline, particularly in solar technology.

Figure 18 outlines our scenarios forecast, with distributed generation and storage capacity in our SP Manweb region to be approximately two times higher than today by 2030. By 2050, our scenarios indicate there could be as much as four times more generation and storage than today.

A significant increase in new generation capacity is expected in the next few years as known projects with connection requests come online. Beyond this, future growth is expected to be modest in the SPM Falling Short and SPM System Transformation scenarios but could continue to grow to over 14GW in the SPM Leading the Way scenario by 2050. To better illustrate what is driving the changes in generation, Figure 19 shows a breakdown of the generation and storage forecasts from Figure 18 by technology type, for 2030 and 2050.

Figure 19 shows that significant growth is expected, particularly from renewable generation. The majority of the increase in capacity to 2030 is expected to come from wind, solar PV, and storage. Given that wind and solar PV generation output is weather dependent, it is unlikely to always occur at the same time as periods of high demand.[26]

This means that the distribution network may need intervention to accommodate wind and solar PV generation capacity. It also means that there may be a greater export of power from the distribution network up onto the transmission network, and greater transfer of power across the transmission network, at times when generation output is high, and demand is low.

Figure 18 and Figure 19 show increasing electricity generation for all scenarios out to 2050. These forecasts and trends are the total values for North Wales, Merseyside, Cheshire and North Shropshire. However, different regions will see different increases in generation, based on a range of factors.

By 2030, connected generation and storage could more than double, reaching over 7 GW

OVERALL GENERATION AND STORAGE TRENDS:

1. All scenarios show a significant growth in generation and storage capacity by 2030 and again by 2050. This means that the network will need intervention to facilitate Net Zero.
2. Generation and storage can help reduce peak demand and deliver real benefits to consumers. This means that we should all be working to enable flexibility.
3. The growth in generation and storage is not geographically uniform – some areas of the network will be impacted earlier, and to a greater extent, than others.

Figure 18 | Total installed generation and storage capacity *Installed capacity (MW)*

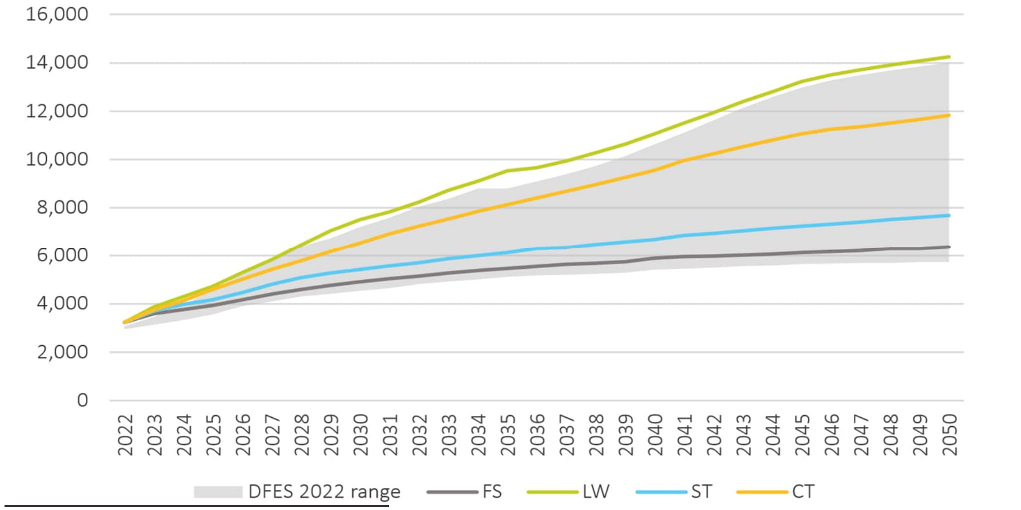
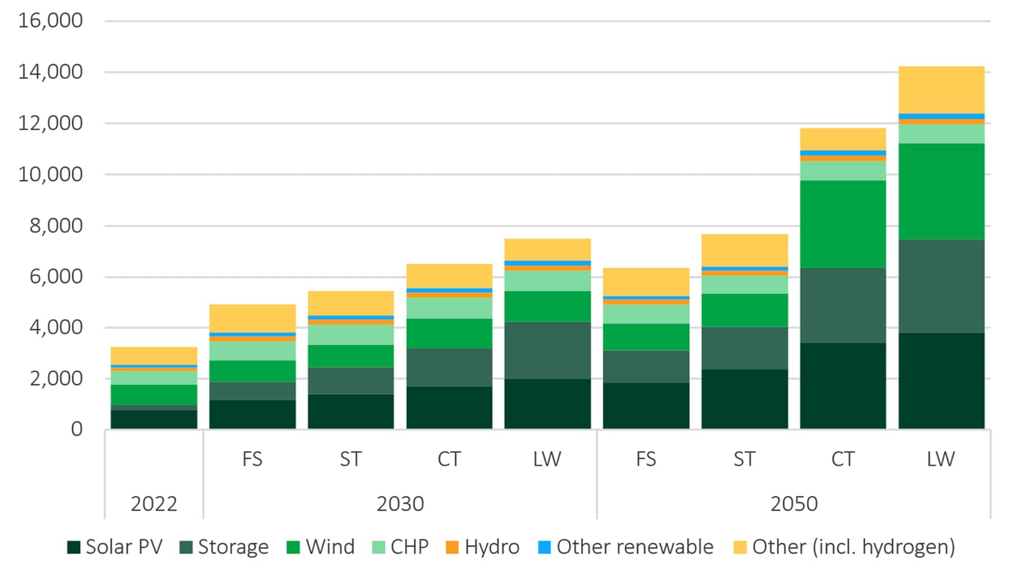


Figure 19 | Breakdown of installed generation capacity by technology *Installed capacity (MW)*



[26] is coincidence of generation and demand would have been beneficial for the network, as it tends to result in lower overall power flows and a lower requirement for network capacity

Figure 20 shows the geographical breakdown of how the generation and storage capacity connected to the distribution network could change by 2030 and 2050 from current levels for the highest and lowest forecast scenarios.

Figure 21 shows a similar representation, for domestic-scale and smaller-scale generation and storage at the primary substation level.

Figure 20 | Installed generation and storage capacity by GSP area *Installed capacity (MW)*

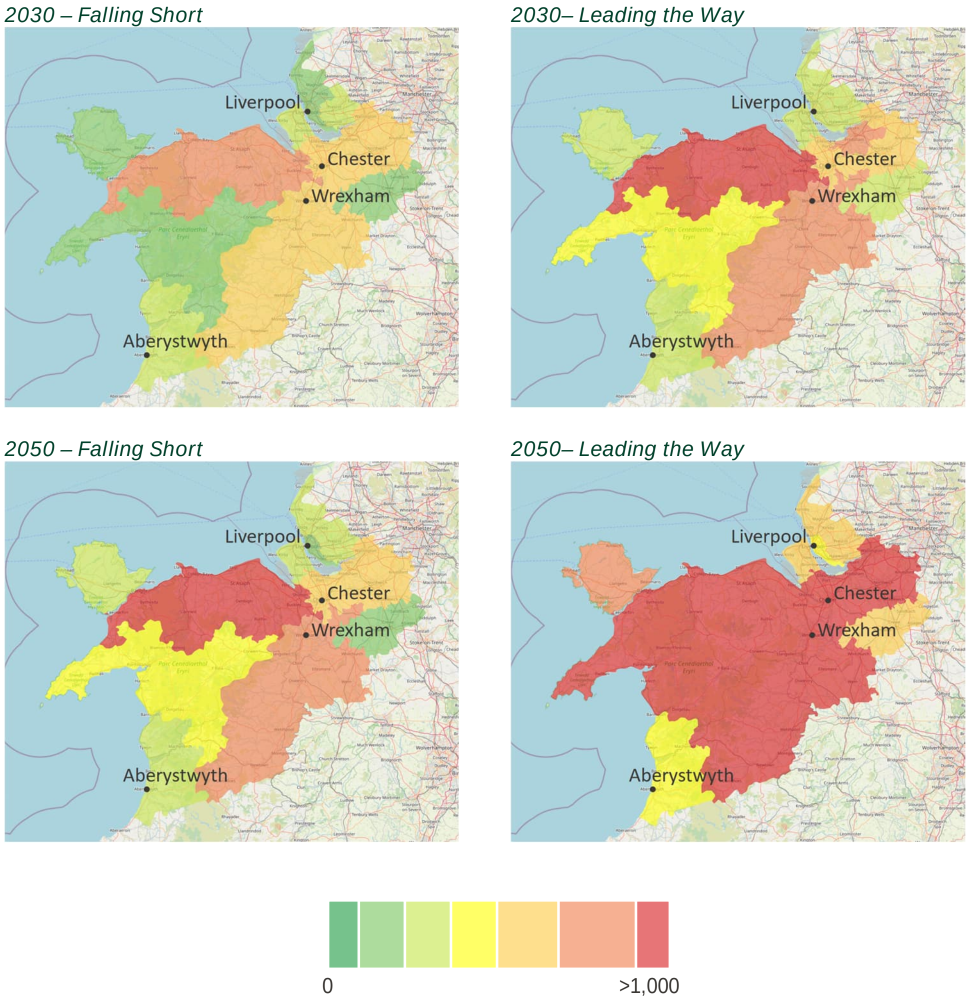
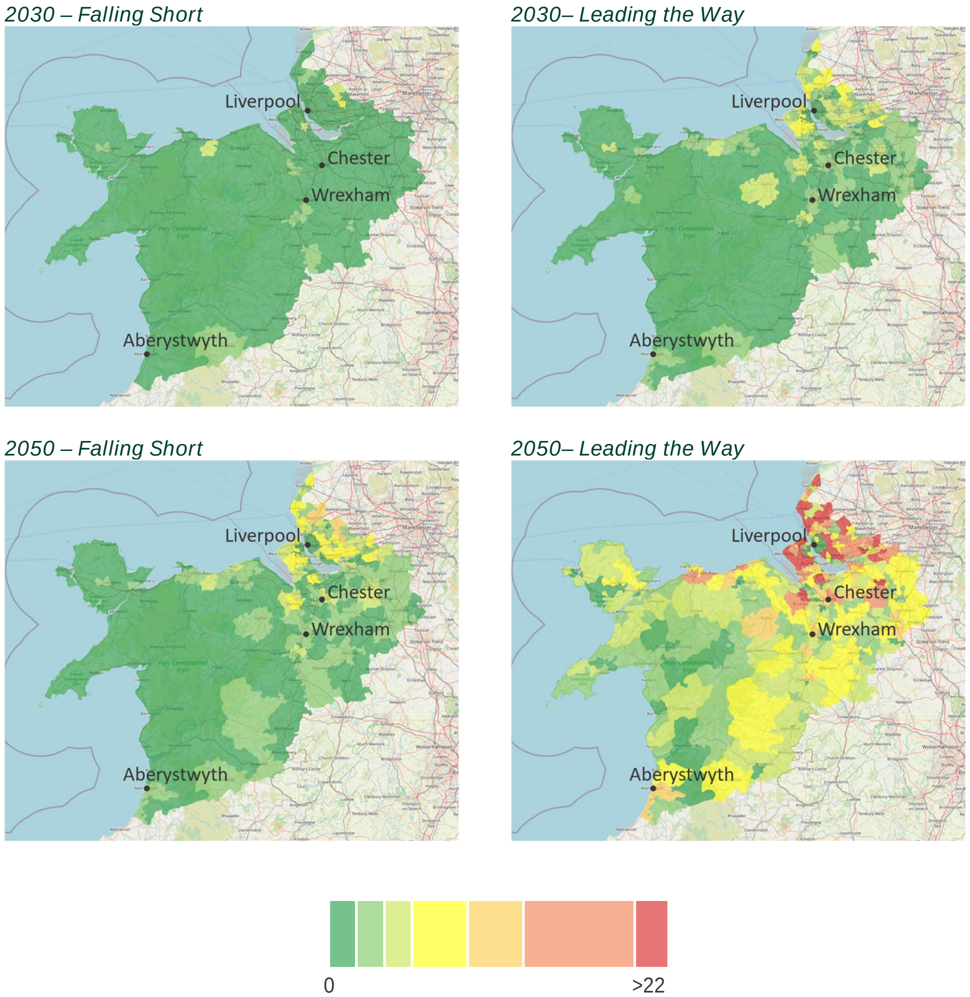


Figure 21 | Domestic-scale and smaller-scale installed generation and storage capacity by primary substation area *Installed capacity (MW)*



Solar PV

Over the past five years, our distribution network has seen a moderate uptake of solar PV generation. However, our forecasts have projected significant growth in solar to facilitate the further decarbonisation of electricity generation.

