SP Distribution Future Energy Scenarios

December 2022

Commissioned partners:

Supported by:

Contents

Foreword

Welcome to our Distribution Future Energy Scenarios (DFES). This document sets out our forecasts for how electricity generation and consumption may evolve in Central and Southern Scotland over the next 30 years. This report presents our annual update to the forecasts following the publication of the Electricity System Operator's Future Energy Scenarios in July 2022.

1

A changing landscape

The distribution network is at the heart of the energy transition as it's here that most societal decarbonisation is happening. To tackle the climate emergency and deliver Net Zero carbon targets, a significant proportion of transport and building heating will need to be electrified. We are also going to see a further leap in renewable generation capacity as fossil fuel power stations close.

We know from detailed modelling that this new demand and generation will push the distribution network beyond what it is designed for, meaning that our network will need 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.

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 – global gas prices have made electricity prices historically high, changing decarbonisation business models; the Ukraine war has promoted the importance of energy security.

Given these uncertainties and the ever changing energy landscape, 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.

"The energy landscape is changing fast as the way our customers generate, consume, and interact with energy evolves."

Working together as a team

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.

Given the important role of these forecasts, we need to ensure that we have correctly forecast our customers' requirements; feedback from our stakeholders is vital for this. We welcome the feedback we have already received, which has been used in these latest forecasts. However, given the rate of change in the energy landscape, it is important that this stakeholder input is not a one-off, but a regular process. We therefore look forward to continuing to engage with you and understanding your insights.

A final note: we know that our customers are experiencing a cost of living crisis and historically high energy bills. We know that, for many of them, this may impact their ability to purchase low carbon technologies such as heat pumps in the short term. But the bigger long-term picture has not changed – 2045 Net Zero and interim targets remain in legislation in Scotland – and in some cases high electricity costs have strengthened the business case of decarbonisation, for example for renewable generation. This is why our scenarios, using the same framework as the Electricity System Operator's Future Energy Scenarios, continue to assess scenarios that achieve Net Zero legislated targets.

Scott Mathieson
Network Planning & Regulation Director

Introduction

We are SP Energy Networks. We own and operate the electricity distribution network in the SP Distribution licence area covering Central and Southern Scotland. It is through this network of underground cables, overhead lines, and substations that 2 million homes, businesses, and public services are provided with a safe, economical, and reliable supply of electricity.

2

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.

2.1 Our DFES forecasts

In order to ensure our network has sufficient capacity to meet our customers' changing electricity needs, we need to forecast what their electricity requirements are going to be into the future (we forecast out to 2050).

These forecasts need to cover how much electricity existing and new customers might consume (demand) and how much they might produce (generation) given a range of external factors. We call these forecasts Distribution Future Energy Scenarios (DFES).

We use the understanding of future customer needs forecasted by the DFES to plan and design our network – the DFES forecasts help us understand where we might need to create more network capacity, and how our operational and maintenance activities should be undertaken. This in turn helps us to calculate what financial investment is required, and to seek approval for this expenditure from Ofgem. The DFES forecasts are the foundation on which we produced our RIIO-ED2 Business Plan[1] and are central to its delivery to meet our customers' needs.

2.2 Incorporating your views

We update our forecasts on an annual basis in line with national and regional projections, engaging with a wide representation of our stakeholders to test the forecasts' data, methodology, and outputs to find out more about our internal processes.

This engagement has generated a range of feedback, which we assessed and used to update the forecasts. This update incorporates all feedback received since our first publication in May 2020. Please see Section 5.2 for a summary of the feedback we received and how we have used it.

If you have any questions on our forecasts, or want to engage with us further, please do not hesitate to contact us at RIIO_ED2@spenergynetworks.co.uk

"We use the understanding of future customer needs forecasted by the DFES to plan and design our network."

[1] RIIO-ED2 is the distribution network price control period which runs from 1 April 2023 to 31 March 2028. (https://www.spenergynetworks.co.uk/pages/our_riio_ed2_business_plan.aspx)

2.3 Other SP Energy Networks forecasts

SP Distribution is part of SP Energy Networks. SP Energy Networks includes two other electricity network companies: SP Manweb, the distribution network operator for North Wales, Cheshire, North Shropshire and Merseyside, and SP Transmission, the transmission network owner for Central and Southern Scotland. These two companies each have their own forecasts, which are available separately[2,3]. The areas of operation of SP Distribution, SP Manweb and SP Transmission are shown in Figure 1.[4]

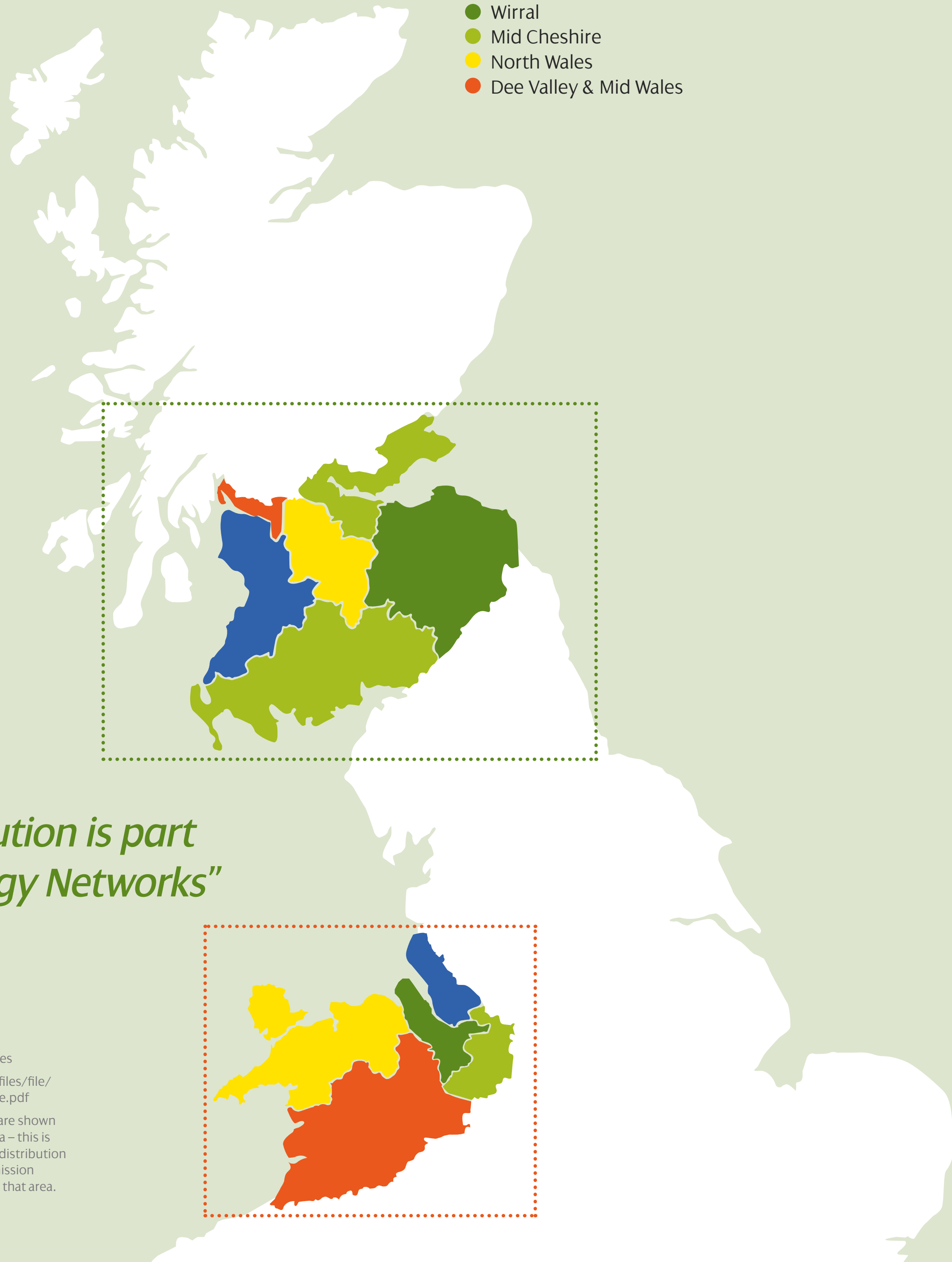
Figure 1 | SP Energy Networks' three electricity network companies

SP Transmission PLC (SPT)
SP Distribution PLC (SPD)

- Central & Fife
- Glasgow
- Ayrshire & Clyde South
- Lanarkshire
- Edinburgh & Borders
- Dumfries

SP Manweb PLC (SPM)

- Merseyside
- Wirral
- Mid Cheshire
- North Wales
- Dee Valley & Mid Wales

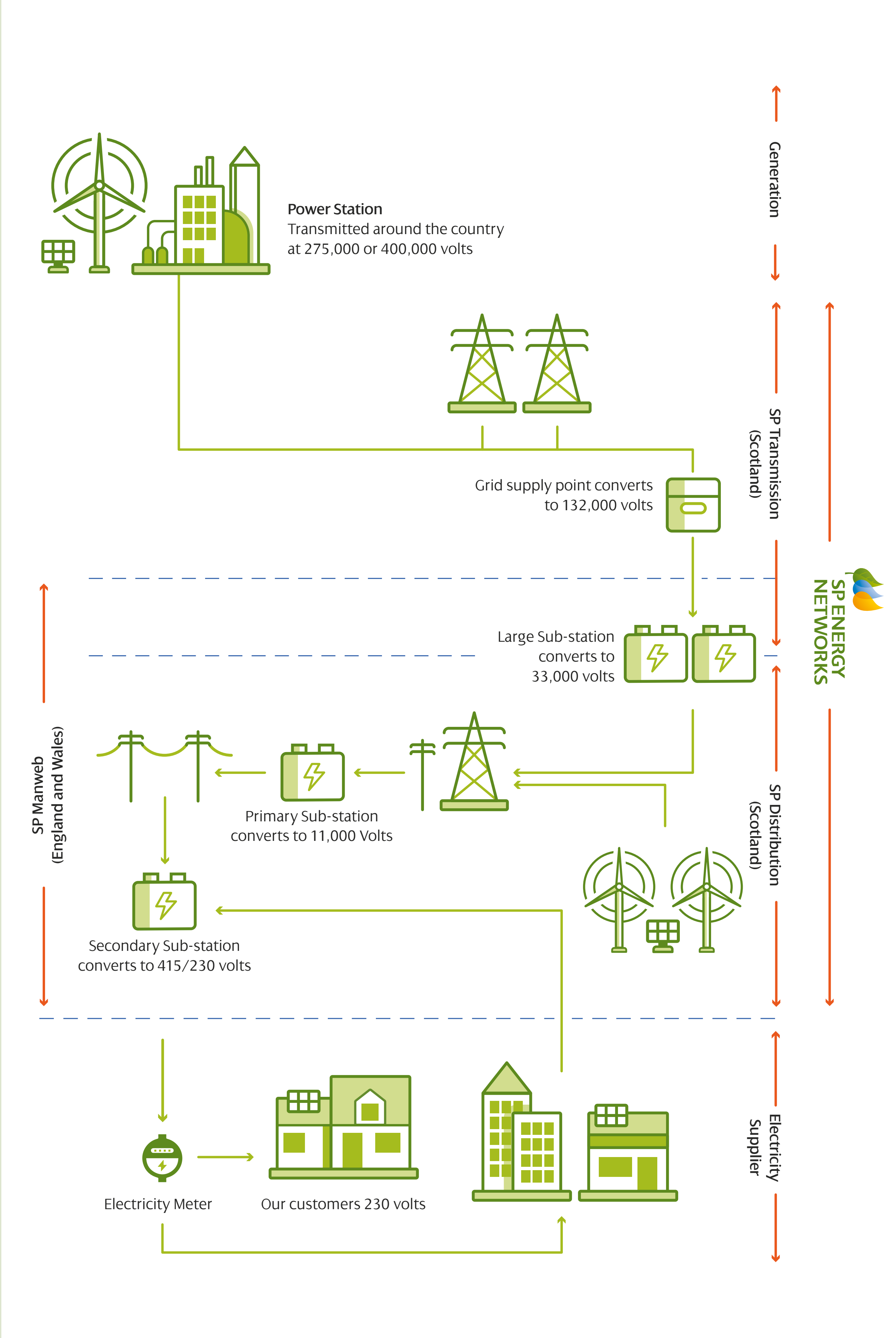


"SP Distribution is part of SP Energy Networks"

[2] www.spenenergynetworks.co.uk/dfes

[3] www.spenergynetworks.co.uk/userfiles/file/SPEN_Energy_Scenarios_2019_update.pdf

[4] SP Distribution and SP Transmission are shown as operating the same geographic area – this is because SP Distribution operates the distribution network in that area, whilst SP Transmission operates the Transmission network in that area.



Legislative context

The Scottish and UK 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 Scottish Government introduced the Climate Change (Emissions Reduction Targets) Act 2019[5].

This introduces a legally binding target for Scotland to achieve Net Zero (greenhouse gas emissions) by 2045. This is five years ahead of the UK target of Net Zero greenhouse gas emissions by 2050[6].

In addition, the Scottish Climate Change Act sets interim targets for emission reductions of 75% by 2030, and 90% by 2040.

3

Given that these targets depend on switching from fossil fuel use to electricity, they require a significant change to Scotland's electricity distribution network.

Building on these targets, the Scottish Government's Climate Change Plan[7] and Scottish Energy Strategy[8] identify a number of ambitions which will have a direct impact on the electricity distribution network.

THESE AMBITIONS INCLUDE:

1. By 2030, the equivalent of 50% of the energy for Scotland's heat, transport and electricity should be supplied from renewable sources.
2. Scotland should have the capacity, connections, flexibility, and resilience to maintain secure and reliable supplies of energy to all homes and business duringthe energy transition.

The Scottish Government also published the Update to the Climate Change Plan[9], which lays the foundation for a Green recovery, and introduced the Heat Networks (Scotland) Act 2021[10] including a target for heat networks to supply no less than 6TWh of heat demand by 2030.

THE UPDATED PLAN INCLUDES:

1. Phase out the sale of new petrol and diesel cars and vans by 2030.
2. By 2030, around 50% of buildings will need to convert to low or zero carbon heating to achieve the interim statutory target.
3. The development of 11-16GW of renewable generation capacity by 2032.

More recently, the Scottish Government has updated the Heat in Buildings Strategy[11], increasing support for heat and energy efficiency measures for those least able to pay. This support will help to meet the strategy's ambitious targets.

SOME OF THESE INCLUDE:

1. By 2030, more than 1 million homes and 50,000 non-domestic buildings to use zero emissions heating systems.
2. From 2024, new buildings to use heating systems which produce zero direct emissions at the point of use.

At a more local level, a number of Scottish local authorities have declared climate emergencies. We expect this to feed into regional development plans, further impacting the electricity distribution network.

The distribution network is the key enabler 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.

By

2030

the Scottish Government plans to phase out the sale of new petrol and diesel cars and vans.

[5] www.legislation.gov.uk/asp/2019/15/enacted
[6] www.legislation.gov.uk/ukpga/2008/27/contents
[7] www.gov.scot/Publications/2018/02/8867
[8] www.gov.scot/Publications/2017/12/5661
[9] www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[10] www.legislation.gov.uk/asp/2021/9/enacted
[11] www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/pages/2/

How we create our DFES forecasts

Our DFES forecasts are updates to those we published in November 2021, following the publication of the ESO's 2022 FES. This section explains how they were created.

4

4.1 The starting point – November 2021 DFES

As a starting point, we used the SP Distribution DFES forecasts published in November 2021.

The DFES forecasts growth in the Low Carbon Technologies (LCTs) such as heat pumps and Electric Vehicles (EVs), changes to demand and consumption as a result of technology and behaviour changes, and growth in Distributed Generation (DG) – generation connected to our distribution network, as opposed to the transmission network.

THESE DFES FORECASTS WERE BASED ON THE ESO'S 2021 FUTURE ENERGY SCENARIOS (FES), AUGMENTED WITH REGIONAL AND LOCAL DATA INCLUDING:

1. UK and Scottish governments' legislation (including the incorporation of Net Zero).
2. Regional ambitions and development plans.
3. Network data we already have, for example views on near term connections of distributed generation.
4. Outputs from SP Energy Networks' EV-Up, PACE and Heat-Up projects.
5. Other highly spatially disaggregated sources of data (e.g. number of, and footprint of buildings in an area).
6. Stakeholder evidence and feedback.

TO CREATE SUFFICIENTLY GEOGRAPHICALLY GRANULAR FORECASTS, ALL OF THE KEY SCENARIO ELEMENTS WERE SPATIALLY DISAGGREGATED TO TWO LEVELS OF DETAIL:

1. UK Grid supply point (GSP) level. There are 86 GSP areas across Central and Southern Scotland.
2. Primary substation level. There are 385 primary substation network areas across Central and Southern Scotland. These geographic areas cover, on average, approximately $50km^2$.

The resulting DFES forecasts were regionally reflective, geographically granular forecasts out to 2050 for four scenarios. Each scenario was disaggregated to show forecasts for individual demand and generation metrics, for example electric vehicle (EV) uptake or solar photovoltaic (PV) capacity.

We have retained the approach of forecasting for four scenarios, as we feel it is important to represent a range of credible pathways. To see any previous DFES publications please visit www.spenergynetworks.co.uk/dfes

4.2 Incorporation of the ESO's FES

After our DFES publication in November 2021, the ESO updated its Future Energy Scenarios[12] (2022 FES), which explore different pathways to reach Net Zero.

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.

These DFES forecasts are updates to those we published in November 2021, following the publication of the ESO's 2022 FES. Last year's 'Steady Progression' scenario has been renamed 'Falling Short' and it has a slightly greater decarbonisation ambition in line with ESO's FES.

To illustrate their different representations, Figure 2 maps the four scenarios against two metrics: the speed of decarbonisation (how fast low carbon technologies are adopted) and the level of societal change. Key assumptions characterising each of the scenarios are shown in the table overleaf.

Figure 2 | Overview of the ESO's Future Energy Scenarios

[12] www.nationalgrideso.com/document/263951/download and Data Workbook Version 5 published November 2022

Key scenario assumptions

The following table outlines the key assumptions characterising each of the scenarios.

	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)	Low	Medium	High	High
Home EV charging	Medium	Low	High	High
Home thermal efficiency levels	Low	High	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

4.3 DFES outputs

WE HAVE RETAINED THE SAME LEVEL OF DETAILED OUTPUTS AS IN OUR PREVIOUS DFES:

1. We have forecast four scenarios, as we feel it is important to represent a range of credible pathways.

2. We have forecasts for all key customer demand and generation metrics. These key metrics are forecast for each scenario at a GSP and primary substation geographic level, and for each year out to 2050.

This level of detail gives us a greater understanding of the potential timing, magnitude and location of our customers' requirements. Therefore, we can make more timely, targeted and efficient interventions in the network.

WE HAVE ARRANGED THE OUTPUTS OF THE DFES FORECASTS INTO TWO MAIN CATEGORIES:

1. Those 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 5.3.

2. Those which affect electricity generation and storage[13]. These are set out in Section 5.4.

FOR EACH METRIC WE HAVE FORECAST WE INCLUDE, WHERE POSSIBLE:

1. A measure of the absolute number (e.g. number of electric vehicles); and

2. Its impact on electricity demand or generation capacity (shown in MW). Demand forecasts are shown as 'peak demand'; this is because the contribution of 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.

For demand components (e.g. electric vehicles, heat pumps), we also consider the potential flexibility of each component. 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 which could 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.

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 *"SPEN Distribution Future Energy Scenarios – Summary of Methodology"* document, developed in conjunction with Baringa.

[13] 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.

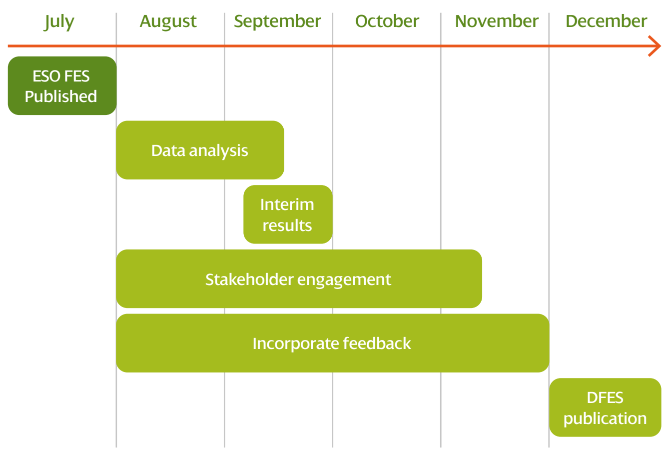
4.4 Updating the DFES

We update and publish our DFES forecasts annually, as shown in Figure 3. For each main annual update there will be the opportunity for stakeholders to provide feedback. Feedback from customers and stakeholders is vital to ensure that our DFES forecasts reflect the plans and ambitions of the communities we serve.

