Distribution Future Energy Scenarios

SP Distribution

February 2025

Contents

Commissioned partners: Baringa

Supported by: Field Dynamics

Welcome to our DFES

Welcome to our Distribution Future Energy Scenarios (DFES). This document sets out our forecasts for how electricity generation and consumption may evolve in Central and Southern Scotland out to 2050.

This document presents our annual update to these DFES forecasts following the publication of the National Energy System Operator's Future Energy Scenarios in July 2024, and their subsequent advice to government on Clean Power 2030.

Scott Mathieson
Director, Network Planning & Regulation

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

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

We know from detailed modelling that this new demand, generation, and storage will increasingly push the distribution network beyond what it is designed for. In response, we must invest in network capacity, flexibility markets, and operational capabilities to enable our customers' Net Zero transition.

Managing the network in real time, keeping the lights on, and keeping our customers and staff safe will soon involve dispatching and settling thousands of flexibility service contracts and coordinating their use with the NESO. Data, visibility, automation, and working with our customers are all essential to enabling us to develop and operate this more active distribution system.

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

These forecasts have been developed to include the government's Clean Power 2030 (CP2030) target, which is a new development since our last DFES. This is the target to run a 95% decarbonised system by 2030. Achieving this depends on connecting specific generation technologies in certain volumes and locations.

While the overall direction of travel towards CP2030 and Net Zero is clear, there are some areas where detailed local authority and community action plans are still under development. At a more macro level, we know new drivers can develop overnight, for example the government's updates to onshore wind planning rules in July 2024 and the expected decision on heat decarbonisation in 2026. The Climate Change Committee's 7th Carbon Budget, due this year, may affect the 2038-42 period.

To account for these uncertainties, we set out four forecast scenarios which cover a range of credible pathways to describe the potential decarbonisation routes which our customers may follow. In future DFES publications these uncertainties will be resolved through the RESP process – a positive step we welcome for aiding coordinated regional decarbonisation.

Our main role is to provide the safe, efficient, and reliable network capacity needed to enable the decarbonisation route that our customers and communities choose. To achieve this, these DFES forecasts are used to assess future network capacity requirements and plan the delivery of this capacity. These DFES forecasts also help the two transmission operators that supply our distribution networks.

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

1. Introduction

We are SP Energy Networks. We own and operate the electricity distribution network in 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.

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

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

Our DFES

The DFES comprises forecasts of the following key areas:

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

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

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

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

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

This document

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

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

Section 5 gives comparisons back to industry GB forecasts.

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

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

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

Incorporating your views

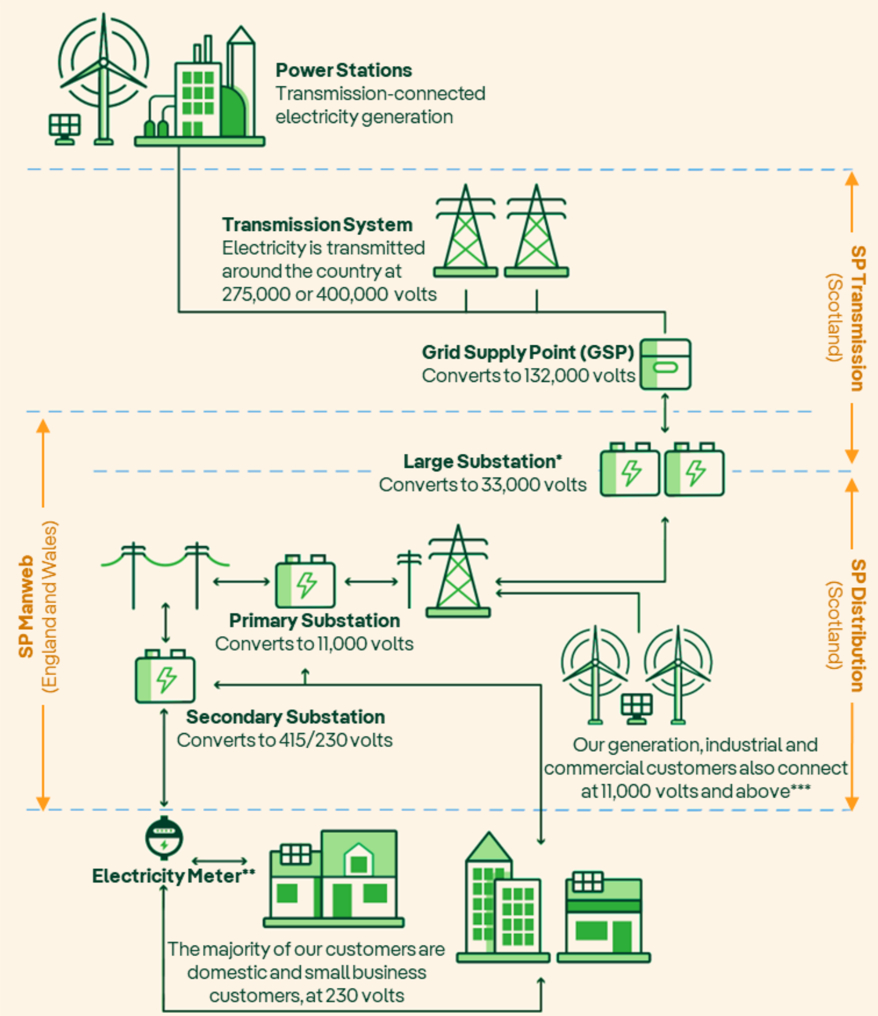
We update our forecasts on an annual basis in line with national and regional projections. As part of this annual process, we engage with a wide representation of our stakeholders to test the forecasts' data, methodology, and outputs.

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

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

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

Figure 2 | Diagrammatic view of transmission and distribution system



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

[2] https://www.spenergynetworks.co.uk/userfiles/file/DFES_SP_Manweb_2024.pdf

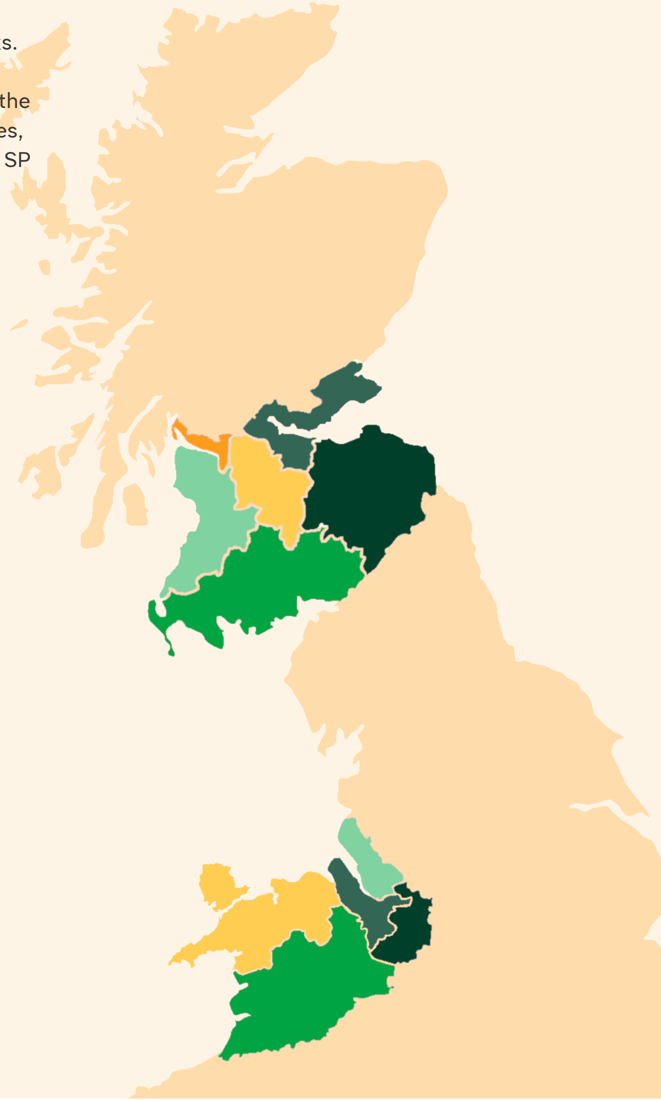
Our network areas

SP Distribution owns and operates the electricity distribution network – the network at 33 thousand volts and below – across Central and Southern Scotland. It has six operating regions: Central & Fife, Glasgow, Ayrshire & Clyde South, Lanarkshire, Edinburgh & Borders, and Dumfries. Across these regions, we transport electricity to and from circa 2 million homes and business.