In our previous DFES, we uplifted both our short-medium term solar forecasts due to our growing pipeline of solar projects and our longer-term forecasts in line with regional drivers. Since our previous DFES, we have experienced a further significant increase - over 50% – in solar PV that is contracted to connect to the network. We have also seen a bigger jump in connected solar. This has slightly increased our short-medium term forecast further. However, this has minimal impact on the long-term outlook, where we are largely aligned with our December 2022 DFES across all but our SPM Falling Short scenario.

In our SPM Falling Short scenario the increase in pipeline-driven, medium-term growth results in an upward shift in the long-term capacity forecast. This results in a tightening of our DFES solar PV forecast range, reflecting the significant role that solar generation is expected to play in any view of the future.

Figure 22 shows the forecast uptake of solar PV for the four scenarios. It shows significant future increases in solar PV capacity across all scenarios, potentially more than doubling from current levels by 2030 and increasing over five times by 2050. The increase in solar PV across all four scenarios is due to it being a low-cost and tried and tested technology, with a lower visual and noise impact than other forms of renewable generation.

Unfortunately, the beneficial impact of solar PV offsetting peak demand on the network is likely to be limited, given that its output does not currently coincide with the times of winter peak demand (as these occur in the hours of darkness). We might expect to see more solar PV generation co-located with energy storage as a way to utilise a greater generation potential.

Solar PV capacity can be split into two categories: small-scale building rooftop schemes, which are connected behind the meter, and larger-scale ground-mounted solar PV farms, which connect directly to the distribution network. Figure 23 shows a breakdown of the Figure 22 solar PV forecasts for these two categories, for 2030 and 2050.

Figure 23 shows that, for all scenarios, the largest growth is expected to come from larger-scale ground mounted solar PV. New capacity for behind the meter solar PV is expected to be focused in areas that have already had some uptake due to subsidy support from Feed-in-Tariffs. Larger-scale ground-mounted solar PV schemes are expected to be deployed in more rural areas, due to the additional land area needed.

Solar PV generation could be up to two and a half times greater than today by 2030.

Figure 22 | Installed solar PV generation capacity *Installed capacity (MW)*

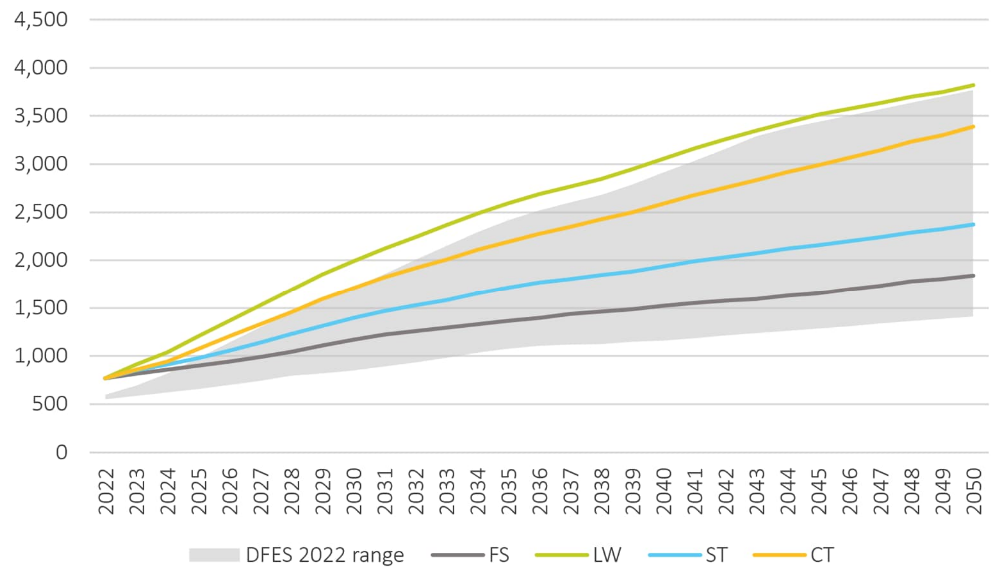
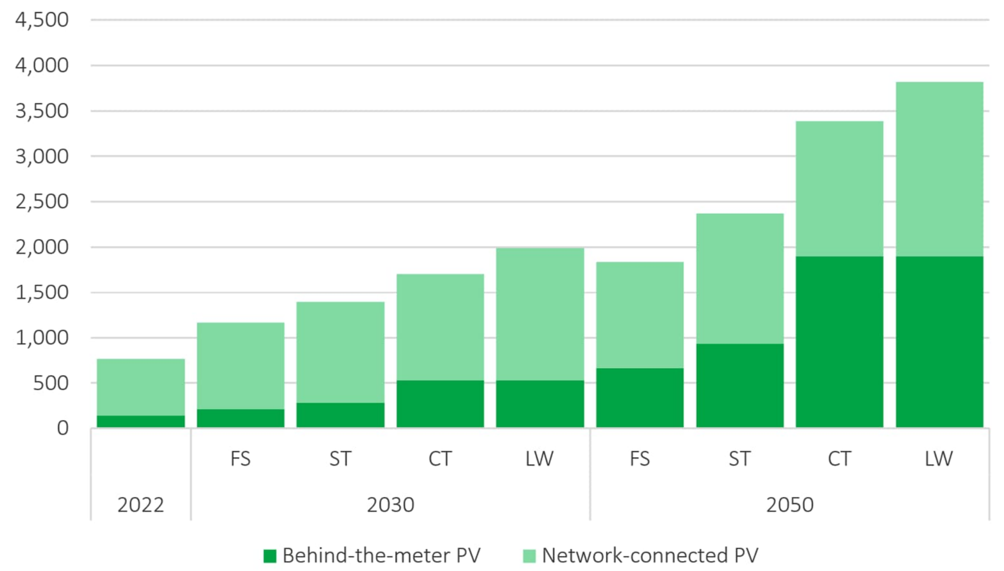


Figure 23 | Distribution connected and BtM solar capacity *Installed capacity (MW)*



Wind

Over the last ten years, there has been steady growth in wind capacity on the SP Manweb network leading to circa 800MW of installed capacity.

Wind generation is commonly split into two categories: onshore wind and offshore wind. Very few large-scale offshore wind projects are expected to connect to the distribution network. Currently under 250MW of wind projects connected are offshore within our SP Manweb licence area, with no offshore wind projects in our pipeline. As a result we forecast minimal growth in offshore wind capacity in all four of our December 2023 DFES scenarios, growth outlined in Figure 24 is expected to be mostly attributed to onshore wind. Any increase in distribution connected wind is expected to be sited in rural areas, taking advantage of more favourable wind conditions.

Our wind generation reflects this with up to 1.8GW forecast to connect to our SP Manweb network in the medium-term, mostly in our rural areas. Of this growth over 400MW is attributed to projects in the mid-Wales area which has sparse existing infrastructure. We are working closely with the Energy System Catapult (ESC) and National Grid Electricity Distribution (NGED) to ensure coordinated whole system planning solutions for mid-Wales.

In the long term, Figure 24 shows significant variance in the levels of wind generation across the four scenarios. As Wind generation is a cost-effective established technology, the extent of new wind generation post-2030 will likely depend on the onshore planning regime, government/policy support, and local support for individual schemes. These factors are scenario specific and are reflected with our DFES scenario range.

However, these refreshed values within our updated DFES scenario range are largely aligned to our December 2022 DFES, with a slight reduction in the long-term forecast in-line with updates to >1MW onshore wind in the ESO's July 2023 FES.

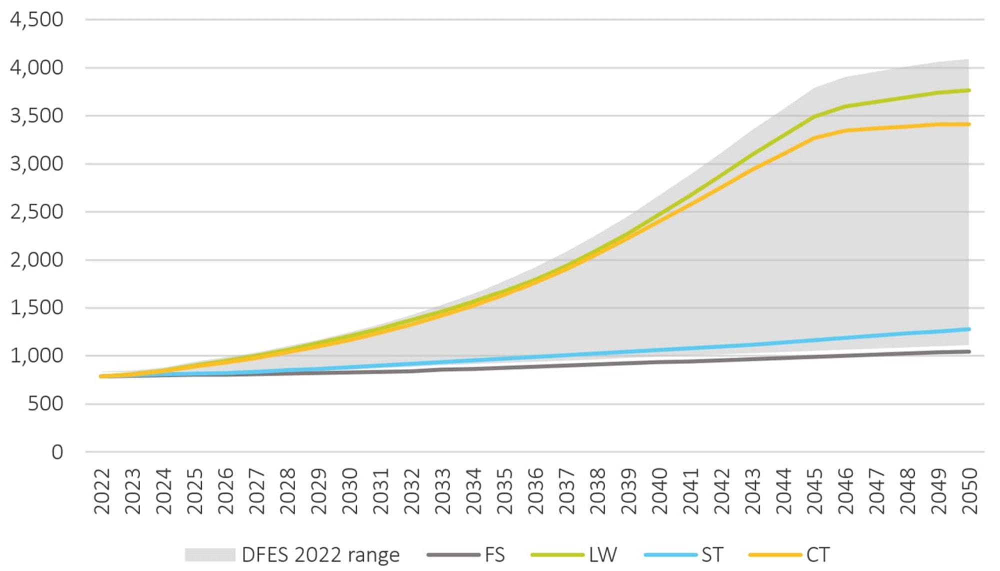
The maximum installed capacity in SPM Consumer Transformation and SPM Leading the Way are still reached in the mid-2040s.Installed wind capacity is forecast to be the larger generation technology in all DFES scenarios.

This continues to highlight that wind is expected to play a key role in electricity generation in any view of the future.

The beneficial impact of wind generation offsetting peak demand on the network could be limited, given that it is weather dependent.

Wind generation could increase by up to 53% by 2030.

Figure 24 | Installed wind generation capacity *Installed capacity (MW)*



Storage

Electricity storage means any technology which can import, store and export electricity. It can range from large-scale pumped hydro schemes down to domestic-scale battery units. Electricity storage can help manage peak demand (by exporting to reduce local demand) and provide valuable system services (such as frequency response). As we move to a decarbonised system with renewable generation, storage is likely to play a valuable role in balancing that generation and ensuring system stability.

Figure 25 shows the forecast uptake of electricity storage for the four DFES scenarios. Given the many different storage technologies and their evolving nature, we have not created individual forecasts for each technology.

Figure 25 shows significant growth in distribution connected storage capacity is expected through the 2020s and early 2030s. Beyond 2035, growth could be substantial in scenarios where there is more decentralised generation, in particular solar PV, that storage would help to manage. Storage capacity can be split into two categories: small-scale storage at individual properties, which are connected behind the meter, and larger scale standalone storage, which connects directly to the distribution network. Behind the meter storage is generally assumed to be sited alongside rooftop solar PV installations; this does not include vehicle to grid storage capacity.

Figure 26 shows a breakdown of the Figure 25 storage forecasts for these two categories, for 2030 and 2050. Figure 26 shows that, across all scenarios, the majority of storage growth is for network-connected storage.