We will consider all information we receive from stakeholders to help shape our forecasts. As these forecasts will inform the network we deliver for our customers, we also have a duty to our customers to ensure that all information included is well evidenced and credible. We will therefore consider the extent to which information we receive should be used to update the forecasts. For information relating to specific developments in the shorter-term, we will consider how developed that scheme is and its underlying drivers.

In the meantime, if you have any further questions or feedback, please do not hesitate to email us at RIIO_ED2@spenergynetworks.co.uk

Figure 3 | Annual process to create our DFES



Our DFES forecasts

This section sets out our demand and generation DFES forecasts for each scenario out to 2050.

All the forecast values are for the SP Distribution network only; they are not forecasts for the whole of Scotland or the UK, or the transmission network[14].

5

5.1 Scenario overview

Our DFES forecasts reflect the ESO's 2022 FES scenario framework. A description of each scenario[15] is provided below:

In **SPD Falling Short (FS):** progress is made on decarbonisation, however it is slower than in the other scenarios. While home insulation improves, there is still heavy reliance on natural gas, particularly for domestic heating. Electric vehicle take-up 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 2045 this scenario still has significant annual carbon emissions, some way short of the 2045 Net Zero Scottish target.

In **SPD Consumer Transformation (CT):** the 2045 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 **SPD System Transformation (ST):** the 2045 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 **SPD Leading the Way (LW):** rapid decarbonisation 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.

14 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 these forecasts will capture nearly all demand and medium-scale, smaller-scale and domestic-scale generation in central and south Scotland.

15 We have reflected key changes in scenarios in line with FES 2022 (www.nationalgrideso.com/document/263906/download)

SP Distribution Future Energy Scenarios – December 2022 19

5.2 Incorporating your views

Since the publication of our first DFES document, we have engaged with a wide range of stakeholders.

We have received feedback from 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.

Section 5.2.1 summarises this feedback, and Section 5.2.2 explains how it has been incorporated within our DFES forecasts.

5.2.1 Summary of feedback

Our stakeholders agree 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: Based on the Scottish Government's own detailed assessment work and feedback, we updated our SPD Leading the Way scenario to include an accelerated electric vehicle uptake. This is because their legislated target of 75% greenhouse gas emission reductions by 2030 could feasibly accelerate electric vehicle uptake beyond the FES baseline high uptake scenario. There was broad support amongst stakeholders for the range the scenarios covered.

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 (SPD Leading the Way and SPD 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. SPD 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 (see section 5.3.2).

Our stakeholders generally agreed that electric vehicle smart charging can provide flexibility. They broadly agreed with our forecasts that the majority 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: Based on the Scottish Government's own detailed assessment work and feedback, we have updated our SPD Consumer Transformation scenario to include an increased heat pump uptake in the short to medium term. This is because their legislated target of 75% greenhouse gas emission reductions by 2030, could feasibly accelerate heat pump deployment. There was broad support amongst stakeholders for the range the scenarios covered.

Other 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 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 (2-5% reduction of heat pump contribution to peak demand in the SPD Falling Short scenario to between 3-32% in the SPD 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 is the generation technology most likely to increase significantly to meet Net Zero by 2045, and will most likely follow the SPD Consumer Transformation scenario. However there were mixed views on the uptake of large-scale wind projects due to land availability. Considerable growth is also expected for solar PV technologies due to their low cost.

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.

5.2.2 How we updated our forecasts

We applied a number of updates to our scenarios to reflect what our stakeholders told us.

The table below summarises the feedback we received and explains the resulting action we have taken.

Electric Vehicles

Stakeholder feedback	Actions we have taken
Consider a more rapid uptake of electric vehicles to help achieve the legislated target of 75% carbon reduction by 2030.	We have updated the electric vehicle forecast for the SPD Leading the Way scenario to show a faster adoption rate.
By 2050 the number of vehicles is expected to decrease due to autonomous and shared vehicles, and increased home working.	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 2022 FES. We have ensured a greater impact of industrial and commercial electric vehicle contribution to peak demand in our updated forecasts.
Whilst total electric vehicle numbers may decrease beyond 2040, the peak demand contribution is not likely to follow similar tends as number of industrial and commercial electric vehicles would continue to grow.	
Bus electricity consumptionis expected to be around 1.6kWh/mile.	We have updated our assumptions for electricity consumption for buses in all scenarios. This change has had limited impact on peak demand, as most bus charging will occur outside of peak demand periods.
Destination charging at popular tourist spots could be a significant challenge, particularly in remote areas.	We have updated all scenarios to incorporate the contribution from destination charging at popular tourist spots.
The uptake of electric vehicles may see a "hockey stick" around 2025-26 as the second-hand car market picks up.	Our EV-Up project considers different socioeconomic groups and their likelihood of purchasing new and second-hand cars. Our SPD Consumer Transformation and SPD Leading the Way scenarios already reflect that knee point, so we have not made updates.
Rural areas may see more electric vehicles as there is often a lack of public transport alternative.	
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.	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.
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.	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.
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.

Heat pumps

Stakeholder feedback	Actions we have taken
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 out future network plans more efficiently.
Scotland is likely to see a higher uptake of district heating schemes.	We believe our forecasts facilitate the Scottish Government's 2030 target of at least 6TWh of heat demand supplied through heat networks.
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.
Consider a more rapid uptake of heat pumps to help achieve the legislated target of 75% carbon reduction by 2030.	We have updated the heat pump forecast for the SPD Consumer Transformation scenario to show a faster adoption rate in the short to medium term.
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.

Distributed 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.	
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.	
Storage is expected to account for at least 25%, rising over time.	In our forecasts, electricity storage accounts for between 19-33% of the total generation capacity by 2030. In our DFES 2022 update we have included a significantly increased storage pipeline. This does not include the inherent storage capacity of electric vehicles. We consider this an area of high uncertainty and will continue to monitor evolving trends around energy storage.
There is significant uncertainty around the impact of the Significant Code Review (SCR).	Whilst Ofgem's final decision on Access SCR provided certainty around connection guidelines from April 2023, there remains significant uncertainty around the scale of Access SCR driven connections. We will continue to monitor and work with industry and stakeholders to understand this impact.
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.

Hydrogen	
Stakeholder feedback	**Actions we have taken**
Electricity demand is expected to increase due to hydrogen production through electrolysis.	Electrolysis is one potential option for hydrogen production. Our analysis assumed that electrolysis would primarily take place at transmission level, and so will not impact distribution peak demand. We therefore did not update our forecasts.

5.3 Electricity demand

This section sets out the forecasts for demand. The two main drivers of increased demand are the electrification of transport and heat, so we provide disaggregated forecasts for each.

5.3.1 Demand overview

Understanding how electricity demand could evolve on the SP Distribution network is the first key factor informing the need for network intervention to increase or 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;**
3. **the speed of the uptake of new sources of demand and when this happens;**
4. **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 Distribution 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). For comparison, the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our November 2021 DFES. There is a material split between the scenarios. Even though SPD System Transformation, SPD Consumer Transformation and SPD Leading the Way all achieve the Net Zero targets, this is achieved through differing levels of electrification. Both SPD Consumer Transformation and SPD 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, SPD 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.

Figure 4 shows the 'worse case' impact, as it assumes that no existing or new demand has any flexibility. This does not reflect reality: 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.

Without flexibility, demand could increase by as much as 26% by 2030 and more than double by 2050.

Figure 4 | Electricity peak demand without flexibility

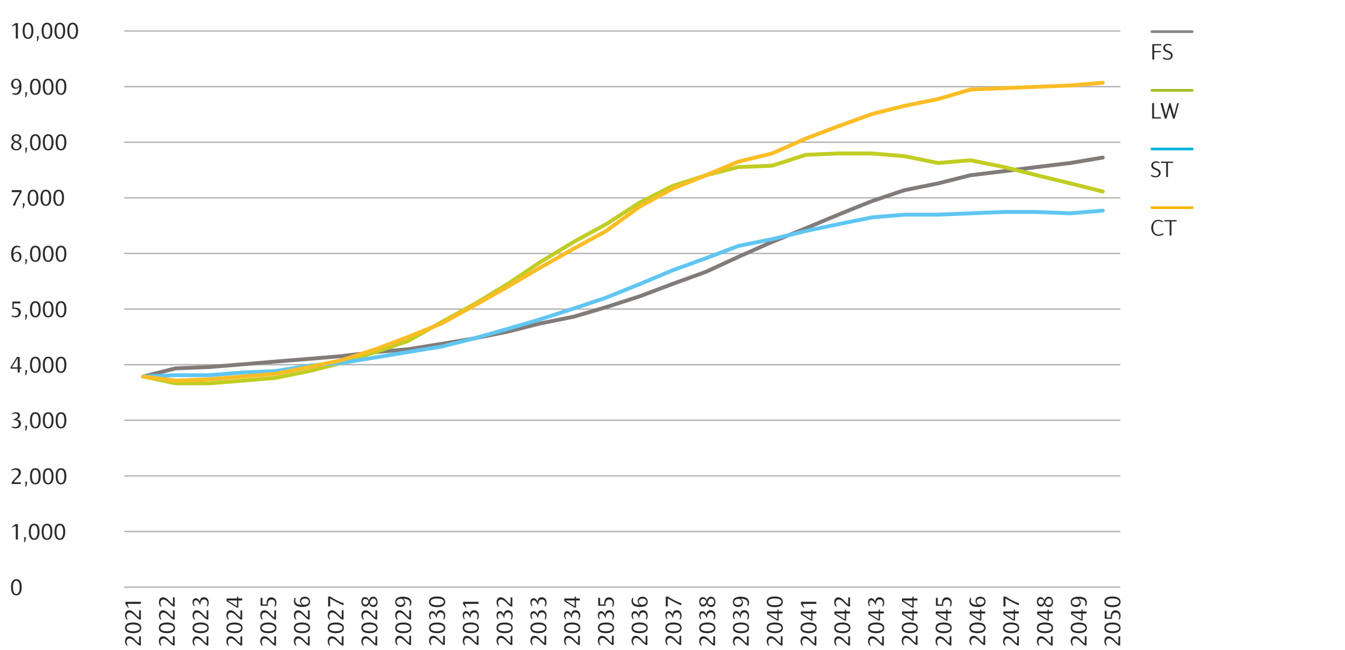


Figure 5 shows how demand flexibility (excluding vehicle to grid) could reduce the SP Distribution total peak demand.

Figure 5 shows that flexibility could reduce peak demand by up to 5% by 2030 compared with no demand flexibility, depending on the scenario. Such a reduction will directly deliver benefits for consumers as it will require less investment in the network, resulting in lower electricity bills. SPD Consumer Transformation and SPD Leading the Way involve greater levels of heat and transport electrification. There are therefore greater levels of electric vehicle and heat pump flexibility for these two scenarios.

To better illustrate what is driving the changes in demand, and where the demand flexibility is coming from, Figure 6 shows a breakdown of the components of the Figure 5 peak demand forecast for 2030 and 2050. The difference between the solid (flexible) and dashed (non-flexible) forecasts in Figure 5 are shown by the shaded components in Figure 6 – the shaded components represent what can be flexibly controlled.

Given the benefits of flexibility, all subsequent demand forecasts in this report assume flexibility will be available to the extent shown in Figure 5 and Figure 6 (e.g. where an electric vehicle forecast shows the impact on peak demand, those forecasts assume electric vehicle demand flexibility).

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 Central and Southern Scotland. 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.

With flexibility, demand could increase by as much as 20% by 2030 and 89% by 2050.

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

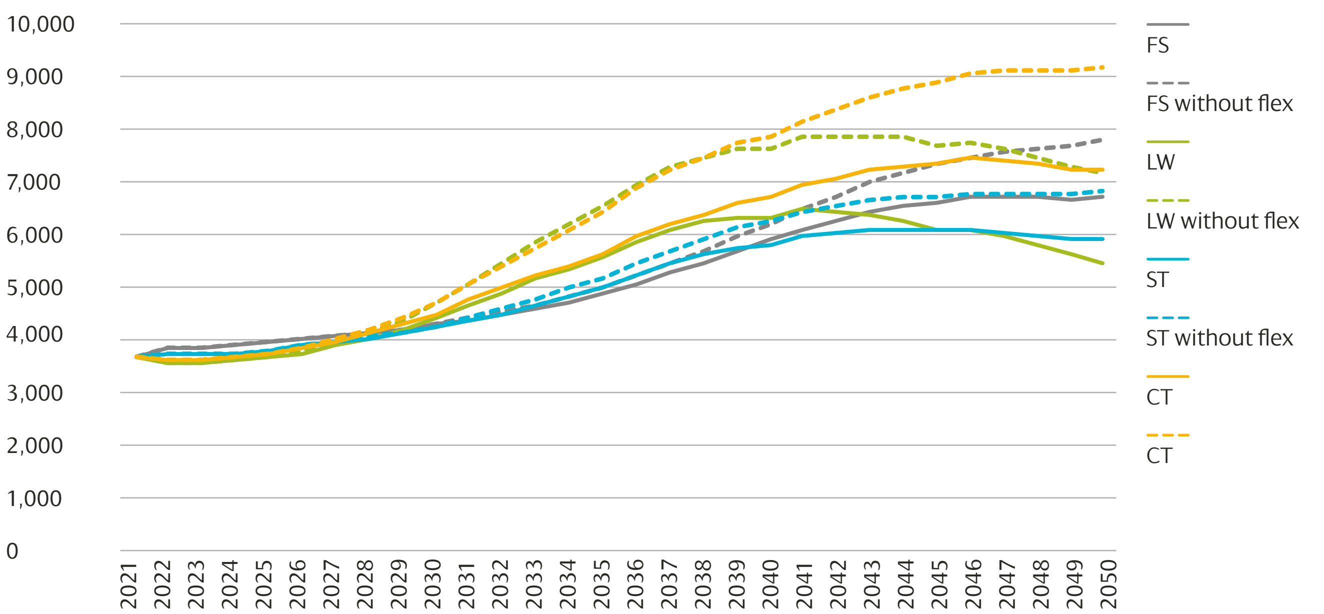


Figure 6 | Electricity peak demand breakdown for 2030 and 2050 *Peak demand (MW)*

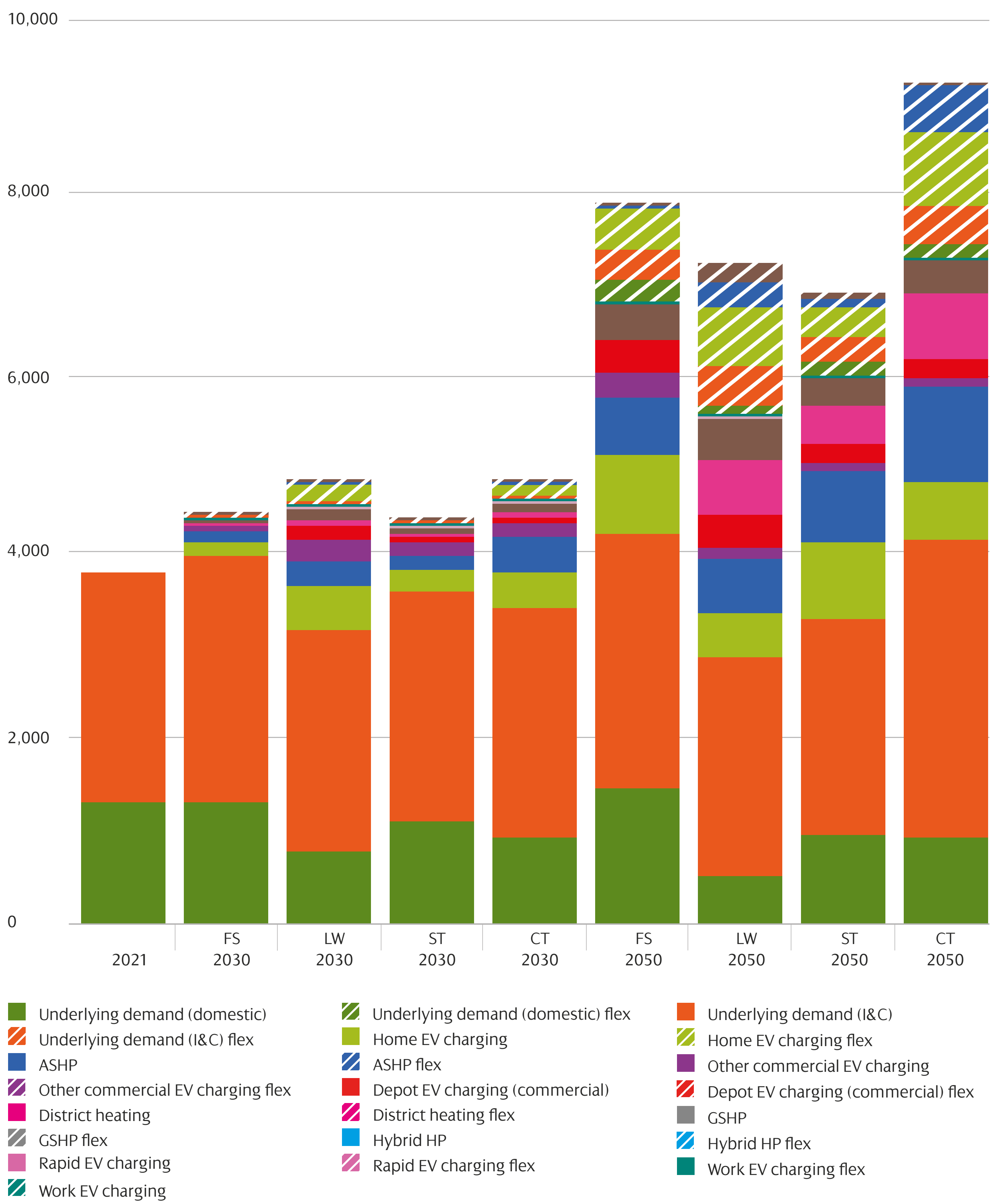
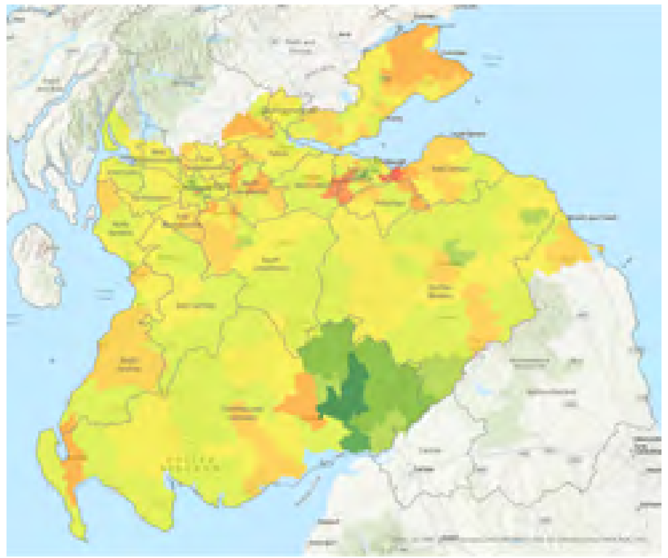


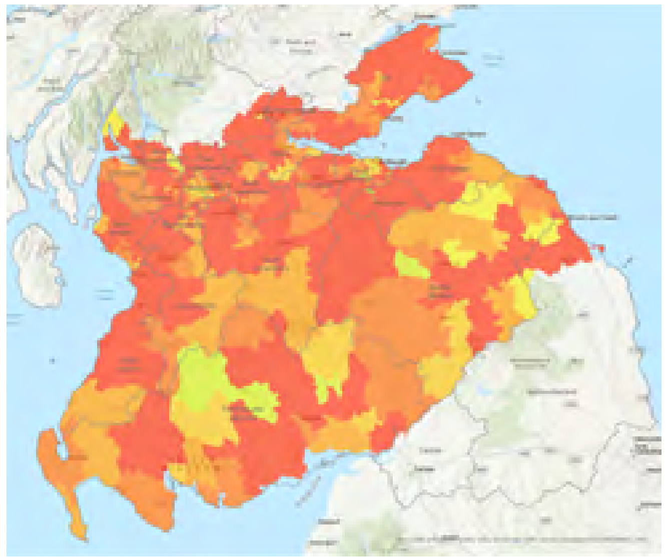
Figure 7 | Electricity peak demand changes from 2020 by primary substation area

Scale range: -4MW to >7MW

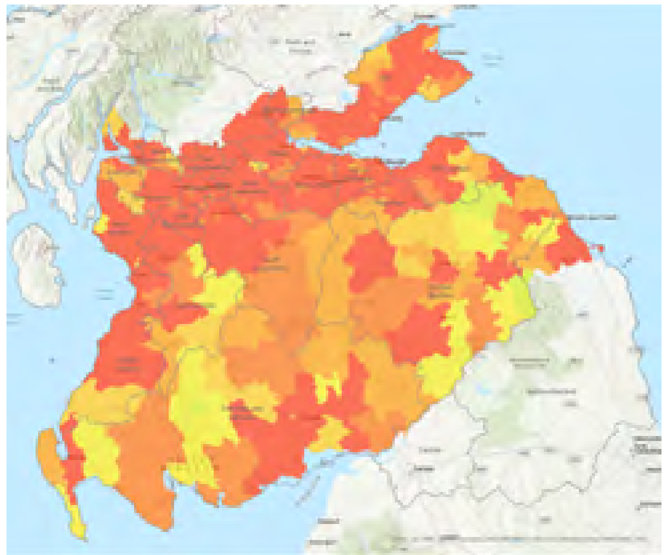
2030 – Low



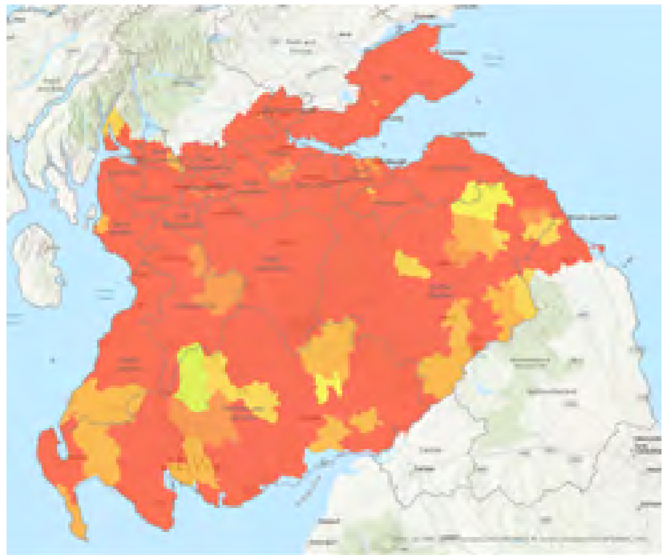
2050 – Low



2030 – High



2050 – High



OVERALL DEMAND TRENDS:

1. All scenarios show increasing demand. This means that the distribution network will need intervention to facilitate Net Zero.
2. Demand flexibility can help reduce peak demand. This would deliver benefits to consumers. This means that we should all be working to enable flexibility.
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.