SP Distribution is part of SP Energy Networks. SP Energy Networks includes another distribution network company: SP Manweb, the distribution network operator for North Wales, Cheshire, North Shropshire and Merseyside. SP Manweb has its own forecasts, which are available separately[2].

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

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



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

2. Regionally reflective forecasts

The DFES are long-term forecasts of electricity demand and generation connected across our networks, which we update and publish annually. This year's DFES 2024 publication reflects updates in the NESO's 2024 FES publication. This section describes how we created our DFES and what it contains.

Our DFES scenarios are aligned to the National Energy System Operator's (NESO's) Future Energy Scenarios (FES)[3]. These are four GB-wide holistic energy scenarios out to 2050, considering gas and electricity supply and consumption. Three of these represent the range of credible paths for GB to achieve Net Zero. They each represent differing levels of consumer ambition, government/policy support, economic growth and technology development. The counterfactual scenario does not achieve Net Zero.

To illustrate their different representations, Figure 3 maps the four scenarios against two metrics: the type of energy source used to meet demand (primarily electrification versus hydrogen) and the level of demand flexibility achieved through consumer engagement.

Creating our DFES

Our forecasts are developed through extensive engagement with stakeholders to ensure they are regionally reflective. They build on the NESO pathways which are widely recognised as being an industry reference point.

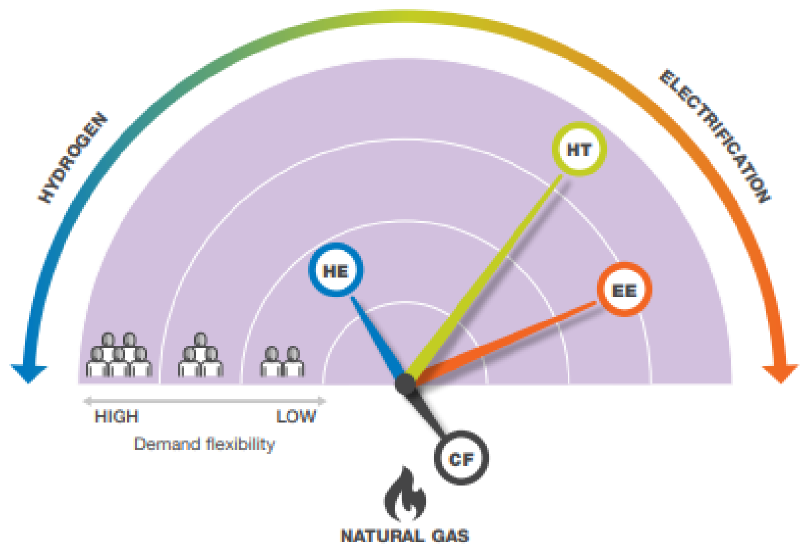
We start by looking at medium and long-term growth patterns at a regional and licence levels. We gather evidence from NESO's FES, UK and devolved government legislation and proposals (including Net Zero and interim targets), regional ambitions and development plans.

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

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

- Grid supply point (GSP) level. There are 88 GSP areas across Central and Southern Scotland.
- Primary substation level. There are 390 primary substation network areas across Central and Southern Scotland. These geographic areas cover, on average, approximately $50km^2$.

Figure 3 | Overview of the NESO's Future Energy Pathways



We also provide key metrics disaggregated by Local Authority region.

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

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

In Section 8, we present the feedback we have received from this engagement and discuss how this has been assessed and used to update the forecasts. We continue to assess the relevance of all feedback we receive, dating back to our first publication in May 2020.

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

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

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

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

Developments in industry network planning

In October 2024, the Department for Energy Security and Net Zero (DESNZ) launched the NESO. The NESO are tasked with coordinating planning activities across the energy industry, as well as continuing to operate the electricity network. NESO aims to ensure a secure, resilient, and flexible energy infrastructure to support the transition to a decarbonised energy system.

In August 2023, the new Electricity Networks Commissioner published his recommendations[5] for accelerating the rollout of electricity transmission infrastructure. One of his key recommendations is the development of a Strategic Spatial Energy Plan (SSEP).

The purpose of the SSEP is to define the optimal mix, volumes and locations of generation technologies needed to deliver Net Zero by 2050 to give greater confidence on what needs to be built when and where. The SSEP outputs are intended to act as the first stage of the Centralised Strategic Network Plan (CSNP) – a plan for transmission network infrastructure. The CSNP identifies a delivery pipeline for transmission network development for the first 12 years, and a longer-term pathway covering a 25-year horizon.

Whilst the SSEP and CSNP will focus on the strategic planning of transmission networks, this work will influence our distribution scenario planning. At the distribution level, the introduction of Regional Energy Strategic Plan (RESP) will cement this shift to strategic spatial energy planning. The RESP pathways will be based on a holistic understanding of relevant national and local plans and priorities and will set out, spatially, how energy needs will change in a region.

In July 2024, NESO published their FES 2024 with a significant update to their forecasting framework - moving from a wide scenario range to 'pathways' with a narrower range of future decarbonisation options. We have updated our forecasting framework to reflect the FES 2024 forecasting framework. Further details can be found in the 'Scenario Overview' section.

In November 2024, NESO published Clean Power 2030 (CP2030) providing advice to the Government on the steps needed to achieve clean power by 2030. NESO have derived the 2035 capacity ranges, by technology type, using FES 2024.

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

Regional Energy Strategic Planner (RESP)

Ofgem have introduced the RESP framework to provide accountability for strategic energy planning and to provide whole system coordination. The main goals of RESP are to:
1. Enable coordinated development: By integrating multiple energy vectors, RESP aims to ensure that the energy system is developed in a cohesive and efficient manner.
2. Provide confidence in system requirements: It helps in understanding and planning for future energy needs, ensuring that the infrastructure is in place ahead of demand.
3. Support the transition to Net Zero: RESP is designed to facilitate the UK's transition to a net-zero energy system in a cost-effective way.

RESP involves creating an endorsed long-term vision for each region, developing strategic pathways to achieve Net Zero targets, and establishing regional governance structures to oversee the implementation of these plans.

Ofgem's RESP consultation in July 2024, draws RESP regional boundaries across GB, with each region having a Strategic Board for governance. The consultation proposed 11 RESP regions: one in Scotland, one in Wales, and nine in England.

In developing a strategic plan, the RESPs are expected to develop a cross-vector, regional view using a wide range of inputs – including national forecasts, electricity and gas network operator data, heat networks and local plans (e.g. Local Area Energy Plans). The RESPs have the potential to help us unlock an enhanced understanding of regional development priorities and incorporate them into our forecasting and network planning processes.

With this in mind, we think the RESP role presents a significant opportunity to support our customers' ambitions to decarbonise and to enable true cross-vector coordination. We recognise the advantages of defining regional Net Zero pathways that lead to a common understanding of what different actors need to deliver. This will be more important than ever in the next few years to facilitate the fast-paced planning and delivery of infrastructure and connections that will be needed to achieve the Clean Power 2030 target.

DFES will remain a crucial step in our planning process, as this is the natural vehicle to bring stakeholder transparency to the DNO forecasts whilst taking account of the RESP pathways.

We look forward to working closely with Ofgem, NESO, industry and stakeholders throughout 2025 to support the rapid development of the RESP framework and regional pathways ahead of the first RESP Output in Q1 2026.

Clean Power 2030

In November 2024, NESO published Clean Power 2030 (CP2030), a report detailing advice to the Government and network companies regarding the steps needed to achieve clean power by 2030. NESO defines the achievement of clean power as having clean sources (mainly renewables) meeting the total energy consumption of GB, with unabated gas providing less than 5% of generation in a typical weather year.

Throughout their report, NESO is clear that achieving clean power by 2030 will be a challenge that requires significant shifts in priority in generation and demand connections, and flexibility. These include:

1. Connections: The connections queue is currently oversubscribed, with NESO's research showing over double the amount of capacity awaiting connection as there is network capacity to accept it. Historically, connections requests have been accepted on a first-come, first-served basis. Achieving CP2030 will require a shift to a more strategic approach, which prioritise projects that align with government targets for network reinforcement and expansion, alongside local authority priorities and initiatives.

2. Demand: The adoption of clean energy domestically through an increase in electric vehicles and heat pumps will be vital, as will the electrification of industry. Consumer approach to demand should develop together with their engagement in flexibility initiatives, providing the dual benefit of affordable energy prices for consumers, and enhanced network performance.

3. Flexibility: A dynamic approach to energy management will be key to meeting both supply and demand and providing affordable energy for consumers. Consumer engagement with the energy system, and digitalisation of the flexibility feedback loop, will be necessary to unlock the full potential of the network.