In 2022, SPM experienced a step-change in battery storage applications, leading to over 1GW of contracted storage projects. This significant increase in activity led to a substantial uplift between our November 2021 DFES and December 2022 DFES storage forecast. Our updated storage forecasts represent incremental change from our December 2022 DFES. Short-term growth has slightly slowed to better reflect the current rate at which we are seeing projects transition from our contracted pipeline to a network connection. Another driver for the update is how recently a large majority of the pipeline contracted.

In the last year our pipeline has continue to grow which has led to a storage pipeline of circa 1.5GW, a 50% increase on the previous year.

However, this is not reflected in an increase to our SPM Leading the Way scenario due to a refinement in our modelling of storage pipeline attrition which effectively delays pipeline uptake to the medium-term. As there was already significant growth in this time range this has resulted in minimal movement from our December 2022 DFES.

Given the high degree of uncertainty in this area, we continue to take learnings from the extensive work undertaken by industry working groups and monitor this area closely.

> In the next five years there is likely to be more storage growth than any other generation technology

Figure 25 | Installed storage capacity — *Installed capacity (MW)*

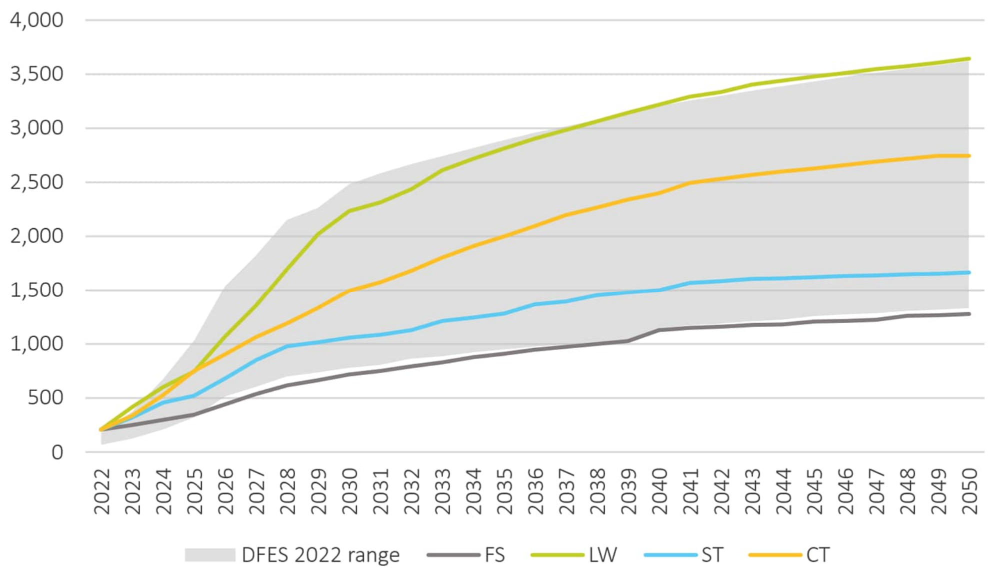
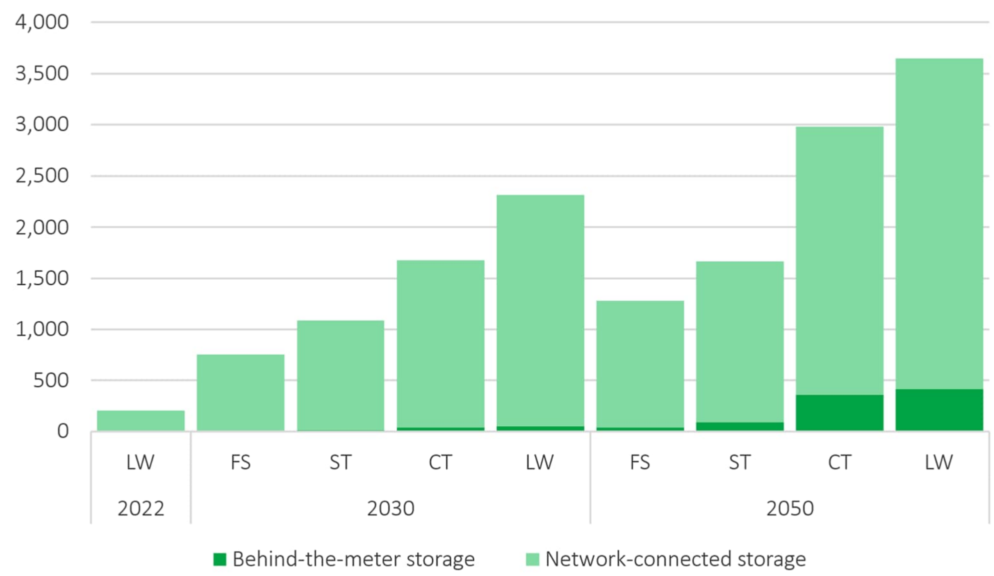


Figure 26 | Distribution connected and BtM storage capacity — *Installed capacity (MW)*



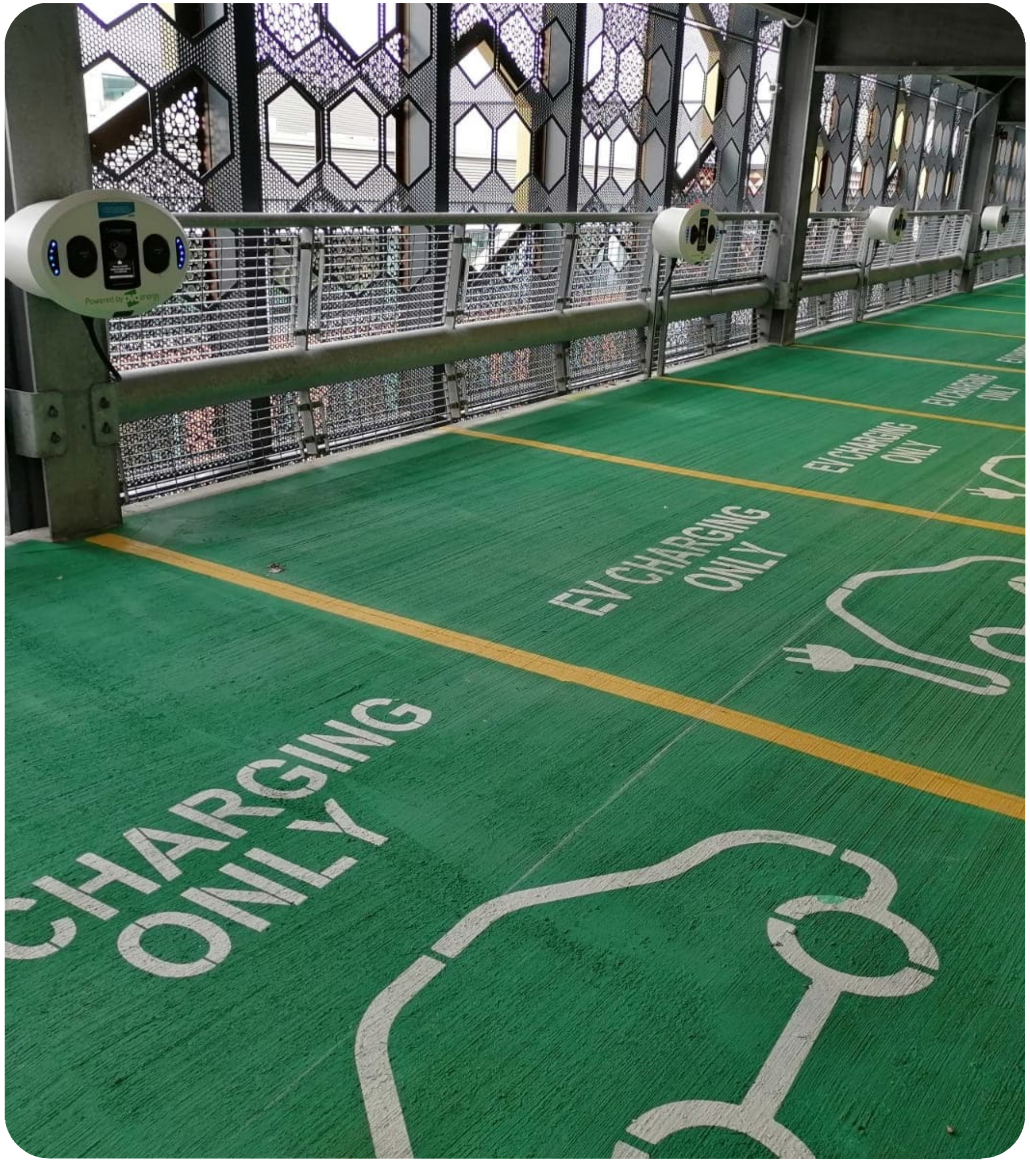
5. Comparing back to FES

This section provides a comparison between the SP Manweb forecasts and the ESO's 2023 FES for key building blocks.

As we explained in Section 3, we use the ESO's FES as a starting point for our DFES forecasts. However, the FES is not detailed enough for our requirements, so we augment it to provide a much more regionally reflective and geographically granular view. This is done using a combination of top-down and bottom-up assessments, stakeholder feedback, devolved government policy and plans, and other regional data.

Once we create DFES forecasts, it is important to reconcile them back to the ESO's FES. This is to identify any significant discrepancies. We reconcile back using common building blocks[28] and FES regionalisation[29] to compare our DFES forecasts to the FES forecasts.

This section provides a comparison of our DFES forecasts to the regionally equivalent ESO's 2023 FES for key building blocks. Other building block data is available in the DFES data workbook[30].



[28] As part of ENA Open Networks' project, all DNOs committed to preparing their DFES using the same scenario framework as the ESO GB FES and to share data using a common set of building blocks.

[29] To compare the national FES forecasts to our regional DFES, we need to know what proportion of the total FES forecasts equates to our licence area. We do this using the grid supply point (GSP) breakdown contained in the FES – the FES contains forecasts for each building block for every GSP. We compare our DFES forecasts to the aggregate of the FES forecasts for the GSPs within our licence area

[30] Distribution Future Energy Scenarios - SP Energy Networks

Electric vehicles

Our forecasts for the uptake of battery electric vehicles in the SP Manweb network are broadly aligned with FES, as shown in Figure 27.

We have broadly aligned our battery electric vehicle forecasts with FES for all scenarios in our SPM licence.

Our stakeholders are in general agreement that this scenario range reflects their ambition in the short, medium and long-term.

Figure 27 | Battery electric vehicle uptake comparison (Lct_BB001 and Lct_BB003) — *Number of vehicles*

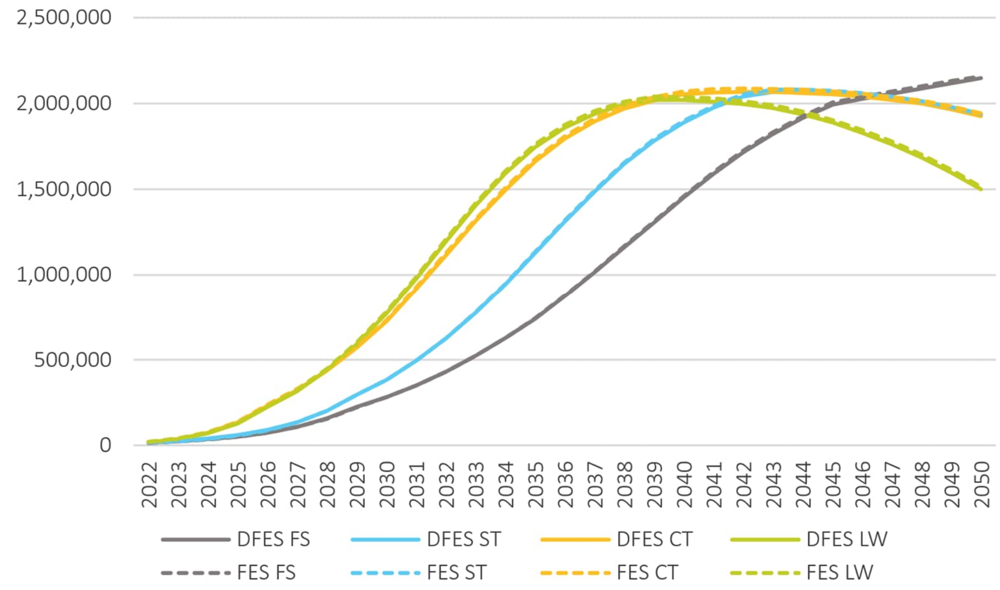


Table 1 | Battery electric vehicle volumes by 2030 — *Thousands*

		Cars, vans and motorbikes *Lct_BB001*	Other vehicle types *Lct_BB003*
DFES	Falling Short	283	1
	System Transformation	383	2
	Consumer Transformation	724	2
	Leading the Way	771	3
FES	Falling Short	282	1
	System Transformation	383	2
	Consumer Transformation	733	2
	Leading the Way	779	3

Heat pumps

Our forecasts do not reflect a short-term reduction in FES forecasted uptake of heat pumps results in our most ambitious DFES scenarios, as shown in Figure 28.