5.3.2 Electric vehicles

By the end of 2021/22, we estimate the number of electric vehicles – both plug-in hybrids and battery electric – registered within the SP Distribution area was over 35,000. However, momentum in support of electric vehicle adoption is building quickly. Battery electric vehicle registrations in 2022 have again surpassed last year's. Their market share continues to grow on a monthly basis, and has now started to regularly surpass the sale of all forms of diesel cars.

Figure 8 shows the forecast numbers of residential battery electric vehicles in the SP Distribution region. For comparison the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our November 2021 DFES.

Figure 8 shows that across the scenarios, the share of residential battery electric vehicles rises from circa 16,000 in 2021 to between 267,000-933,000 in 2030. The reason for this high level of variance in the 2030s is that the scenarios include differing levels of ambition to phase out the sale of new petrol and diesel cars and vans. This ban has been brought forward to 2030, in line with the Scottish Government Update to the Climate Change Plan. Compared to today, this would mean almost 56 times more battery electric vehicles by 2030 and over 112 times by 2040 in our SPD Leading the Way scenario.

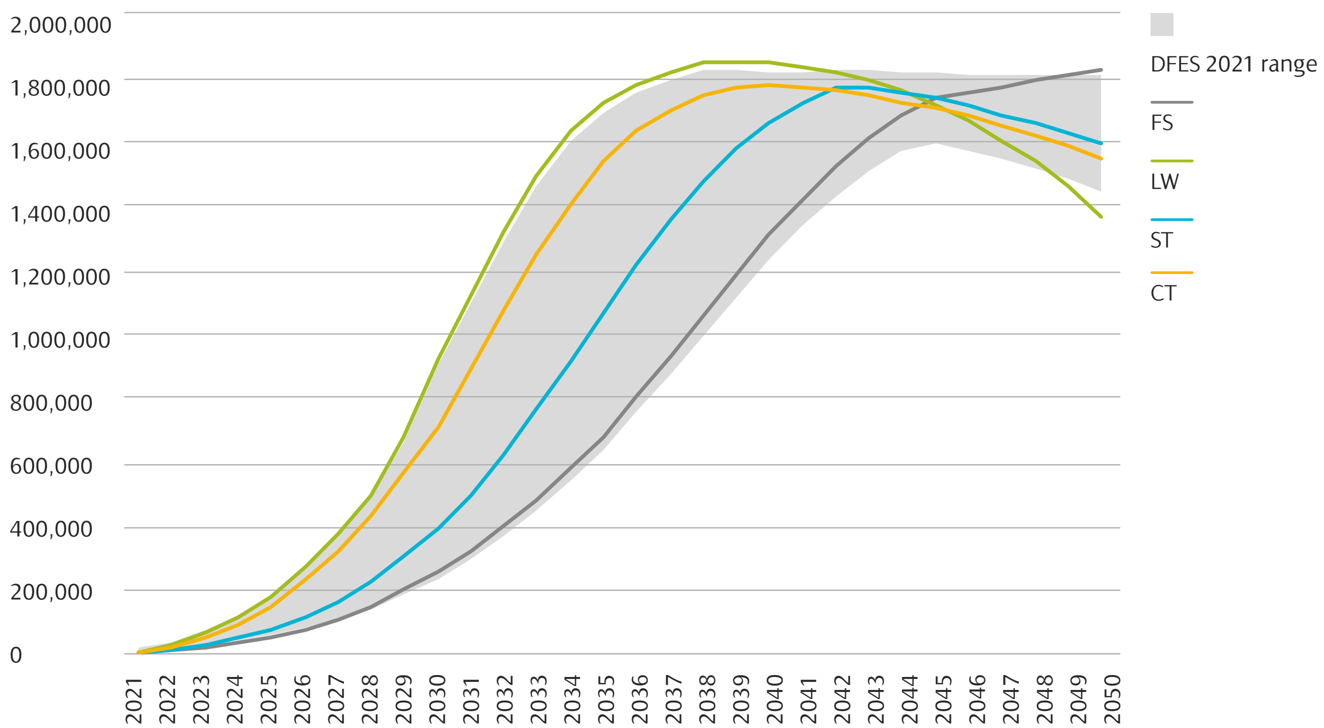
Our SPD Falling Short and SPD System Transformation scenarios contain a much slower uptake of residential battery electric vehicles up to 2030. Growth rates pick up in the early 2030s for SPD System Transformation and in the mid 2030s for SPD Falling Short, reaching around 1.8 million by 2043 and 2048, respectively.

All scenarios except Falling Short see a reduction in residential electric vehicles from the 2040s due to a reduction in car ownership. This reduction is earliest and most pronounced in the SPD Leading the Way scenario.

There could be as many as 933,000 residential EVs within the SP Distribution network area by 2030.

Figure 8 | Residential battery electric vehical uptake

Number of vehicles



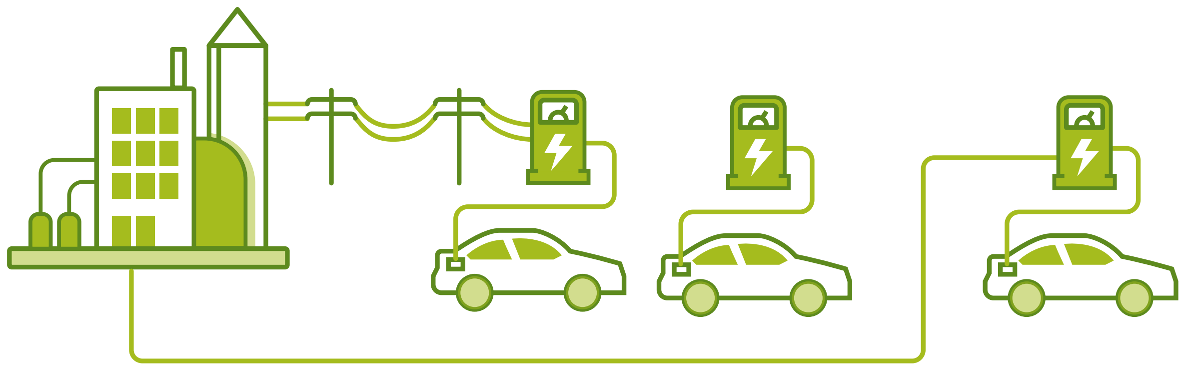
Widespread adoption of electric vehicles is expected to provide a significant challenge to the electricity sector due to the resultant large increases in peak demand.

Electric vehicle charging could have a significant impact on the SP Distribution peak demand if left unmanaged. Smart charging and vehicle to grid 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, and the benefits of smart charging and vehicle to grid.

Figure 9 also shows that the development of effective smart charging and vehicle to grid capabilities could considerably reduce peak demand compared to not having this capability. This means that the development of smart charging and vehicle to grid could deliver significant benefits for customers.

By 2030

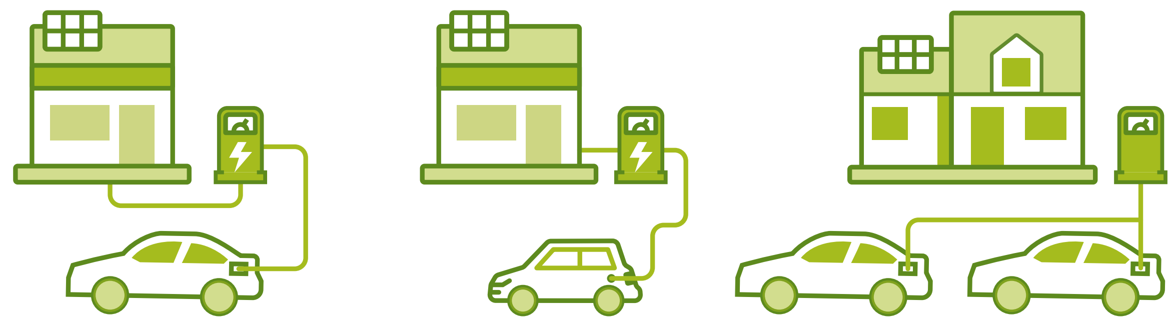


EV charging could add to SPM's peak demand between
162-662MW

Smart charging could reduce this contribution by
4-31%

V2G could help decrease this by a further
0-14%

By 2050



EV charging could add to SPM's peak demand between
1,178-1,568MW

Smart charging could reduce this contribution by
28-63%

V2G could help decrease this by a further
14-80%*

*The resultant peak demand reduction of over 100% means vehicle to grid has gone beyond offsetting the peak demand contribution from electric vehicles – as shown in Figure 9a.

Figure 9a | Home EV contribution to peak demand (LW scenario) *Peak home electric vehicle demand (MW)*

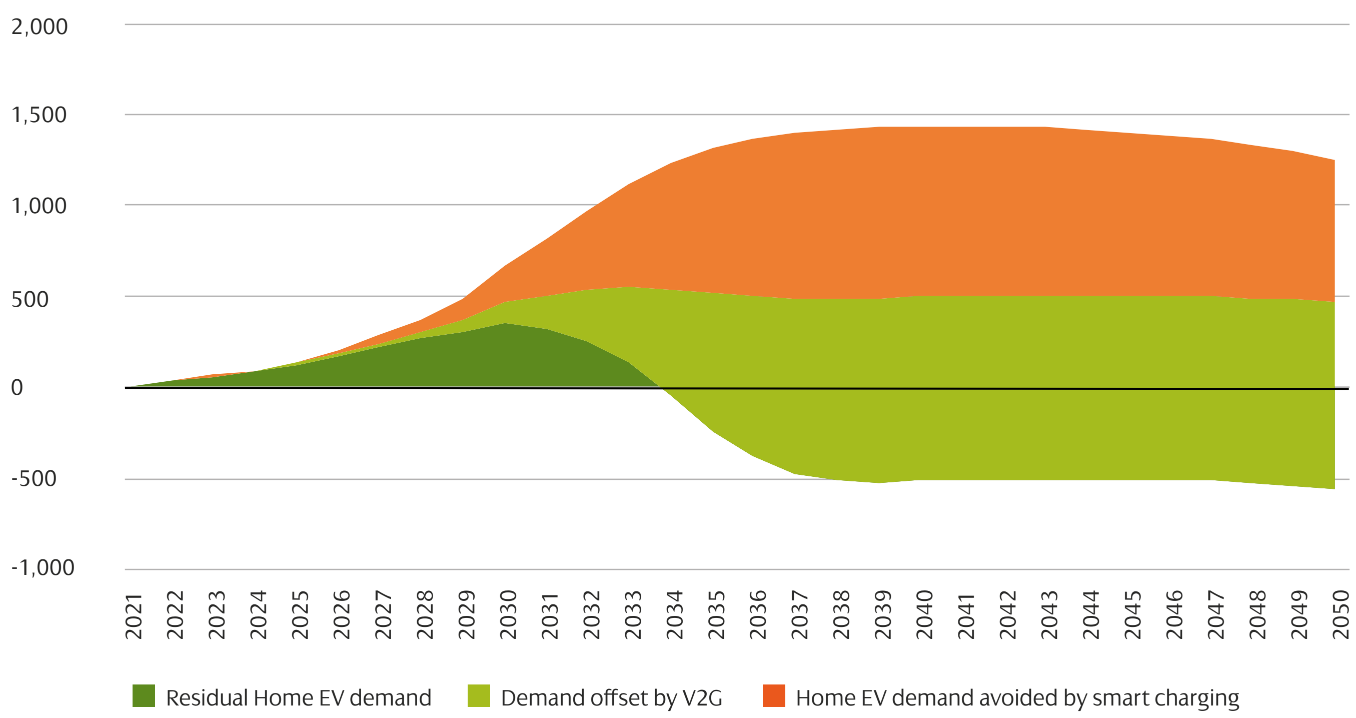
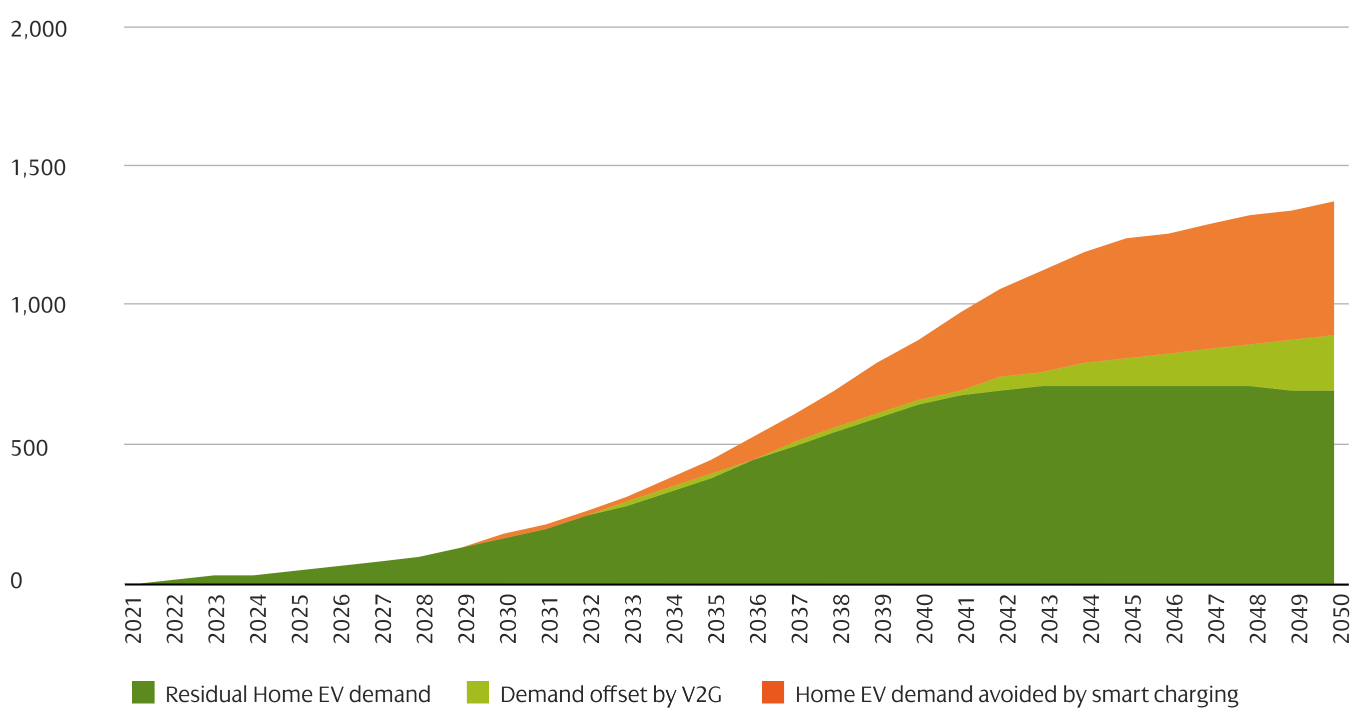


Figure 9b | Home EV contribution to peak demand (FS scenario) *Peak home electric vehicle demand (MW)*



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 socio-demographic information to understand the probability of specific areas to transition to electric vehicles.

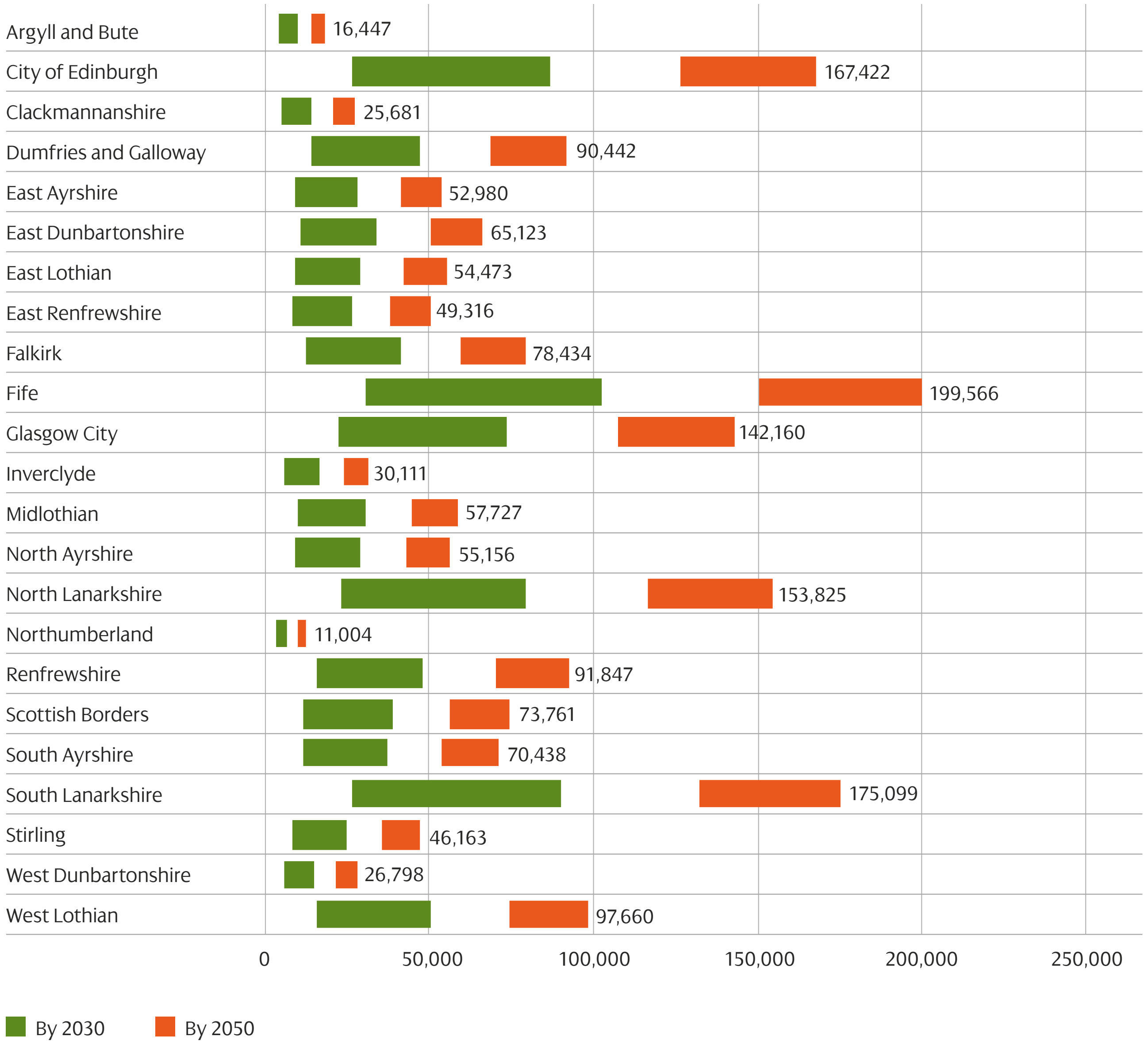
We have aggregated the results to show residential battery electric vehicle roll-out forecast by local authority area (Figure 10) and primary substation area (Figure 11). For all local authorities, we only provide forecasts for the area of that local authority which we serve.