With these developments, NESO emphasises the need for bold and rapid delivery of projects and innovations to reach clean power by 2030. Due to the inherent uncertainty of the energy network, investment in a broad range of technology and infrastructure will be necessary to achieve the priorities set out above.

Incorporation of CP2030 in our DFES: We are working with NESO to refine the impact of the ambitious plans set out in CP2030 on our forecasting process.

As our DFES is the vital first step in our investment planning process, we have updated our assumptions to reflect the analysis within CP2030 and the proposed connections reforms. At present these are applied at a licence level. We will continue to work closely with NESO to assess the impact on specific pipeline schemes as these connection reforms develop and maintain close relations with customers and stakeholders.

Legislative context

The UK and Scottish 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[6]. 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[7].

The latest report, published in June 2023, shows that emissions reductions fell slightly short of the interim target in 2021[8]. In addition to this, in March 2024, the CCC published a report stating that they did not believe Scottish Government will meet their interim Net Zero targets. In response the Scottish Government passed the Climate Change (Emissions Reduction Targets) (Scotland) Act 2024 in November 2024. This bill outlines a proposed carbon budget approach to target setting, with budgets set through secondary legislation using the latest advice from the CCC once available. The Bill will require that secondary legislation is brought forward to set a carbon budget for 2026 to 2030 and each, successive period of five years, up to and including the Net Zero target year in 2045. This does not impact the 2045 Net Zero target of the Scottish Government, which will remain in place.

Building on these targets, the Scottish Government's Climate Change Plan[9] and Scottish Energy Strategy[10] identify a number of ambitions which will have a direct impact on the electricity distribution network.

The Scottish Government also published an Update to the Climate Change Plan[11], which lays the foundation for a Green Recovery, and introduced the Heat Networks (Scotland) Act 2021[12] 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 (though this is likely to stall given the slip of the UK government target date to 2035).
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.

In January 2023, the Scottish Government published its Draft Energy Strategy and Just Transition Plan[13] for consultation. We must ensure that these plans are captured by our DFES so that our electricity network is also ready to support this just transition – to make sure that low carbon technologies can be utilised equitably by all customers across our region.

The plan reinforces previous targets set out by previous strategies – including the Local Heat and Energy Efficiency Strategies (LHEES)[14] – and sets out some new policy positions and a route map of actions with a focus out to 2030.

[6] www.legislation.gov.uk/asp/2019/15/enacted
[7] www.legislation.gov.uk/ukpga/2008/27/contents
[8] https://www.gov.scot/news/scottish-greenhouse-gas-statistics-2021/
[9] http://www.gov.scot/Publications/2018/02/8867
[10] http://www.gov.scot/Publications/2017/12/5661
[11] http://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/
[12] http://www.legislation.gov.uk/asp/2021/9/enacted
[13] https://www.gov.scot/publications/draft-energy-strategy-transition-plan/pages/2/
[14] http://www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/pages/2/

Some of the policies and proposals of relevance to our 2024 DFES are summarised below.

For Distributed generation:

- An ambition for more than 20GW of additional low-cost renewable electricity generation capacity by 2030, including 12GW of onshore wind.
- Reportedly, an ambition for 4-6GW of solar power by 2030[15].
- A call for hydro-power to play a greater role in the energy transition[16].
- In November 2024, the NESO published Clean Power 2030[17], a report detailing advice to the Government and DNOs regarding the steps needed to achieve clean power by 2030. In December 2024, the Government published the policy paper Clean Power 2030 Action Plan[18].
- NESO has advised that achieving CP2030 will require expediting development of offshore wind so that by 2030, it will generate over half of GB's energy. Similarly, CP2030 requires developing onshore wind and solar PV infrastructure to provide another 29% of generation capacity. Additionally, dispatchable low carbon generation should be harnessed. We will continue to assess the impact of CP2030 on the Scottish Governments ambitions for low carbon generation.

For the decarbonisation of heat:

- From 2024, new buildings are to use heating systems which produce zero direct emissions at the point of use. Indeed, we have already begun to see this shift towards heat pumps in new developments.
- By 2030, more than 1 million homes and 50,000 non-domestic buildings to use zero emissions heating systems.

For the decarbonisation of transport:

- Support will be provided to people on lower incomes and in remote or rural communities, to switch to zero-emissions vehicles.
- There is ambition to reduce car kilometres by 20% by 2030, with investments to be made in public transport (bus and rail).
- Consultation feedback expressed the importance of early deployment of public electric vehicle charging infrastructure.

For industrial decarbonisation:

- Ambition for renewable and low-carbon hydrogen production of 5 GW by 2030, and of 25 GW by 2045.
- Target for industrial decarbonisation of 43% from 2018 levels by 2032.

The latter would be met with efficiency measures, which could reduce some electricity demand, or by Carbon Capture, Usage and Storage (CCUS); however, we expect this will be more than offset by a shift to electrification of key industrial processes.

The Heat in Building Bill proposal was also released for consultation in November 2023[19] and sets out the following:

- Reconfirms that the use of polluting heating systems will be prohibited after 2045.
- Plan to require those purchasing a home or business to end their use of polluting heating systems within a fixed period (to be confirmed) following completion of the sale.
- Plan to require homeowners to make sure that their homes meet a reasonable minimum energy efficiency standard by 2033, and 2028 for private landlords.
- Plan to require people and businesses to end their use of polluting heating when a heat network becomes available.

There is still uncertainty when and by how much these plans will impact electricity use for heating: for this, exemptions and timescales will be critical, which we expect to be confirmed in the final bill. However, these proposals continue to strongly signal a commitment to transition to low carbon heating technologies in Scotland.

The Local Authorities in our SP Distribution area have published their Local Heat and Energy Efficiency Strategies (LHEES)[20] which were reviewed and incorporated into our forecasts.

We have followed and supported the development of these LHEESs closely and completed a full review of all published documentation to inform our pipeline of known projects. These strategies have given us more details on heat decarbonisation plans, including possible future locations and scales for heat networks. We will be working closely with Local Authorities to provide the data they require to develop these strategies, as well as ensure that our DFES forecasts align to their own local forecasts.

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

[15] This was announced in October 2023 by Lorna Slater MSP about the forthcoming Energy Strategy and Just Transition Plan.
[16] Our scenarios show a steady but only small increase in embedded hydro-power from today's level of around 0.2GW, but we will continue to follow policy and market indicators in this area.
[17] https://www.neso.energy/publications/clean-power-2030
[18] https://www.gov.uk/government/publications/clean-power-2030-action-plan
[19] https://www.gov.scot/publications/delivering-net-zero-scotlands-buildings-consultation-proposals-heat-buildings-bill/
[20] https://www.gov.scot/publications/local-heat-energy-efficiency-strategies-delivery-plans-guidance/

Scenario overview

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

In **SPD Counterfactual (CF)**, Net Zero is not achieved by 2050. Despite some progress in decarbonization, there remains a heavy reliance on natural gas across all sectors, particularly for power and space heating. Electric vehicle adoption is slower compared to other pathways, but still replaces petrol and diesel vehicles. The pathway sees the least renewable capacity and continues to depend heavily on natural gas, leading to significant residual emissions. Negative emissions are only provided through Bioenergy with Carbon Capture and Storage (BECCS), but this is insufficient to meet net zero targets. This scenario is akin to the previous 'Falling Short' scenario.

In **SPD Electric Engagement (EE)**, the 2050 Net Zero target is met primarily through electrification. Consumers play a crucial role by adopting smart technologies like electric heat pumps and electric vehicles, which help reduce energy demand and provide grid flexibility. This pathway envisions the highest peak electricity demand, requiring substantial renewable and nuclear capacities. Natural gas plants see reduced utilization post-2035, with supply-side flexibility provided by electricity storage, interconnectors, and low-carbon dispatchable power. Negative emissions are targeted through BECCS and Direct Air Carbon Capture and Storage (DACCS). This approach highlights the importance of consumer engagement and electrification in achieving a sustainable energy system. This scenario is akin to the previous 'Consumer Transformation' scenario.

In **SPD Hydrogen Evolution (HE)**, Net Zero is met by 2050 through rapid advancements in hydrogen technology, particularly for industry and heating. This pathway envisions many consumers using hydrogen boilers, although energy efficiency remains crucial to reduce costs. Hydrogen will be prevalent for heavy goods vehicles, while electric car uptake remains strong. The pathway includes high levels of hydrogen dispatchable power plants, reducing the need for renewable and nuclear capacities. Natural gas plants have lower utilization post-2035, with hydrogen storage providing most of the flexibility. Negative emissions are targeted mainly through BECCS. This approach highlights the significant role of hydrogen in decarbonizing various sectors and achieving a balanced energy system transformation. This scenario is akin to the previous 'System Transformation' scenario.