The FES forecast for the uptake of heat pumps has notably dropped in the short term from the July 2022 FES in our SP Manweb licence area across the forecasted range. In the short-term, FES have greatly reduced uptakes in all scenarios; this is notable until circa 2027. To ensure we reflect the ambition of the ambition of our stakeholder and interim net-zero targets, we have not reflected this drop in our SPM Leading the Way and SPM Consumer transformation scenarios. For these scenarios we remain broadly aligned with our December DFES 2022 uptakes.

For our SPM Falling Short and SPM System Transformation scenarios, we have closely aligned to the values within FES.

Figure 28 | Heat pump uptake comparison (Lct_BB005 to Lct_BB008) *Number of heat pumps*

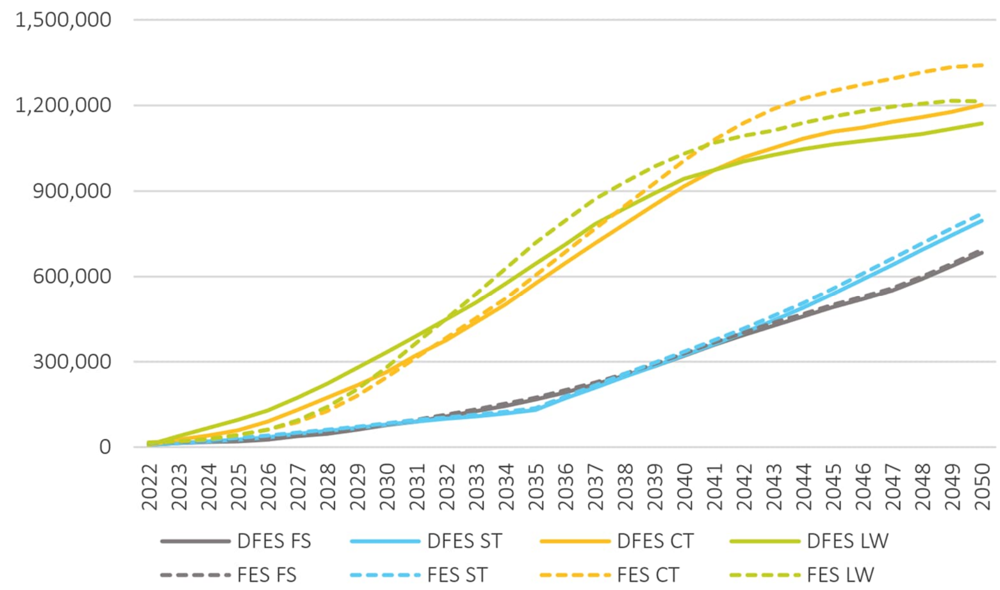


Table 2 | Heat pump volumes by 2030 *Thousands*

		Non-hybrid *Lct_BB005 & Lct_BB007*	Hybrid *Lct_BB006 & Lct_BB008*
DFES	Falling Short	71	7
	System Transformation	64	17
	Consumer Transformation	225	40
	Leading the Way	309	26
FES	Falling Short	74	8
	System Transformation	65	19
	Consumer Transformation	207	38
	Leading the Way	258	23

Overall distributed generation and storage capacity

Our distributed generation forecasts show a faster uptake in the short-term for all scenarios and a comparative growth trend to FES in the medium to longer term, as shown in Figure 29.

This results in an overall higher installed capacity. The faster uptake in the earlier years is mainly driven by the known generation projects currently in development, and review of the remaining pipeline of contracted generation connections.

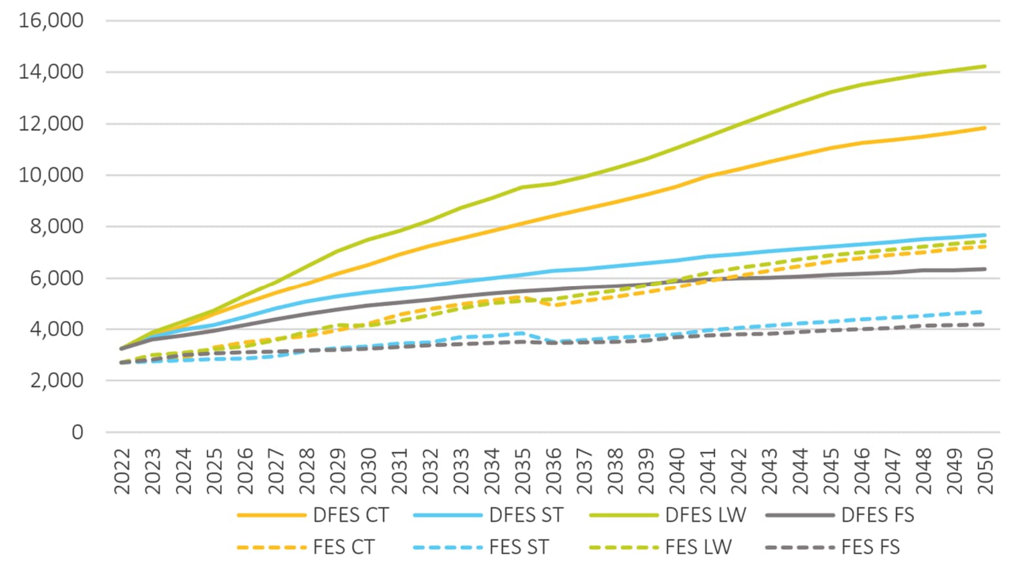
We reviewed these projects against progression criteria such as project design, submission and granting of planning, project finance, past or recent connection requests, or commencement of delivery.

The main growth in distributed generation capacity is driven by three technologies: solar PV, wind and storage. Table 3 provides a summary of the expected overall growth for these three technologies in addition to the current level of connected generation for each scenario by 2030.

Table 3 | Additional Capacity by 2030 *Installed capacity (GW)*

		Total DG *Gen_BB001-Gen_BB023, Srg_BB001-Srg_BB004*	Solar PV *Gen_BB012-Gen_BB013*	Wind *Gen_BB014-Gen_BB016*	Storage *Srg_BB001-Gen_BB004*
	Currently Connected	3.2	0.8	0.8	0.2
DFES	Falling Short	1.7	0.4	0.0	0.5
DFES	System Transformation	2.2	0.6	0.1	0.9
DFES	Consumer Transformation	3.3	0.9	0.4	1.3
DFES	Leading the Way	4.3	1.2	0.4	2.0
FES	Falling Short	0.5	0.1	0.0	0.2
FES	System Transformation	0.6	0.3	0.1	0.2
FES	Consumer Transformation	1.5	0.6	0.3	0.6
FES	Leading the Way	1.4	0.8	0.2	0.8

Figure 29 | Distribution generation and storage capacity comparison (Gen_BB001 to Gen_BB023, Srg_BB001 to Srg_BB004) *Installed capacity (MW)*



Solar PV generation

Our solar PV generation forecasts show a faster uptake in the short-term, as shown in Figure 30. This is driven by the number of known generation projects that are in development. Growth rates in the medium to long-term are broadly aligned with FES.

In 2021, our solar forecasts were broadly aligned with FES. Since then, we have seen our Solar PV connections pipeline grow significantly which has been reflected in our short to medium-term growth.

In the medium to long-term, growth in solar PV generation is expected to increase with increased support for renewable generation technologies, as set out in the UK Government's Energy White Paper and Net Zero Strategy, and Future Wales: The National Plan 2040.

This ambition for solar PV growth has also been echoed by our Local Authorities when engaging on their Local Area Energy Plans.

Wind generation

Our pipeline of contracted generation projects drives a greater uptake in our wind forecasts compared to FES. Our scenario range reflects large growth of wind generation in our Mid-Wales area of network.

Our wind generation forecasts a faster uptake across the short, medium and long-term for all scenarios, as shown in Figure 31.

This faster uptake in the earlier years is mainly driven by the number of known generation projects that are in development, particularly in the Mid-Wales area of network where we have over 400MW of contracted wind generation projects.

This growth in a key renewable generation source is also supported by the UK Government's Energy White Paper and Net Zero Strategy, and Future Wales: The National Plan 2040.

Figure 30 | Solar PV generation capacity comparison (Gen_BB012 and Gen_BB013) *Installed capacity (MW)*

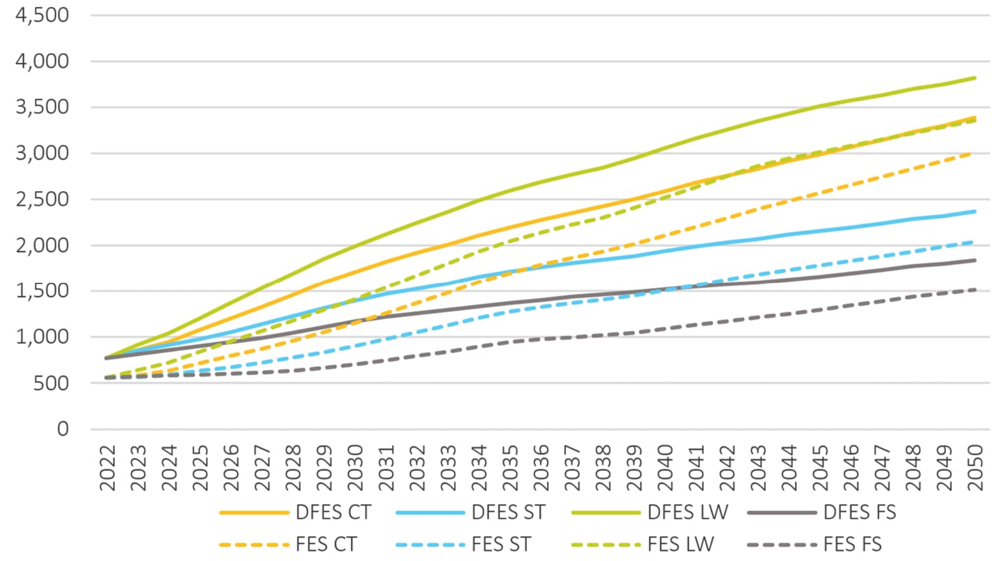
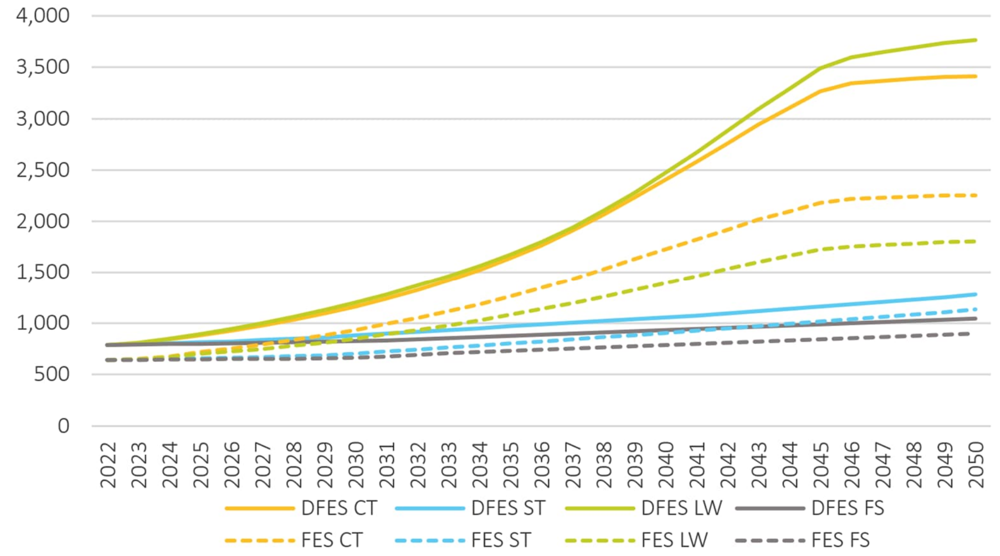