The values shown in Figure 10 represent the range between the low and high forecasts.

Figure 10 shows that in Central & Southern Scotland, residential battery electric vehicles are predominantly found in densely populated areas such as Glasgow, Edinburgh, North Lanarkshire, South Lanarkshire or Fife, where each could see over 75,000 electric vehicles by 2030, increasing to over 140,000 by 2050.

Figure 10 | Potential range of residential battery EV uptake by Local Authority (by 2030 and 2050)

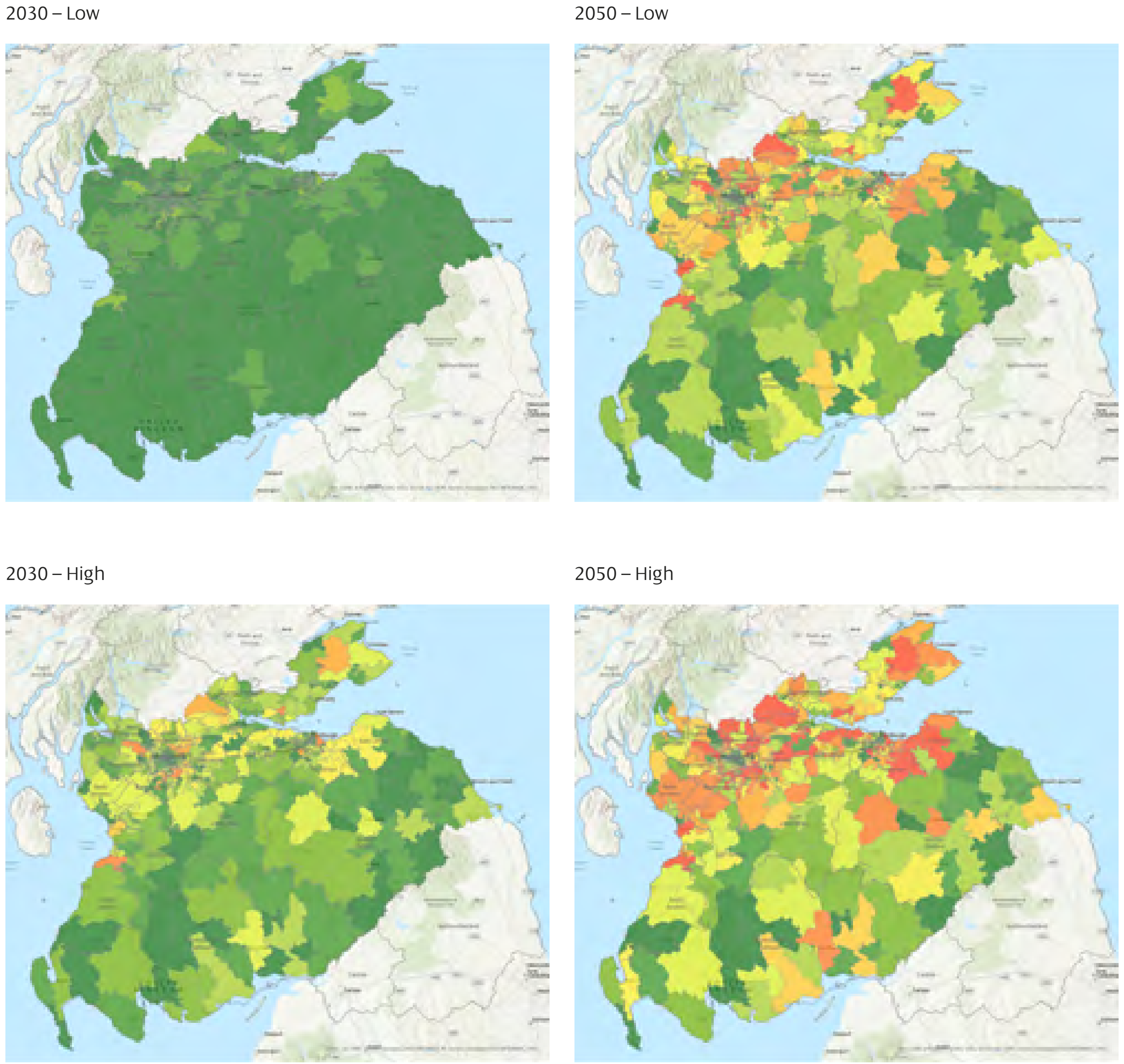
Range of number of EV uptake



SP Distribution Future Energy Scenarios – December 2022

Figure 11 | Residential battery EV uptake numbers by primary substation area

Scale range: 0 to >10,000



5.3.3 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. Deployment is still currently low, representing significantly under 1% of households within a total stock of circa 2 million households in the SP Distribution area. 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.

We have forecast heat pump uptake given the potential impact they could have on the network. 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 November 2021 DFES.

Figure 12 shows that there is significant variance between the heat pump forecasts.

THIS IS FOR TWO REASONS:

1. The SPD Falling Short scenario achieves less decarbonisation overall compared to the other three scenarios.

2. There are low carbon alternatives to small-scale heat pumps: district heating and hydrogen in the gas network are the two lead possibilities. SPD Consumer Transformation and SPD Leading the Way have a much higher degree of heat electrification than SPD System Transformation.

Compared to electric vehicles, where the roll-out rate between scenarios is different but by 2050 the overall volumes are broadly similar, there is significant variance across the four scenarios for heat pumps. This means that there will be very different impacts on the electricity network depending on which heat decarbonisation route is followed.

Figure 13 shows the impact on peak demand of the highest flexibility scenario* forecast and the potential of heat pump flexibility.

Figure 14 shows the same information for the lowest flexibility scenario forecast.

Figure 13 shows that the development of effective heat pump flexibility could reduce their associated peak demand contribution by up to 32% by 2050. This means that the development of this flexibility capability could deliver material benefits to network customers.

The total proportion of homes with a heat pump could reach 33% by 2030.

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

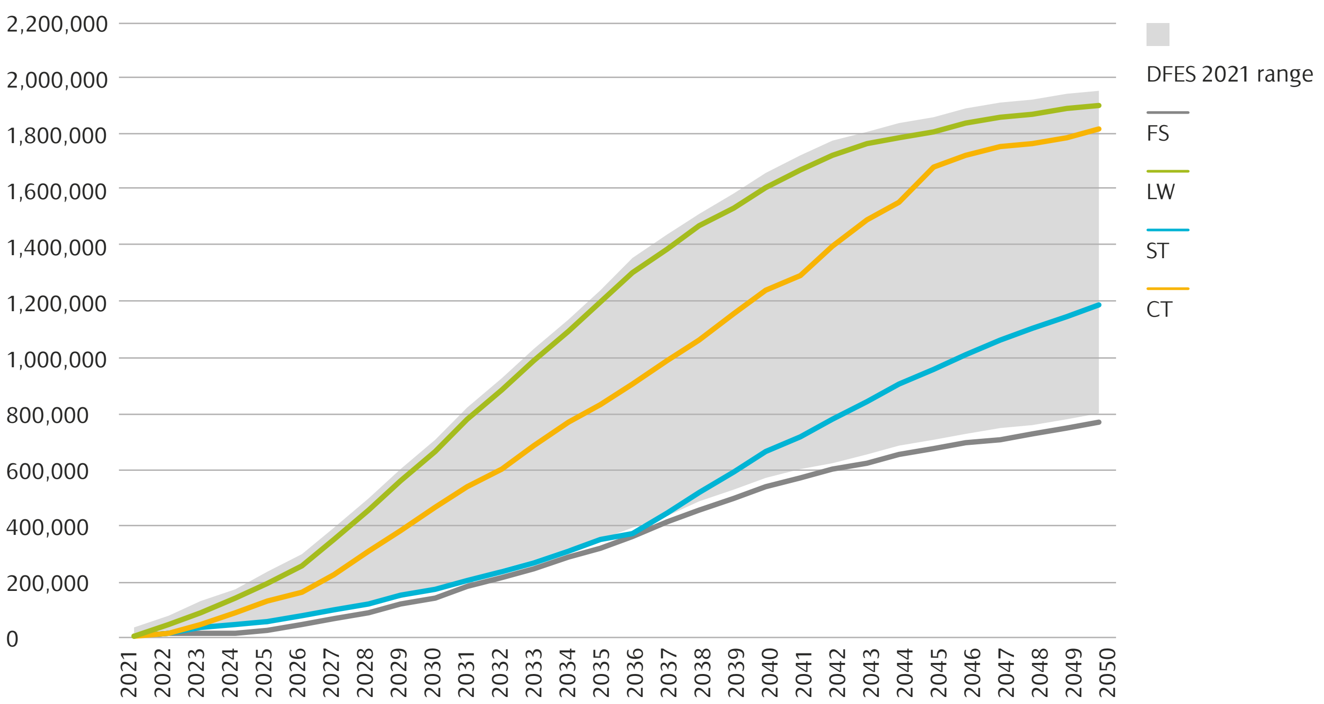


Figure 13 | Heat pump contribution to peak demand (LW scenario) *Peak heat pump demand (MW)*

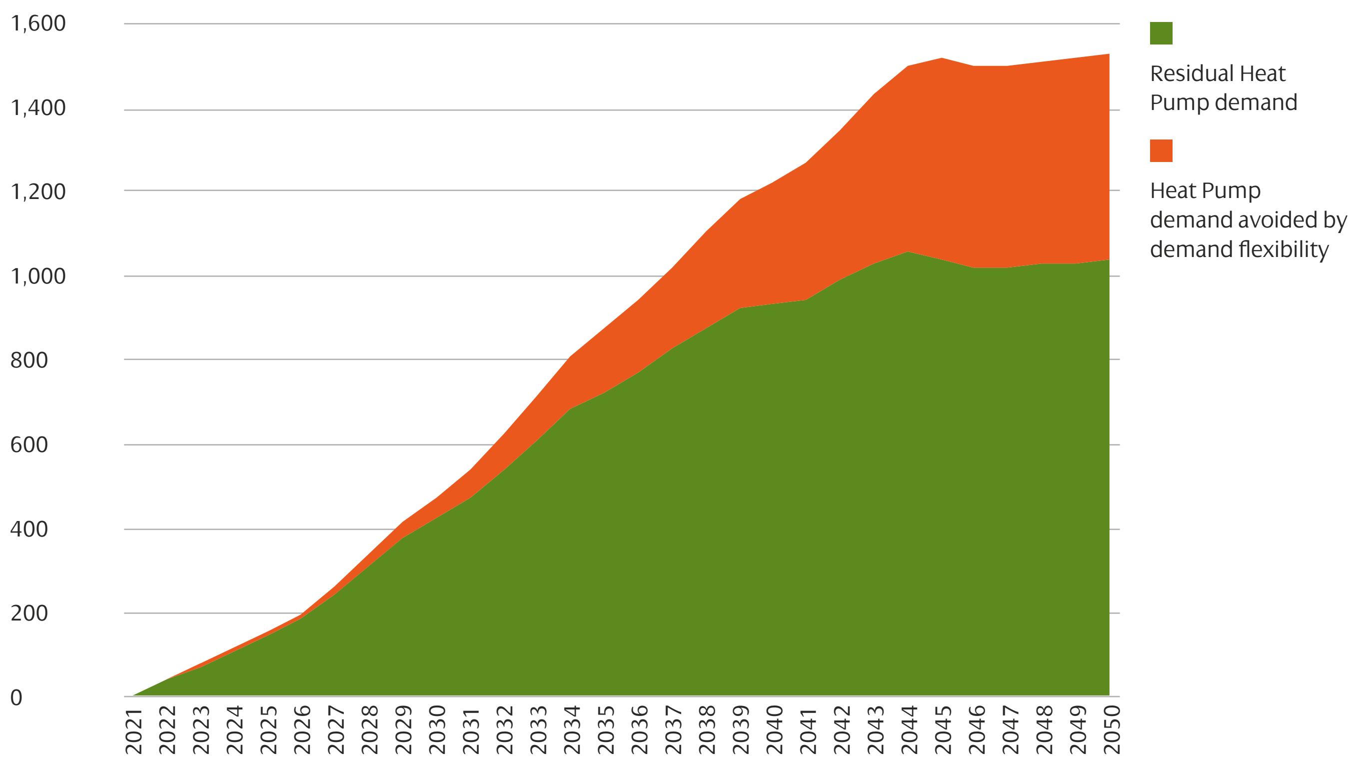
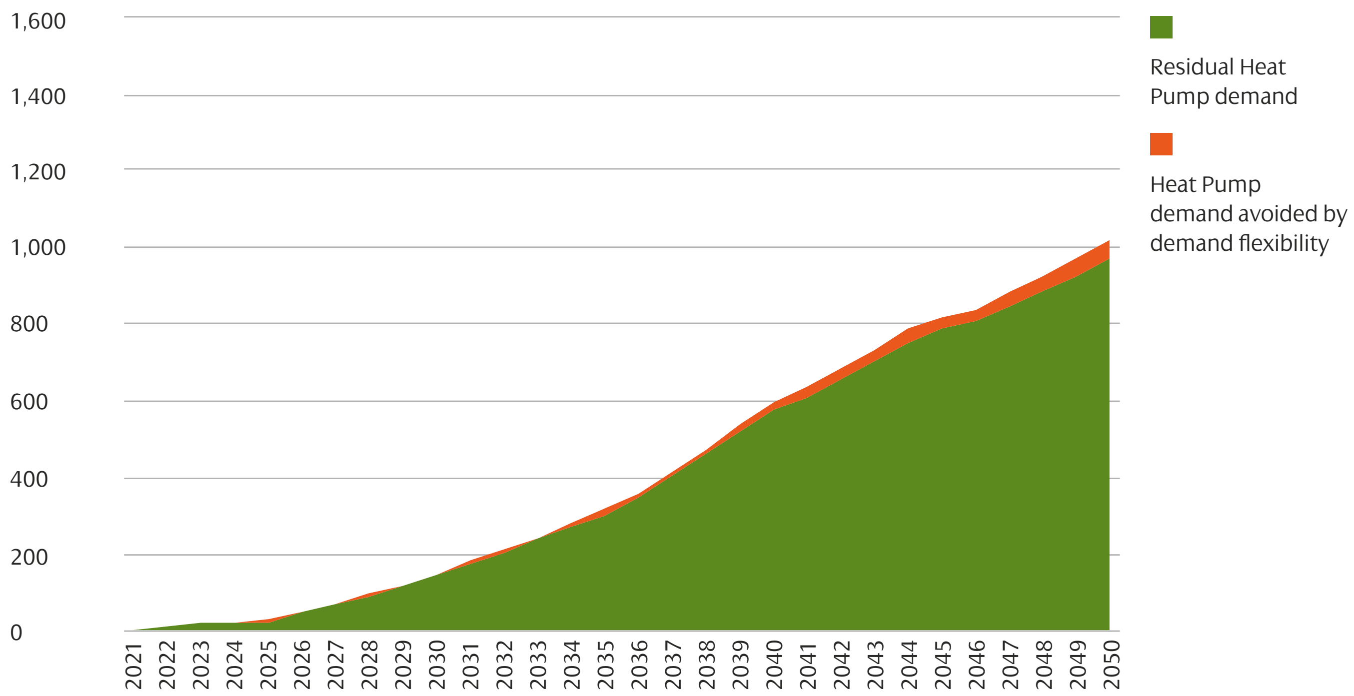


Figure 14 | Heat pump contribution to peak demand (FS scenario) *Peak heat pump demand (MW)*



*Note that peak heat pump demand is higher in the Consumer Transformation scenario, but the affect of flexibility is less than in Leading the Way.

Figure 15 | Potential range of heat pump uptake by local authority (by 2030 and 2050)