In **SPD Holistic Transition (HT)**, Net Zero is met by 2050 through a balanced mix of electrification and hydrogen. It emphasizes strong consumer engagement, with smart homes and electric vehicles playing a crucial role in providing grid flexibility. The pathway envisions the highest renewable capacity, with unabated gas usage dropping sharply after 2036. It also includes moderate nuclear capacity and significant supply-side flexibility through electricity storage and interconnectors. Negative emissions are targeted through BECCS and DACCS. This approach ensures a comprehensive and integrated energy system transformation, focusing on both supply and demand-side innovations. This scenario is akin to the previous 'Leading the Way' scenario.

	Counterfactual	Hydrogen Evolution	Electric Engagement	Holistic Transition
Residential electrical energy efficiency	Low	Medium	Medium	High
Residential consumer engagement	Low	Medium	High	High
Battery electric vehicles (BEVs)	Medium	Medium	High	High
Home EV charging	Medium (High by 2050)	Medium	High	High
Home thermal efficiency levels	Low	Medium	High	High
Heat pumps	Low	Medium	High	High
District heating	Low	Medium	High	High
Solar PV generation (<1MW)	Low	Medium	High	High
Solar PV generation (>1MW)	Low	Medium	Medium	High
Onshore wind	Low	Medium	High	High
Medium duration electricity storage	Low	Medium	Medium	High

DFES outputs:

1. Demand

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

2. Flexibility

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

3. Generation

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

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

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

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

3. Electricity demand

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

Peak demand

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

Electricity demand out to 2050 will be affected by:

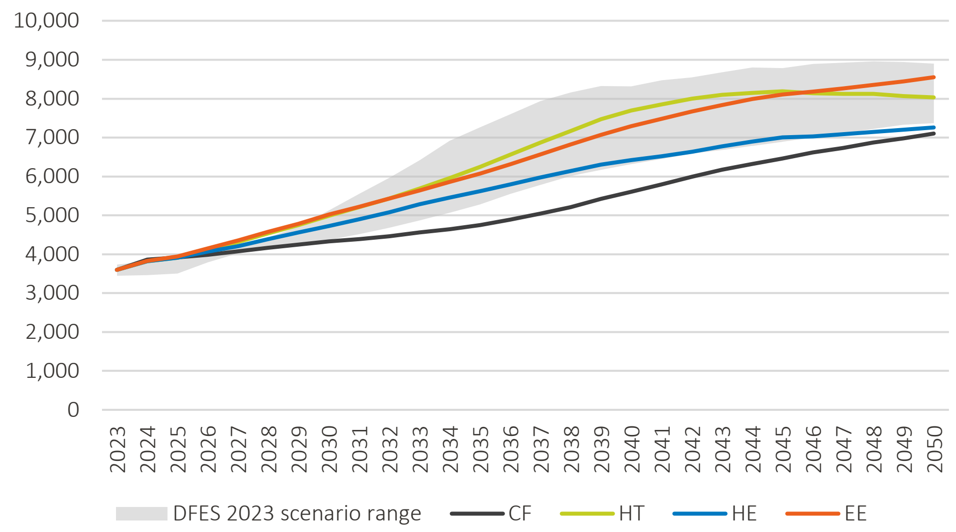
1. Energy efficiency and underlying demand trends;
2. The extent of new sources of demand, i.e. how much heating and transport is electrified, and the speed of this uptake;
3. The degree to which both existing and new load can be shifted or reduced at times of system peak demand (flexibility).

Figure 4 shows how the SP 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). This is shown as the sum of the GSP forecast maximum half-hourly averaged demands, in MW, that are forecast at each GSP across the network over the course of each year[20]. It shows the 'true demand', which is the total demand used by our customers. In other words, this includes the gross power provided by both the transmission system, and that provided by embedded generation connected directly to our distribution network.

For comparison, the grey area of Figure 4 shows the forecasted range (i.e. the difference between the lowest and highest scenario) from our 2023 DFES. The observed sum of GSP peak demands for 2024 is within the previously forecasted range in our previous DFES 2023 – which forecasted minimal growth in peak demand. Up to 2030, our updated DFES 2024 forecasts have seen a growth of our Net-Zero compliant range. This is driven by two key factors:

1. Historically, our most ambitious decarbonisation scenarios forecasted that, before demand begins to significantly increase as we transition to Net Zero, we would observe a decrease in peak demand in the early 2020s. This was driven by more ambitious energy efficiency measures in these scenarios where assumptions had reduced both overall consumption and the power requirements at peak times. Previously assumed impact of energy efficiency measures on overall consumption was observed in the previous year but there was minimal impact at periods of peak demand. We have updated our assumptions to reflect this.
2. Previously we assumed hybrid heat pumps had no impact on peak demand. We have updated our assumptions around gas availability to align with NESO's FES. In addition, we have started to include the impact of electric resistive hybrid heat pumps in our forecasts. This results in hybrid heat pumps having an electrical impact at times of peak demand.

Figure 4 | Electricity peak demand without flexibility *Peak demand (MW)*



Between 2030 and 2040 we have seen a reduction of peak demand in SPD Holistic Transition and SPD Electric Engagement, historically our highest uptake scenarios. This is driven by a tightening of the range of uptake of electric vehicles to follow a single Office for Zero Emission Vehicles (OZEV) mandate projection; this is discussed in greater detail in the Electric Vehicle segment of this section. By 2050, our forecasted growth in peak demand has remained aligned to previous forecasts. Throughout the forecasted period we have ensured that regional specific evidence from our local stakeholders drives our pipeline of known strategic projects – something we believe is vital for realising local Net Zero and economic ambition.

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

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

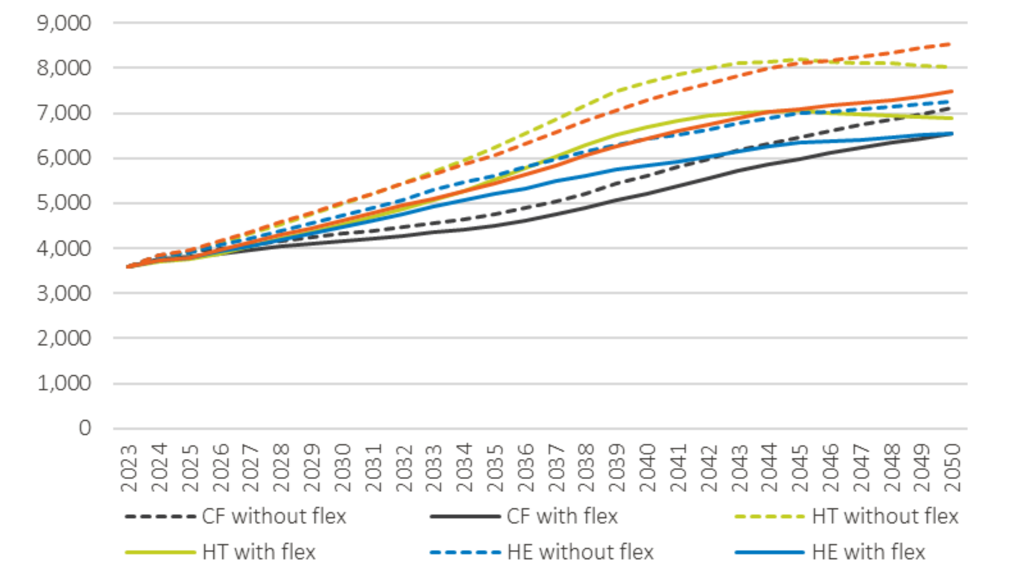
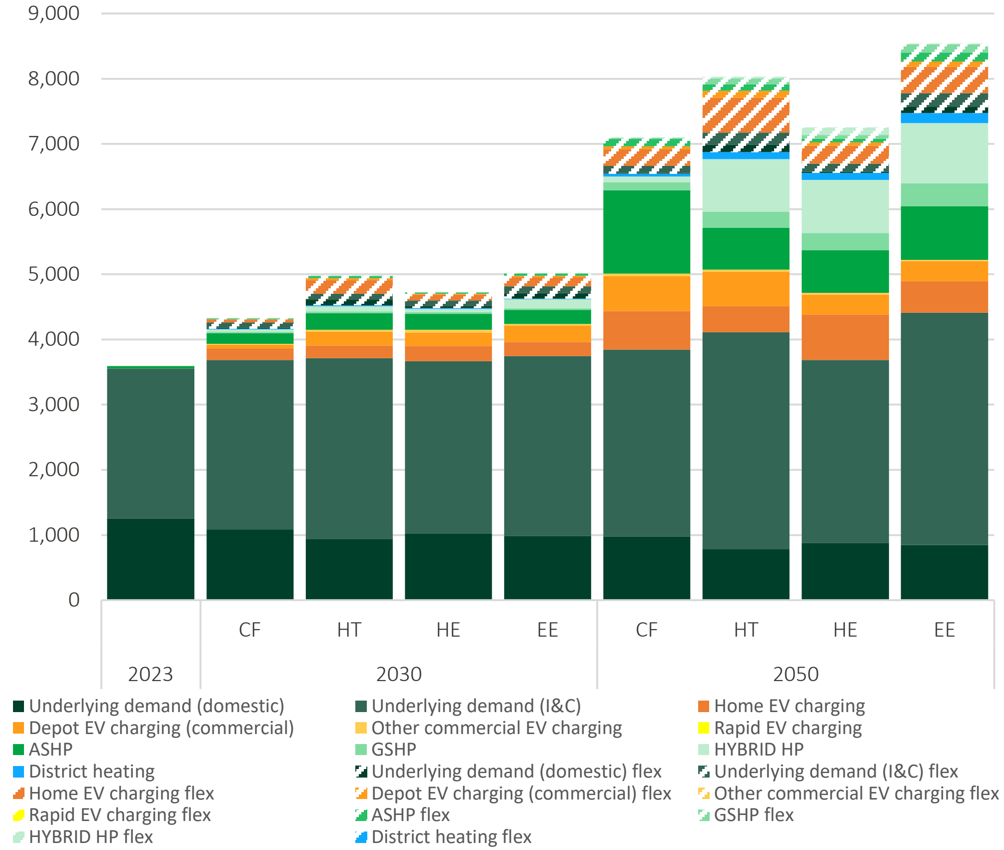