Figure 31 | Wind generation capacity comparison (Gen_BB014, Gen_BB015 and Gen_BB016) *Installed capacity (MW)*



Storage

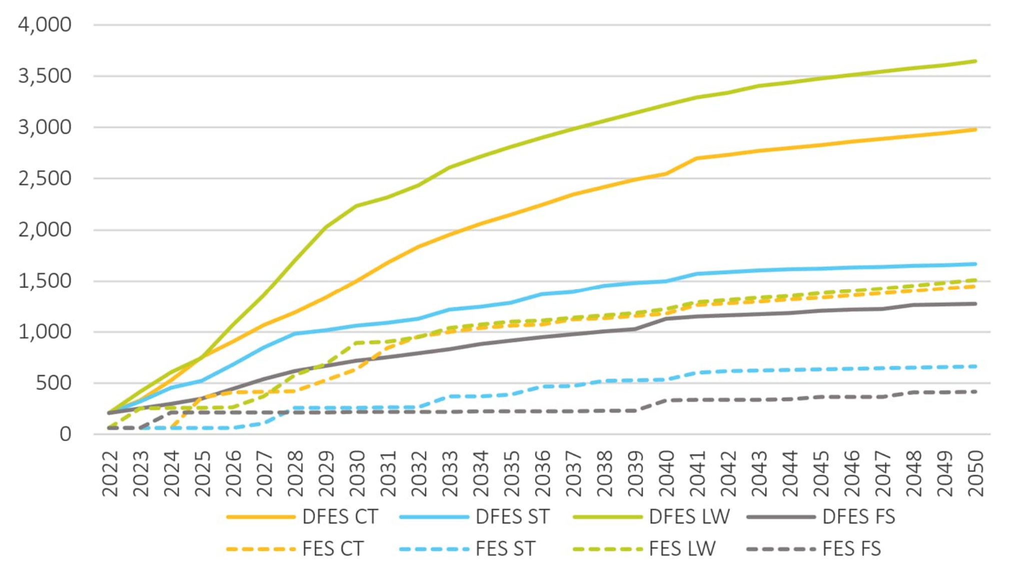
Since 2021 we have seen a step change in the level of connection enquiries for storage, including hybrid sites combing wind or solar PV with battery storage.

In 2021, battery storage accounted for 27% of our pipeline; this year it accounts for over 45% of our greatly increased pipeline. This means we anticipate a significantly faster growth in this technology over the short and medium term compared to FES.

Our growth rate in the longer term in all scenarios is also higher, although more moderately so in the SPM System Transformation and SPM Falling Short scenarios, resulting in a large scenario range by 2050.

Figure 32 | Storage capacity comparison (Srg_BB001 and Srg_BB004)

Installed capacity (MW)



6. Integrating the CCC scenarios

The Climate Change Committee (CCC) published The Sixth Carbon Budget report in November 2021[31], setting recommendations for the UK's path to Net Zero.

The CCC developed five scenarios to explore different pathways of achieving Net Zero. Key assumptions characterising each of the scenarios are shown in the table on the right-hand side of the page.

This section provides an overview of the forecasts from the CCC, and compares them to the ESO's 2023 FES, and our SP Manweb DFES forecasts.

CCC's Sixth Carbon Budget

Carbon budgets are statutory caps for the level of greenhouse gas emissions over a five-year period, to provide a path towards achieving the UK's emission reduction targets. These are a requirement under the Climate Change Act 2008[32].

The Sixth Carbon Budget 22 (for the period 2033-2037) is the first carbon budget publication after the UK introduced a legally binding target to achieve Net Zero by 2050.

Regionalisation of CCC scenarios

The Sixth Carbon Budget dataset provides scenario data for the whole of the UK and also splits the totals for Northern Ireland, Scotland and Wales.

In order to compare the national CCC forecasts on a like-for-like basis with our regional forecasts, the CCC forecasts have been disaggregated to produce regionally equivalent forecasts for each metric based on the FES GSP building block share.

These regionalised CCC scenarios enable stakeholders and us to understand what they mean for our networks. We have not applied any adjustment to the assumptions behind the CCC scenarios.

This section provides a comparison between the DFES forecasts, the regional GSP results from the ESO's 2023 FES, and for the regionally equivalent CCC forecasts for the SP Manweb network from battery electric vehicles (BEVs) and heat pumps. We have shown these two metrics as they are the main drivers of increasing demand.

Tables and charts of these scenario comparisons are shown overleaf.

[31] https://www.theccc.org.uk/publication/sixth-carbon-budget/

[32] https://www.legislation.gov.uk/ukpga/2008/27/contents

Figure 33 shows the total volume of BEVs considered across all scenarios. Table 4 shows the same data at 2030, 2040 and 2050.

Figure 34 shows the total volume of heat pumps considered across all scenarios. Table 5 shows the same data at 2030, 2040 and 2050.

	Balanced NZ pathway	Headwinds	Widespread engagement	Widespread innovation	Tailwinds
Internal combustion engine ban (new cars and vans)	2032	2035	2030	2030	2030
Heavy Goods Vehicles (HGVs)	Most cost-effective technology mix	Mostly hydrogen	Substantial electric road systems network	Mostly electric	Mix of low carbon technologies
Home energy efficiency	Medium	Low	Medium-High	Low	High
Residential building heating technology	Hybrid heat pumps, with 14% homes using hydrogen	Widespread conversion to hydrogen (86% of homes)	Fully electrified	Hybrid heat pumps, with 12% homes using hydrogen	Fully electrified except for areas by industrial clusters. 13% homes using hydrogen
Heat networks	Fully electrified	Hydrogen & large-scale	HP Fully electrified	Fully electrified	
Renewable generation (% of total)	80%	75%	85%	90%	90%
Dispatchable generation (% of total)	10%	15%	10%	8%	7%

Figure 33 | Battery electric vehicle (BEV) uptake comparison *Number of vehicles*

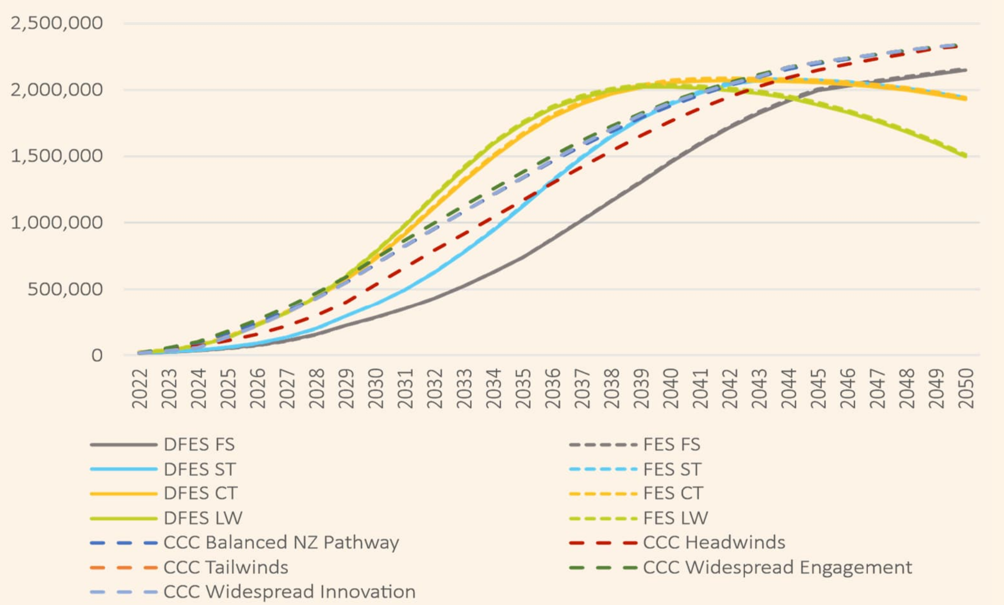


Table 4 | Industry forecasts for BEVs *Millions*

		2030	2040	2050
DFES	Falling Short	0.28	1.45	2.15
	System Transformation	0.38	1.89	1.93
	Consumer Transformation	0.73	2.05	1.93
	Leading the Way	0.77	2.02	1.50
FES	Falling Short	0.28	1.46	2.16
	System Transformation	0.38	1.90	1.94
	Consumer Transformation	0.74	2.07	1.94
	Leading the Way	0.78	2.04	1.51
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.68	1.88	2.34
	Headwinds	0.53	1.76	2.33
	Widespread Engagement	0.73	1.91	2.34
	Widespread Innovation	0.69	1.90	2.34
	Tailwinds	0.69	1.90	2.34

Figure 34 | Heat pump uptake comparison *Number of heat pumps*

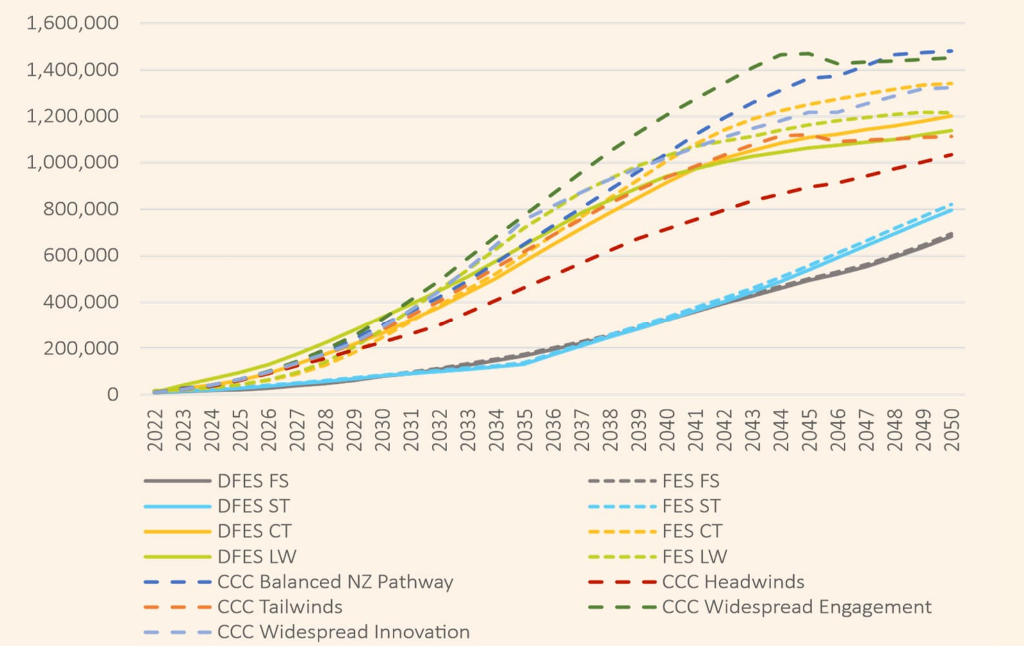


Table 5 | Industry forecasts for heat pumps *Millions*

		2030	2040	2050
DFES	Falling Short	0.08	0.32	0.68
	System Transformation	0.08	0.32	0.80
	Consumer Transformation	0.26	0.92	1.20
	Leading the Way	0.33	0.94	1.14
FES	Falling Short	0.08	0.33	0.69
	System Transformation	0.08	0.33	0.82
	Consumer Transformation	0.25	1.01	1.34
	Leading the Way	0.28	1.03	1.21
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.30	1.04	1.48
	Headwinds	0.23	0.72	1.03
	Widespread Engagement	0.32	1.21	1.45
	Widespread Innovation	0.29	1.02	1.32
	Tailwinds	0.28	0.94	1.11

7. Range of Net Zero compliant pathways

Electricity distribution networks will play a key role in society being able to reach Net Zero. They must be ready for the millions of EV chargers and heat pumps needed for Net Zero, for the renewable generation needed to power these new technologies, and for the GW of energy storage needed to maintain stability and supplies.