Range of number of heat pumps

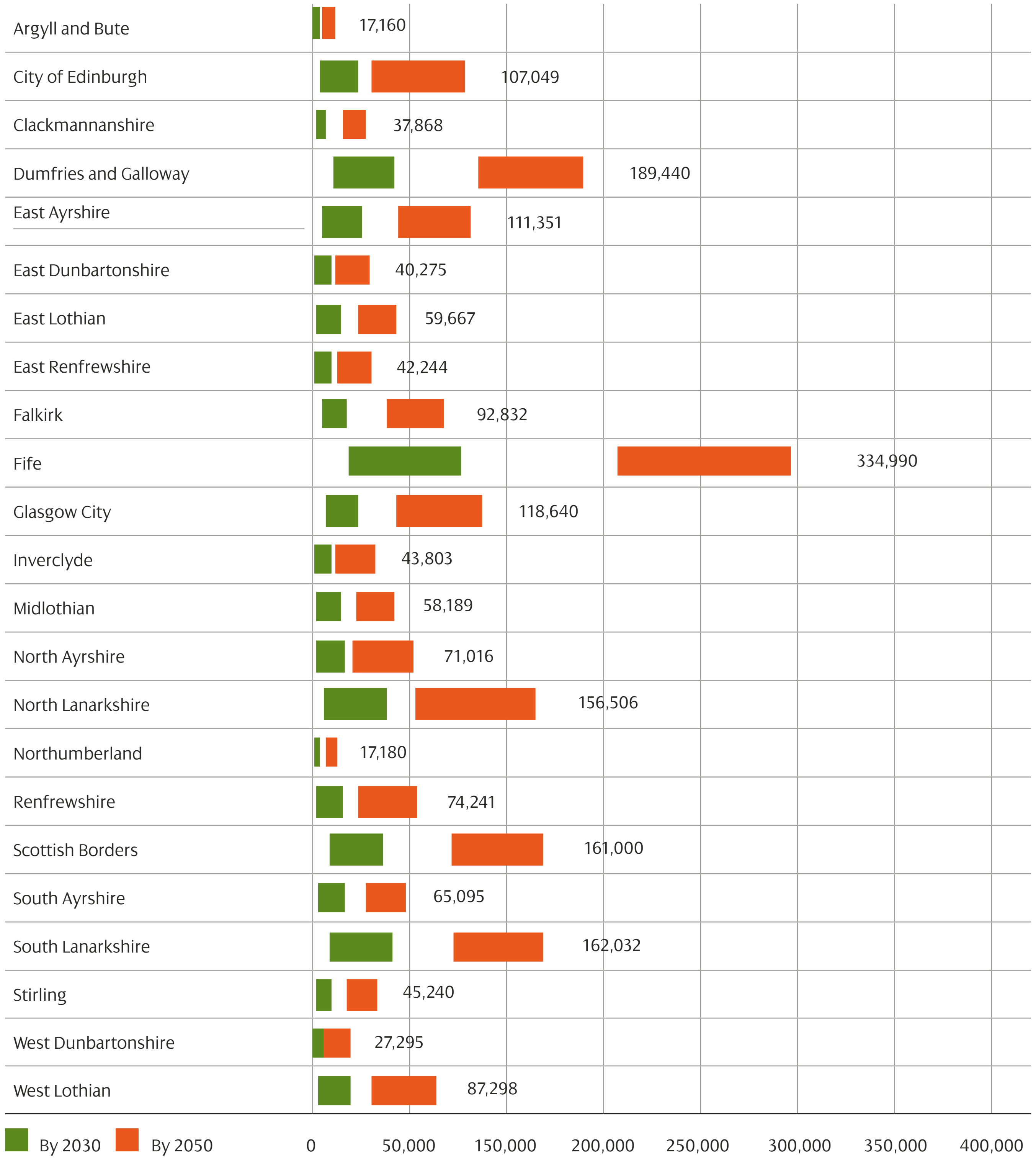
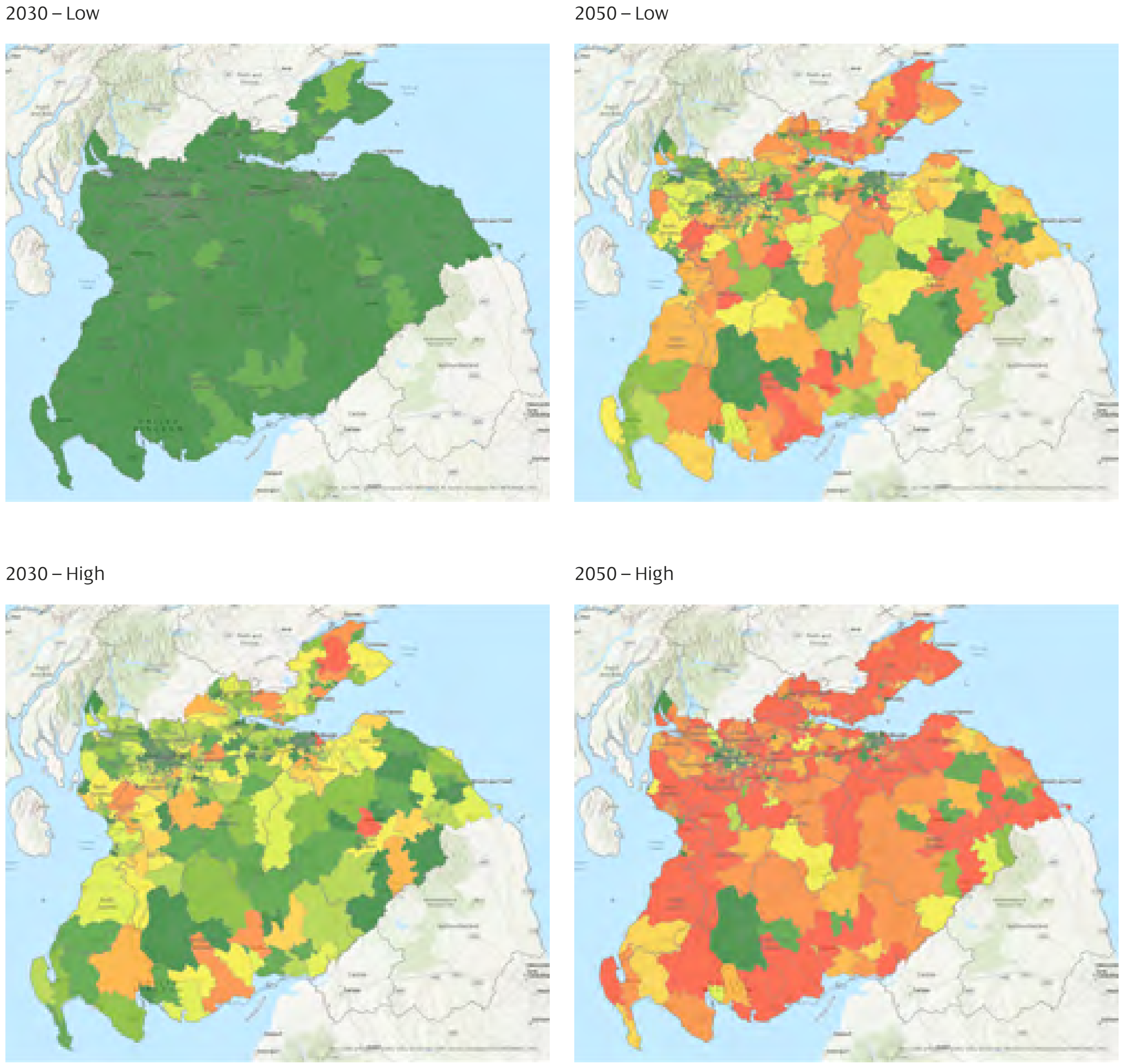


Figure 16 | Heat pump numbers by primary substation area

Scale range: 0 to >7,500



5.4 Electricity generation and storage

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

5.4.1 Generation and storage overview

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

THE VOLUME OF ELECTRICITY GENERATION CONNECTED TO THE DISTRIBUTION NETWORK IN CENTRAL AND SOUTHERN SCOTLAND 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).

Figure 17 shows how the total generation and storage capacity connected to the Central and Southern Scotland 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 November 2021 DFES. The increase is driven by recent trends in our short term pipeline (the amount of generation that is contracted to connect), which has seen exceptional increase predominantly in battery storage, but also to a lesser extent in solar PV. More detail is given later in this section.

Figure 17 shows that our scenarios forecast the distributed generation and storage capacity in our SP Distribution region to be circa three times higher than today by 2030. By 2050, our scenarios indicate there could be as much as 3-6 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 SPD Falling Short and SPD System Transformation scenarios but could triple the amount of small-scale generation in the SPD Leading the Way scenario by 2030.

To better illustrate what is driving the changes in generation, Figure 18 shows a breakdown of the generation and storage forecasts from Figure 17 by technology type, for 2030 and 2050.

Figure 18 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.[16] 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 17 and Figure 18 show increasing electricity generation for all scenarios out to 2050. These forecasts and trends are the total values for Central and Southern Scotland. However different regions will see different increases in generation, based on a range of factors.

[16] This 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 17 | Total installed generation and storage capacity *Capacity (MW)*

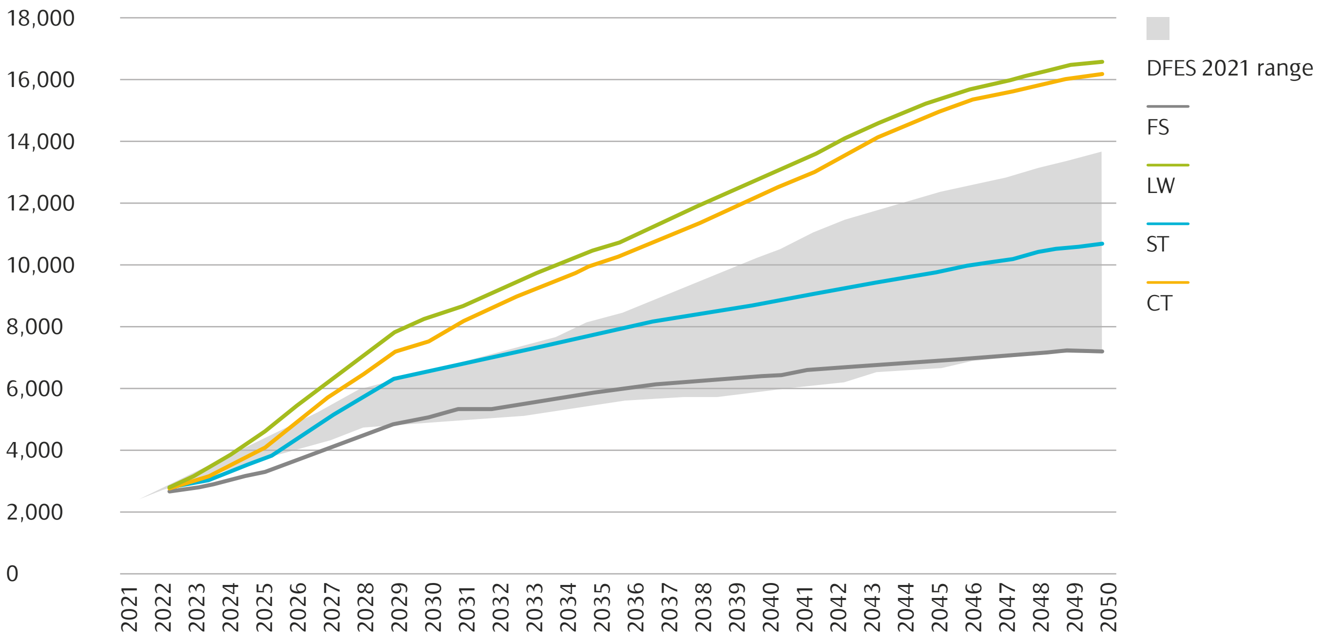


Figure 18 | Breakdown of installed generation capacity by technology type *Capacity (MW)*

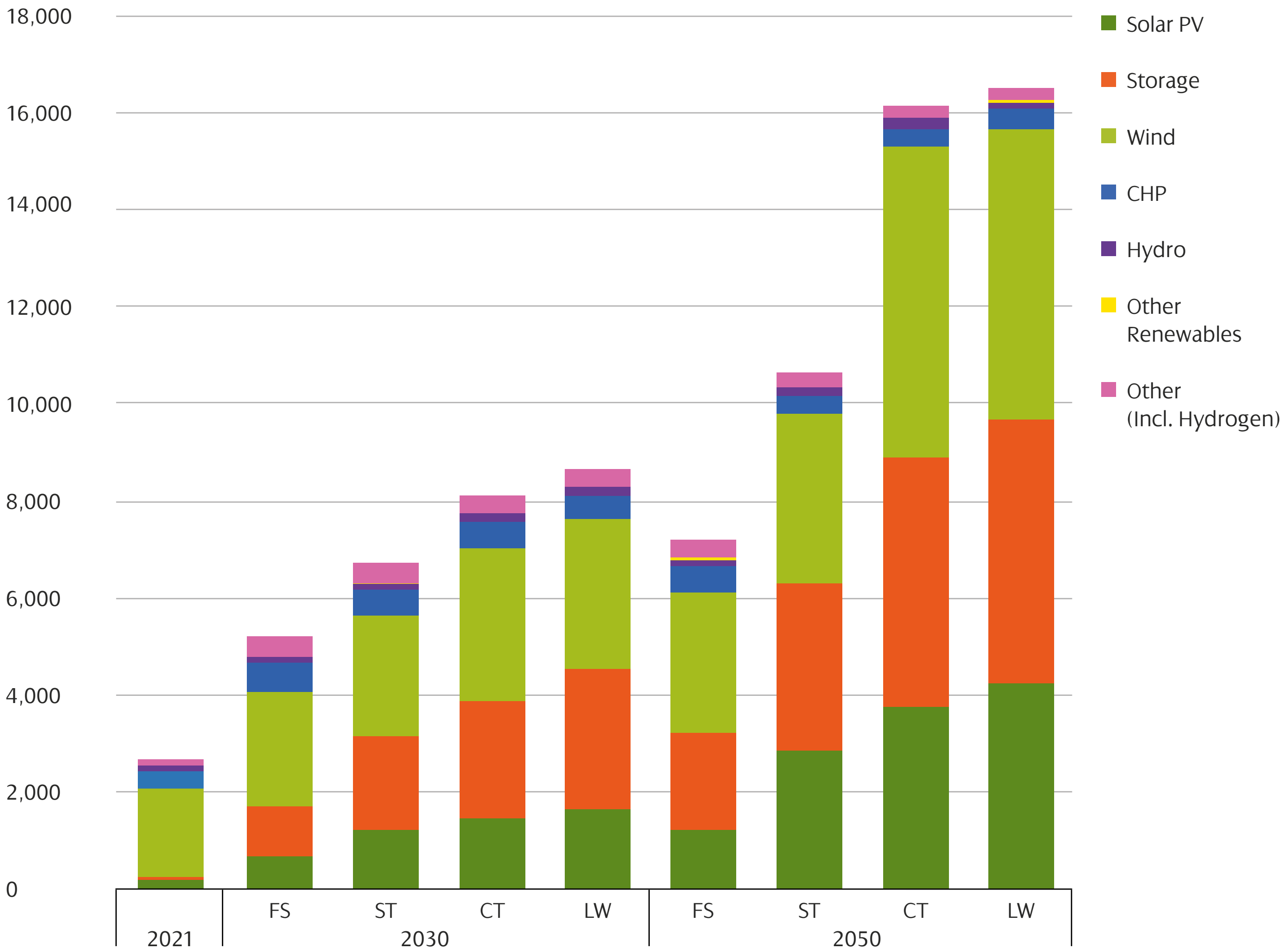
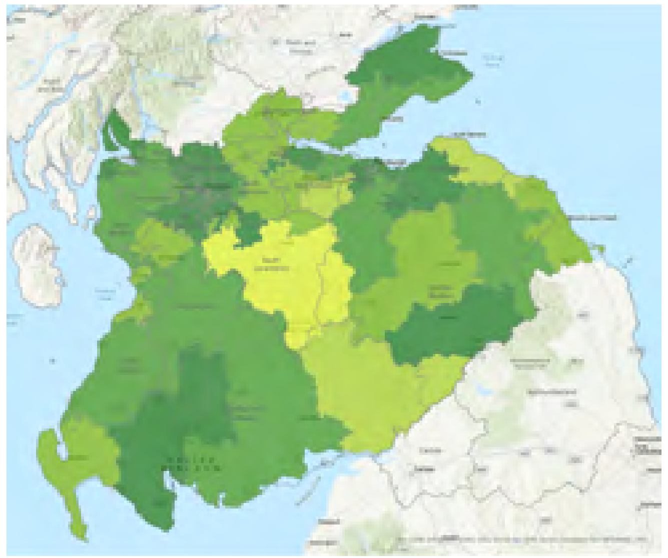


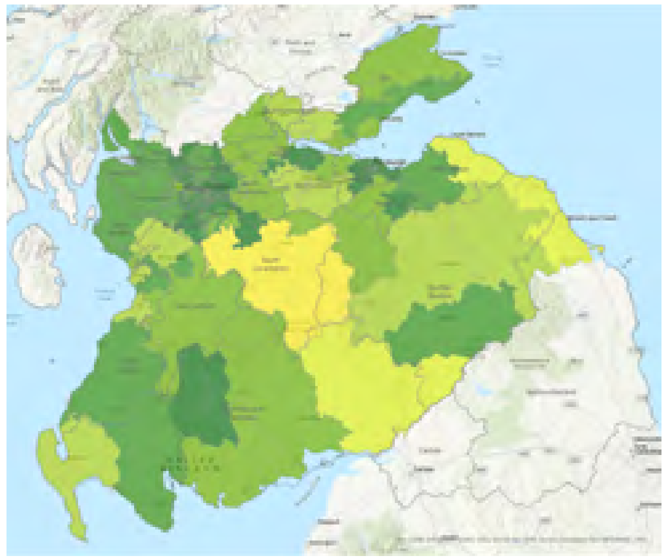
Figure 19 | Installed generation and storage capacity by GSP area

Scale range: 0MW to >500MW

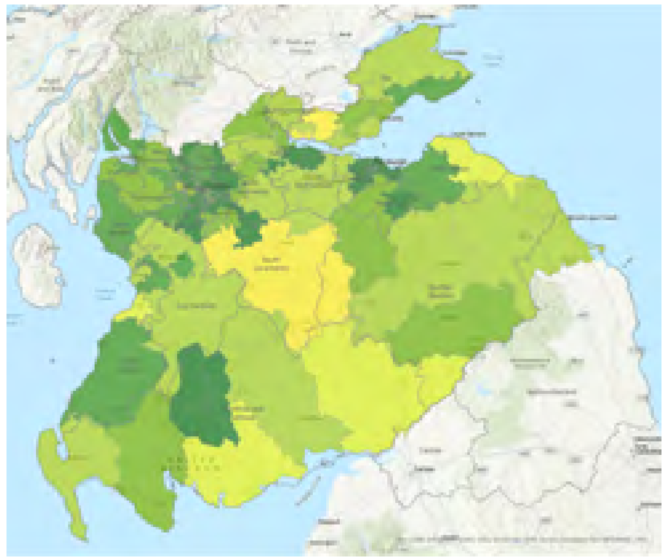
2030 – Low



2050 – Low



2030 – High



2050 – High

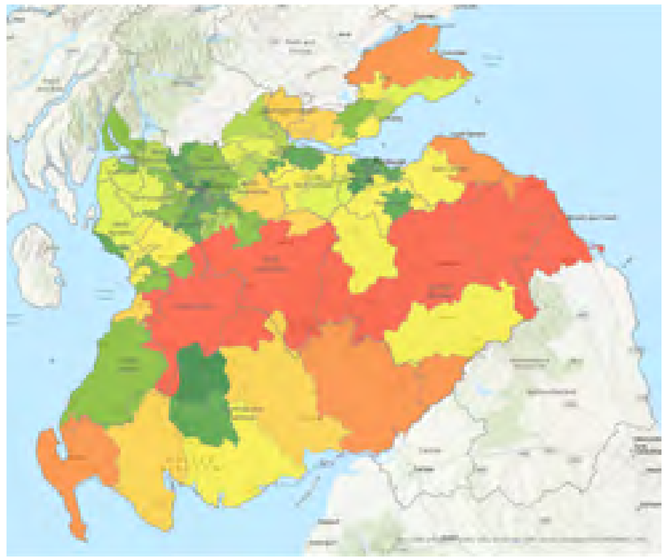


Figure 19 shows the geographical breakdown of how the generation and storage capacity connected to the distribution network could change by 2030 and 2050 from current levels for the highest and lowest forecast scenarios.

Figure 20 shows a similar representation, for domestic-scale and smaller-scale generation and storage at the primary substation level.

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.
4. Compared to last year, total generation and storage growth has increased significantly due to significant increase in connection applications predominantly in battery storage.

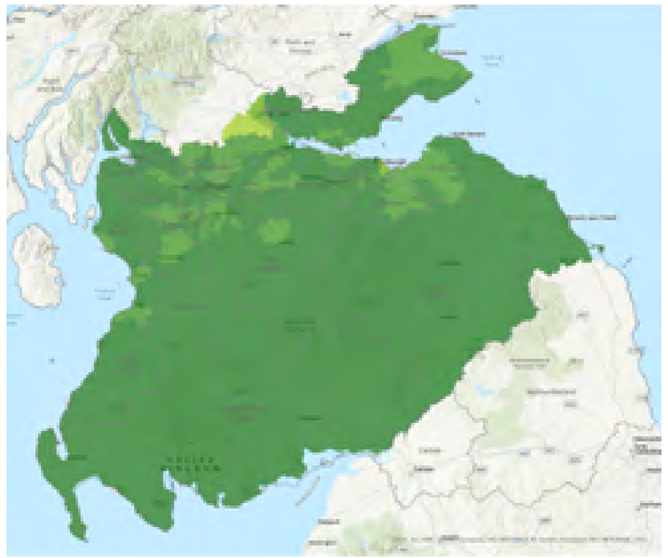
Figure 20 | Domestic-scale and smaller-scale installed generation and storage capacity by primary substation area

Scale range: 0MW to >18MW

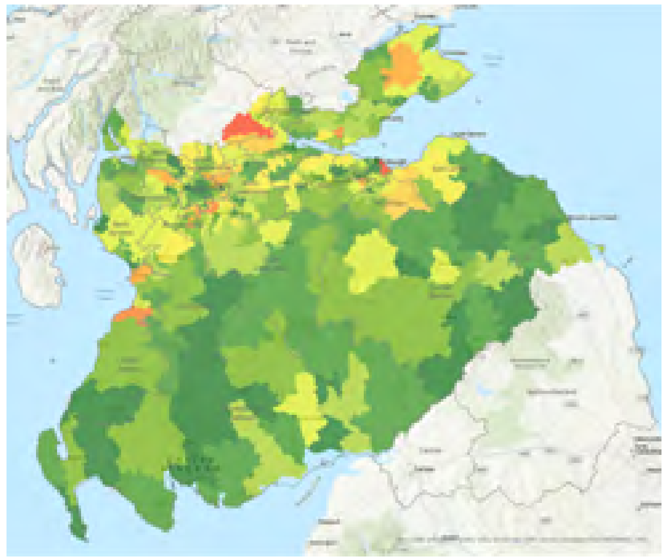
2030 – Low

2050 – Low

2030 – High



2050 – High



5.4.2 Solar PV

Over the past five years, our distribution network has seen a slower uptake of solar PV generation compared to other technologies such as wind. However, our forecasts have projected significant growth in solar to facilitate the further decarbonisation of electricity generation. This year, we have experienced a large increase - over 130% – in solar PV expected to connect to the network in the medium term. This has in turn increased our growth forecasts, albeit by a smaller amount, out to 2050.

Figure 21 shows the forecast uptake of solar PV for the four scenarios. It shows significant future increases in solar PV capacity across all scenarios, potentially increasing eight times from current levels by 2030 and 21 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 22 shows a breakdown of the Figure 21 solar PV forecasts for these two categories, for 2030 and 2050.

Figure 22 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 eight times greater than today by 2030.