Figure 6 | Electricity peak demand breakdown for 2030 and 2050 *Peak demand (MW)*



We have seen a tightening of the range in our Net Zero compliant scenarios in the short-term. Even though SPD Hydrogen Evolution, SPD Electric Engagement and SPD Holistic Transition all achieve the Net Zero targets, this is achieved through differing levels of electrification. Both SPD Electric Engagement and SPD Holistic Transition 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 Hydrogen Evolution and Counterfactual 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.

With flexibility, peak demand could reduce by over 10% when compared to the no flexibility forecasts.

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

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

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

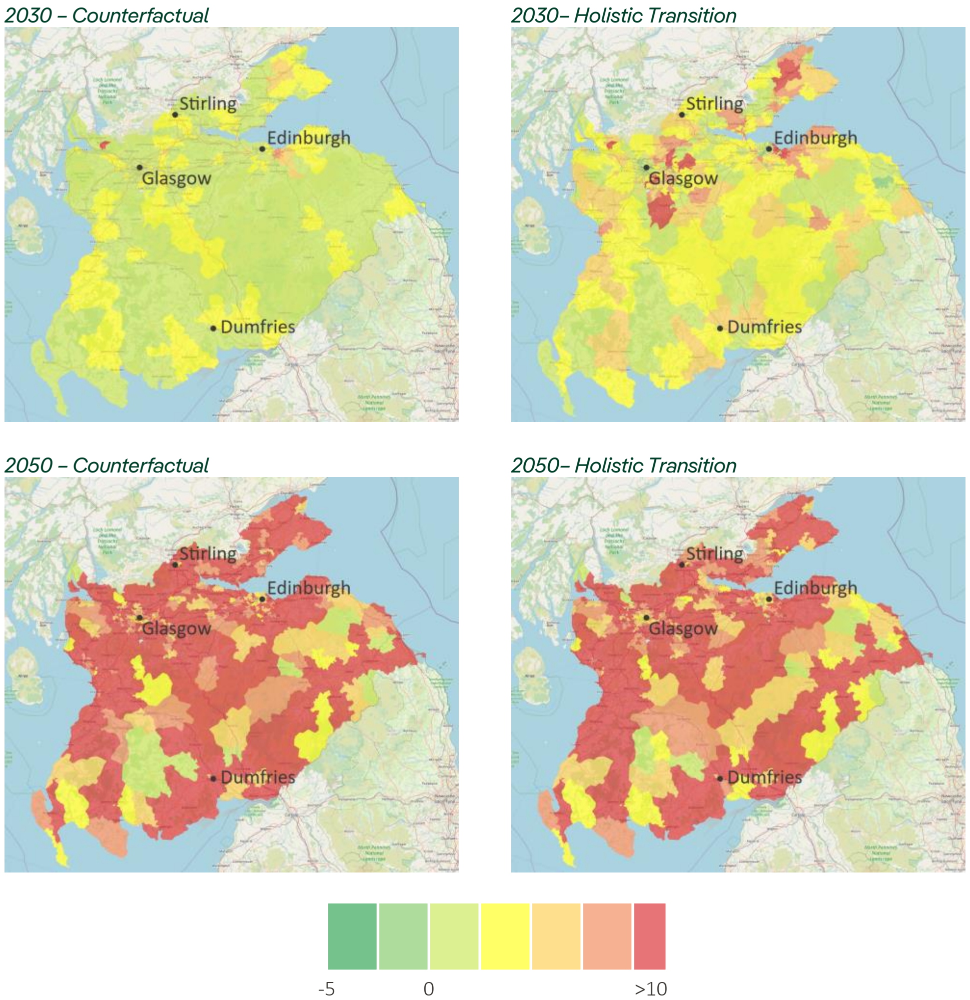
Figure 5 shows how demand flexibility (excluding vehicle to grid) could reduce the SP Distribution total peak demand. This reduction will directly deliver benefits for consumers as it will require less investment in the network, resulting in lower electricity bills. SPD Electric Engagement and SPD Holistic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

In all scenarios, GSP peak demand is forecast to double by 2050.

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

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. This may well present the industry with a challenge, as these focussed regions of particularly high growth could develop into hot spots of required reinforcement.

Figure 7 | Electrical peak demand by geographic area *Peak demand (MW)*



Overall peak demand trends:

1.

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

2.

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

3.

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

Reflecting local ambition

Through our extensive stakeholder engagement since our first DFES publication in 2020, stakeholders have emphasised the importance of our forecasts reflecting local ambition and strategic projects when developing our DFES. We continually engage with stakeholders to ensure their plans are factored into our forecasts, the following outlines some of the projects we've undertaken to achieve this:

Register of strategic projects: some projects and developments will be key catalysts or enablers for Net Zero and would benefit from early visibility and coordination. This is particularly true of cross vector projects and industrial clusters of decarbonisation. Over the past three years we have been working with stakeholders to develop a register of projects with strategic significance in our areas. This register includes information on the nature of each project (location, capacity requirement range, how these requirements are likely to change over time), the project's significance (links to government targets, policy landscape etc.), and whether any additional support needs to be sought. This framework provides us with early insight into key strategic zones which can be factored into our DFES forecasts.

Supporting Local Authorities: our Strategic Optimiser team has supported our 22 Scottish Local Authorities develop their Local Heat and Energy Efficiency Strategy (LHEES) submissions to Scottish government. This support included proactively developing an LHEES tool for each of the Local Authorities to complete high level analysis and develop their plans, with SPEN's network information as an integral part of the process. Separately, we've supported Local Authorities to optimise the design and implementation of public EV charging and heat electrification initiatives, including provision of costs and timescales for 1,400 potential locations, and are working with Fife Council to develop a heat network proposal for Dunfermline. By undertaking a full review of these Local Authority development plans, we are able to inform our DFES forecasts. This ensures our forecasts are coordinated with our Local Authorities' ambitions and plans.

The Forth Green Freeport: we are working with stakeholders in Forth Green Freeport to identify and enable new connections across 550 hectares in Grangemouth, Leith, Rosyth, Burntisland and Edinburgh Airport. The Forth Green Freeport will act as a catalyst for new green technologies, alternative fuels, and renewable energy manufacturing. The freeports will focus on reindustrialisation of Scotland towards Net Zero Transition. This will increase trade through Scotland's sea and air gateways and support the growth of trading businesses across the Firth of Forth and at sites spread north, south and west of the estuary.