Our DFES forecasts, combined with the ESO's FES and the CCC's own scenario outputs, underpin our understanding of future energy needs in SP Manweb. We use them to develop a pathway for our networks to reaching Net Zero.

DFES: the starting point for network planning

The new demand, generation, and storage that is forecast in these future scenarios will increasingly push the distribution network beyond what it is designed for, meaning that our network needs to evolve to enable our customers' Net Zero transition.

It is important that we understand the likely uptake of this new demand and generation, so we know how best to respond. Therefore, we use the information in our DFES (and wider industry scenarios) to understand when, where and how we must develop our networks.

The Net Zero range and Baseline View

We must endeavour to ensure that any interventions we make are futureproof and will facilitate the Net Zero transition. Taking this long-term view ensures our network is ready to accommodate the energy use and supply requirements of our customers as they decarbonise. By making interventions that we know will stand the test of time, we ensure best value for money for our customers in the long term and efficiently maintain the safe and secure network that our customers can rely on.

WE THEREFORE DEVELOP A VIEW OF THE CREDIBLE RANGE OF NET ZERO COMPLIANT SCENARIOS AND OUR BASELINE SCENARIO FOR PLANNING PURPOSES.

The 2023 Net Zero compliant range was developed with the previous year's range as an input. To develop this range, we consider the ESO's FES and other industry scenarios (including the CCC 6th carbon budget scenarios). We then discount DFES and FES scenarios that do not achieve Net Zero or interim targets.

THE FOLLOWING TWO SCENARIOS ARE DISCOUNTED:

1. Falling Short (FS): this scenario does not meet Net Zero and so it is excluded.
2. System Transformation (ST): we consider this unable to meet Scottish Government legislative target or interim emission reduction targets, and so it is excluded.

The remaining DFES scenarios (Consumer Transformation (CT) and Leading the Way (LW)) and the five CCC Sixth Carbon Budget scenarios collectively form the Net Zero compliant scenario range. This range meets UK Net Zero legislation; the requirements of the UK Government's targets, policies, and proposals; and the Net Zero Wales Plan.

The range also comprises our Baseline View scenario against which we can undertake network assessments and investment plans that represent the best approach for our customers – this is the minimum investment needed to enable Net Zero.

We must also plan to have agility within our delivery strategy to meet anywhere within the low to high scenario range, and so test the whole of the range in our impact assessments and optioneering processes. An overview of the steps in our investment planning process is shown in Figure 35.

Our Baseline View scenario is set to achieve Net Zero, including interim targets and devolved government policies, and is set towards the low end of the Net Zero compliant scenario range. This means we have a high confidence that LCT uptakes will be at least this level to achieve Net Zero.

IN SETTING OUR BASELINE SCENARIO WE INCORPORATE THE JUSTIFICATION CRITERIA, AS DEFINED IN OPEN NETWORKS (WS1B P2):

Category 1: Justification criteria for alignment with existing/announced policies.

Category 2: Justification criteria for stakeholder engagement inputs.

Category 3: Justification criteria for regional and local characteristic inputs.

More on these criteria is discussed overleaf.

Figure 35 | DFES is the first step in our investment planning process

Category 1: Alignment with existing/announced policies

This range of Net Zero compliant scenarios meets UK Net Zero legislation; the requirements of the UK Government's targets, policies, and proposals; and the Net Zero Wales Plan. Our Baseline scenario also considers emerging policy and thinking as it becomes available.

Category 2: Stakeholder engagement inputs

Our Baseline scenario incorporates well-justified stakeholder evidence and feedback to capture regional requirements. Stakeholder feedback is used to inform: the timing/level/location of LCT uptake; the underlying factors which affect the forecasts; and to influence the weighting we ascribe to different scenarios during our network analysis. Feedback is reviewed and only included where sufficiently justified based on substantiated evidence, level of consensus and stakeholder ability to influence the metric

We continue to work alongside local authorities to incorporate their latest thinking and provide support in the development of their Local Area Energy Plans (LAEPs), as part of our Strategic Optimiser role.

Category 3: Regional and local characteristic inputs

Our Baseline incorporates the granular outputs of our innovation projects (EV-Up, Heat-Up, PACE), new connection projects that are in development and a review of the contracted project pipeline against progression criteria such as project design, submission and granting of planning, project finance, past or recent connection requests, or commencement of delivery.

We will continue to reflect categories 1, 2, and 3 feedback into our DFES scenarios and our Baseline scenario.

	UK	Wales
Net Zero target	2050	2050
% GHG emission reduction target	68% by 2030 78% by 2035	Avg. 58% (2026–2030) 63% by 2030 89% by 2040
EV targets	End the sale of new petrol and diesel vehicles by 2035.	
Heat targets	Ban on gas boilers in new homes from 2025. Install 600,000 heat pumps every year by 2028.	All new homes built in Wales should be heated and powered from clean energy from 2025.
Renewable generation targets	50GW offshore wind by 2030. A five-fold increase in solar power (up to 70GW) by 2035. Up to doubling the renewable energy capacity in the next CfD. By 2035 the UK to be powered entirely by clean electricity, subject to security of supply.	70% renewable by 2030 (set in 2017) 22.5GW of renewable power by 2025 (from 2013). By 2025, 1GW of additional renewable energy capacity to be installed.

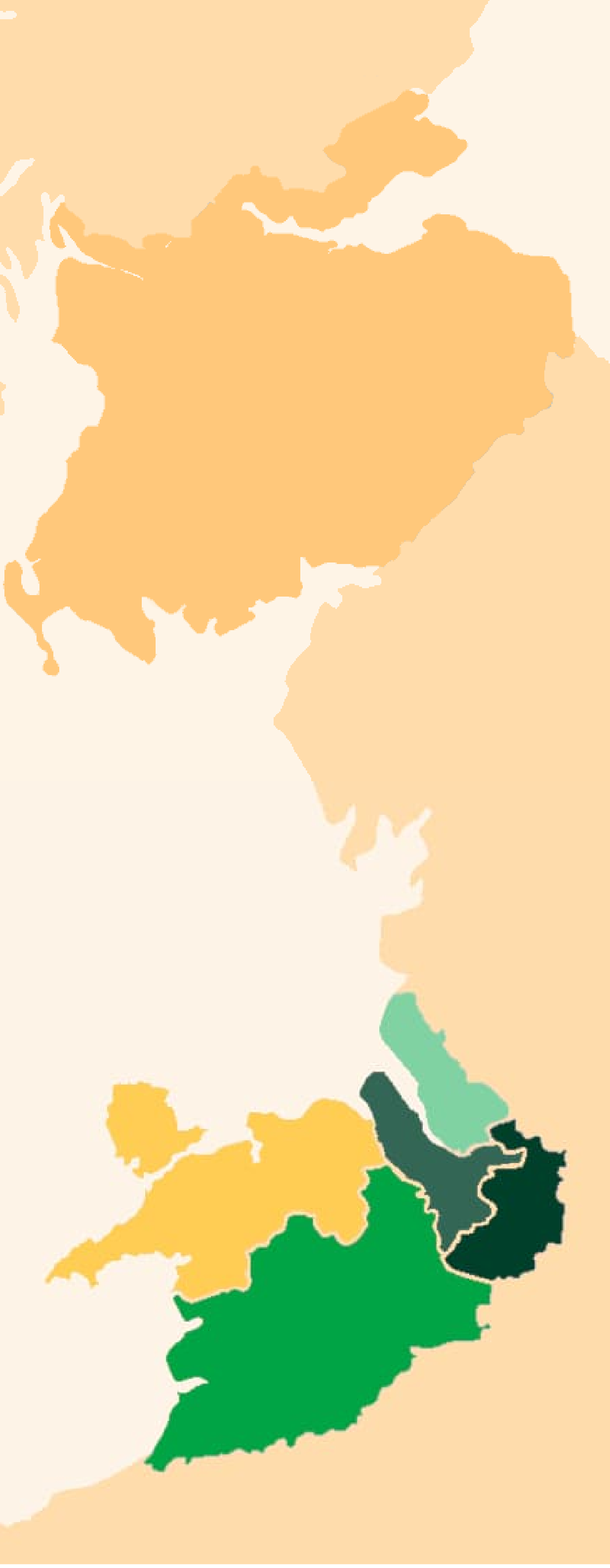


Figure 36 | Total BEV Net Zero range *Number of vehicles*

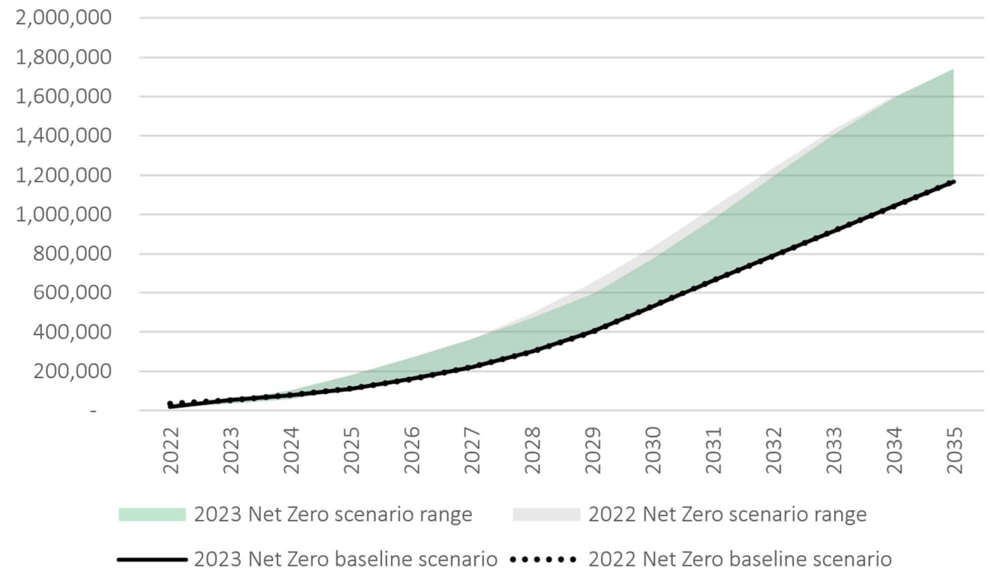


Figure 36 and Figure 37 show our baseline scenario and the range of the Net Zero compliant industry forecasts for the uptake of battery electric vehicles and heat pumps respectively. We have shown these two metrics as they are the main drivers of increasing demand.

Figure 38 shows our baseline scenario and the range of the Net Zero compliant i ndustry forecasts for distributed generation and storage.

Also plotted is the range at the time of last year's DFES 2022 publication, to show how the range is evolving over time. There have been only incremental changes to the ranges this year meaning in the most part, the two years' ranges overlay.