Figure 21 | Installed solar PV generation capacity *Capacity (MW)*

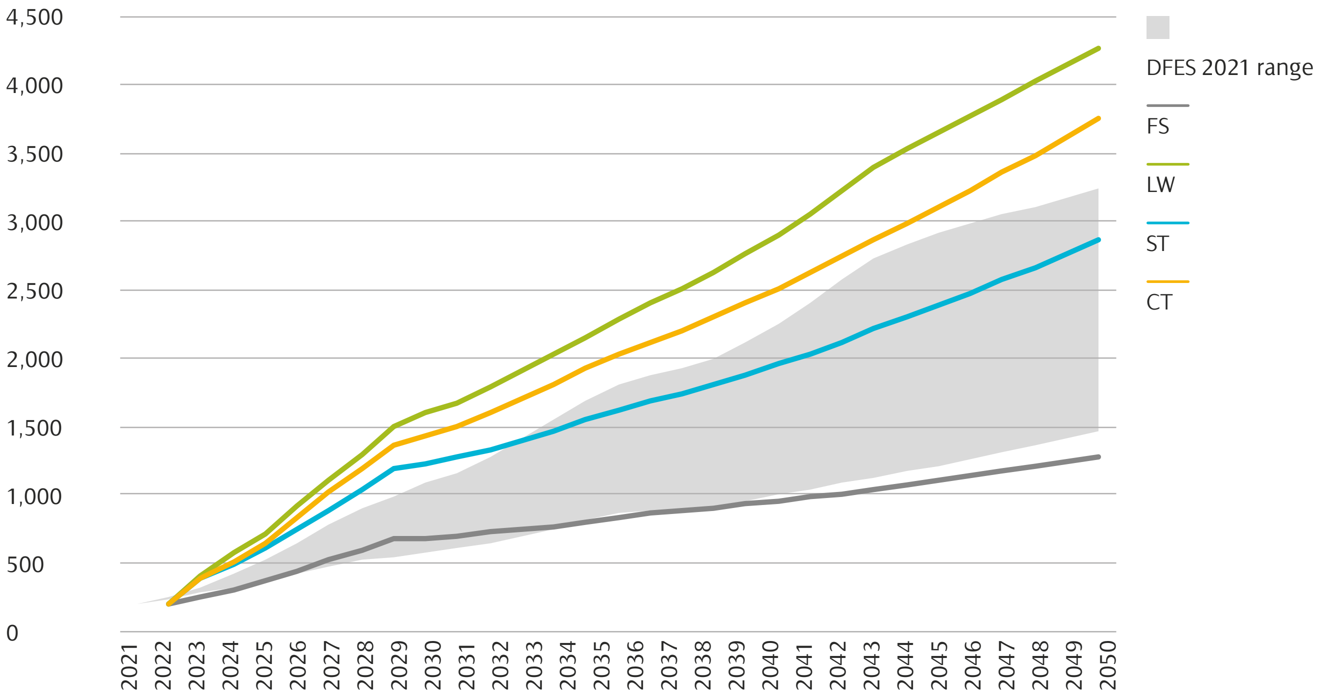
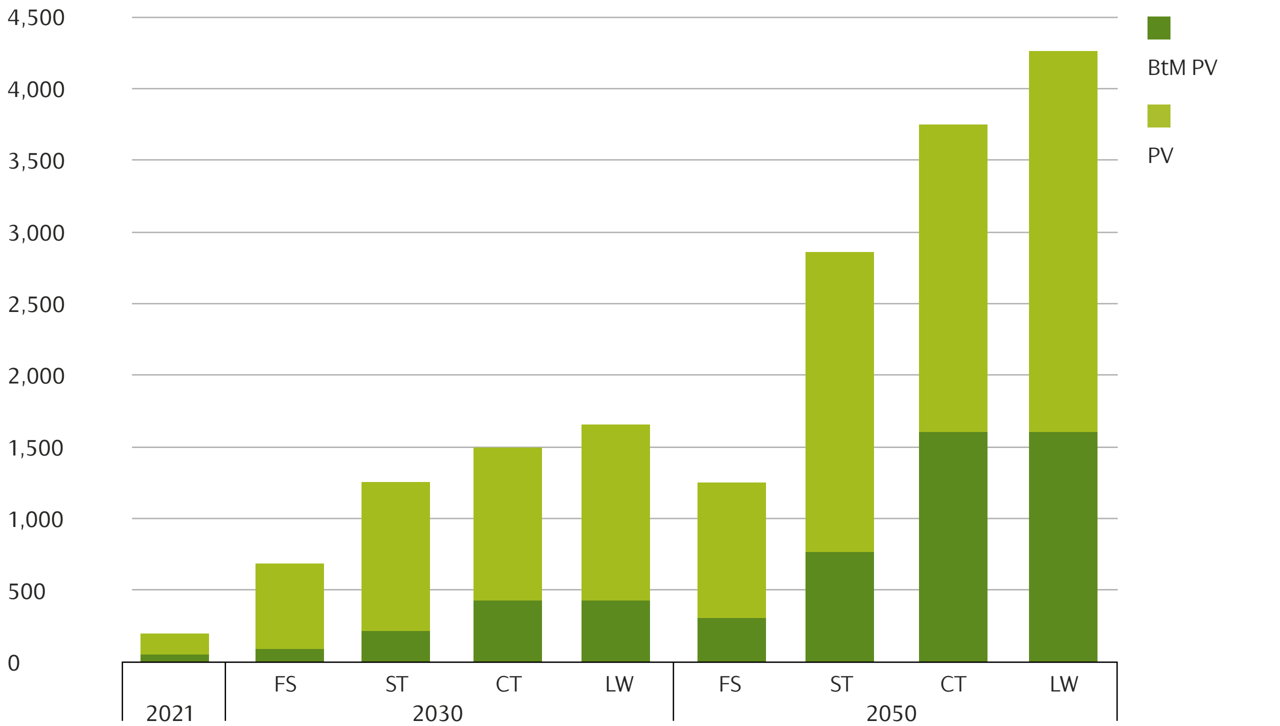


Figure 22 | Distribution connected and behind the meter solar PV capacity *Capacity (MW)*



5.4.3 Wind

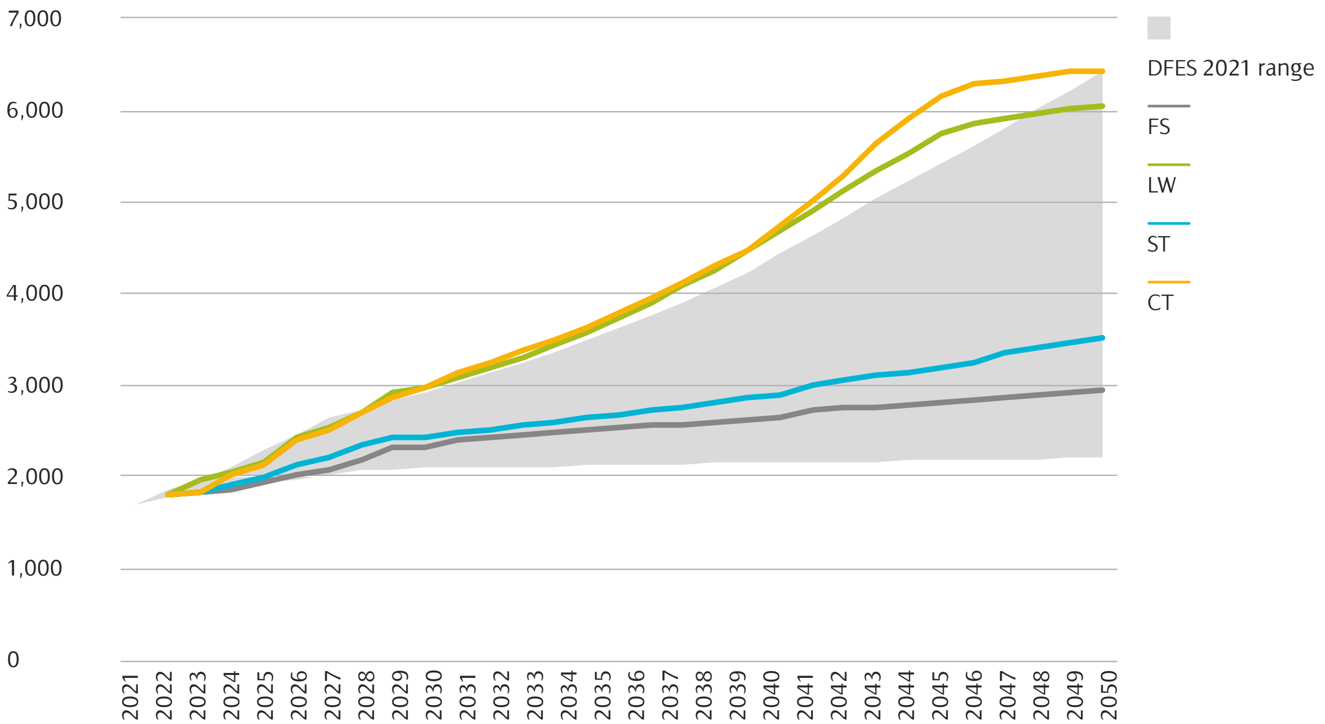
Over the last ten years, there has been steady growth in wind capacity on the SP Distribution network leading to circa 1.8GW of installed capacity.

Figure 23 shows significant variance in the levels of wind generation across the four scenarios. Wind generation is a cost-effective established technology, so the extent of new wind generation will likely depend on the onshore planning regime, government/policy support, and local support for individual schemes. Any increase in distribution connected wind is expected to be sited in rural areas, taking advantage of more favourable wind conditions.

The beneficial impact of wind generation offsetting peak demand on the network could be limited, given that it is weather-dependent. The scenarios are slightly more ambitious this year in line with updates in the ESO's July 2022 FES: the maximum installed capacity in SPD Consumer Transformation and SPD Leading the Way are reached earlier, in the mid 2040s, which is better aligned to Scotland's 2045 Net Zero target. There has also been a significant uplift in the longer term forecast of least ambitious scenario, SPD Falling short. This shows that wind is expected to play an increasing role in electricity generation in any view of the future.

Wind generation could increase by up to 78% by 2030.

Figure 23 | Installed wind generation capacity *Capacity (MW)*



5.4.4 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 24 shows the forecast uptake of electricity storage for the four scenarios. Given the many different storage technologies and their evolving nature,we have not created individual forecasts for each technology.

Figure 24 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.

Distribution connected storage is assumed to be sited initially in areas with low network constraints (to allow services to be provided to the wider system). At different points in time, depending on the scenario, the siting of storage then shifts to areas of high network constraint, as the value of providing distribution level constraint management services increases.

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.

Figure 25 shows a breakdown of the Figure 24 storage forecasts for these two categories, for 2030 and 2050.

Figure 25 shows that, across all scenarios, the majority of storage growth is for standalone storage. It is worth noting that, the forecasts in Figure 24 and Figure 25 do not include the inherent storage capacity in electric vehicles. When plugged in, electric vehicles could be another widespread form of electricity storage – smart charging and vehicle to grid technologies would enable this capability.

In the past year, SPD has experienced a step-change in battery storage applications, of which 3GW* has already been contracted to connect across almost half our GSPs. This large increase in activity has lead to a significant uplift from previous forecasts in our SPD Leading the Way, SPD Consumer Transformation and SPD System Transformation scenarios.

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

*As of November 2022.

Figure 24 | Installed storage capacity *Capacity (MW)*

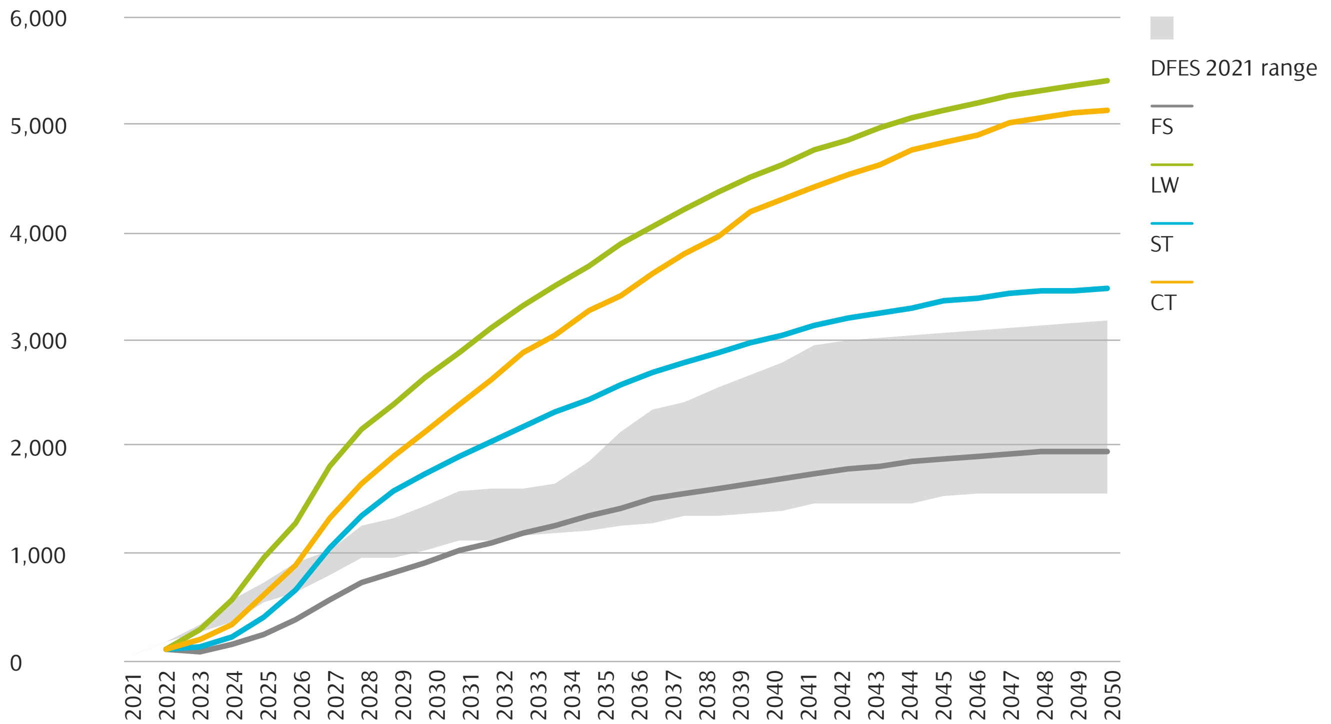
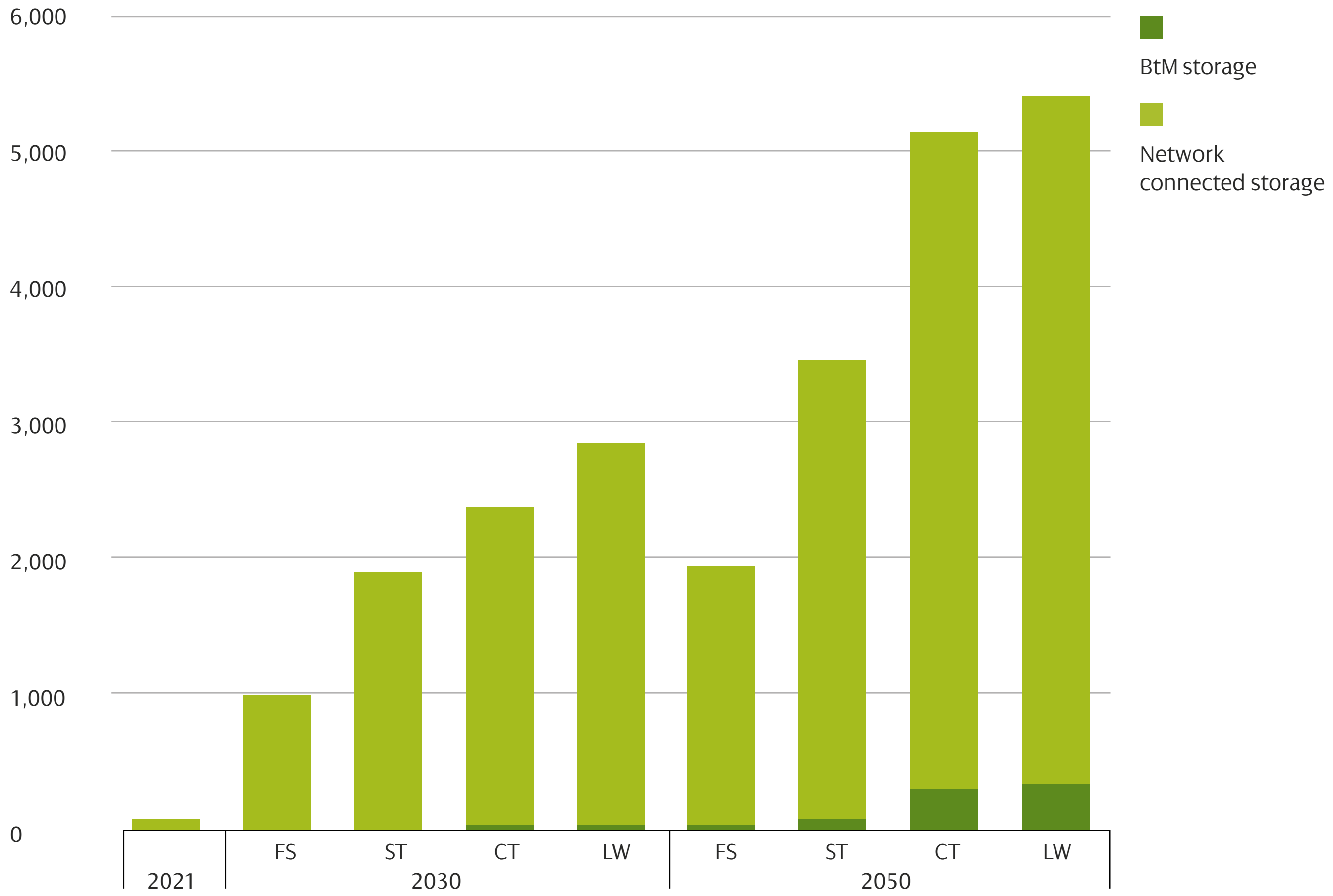


Figure 25 | Distribution connected and behind the meter storage capacity *Capacity (MW)*



Reconciliation with the ESO's 2022 FES

This section provides a comparison between the SP Distribution forecasts and the ESO's 2022 FES for key building blocks.

As we explain in **Section 4**, 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[17] and FES regionalisation[18] to compare our DFES forecasts to the FES forecasts.

This section provides a comparison of our DFES forecasts to the regionally equivalent ESO's 2022 FES for key building blocks. Other building block data is available in the DFES data workbooks[19].

6

6.1 Electric vehicles

Our forecasts for the uptake of battery electric vehicles in the SP Distribution network are broadly aligned with FES, as shown in **Figure 26.**

However, based on the Scottish Government's own detailed assessment work and feedback, we have updated our SPD Leading the Way scenario to include an accelerated electric vehicle uptake. This is because their legislated target of Net Zero by 2045, five years earlier than the rest of the UK, and interim 75% greenhouse gas emission reductions by 2030 could feasibly accelerate electric vehicle uptake beyond the FES Leading the Way scenario (the FES's highest EV uptake scenario). Table 1 provides a comparison with FES for battery electric vehicles by 2030.