Electrification of transport – Ultra-rapid charging and HGVs: we are supporting the rollout of high-capacity electric vehicle charging at some of the region's busiest motorway services. These projects have included creating new electricity capacity for Hamilton, Gretna and Annandale Water motorway service areas. In addition, we are supporting the Heavy Good Vehicles (HGV) Decarbonisation Pathway for Scotland. To provide better cohesion between the DNOs and the road haulage sector, we will work with operators to forecast HGV electricity usage out to 2040, encouraging mutual sharing of information and holding workshops for operators. We are members of Strategic EV Connections Working Groups with Transport for Scotland, Transport for the North, and Transport for Wales. We support the Scottish and Welsh Blue Lights EV Group to facilitate EV charging point (CP) connections for our emergency services colleagues for both devolved governments and are working to develop similar relationships across the similar organisations in England.

Increase in other large demand connections: we are working with stakeholders to facilitate low carbon housing developments and decarbonisation of industrial and commercial establishments with increased capacity needs ranging from ca. 5 – 30MW. We have also experienced an increase in applications to connect industrial and commercial data centres with capacities ranging from ca. 20-50MW.

Electric vehicles

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

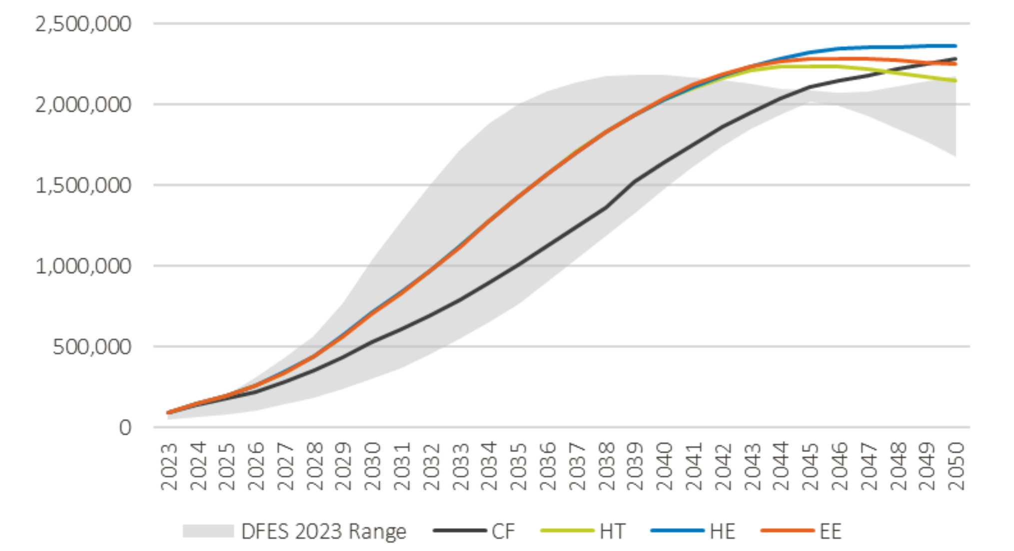
By the end of 2023/24, we estimate the number of electric vehicles (EVs) registered within the SP Distribution area was over 90,000, which is within the range we forecast in the 12 months prior.

Figure 8 shows the forecast numbers of residential Battery Electric Vehicles (BEVs)[21] in the SP Distribution region. For comparison, the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our 2023 DFES. We have updated our EV forecasts to align with the FES 2024 framework which has seen a reduction of our highest uptake scenario when compared to DFES 2023. In this updated framework, all Net Zero compliant scenarios follow a single trajectory which is aligned to the Zero Emission Vehicle (ZEV) mandate. SPD Counterfactual also aligns to the FES framework and has a less ambitious uptake across the forecasted range.

Figure 8 shows that all scenarios forecast there will be over 2.1 million BEVs within the SP Distribution network area, but the scenarios reach this value at different rates.

Across the scenarios, the share of BEVs rises from around 90,000 now to between 500,000-700,000 in 2030. The reason for this high level of variance in the 2030s is the differing levels of ambition between the Net Zero compliant scenarios and the Counterfactual scenario for phasing out the sale of new petrol and diesel cars and vans.

Figure 8 | Total battery electric vehicle uptake — *Number of vehicles*



The SPD Holistic Transition scenario marginally has the fastest uptake until 2042: it forecasts that compared to today, there could be 8 times more BEVs by 2030, and 23 times more by 2040. SPD Holistic Transition, SPD Hydrogen Evolution and SPD Electric Engagement all assume that the sale of new internal combustion engine vehicles ends in 2030, in line with the UK government's original target date. Volumes reach more than 1.9 million by the end of the 2030s.

Our SPD Counterfactual scenario doesn't meet Net Zero targets. Growth rates pick up in the early 2030s for SPD Counterfactual, recovering to similar uptakes to the Net Zero compliant scenarios by 2046.

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

It has been reported across various media that EV sales have plateaued; however, according to our estimates based on DVLA statistics[22], the number of newly registered BEVs and PHEVs in the 2023/24 financial year[23] as a percentage of total new registrations in GB has continued to grow compared to the 12 months prior.

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

In September 2023, the government goal to end the sale of petrol, diesel and hybrid vehicles was indeed pushed back to 2035. There is currently a consultation on whether to reinstate this target. As a result, we have not reflected the delay in our Net Zero compliant scenarios.

All scenarios forecast that the SP Distribution network will have to accommodate 2.1 million or more battery electric vehicles by or before 2045.

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

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

[23] April 2023 to March 2024, or Q2 2023 to Q1 2024 inclusive. BEV and PHEV sales in the 12 months up to and including Q3 2024 (which is the latest available data at the time of writing) have also increased compared to the previous 12 months, as a percentage of total registrations. Source: VEH1153.

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

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

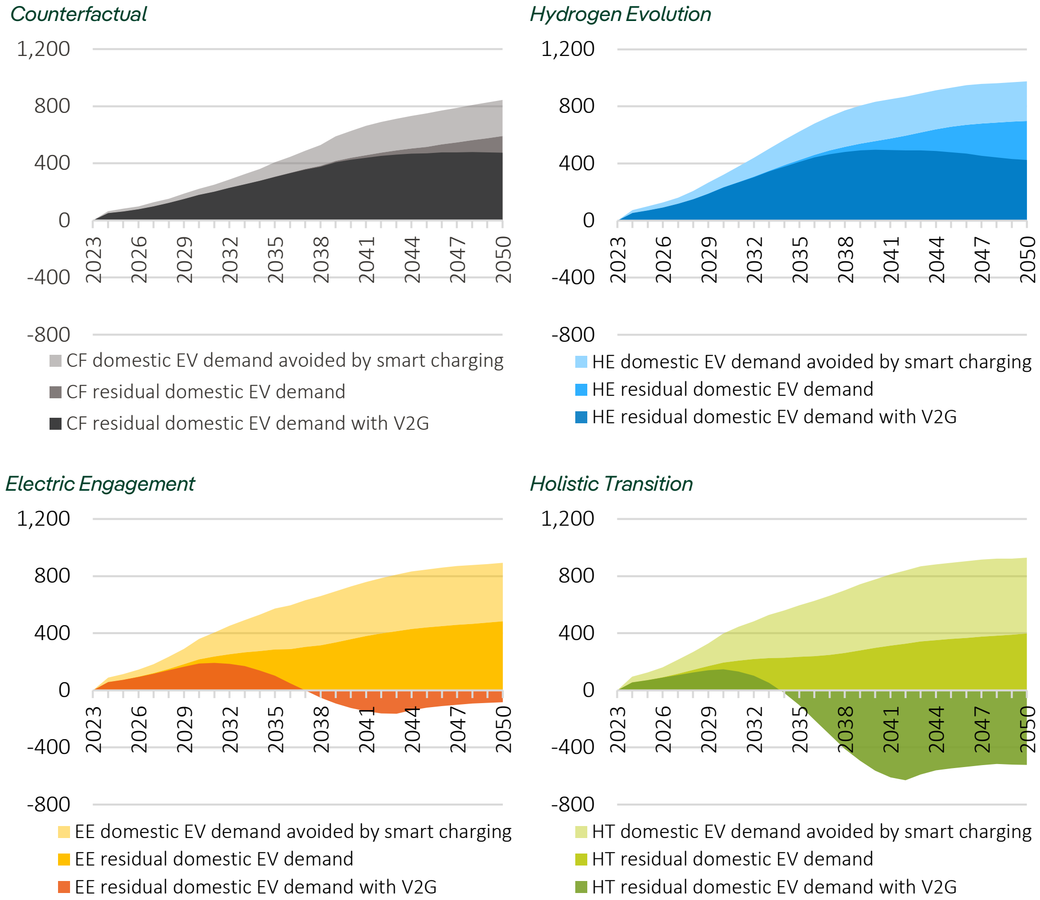
Figure 9 shows the expected contribution from domestic electric vehicle charging at the time of peak with and without smart charging and V2G.