Figure 37 | Total heat pumps Net Zero range *Number of heat pumps*

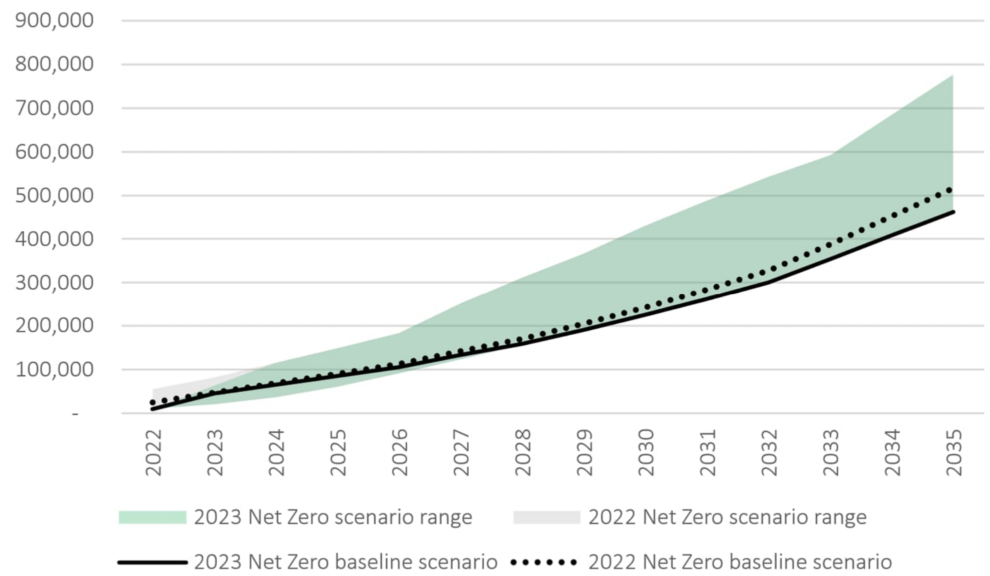
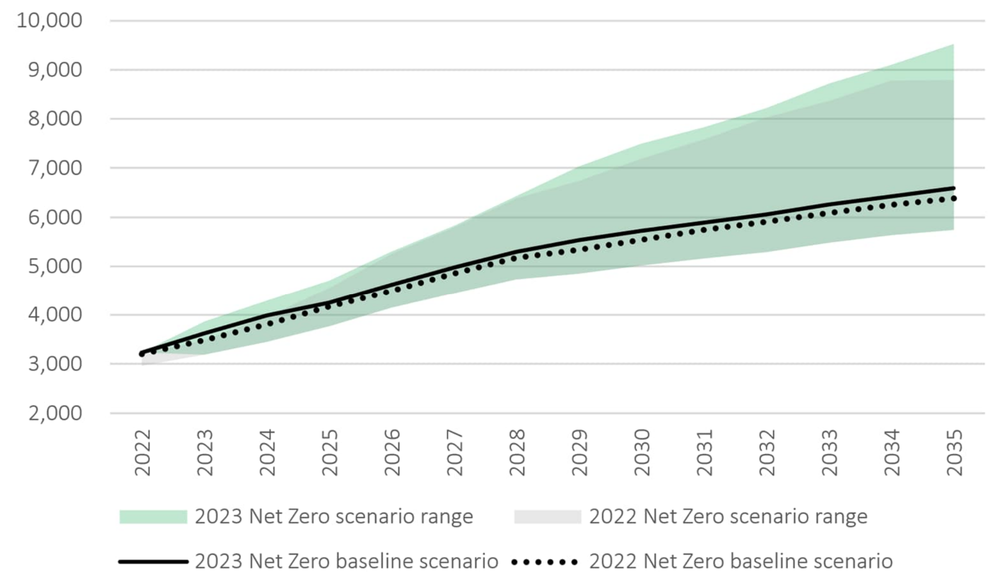


Figure 38 | Generation and storage Net Zero range *Capacity (MW)*



8. Stakeholder engagement

Since the publication of our first DFES document in 2020 we have engaged with a wide range of stakeholders, including government bodies, local authorities, electricity and gas network companies, electricity suppliers, consumer groups, community energy groups, renewable generation developers, electric vehicle charge point operators, manufacturers and other interested parties. This engagement included bilateral meetings, responses to our DFES consultation, feedback via surveys, and workshops. We have considered all feedback in creating our DFES forecasts.

This section summarises this feedback and explains how it has been incorporated within our DFES forecasts.

Summary of feedback

Our stakeholders agree that the journey towards Net Zero will increase the reliance on electricity and the overall demand on the network. However, the rate of decarbonisation will not be geographically uniform and clusters are likely to emerge.

Electric vehicles: Most stakeholders think there is increased momentum in support of electric vehicles due to a range of factors. Stakeholders thought that air quality concerns, whole life costs becoming comparable to petrol / diesel equivalents, improving battery quality and range, and increasing vehicle choice, will support the growth of electric vehicles. One stakeholder thought that electric vehicle uptake is likely to see a knee point around 2025-2026 once the second-hand car market develops – this is in line with the high uptake scenarios (SPM Leading the Way and SPM Consumer Transformation). Some stakeholders thought fleet vehicles would be amongst the early electric vehicle adopters, with some no longer ordering new petrol / diesel replacements.

The establishment of Clean Air Zones within city centres could encourage more residents to switch to EVs, but stakeholders also saw the lack of on-street chargers, particularly in town centres, as a potential barrier to the fast uptake of EVs.

Some stakeholders thought that increased home working, an increased use of public transport, and the expected development of autonomous and shared vehicles could drive a reduction in vehicle ownership towards 2050. SPM Consumer Transformation, System Transformation and Leading the Way scenarios reflect this decrease from the late 2030s to early 2040s. One stakeholder also sees an increased adoption of fuel cell cars contributing to a reduction in electric vehicles, potentially from 2030.

Stakeholders thought that some geographic areas will see a faster uptake than others, which is broadly aligned with our learning from EV-Up. Stakeholders commented that a key factor in the adoption of electric vehicles would be the ability to roll out on street chargers which is currently limited in historic towns.

Our stakeholders generally agreed that electric vehicle smart charging can provide flexibility. They broadly agreed with our forecasts that themajority of this would be from home charging; they generally did not expect much flexibility from rapid charging as this will mainly be used to charge vehicles mid-journey. Overall, stakeholders were satisfied with the smart charging capability forecast in the scenarios.

Our stakeholders believed that, whilst vehicle to grid (V2G) is technically possible, they did not expect it to offer material levels of flexibility within the next eight to ten years. This was for a range of reasons: most electric vehicle manufacturers currently void the warranty if this service is offered; limitations of existing battery technology; and limitations of existing charging technologies. This feedback is aligned with our forecasts.

Heat pumps: Our stakeholders saw the decarbonisation of heat as an area with greater uncertainty – the different 2050 scenario forecasts reflect that uncertainty. It was generally thought that there is no single way to decarbonise heat and there could be a combination of technologies coming into play; for example, heat pumps, district heating, bio-LPG and hydrogen. However, hydrogen was broadly thought not to be a mainstream option until the mid to late 2030s, with some stakeholders concerned about the uncertainty in pricing and availability in the short-term leading to the adoption of heat pumps and district heat. This is consistent with the assumptions used across the scenarios. Our stakeholders agreed that heat pump uptake will be slower in the earlier years, as it is not economical for early adaptors yet.

Our stakeholders were in agreement that heat pump uptake is more likely to occur in new build properties and off-gas grid properties. This was because, for other property types, there were concerns about costs and the feasibility of retrofits given space availability. Even though there were mixed views regarding the extent of the retrofits, it was agreed that a degree of retrofits will be required.

Stakeholders were concerned this year about the impact historically high energy prices will have on the short term adoption of heat pumps. However, stakeholder expectations that developers will start moving towards heat pumps in the short term have strengthened, due to the approaching introduction of the New Build Heat standard and expected ban on direct emissions heating systems from April 2024. Stakeholders had reservations about the viability of district heating schemes.

The majority of our stakeholders considered there to be little scope for flexibility from heat pumps. This is primarily because customers will naturally want their heating on when they return home from work (the timing of which typically aligns with peak demand periods), and will be reluctant to compromise on heat comfort levels. It was agreed that hot water tank storage could enable some flexibility, but the associated cost and space requirements do not make this feasible for every household. We feel that our forecast range of heat pump flexibility (up to a 5% reduction of heat pump contribution to peak demand in the SPM Falling Short scenario and up to 32% in the SPM Leading the Way scenario) reflects this feedback.

Distributed Generation: There was strong consensus from stakeholders that the amount of distributed generation will significantly rise in the transition towards Net Zero. The specifics of the growth rate will likely depend on future policy, network capacity, project economics, and planning timescales.

Our stakeholders were in agreement that onshore wind and solar PV is the generation technology most likely to increase significantly to meet Net Zero by 2050, and will most likely follow the SPM Consumer Transformation scenario.However there were mixed views on the uptake of large-scale wind projects due to land availability, with stakeholders seeing a greater growth in solar PV where considerable growth is also expected due to their low cost. There was broad support for the storage capacity range the scenarios covers.

Storage is also expected to grow and potentially be co-located with other forms of renewable generation. Some stakeholders thought that as the price of battery storage decreases, more behind the meter storage solutions will be viable for domestic premises. Overall there was broad support for the range of storage capacity the scenarios cover.

Rural areas are anticipated to see more renewable generation than urban areas due to better space availability.

Some stakeholders also indicated that hydrogen could also be used for electricity generation in dispatchable power stations. Such a model would ideally use excess solar PV and wind generation to produce hydrogen through electrolysis for these plants.

How we updated our forecasts

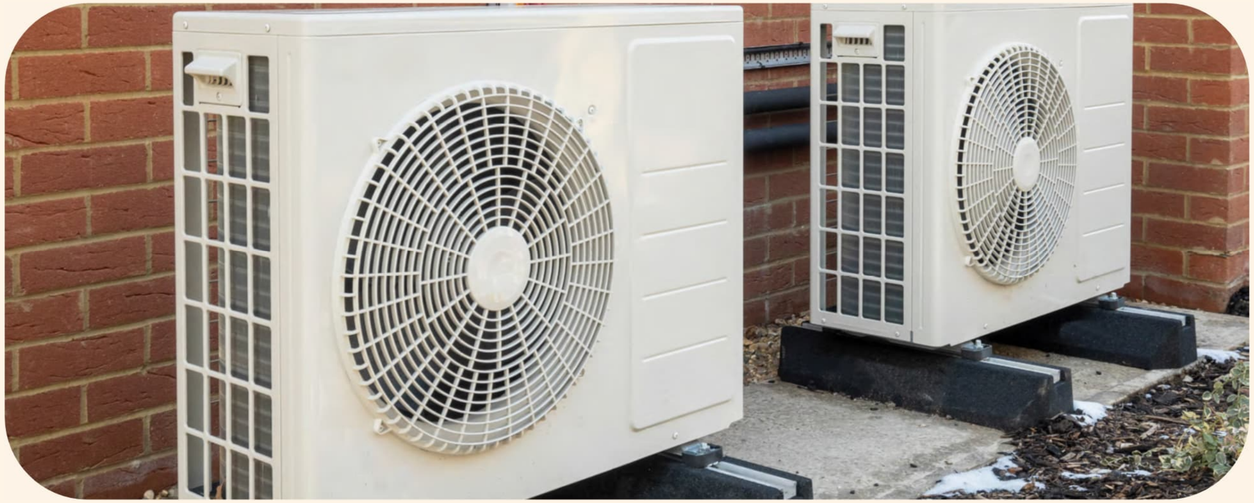
We applied a number of updates to our scenarios to reflect what our stakeholders told us. The tables below summarise the feedback we received and explains the resulting action we have taken.