Figure 26 | Battery electric vehicle uptake comparison (Lct_BB001 and Lct_BB003) *Number of vehicles*

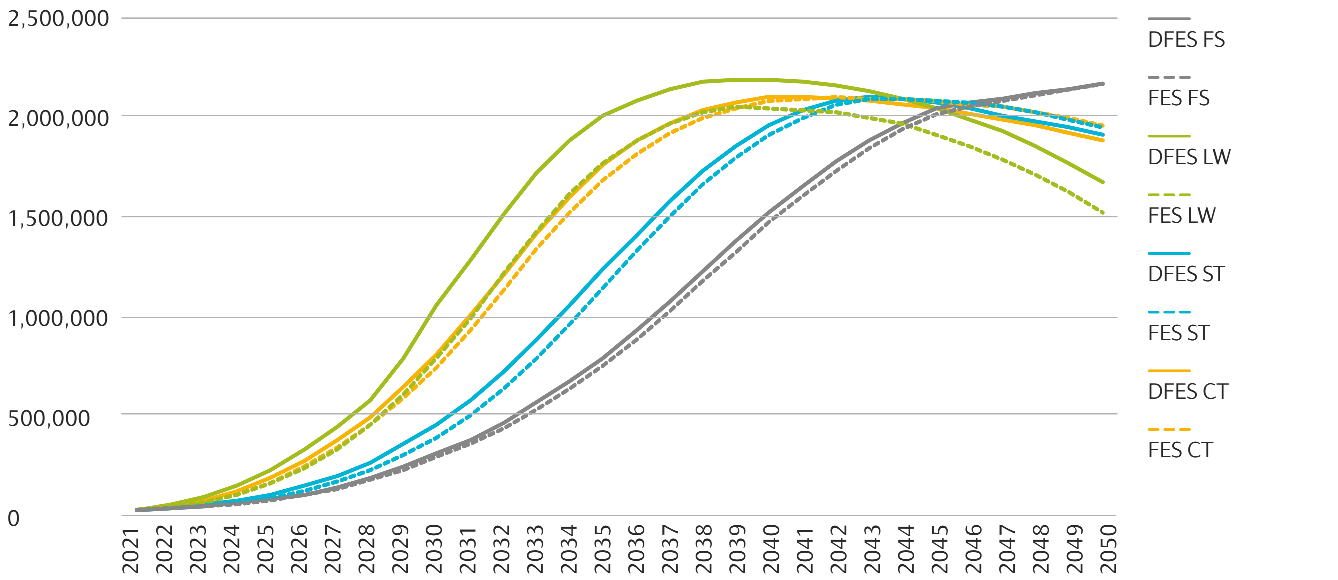


Table 1 | Battery electric vehicle volumes by 2030

Volumes at 2030 (thousands)		Cars, vans and motorbikes Lct_BB001	Other vehicle types Lct_BB003
DFES	Falling Short	304	1
	System Transformation	449	2
	Consumer Transformation	800	3
	Leading the Way	1,047	4
FES	Falling Short	283	1
	System Transformation	385	2
	Consumer Transformation	736	2
	Leading the Way	783	3

[17] 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.

[18] 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.

[19] www.spenergynetworks.co.uk/dfes

6.2 Heat pumps

The FES forecasts for the uptake of heat pumps in the SP Distribution network have increased notably this year, as shown in **Figure 27**.

Our forecasts show broad alignment to FES until 2030. We have previously updated our SPD Consumer Transformation scenario already to includes a faster uptake of heat pumps in the short to medium term based on the Scottish Government's own detailed assessment work and feedback. This is because the interim 75% greenhouse gas emission reduction target by 2030, could feasibly accelerate heat pump uptake in Scotland.

We have not increased our longer term forecasts for SPD Consumer Transformation and SPD Leading the Way by the same extent, which have remained broadly similar to last year, as we think the 2045 and 2050 ranges are already reasonable.

Our forecasts have been revised previously to align with the Scottish Government's Heat in Buildings Strategy. This sets out their plans to achieve Net Zero emissions in buildings by 2045, and the pace of this transition over the next 10 years. This includes over 1 million homes and 50,000 non-residential properties switching to low carbon heating systems to meet 2030 targets. Table 2 provides a comparison with FES for heat pumps by 2030.

We have more conservatively uplifted our SP Falling Short and SP System Transformation in line with FES growth, the latter driven primarily by hybrid heat pumps from the mid 2030s.

Figure 27 | Heat pump uptake comparison (Lct_BB005 to Lct_BB008) *Number of heat pumps*

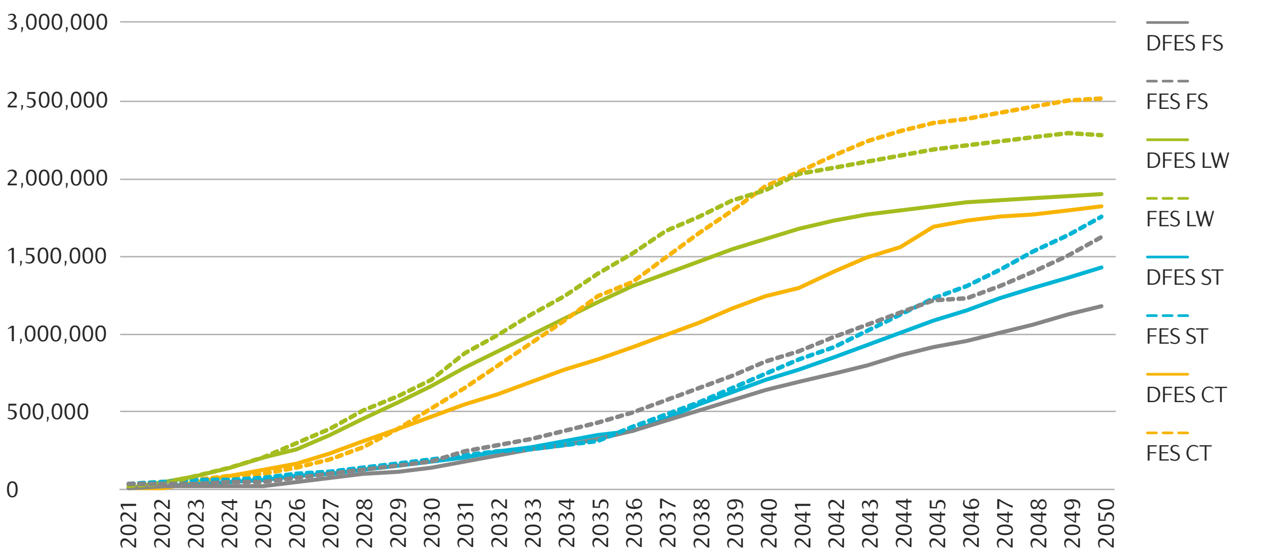


Table 2 | Heat pump volumes by 2030

Volumes at 2030 (thousands)		Non-hybrid Lct_BB005 & Lct_BB007	Hybrid Lct_BB006 & Lct_BB008
DFES	Falling Short	98	59
DFES	System Transformation	144	45
DFES	Consumer Transformation	408	68
DFES	Leading the Way	501	211
FES	Falling Short	168	16
FES	System Transformation	151	36
FES	Consumer Transformation	445	77
FES	Leading the Way	654	49

6.3 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.

This results in an overall higher installed capacity. This faster uptake in the earlier years is mainly driven by the number of 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 below provides a summary of the expected overall growth for these three technologies, for each scenario by 2030, in addition to the current level of connected generation.

Figure 28 | Distributed generation and storage capacity comparison (Gen_BB001 to Gen_BB023, Srg_BB001 to Srg_BB004) *Capacity (MW)*

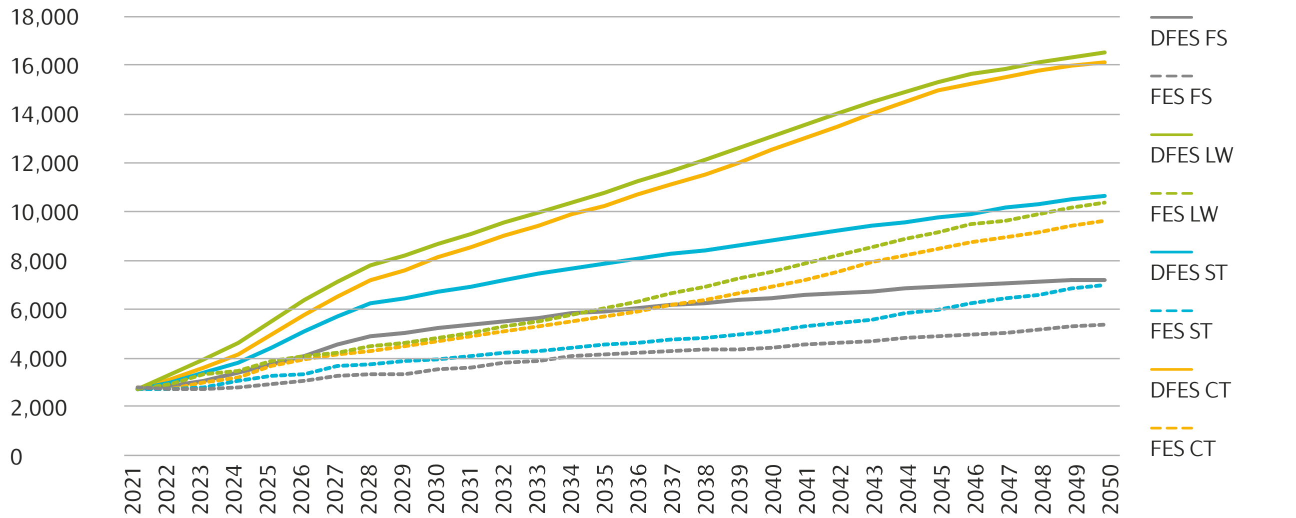


Table 3 | Additional generation and storage capacity by 2030

Additional GW at 2030		Total DG Gen_BB001-Gen_BB023 Srg_BB001-Srg_BB004	Solar PV Gen_BB012-013	Wind Gen_BB014-016	Storage Srg_BB001-004
Currently connected		2.7	0.2	1.8	0.1
DFES	Falling Short	2.5	0.5	0.6	0.9
DFES	System Transformation	4.0	1.1	0.7	1.8
DFES	Consumer Transformation	5.4	1.3	1.3	2.3
DFES	Leading the Way	6.0	1.5	1.3	2.8
FES	Falling Short	0.8	0.2	0.3	0.3
FES	System Transformation	1.2	0.4	0.4	0.4
FES	Consumer Transformation	1.9	0.7	0.8	0.4
FES	Leading the Way	2.1	0.8	0.8	0.5

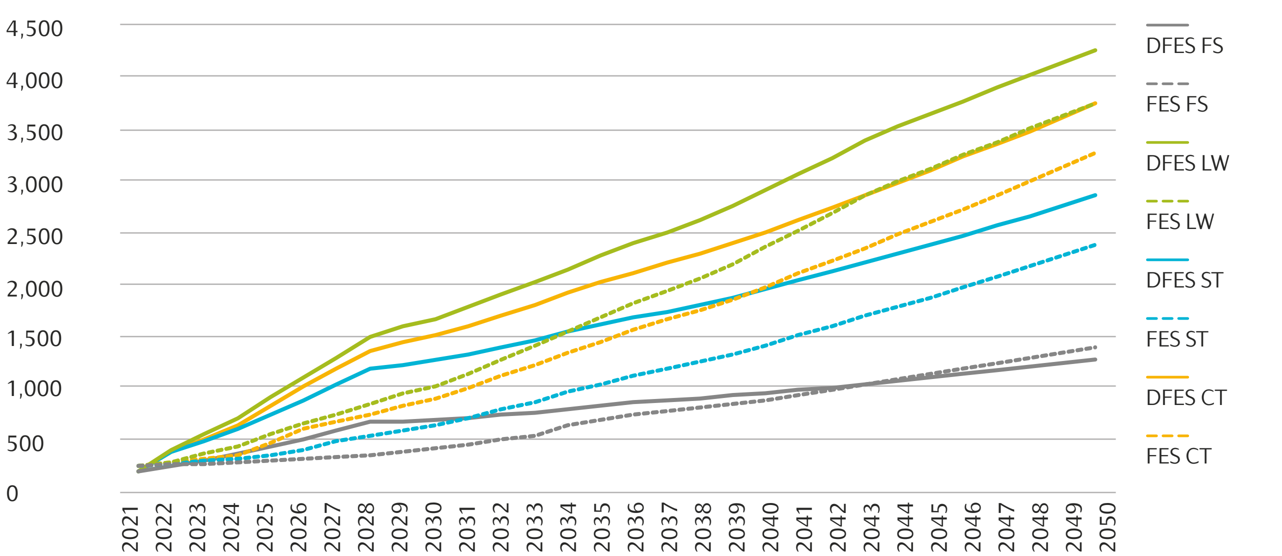
6.4 Solar PV generation

Our solar PV generation forecasts show a faster uptake in the short-term, as shown in **Figure 29**. This is driven by the number of known generation projects that are in development.

In the medium to longer term, growth in renewable energy sources is expected to significantly increase to reach 50% of the energy for Scotland's heat, transport and electricity. This growth is expected to also increase with increased support from the Scottish Government on small scale generation and storage in buildings, set out in their Update to the Climate Change Plan.

These targets translate into slightly faster uptakes across the scenarios. In the longer term, our growth trend is aligned to FES, resulting in a slightly higher installed capacity.

Figure 29 | Solar PV generation capacity comparison (Gen_BB012 and Gen_BB013) *Capacity (MW)*



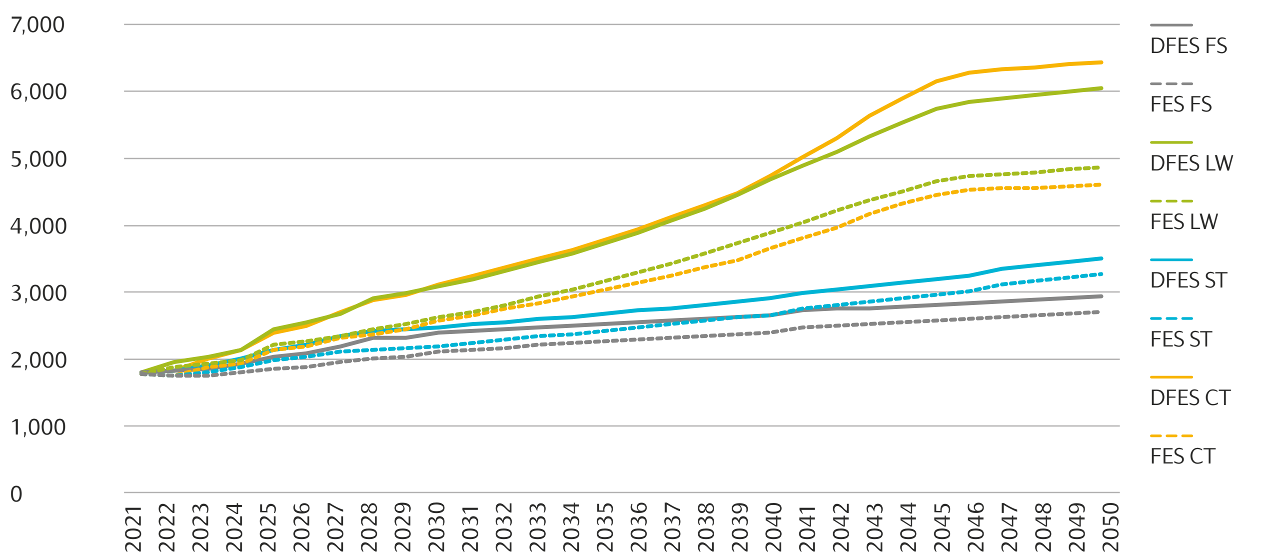
6.5 Wind generation

Scotland has a higher availability of wind resource than other parts of the UK. Onshore wind represents 65%[20] of the total generation capacity in Scotland, out of which over 19% is connected to the SP Distribution network.

Our wind generation forecasts show a faster uptake in the short-term for all scenarios, as shown in **Figure 30**. This faster uptake in the earlier years is mainly driven by the number of known generation projects that are in development.

In the medium to longer term, our forecasts for wind show a similar growth trend to FES, resulting in an overall higher installed capacity.

Figure 30 | Wind generation capacity comparison (Gen_BB014, Gen_BB015 and Gen_BB016 *Capacity (MW)*



[20] https://www.scottishrenewables.com/our-industry/statistics

6.6 Storage

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

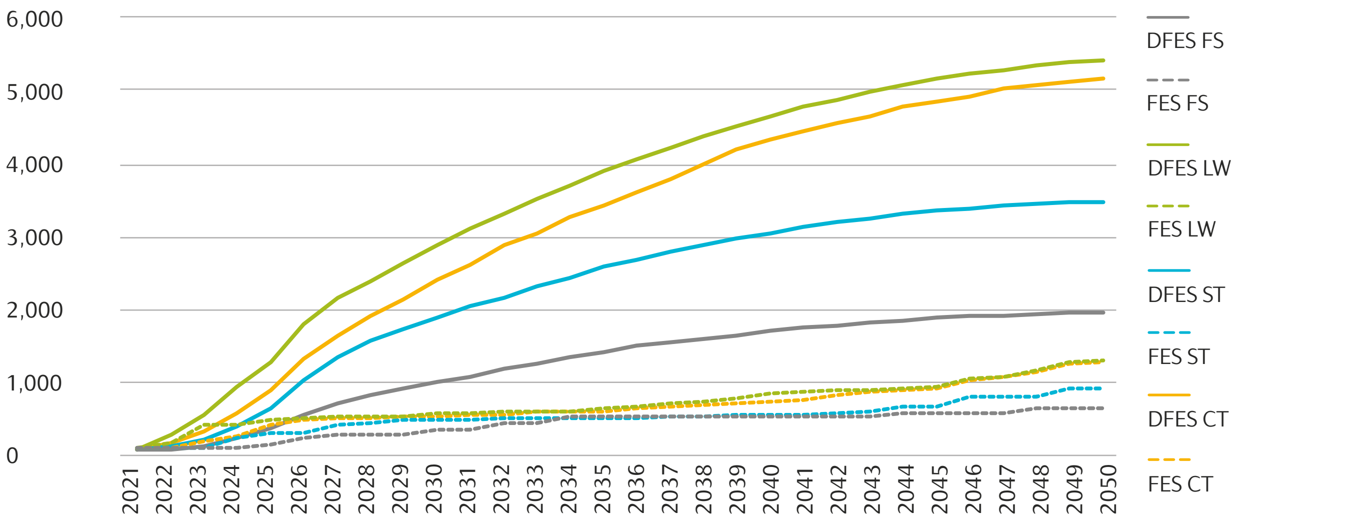
Last year, battery storage accounted for 28% of our pipeline: this year it accounts for 56% of our pipeline.

This means we are anticipating a significantly faster growth in this technology over the short and medium term compared to the FES. Our growth rate in the longer term in all scenarios is also higher, although more moderately so in the SPD System Transformation and SPD Falling Short scenarios, resulting in a large scenario range by 2050.

We are also expecting storage to connect at a higher percentage of GSPs. We have a storage pipeline at almost half of our GSPs, compared to just 12% of GSPs in FES by 2030.

This growth is expected to also increase with increased support from the Scottish Government on small scale generation and storage in buildings, set out in their Update to the Climate Change Plan. These targets translate into faster uptakes across the scenarios.

Figure 31 | Electricity storage capacity comparison (Srg_BB001 to Srg_BB004) *Capacity (MW)*



Incorporating the Climate Change Committee scenarios

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

7

This section provides an overview of the forecasts from the CCC, and compares them to the ESO's 2022 FES, and our SP Distribution DFES forecasts.

7.1 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[21].

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, and Scotland by 2045.

Some of the recommendations and conclusions included in this publication are:

- An emission reduction of 78% by 2035, compared to 1990 levels.
- All new cars and vans, as well as domestic and non-domestic boiler replacements to be low carbon (mainly electric) by the early 2030s.
- By 2035, UK electricity generation to be zero carbon.
- Demand for electricity increasing by half in the next 15 years and 2-3 times in the next 30 years due to decarbonisation of transport, heating, and industry.

The CCC developed five scenarios to explore different pathways of achieving Net Zero. Some of the key scenario assumptions are summarised below[23]:

	Balanced NZ pathway	Headwinds	Widespread engagement	Widespread innovation	Tailwinds
Internal combustion engine ban (new cars and vans)	2032	2035	2030	2030	2030
HGV	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%

[21] https://www.legislation.gov.uk/ukpga/2008/27/contents
[22] https://www.theccc.org.uk/publication/sixth-carbon-budget/
[23] Source and full set of assumptions on: https://www.theccc.org.uk/publication/sixth-carbon-budget/

7.2 Regionalisation of CCC scenarios

The Sixth Carbon Budget dataset[24] provides scenario data for the whole of the UK and also splits the totals for Northern Ireland, Scotland, and Wales.

So we can compare the national CCC forecasts on a like-for-like basis with our regional DFES 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.