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

However, the scenario range shows significant variance, reflecting a large degree of uncertainty in the impact of these technologies, particularly V2G[24]. This is because customers have concerns about technology capability, impact on battery life and the ability to use their EV on full charge on demand. There is also uncertainty in the market; it is unknown what smart charging and V2G products and services will ultimately be available to consumers, and how much networks will be able to rely upon these services.

By 2030	Domestic EV charging could add to SPD's peak demand between **220-398MW**	Smart charging could reduce this contribution by **19-51%**	V2G could reduce this contribution to as low as **147MW**
By 2050	Domestic EV charging could add to SPD's peak demand between **843-929MW**	Smart charging could reduce this contribution by **30-57%**	V2G could reduce **overall** peak demand by as much as **921MW***

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



[24] V2G could reduce peak demand by up to 156% in 2050. A total peak demand reduction above 100% means vehicle to grid has gone beyond offsetting the peak demand contribution from electric vehicles.

* V2G more than offsets the peak demand contribution of domestic EV charging in the SPD Electric Engagement and SPD Holistic Transition scenarios.

The degree of geographical clustering of EVs adoption will also be a key determining factor of the impact on the network – if there are high concentrations of EVs 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 EVs is likely to occur. The model combines detailed spatial analysis to determine off-street parking availability at an individual property level, and sociodemographic information to understand the probability of specific areas to transition to EVs.

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

Figure 11 shows that in Central & Southern Scotland, residential BEVs are predominantly found in densely populated areas such as Glasgow, Edinburgh, North Lanarkshire, South Lanarkshire or Fife, where each could see over 50,000 EVs by 2030, increasing to over 125,000 by 2050.

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

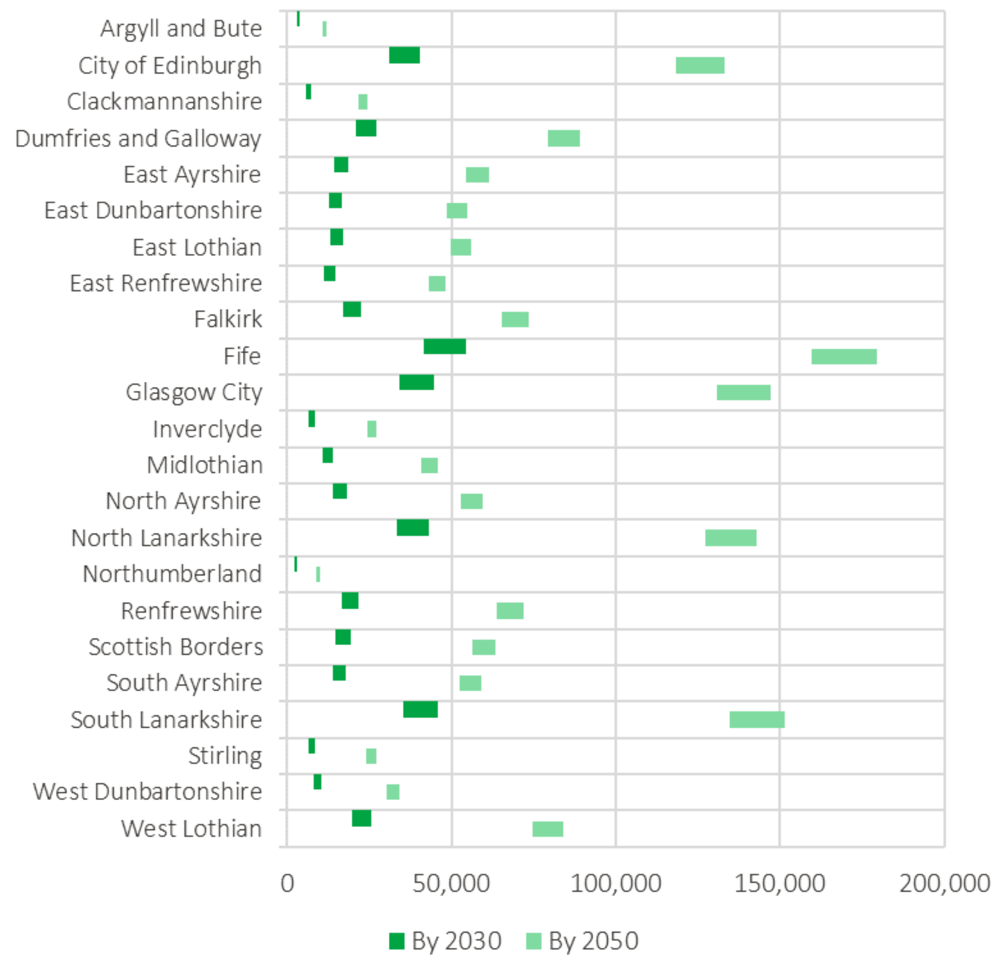
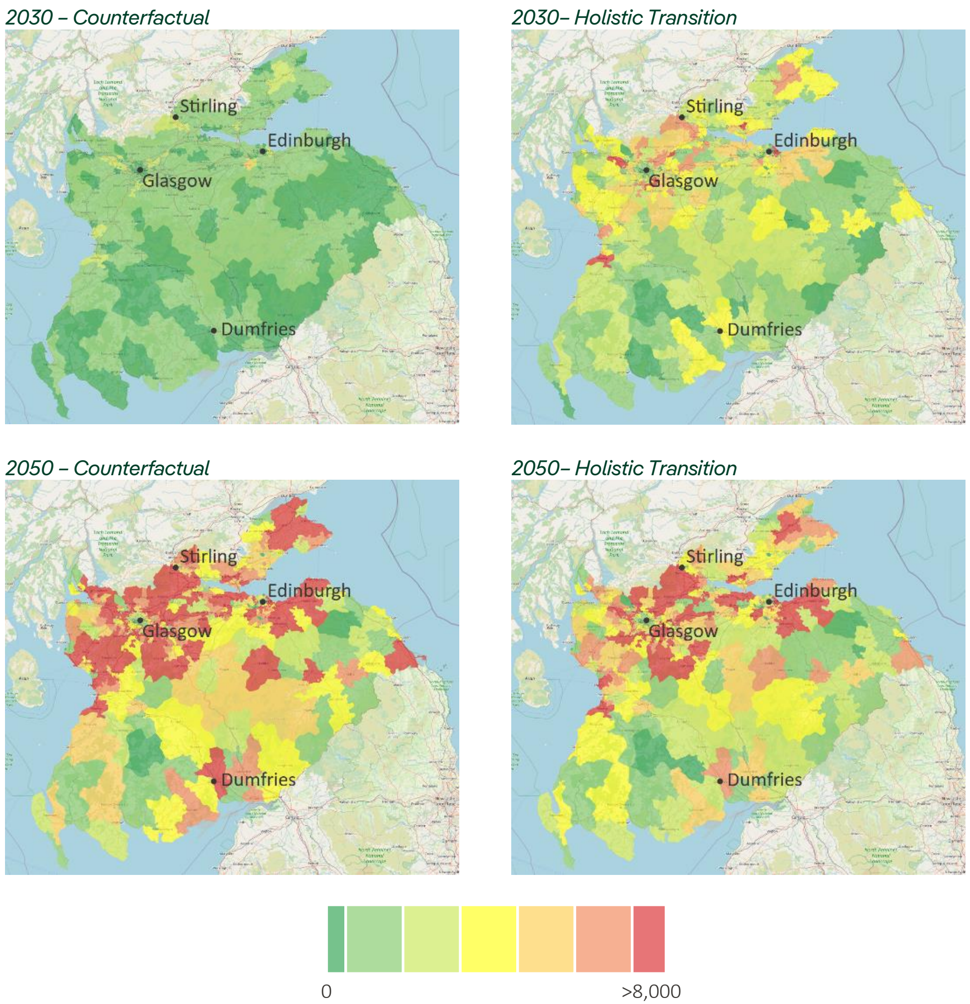


Figure 11 | Residential battery EV uptake numbers by primary substation area *Number of vehicles*