Electric Vehicles

<table>
<tr><th>Stakeholder feedback</th><th>Actions we have taken</th></tr>
<tr><td>It is important to ensure Local Authority (LA) electric vehicle charging projects and ambitions outlined within Local Area Energy Plans (LHEES) flow into SP Energy Networks planning process and DFES.</td><td>Along with our Strategic Optimiser team, we have created the Strategic Project Tracker. This aims to capture projects in early planning which can flow into our DFES pipeline. This allows us to capture projects within our scenarios for DFES, NDP and investment planning.</td></tr>
<tr><td>It is important that the forecasts factor in new and emerging technologies</td><td>We continue to monitor trends and development within this area to ensure our forecasts continue to represent a range of potential futures. However, it is unlikely a technology which is currently not a mature level of development will have significant levels of uptake, in the short to medium-term.</td></tr>
<tr><td>By 2050 the number of vehicles is expected to decrease due to autonomous and shared vehicles, and increased home working.</td><td rowspan="2">We believe this is an area of great uncertainty. However, all scenarios except Falling Short show a decrease in total electric vehicles from 2040. This is most pronounced in our Leading the Way scenario, which sees the biggest transition towards other forms of transport and home working. This is in line with the trends in ESO's 2023 FES. We have ensured a greater impact of industrial and commercial electric vehicle contribution to peak demand in our updated forecasts.</td></tr>
<tr><td>Whilst total electric vehicle numbers may decrease beyond 2040, the peak demand contribution is not likely to follow similar trends as number of industrial and commercial electric vehicles would continue to grow.</td></tr>
<tr><td>Destination charging at popular tourist spots could be a significant challenge, particularly in remote areas.</td><td>We have updated all scenarios to incorporate the contribution from destination charging at popular tourist spots.</td></tr>
<tr><td>The uptake of electric vehicles may see a “hockey stick” around 2025-26 as the second-hand car market picks up.</td><td rowspan="2">Our EV-Up project considers different socioeconomic groups and their likelihood of purchasing new and second-hand cars. Our SPM Consumer Transformation and SPM Leading the Way scenarios already reflect that knee point, so we have not made updates.</td></tr>
<tr><td>Rural areas may see more electric vehicles as there is often a lack of public transport alternative.</td></tr>
<tr><td>Smart charging is key to the integration of electric vehicles in the network. The volume of flexibility from smart charging is likely to partly depend on the level of cost savings for electric vehicle owners.</td><td>We agree that smart charging will enable flexibility to connect more electric vehicles. Our flexibility assumptions already captured the potential for considerable peak demand impact reduction due to charging electric vehicles in a more flexible way.</td></tr>
<tr><td>Most car manufacturers do not cover battery degradation within their warranty if the vehicle is used for V2G services. This means V2G flexibility will likely be low. Another barrier is battery technology as battery cycling currently reduces battery life.</td><td>We agree with our stakeholders that V2G capability will be low in the coming decade. We have updated our assumptions in line with the ESO's 2022 FES, which show V2G making an increasing contribution from the 2030s – we have not adjusted this further as we anticipated that rapid improvements in battery technology could mean that warranties and battery degradation may not be such a barrier to V2G over the longer term. We will continue to monitor further technology developments in this area.</td></tr>
<tr><td>There is greater uncertainty around uptake of LCTs such as electric vehicles and heat pumps given the current cost-of-living crisis.</td><td>Our scenarios were not updated, as they already cover a large range of uptake scenarios. DFES must consider the various pathways to achieving Net Zero; however, the Falling Short scenario already provides a low LCT uptake view that does not meet carbon targets. Additionally, it is assumed any impact of current economic conditions will have a short-term influence on uptake which will be negligible on the medium- and long-term outlook.</td></tr>
</table>

Heat pumps

Stakeholder feedback	Actions we have taken
It is important to ensure Local Authority (LA) heat decarbonisation projects and ambitions outlined within Local Heating and Energy Efficiency Strategies (LHEES) flow into SP Energy Networks planning process and DFES.	Along with our Strategic Optimiser team, we have created the Strategic Project Tracker. This aims to capture projects in early planning which can flow into our DFES pipeline. This allows us to capture projects within our scenarios for DFES, NDP and investment planning.
Strong emphasis on social housing and off-gas grid decarbonisation. Local Heat and Energy Efficiency Strategies will reduce the geographical and technological uncertainty on heat decarbonisation.	We proposed to adopt a Strategic Optimiser role in RIIO-ED2 to provide advice and support to all local authorities, across our network areas, on the development of their heat and transport decarbonisation plans. Ongoing collaboration will work in both directions as this will enable local authorities to make more informed and optimal whole system choices, and will enable us to refine forecasts and deliver our future network plans more efficiently.
Wales is likely to see a higher degree of ground source heat pumps (GSHPs) due to available geothermal resource.	In DFES 2021, we increase the share of GSHPs in all scenarios. This continues to be reflected in our updated forecasts.
There is greater uncertainty around uptake of LCTs such as electric vehicles and heat pumps given the current cost-of-living crisis.	Our scenarios were not updated, as they already cover a large range of uptake scenarios. DFES must consider the various pathways to achieving Net Zero; however, the Falling Short scenario already provides a low LCT uptake view that does not meet carbon targets. Additionally, it is assumed any impact of current economic conditions will have a short-term influence on uptake which will be negligible on the medium- and long-term outlook.
Air source heat pumps (ASHPs) will not materialise in grade 1 and 2 listed buildings.	We have refined our heat pump allocation methodology to exclude these types of buildings. All scenarios have been updated with this refinement.
Heating demand is likely to be less flexible than electric vehicle demand, as there is less appetite to compromise on comfort levels.	In DFES 2021, we slightly increased the range of potential flexibility response, in line with the ESO's 2021 FES. This is reflected in our updated forecasts.



Generation

Stakeholder feedback	Actions we have taken
In rural areas high uptakes may be more prevalent, whereas this would not be realistic for urban areas.	We have improved our rurality assumptions used in the allocation of the different generation technologies and storage. All scenarios have been updated with this change.
Storage is likely to develop in high energy industrial and commercial (I&C) and urban areas for peak shaving.	In our forecasts, storage uptake in the short term is driven by our pipeline of known future projects. These tend to cluster around urban and industrial areas in our SP Distribution licence area which is shown in Figure 17.
No large-scale solar PV and wind generation is likely to be sited in Areas of Outstanding Natural Beauty (AONBs).	We have improved our allocation methodology for generation to limit the size of the developments close to National Parks and AONBs. All scenarios have been updated with this change.
Non-renewable generation is likely to reduce to achieve Net Zero, as it would require negative emissions.	We have updated our forecasts to incorporate hydrogen-fuelled generation and a reduction in non-renewable generation.
Hydrogen could be used for electricity generation in the future.	Our forecasts include growth in hydrogen-fuelled generation from the late 2020s in our SPM Leading the Way, SPM Consumer Transformation and SPM System Transformation scenarios.
There will be more local solar PV and wind projects. The size of projects should be considered.	Our scenarios have not been updated, as when allocating generation to all scenarios, our methodology already considered the size of the projects. Smaller local developments are assigned to primary substations whereas larger sites are considered to be connecting to the higher voltage levels and are accounted for in the GSP generation capacities
Battery storage has been installed alongside electric vehicle charging points and in domestic properties to great effect. Where finances allow this will be a preferable strategy. For the fair and equal decarbonisation of social housing, battery storage may also play an important role when solar PV is unsuitable.	This feedback reinforced what we have already experienced through our generation connections pipeline. During 2022 we have seen a rapid step-change in battery storage connection applications, our forecasts reflect a large growth within the technology.

9. Glossary

Behind the meter (BtM) – generation and storage which is connected within a domestic, commercial, or industrial building as part of that site's internal electricity system (e.g. rooftop solar PV panels on a domestic property). This is as opposed to a dedicated generation or storage site (e.g. a wind farm) which has no other major demands or processes within the same site.

Decarbonisation – the process to reduce the amount of carbon dioxide (CO^2) and other greenhouse gas emissions by introducing new low carbon alternatives and technologies. Much of the decarbonisation strategy is based on switching carbon energy vectors (e.g. petrol and diesel for transport, and natural gas and oil for heating) to electricity, and then using renewable generation to provide zero carbon electricity.

Decentralisation – this reflects the extent to which generation is sited closer to demand consumption (or is even undertaken by consumers themselves) via the use of smaller-scale technologies such as solar PV and local energy storage. A less decentralised system would be characterised by fewer, larger-scale generators sited further from where the electricity is ultimately consumed (demand); a more decentralised system would be characterised by more smaller-scale generators sited closer to demand.

Distributed generation – generation connected to the distribution network, as opposed to the transmission network.

Distribution network – in England and Wales this consists of overhead lines, underground cables and other network infrastructure that operate at 132kV and below; in Scotland this is the infrastructure that operates at 33kV and below. The distribution network delivers electricity from the transmission network and distributed generation to end users (consumers/demand). Nearly all demand in the UK is connected to the distribution network; only very large demand users (e.g. the rail network) are connected to the transmission network. Nearly all medium-scale and smaller scale generation in the UK is connected to the distribution network; typically only large fossil fuel power stations, offshore generation, and large onshore generation are connected to the transmission network.

Flexibility – the ability of a consumer or generator to change their operation (i.e. their generation/consumption levels) in response to an external signal. With the push towards the electrification of heat and transport, being able to flexibly utilise demand and generation will help minimise the amount of additional network capacity required, balance the system and provide system stability – these can all help reduce customer electricity bills.

GW – gigawatt - 1,000MW (see 'MW)

Grid Supply Point (GSP) – an interface point between the transmission network and the distribution network.

kW – kilowatt – 0.001MW (see 'MW')

MW – megawatt is a unit of power (not energy). It is the amount of electricity that is flowing at any instant. We can measure both the amount of power that a demand user is consuming at any instant (e.g. "this town's peak demand has increased by 3MW due to an increase in electric vehicles and heat pumps"), and the amount of power that a generator is producing (e.g. "3MW of solar PV generation has been installed in this area"). For scale, 1MW is about 400 full kettles all boiling at once. The largest onshore wind turbines in GB are about-3-4MW in size.

Minimum demand – the point in the year, typically during the summer months, when our distribution network as a whole sees the lowest demand (measured in MW). It is an important study condition (along with peak demand) as a network with low demand can experience voltage control issues.

National Grid Electricity System Operator (ESO) – the company responsible for operating the GB transmission network.

Peak demand – the point in the year, typically during the winter months, when our distribution network as a whole sees the highest demand (measured in MW). It is an important study condition (along with minimum demand) as it places the greatest need on network capacity – our network must be sized to accommodate peak demand.

Primary substation – an interface point between the 33kV and 11kV networks.

SP Distribution (SPD) – the Distribution Network Operator for Central and Southern Scotland, that owns the distribution network at 33kV, 11kV and LV into the home.

SP Manweb (SPM) – the Distribution Network Operator for Merseyside, Cheshire, North Shropshire and North Wales, that owns the distribution network at 132kV, 33kV, 11kV and LV into the home.

SP Transmission (SPT) – the Transmission Network Owner for Central and Southern Scotland, that owns the transmission network at 132kV, 275kV and 400kV.

Transmission Network – the high voltage electricity network used for the bulk transfer of electrical energy across large distances. The transmission network takes electricity from large generators (e.g. coal, gas, nuclear and offshore wind) to supply large industrial customers and the distribution network.

True Demand – the total demand used by our customers. This includes the gross power provided by both the transmission system, via our Grid Supply Points, and that provided by embedded generation connected directly to our distribution network.

Vehicle to grid (V2G) – this is where plug-in electric vehicles, such as battery electric vehicles, plug-in hybrids or hydrogen fuel cell electric vehicles, can flexibly alter their demand consumption, either by reducing their charging rate or exporting their stored electricity back onto the network. Like other flexibility, this can help reduce the need for new network capacity, balance the system and provide system stability – these can all help reduce customer electricity bills.

SP Energy Networks
Distribution Future Energy Scenarios 2023

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