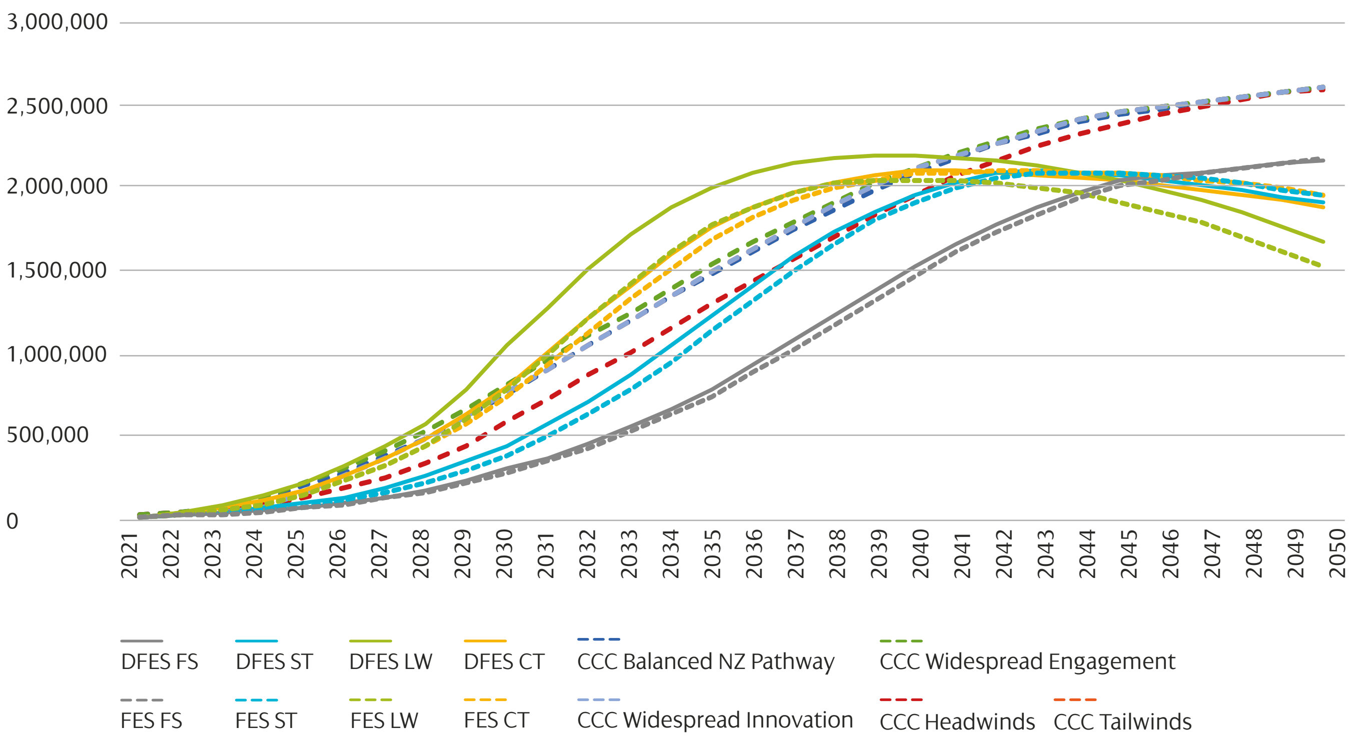
7.3 Range of future pathways

This section provides a comparison between the DFES forecasts. The regional GSP results from the ESO's 2022 FES, and the regionally equivalent CCC forecasts for the SP Distribution network for battery electric vehicles (BEVs) and heat pumps – we have shown these two metrics as they are the main drivers of increasing demand.

7.3.1 Electric vehicles

Figure 32 shows the total volume of battery electric vehicles considered across all scenarios. Table 4 shows the same data at 2030, 2040, and 2050.

Figure 32 | Battery electric vehicle uptake comparison *Number of vehicles*



[24] The dataset is available on the CCC website.

Table 4 | Industry forecasts for BEVs

Volumes (millions)		Electric vehicles		
		2030	2040	2050
DFES	Falling Short	0.30	1.52	2.16
	System Transformation	0.45	1.95	1.91
	Consumer Transformation	0.80	2.10	1.88
	Leading the Way	1.05	2.19	1.67
FES	Falling Short	0.28	1.47	2.17
	System Transformation	0.39	1.91	1.95
	Consumer Transformation	0.74	2.08	1.95
	Leading the Way	0.79	2.05	1.52
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.76	2.09	2.60
	Headwinds	0.59	1.96	2.59
	Widespread Engagement	0.81	2.12	2.60
	Widespread Innovation	0.77	2.11	2.60
	Tailwinds	0.77	2.11	2.60

7.3.2 Heat pumps

Figure 33 shows the total volume of heat pumps considered across all scenarios. Table 5 shows the same data at 2030, 2040, and 2050.

Figure 33 | Heat pump uptake comparison *Number of heat pumps*

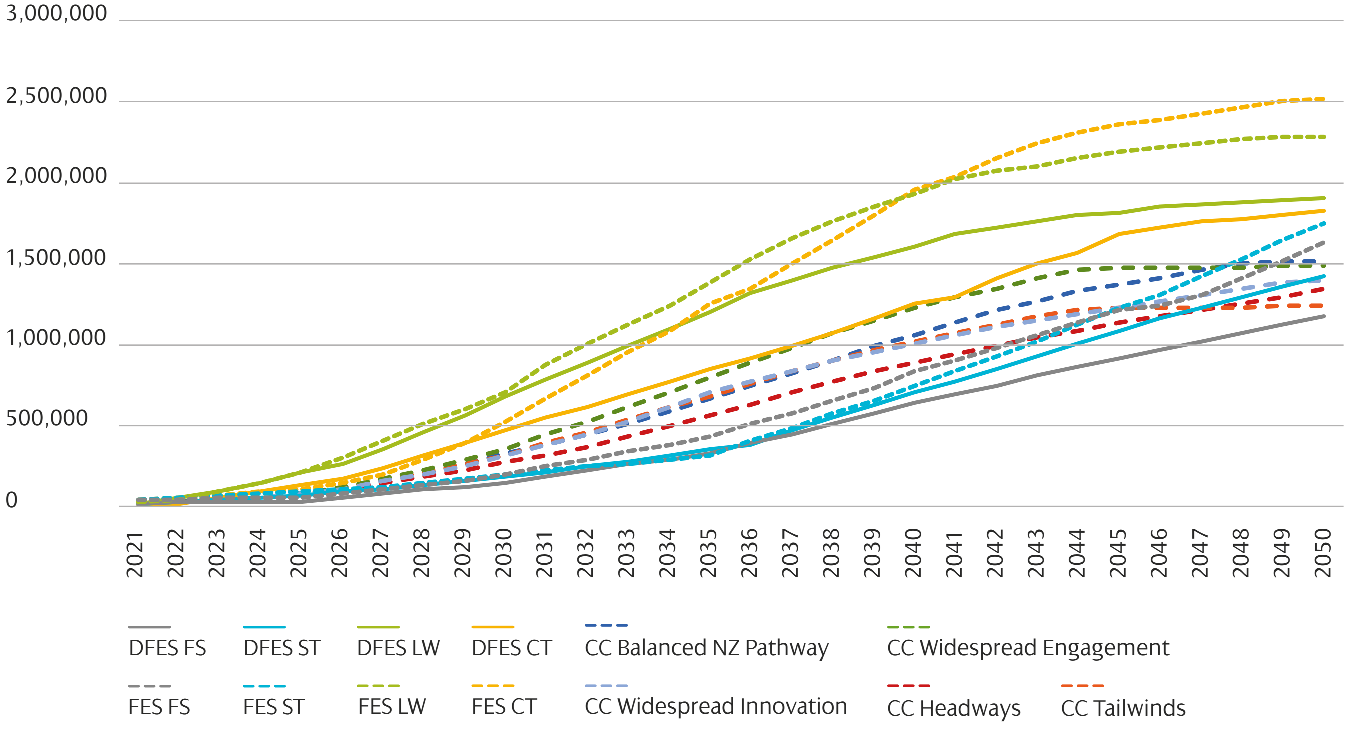


Table 5 | Industry forecasts for heat pumps

Volumes (millions)		Heat pumps		
		2030	2040	2050
DFES	Falling Short	0.14	0.64	1.18
	System Transformation	0.18	0.70	1.42
	Consumer Transformation	0.47	1.25	1.82
	Leading the Way	0.67	1.61	1.90
FES	Falling Short	0.18	0.83	1.62
	System Transformation	0.19	0.74	1.75
	Consumer Transformation	0.52	1.95	2.51
	Leading the Way	0.70	1.93	2.28
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.32	1.06	1.51
	Headwinds	0.26	0.88	1.33
	Widespread Engagement	0.35	1.22	1.49
	Widespread Innovation	0.30	1.00	1.39
	Tailwinds	0.31	1.02	1.24

Range of Net Zero compliant pathways

This section provides an overview of the range of Net Zero compliant industry forecasts for the SP Distribution network.

8

These Net Zero compliant scenarios are key to understanding the range of future possible pathways that the SP Distribution network needs to accommodate. We use this information to efficiently plan and develop our networks.

We need to develop a view of the credible range of Net Zero compliant scenarios and our baseline scenario for planning purposes. Together these help us to efficiently develop our network, and deliver our RIIO ED2 business plan.

To develop this range, we considered the ESO's FES and other industry scenarios (including the CCC 6th carbon budget scenarios). We then discounted DFES and FES scenarios that do not achieve Net Zero or interim targets.

THE FOLLOWING TWO SCENARIOS WERE DISCOUNTED:

1. **Falling Short (FS):** this scenario does not meet Net Zero and so it has been excluded.
2. **System Transformation (ST):** this scenario is significantly lower than the rest of the Net Zero compliant scenarios. We consider it unable to meet Scottish Government legislative targets or interim emission reduction targets, and so it has been excluded.

The remaining DFES/FES scenarios (Consumer Transformation and Leading the Way) and the five CCC Sixth Carbon Budget scenarios collectively form the Net Zero compliant scenario range. This range of scenarios meets UK and Scottish Net Zero legislation; the requirements of the UK Government's Ten-Point Plan, Energy White Paper, and Heat and Buildings Strategy; and the Scottish Government's Update to the Climate Change Plan and Heat in Buildings Strategy.

Our Baseline scenario is set to achieve Net Zero, including interim targets and devolved government policies, and tracks marginally above the low end of the Net Zero compliant scenario range due to Scottish Government targets. This means we have a high confidence that LCT uptakes will be at least this level to achieve Net Zero. This enables us to undertake network assessments and investment plans on scenarios which 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.

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.

Category2: Justification criteria for stakeholder engagement inputs.

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

This section shows this year's credible range and baseline scenario compared to last year's for key drivers: growth in LCT volumes and distributed generation.

Category 1: *Alignment with existing/announced policies*

This range of Net Zero compliant scenarios meets UK and Scottish Net Zero legislation; the requirements of the UK Government's Ten-Point Plan, Energy White Paper, and Heat and Buildings Strategy; and the Scottish Government's Update to the Climate Change Plan and Heat in Buildings Strategy. Our Baseline scenario also considers emerging policy and thinking as it becomes available.

	UK	Scotland
Net Zero target	2050	2045
% GHG emission reduction target	68% by 2030, 78% by 2035.	75% by 2030, 90% by 2040.
EV targets	End the sale of new petrol and diesel vehicles by 2030 (hybrids by 2035).	
Heat targets	Ban on gas boilers in new homes from 2025. Install 600,000 heat pumps every year by 2028.	By 2024 all new homes must use renewable or low carbon heat. By 2030, around over 1 million homes and the equivalent of 50,000 non-domestic buildings will need to convert zero emissions heating.
Renewable generation targets	40GW offshore wind, 1GW floating offshore wind by 2030. Up to doubling the renewable energy capacity in the next CfD.	Renewable generation to supply 50% of energy consumption by 2030, and almost 100% of energy consumption by 2050. The development of 11-16GW of renewable generation capacity by 2032.

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 metrics.

We will continue to work alongside local authorities to incorporate their latest thinking and provide support in the development of their Local Heat and Energy Efficiency Strategies (LHEES), as part of our Strategic Optimiser role.

Category 2: *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.

Figure 34 shows our baseline scenario and the range of the Net Zero compliant industry forecasts for the uptake of battery electric vehicles and heat pumps – we have shown these two metrics as they are the main drivers of increasing demand.

Figure 34a | Range of Net Zero compliant industry forecasts *Number of vehicles*

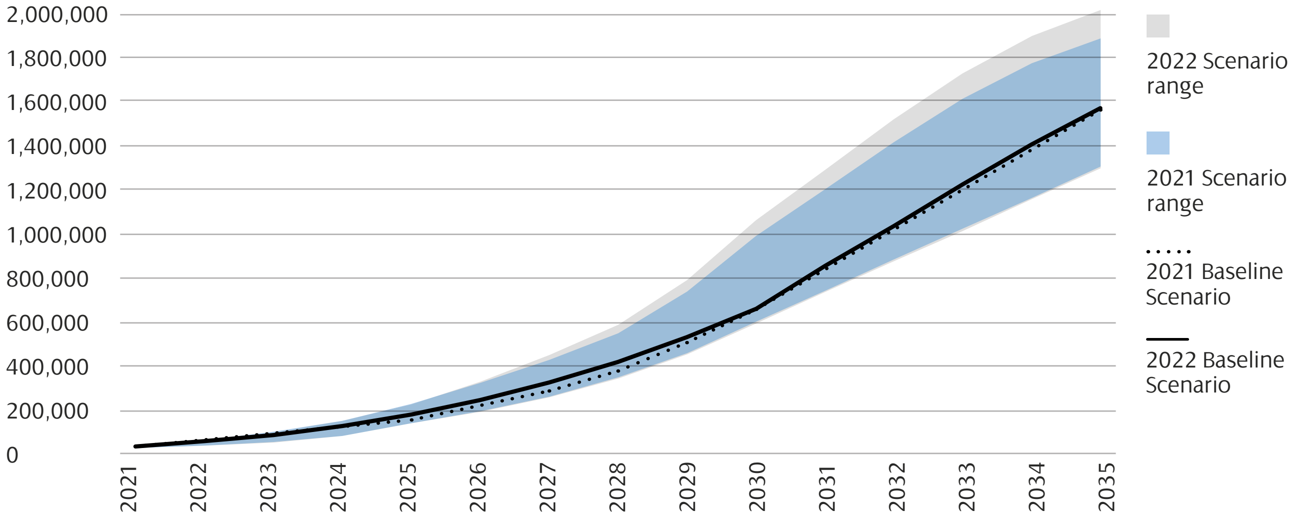


Figure 34b | Range of Net Zero compliant industry forecasts *Number of heat pumps*

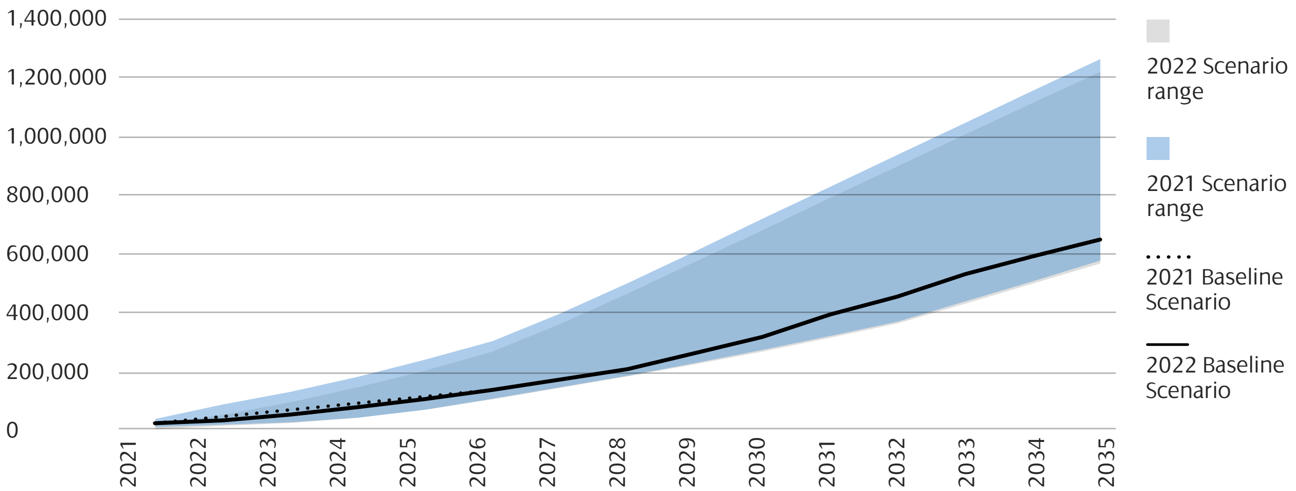
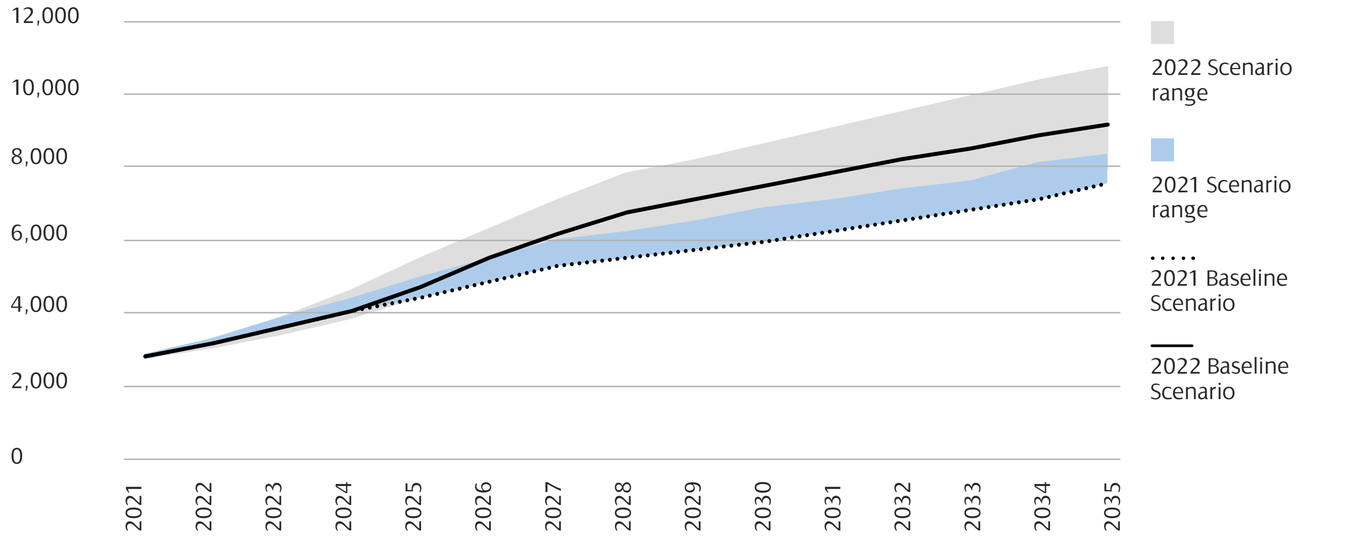
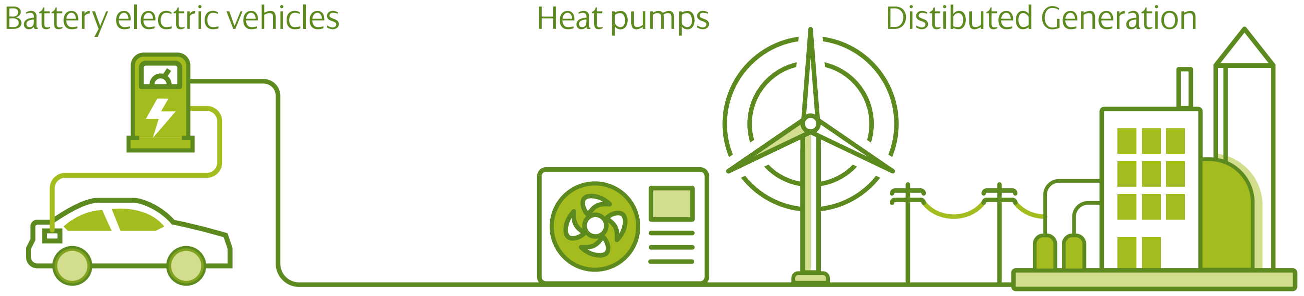


Figure 35 shows our baseline scenario and Net Zero compliant forecasts for distributed generation.

Figure 35 | Range of Net Zero distributed generation forecasts *Capacity (MW)*





		Battery electric vehicles	Heat pumps	Distibuted Generation
Now		21 thousand	2 thousand	2.7GW
2030	High	1.06 million	0.68 million	+5.9GW
2030	Low	0.59 million	0.26 million	+4.0GW

Glossary

9

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 – 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.

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

MW – megawatt is a unit of power (not energy). It can describe both the amount of power that a demand user is consuming (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").

Minimum demand – the point in the year, typically during the summer months, when our distribution network as a whole sees the lowest demand. 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. 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 – the interface points between the 33kV and 11kV networks.

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

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.

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.

Vehicle to grid – 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 bill.

SP Energy Networks
320 St Vincent Street
Glasgow, G2 5AD

Contact us
facebook.com/SPEnergyNetworks
twitter.com/SPEnergyNetwork

spenergynetworks.co.uk