Heat pumps

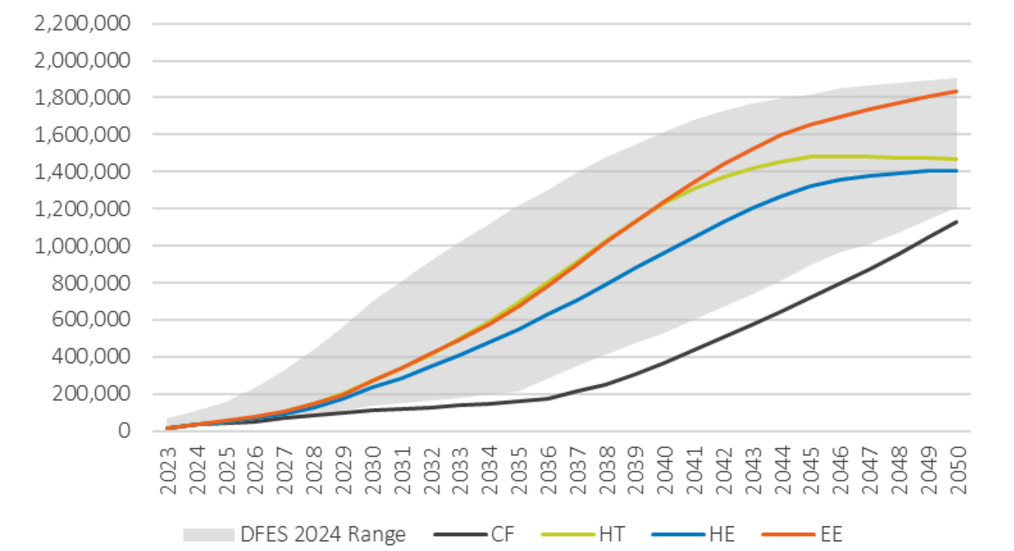
Heat pumps use electricity to heat buildings and provide hot water. Heat pumps – both air source and ground source – represent another change to the future electricity demand.

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

Deployment is still currently low, estimated at about 1% of total households within a total stock of circa 2 million households in the SP Distribution area. This is in the range we forecasted in our 2023 DFES. Although towards the lower end, we are now observing a faster connection of heat pump technologies than in previous years. Under the New Build Heat Standard that comes into effect in 2025, changes to building regulations will mean new homes and buildings will not be allowed to use polluting heating systems, such as oil and gas boilers. We have observed the switch towards heat pumps in new housing developments across our region has already started.

Figure 12 shows the forecast uptake for each of the four scenarios. For comparison, the grey area shows the forecasted range (the difference between the lowest and highest scenario) from our 2023 DFES.

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



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

- SPD Electric Engagement assumes that the decarbonisation of heat will predominantly be met by electricity – either via heat pumps, or district heat networks. The growth in heat pumps is initially expected to be in-line with new housing growth, but the rates of new installations increase to over 100,000 per year by the mid-2030s as more of our customers begin to retrofit old heating systems with heat pumps.
- SPD Holistic Transition, being the most ambitious decarbonisation scenario, has a faster uptake of non-hybrid HPs, assuming a quicker switch to retrofitted heat pump systems, even in the short term. Installation rates of over 50,000 are reached as early as 2028. The end-points are lower than the Electric Engagement scenario as the Holistic Transition scenario assumes hydrogen will be used to decarbonise domestic heating systems in some areas.
- The SPD Counterfactual scenario, which does not meet Net Zero by 2050, has low installation rates, possibly even below the rate of new build houses.
- SPD Hydrogen Evolution also has lower installation rates than SPD Holistic Transition and SPD Electric Engagement, as this scenario assumes hydrogen will play a key role in the decarbonisation of heat. As a result, in Hydrogen Evolution, homes and businesses will continue to use gas for heat into the mid-2030s before switching to hydrogen, at which point hybrid heat pumps become a very popular technology. The sharp uptake in 2035 is due to a significant increase in hybrid heating systems. As a result, more hybrid heat pumps are installed in the 2040s in Hydrogen Evolution than in any other scenario.

The total proportion of homes with a heat pump could reach 14% by 2030.

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

The SPD Counterfactual scenario steadily increases out to 2050 as heat pump numbers are still increasing; notably, it does not meet all Net Zero targets by 2050.

SPD Electric Engagement sees a much earlier impact on peak demand given the greater volume of heat pumps, but the potential impact is reduced from 2030 due to a notable shift towards demand flexibility – i.e. avoiding some heat pump demand at the times of day when the electricity network is busiest. SPD Holistic Transition shows very similar impact from flexibility but has a reduced peak demand impact compared to SPD Electric Engagement from 2040 onward due to having few heat pumps.

In SPD Hydrogen Evolution, the contribution to peak demand from heat is driven predominantly by hybrid heat pumps as this scenario focuses on fast advancement of hydrogen.

The development of effective heat pump flexibility could reduce their associated peak demand contribution by up to 22% by 2050. This volume is significant, although there is a limit to how much flexibility can be delivered by heating technologies alone. Electricity peak demand is most likely to occur in the early evening on a cold, winter weekday – this is when it is dark, workplaces are still open and functioning, but many people are also simultaneously getting back home to houses that have been empty all day. It is unlikely this pattern of behaviour will shift completely, and so there will always be a demand for a boost of heat around this time.

A prevalent low-carbon alternative to heat pumps in SP Distribution network is likely to be district heating, or heat networks. These are likely to be larger-scale, and therefore connect into higher voltage levels. We forecast this will be another significant contributor to peak demand in all scenarios except SPD Counterfactual, as shown in Figure 14.

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

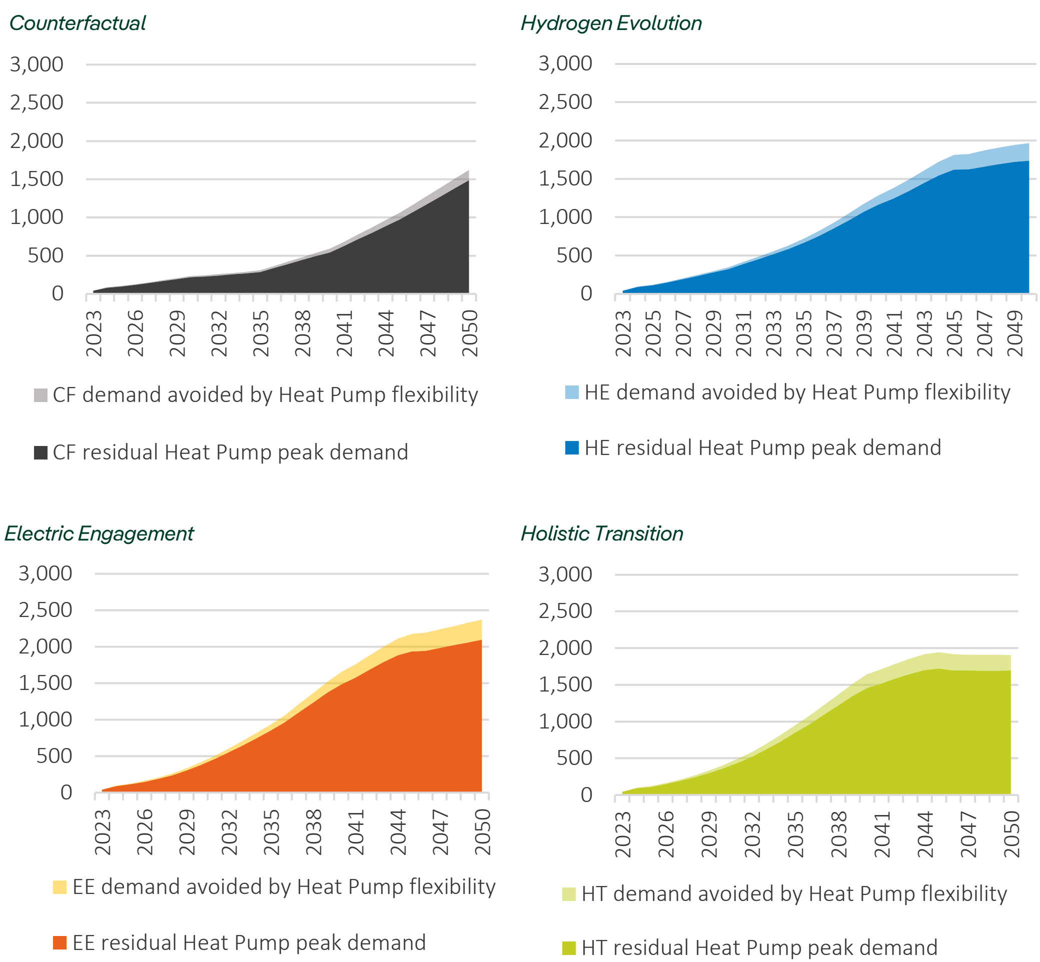
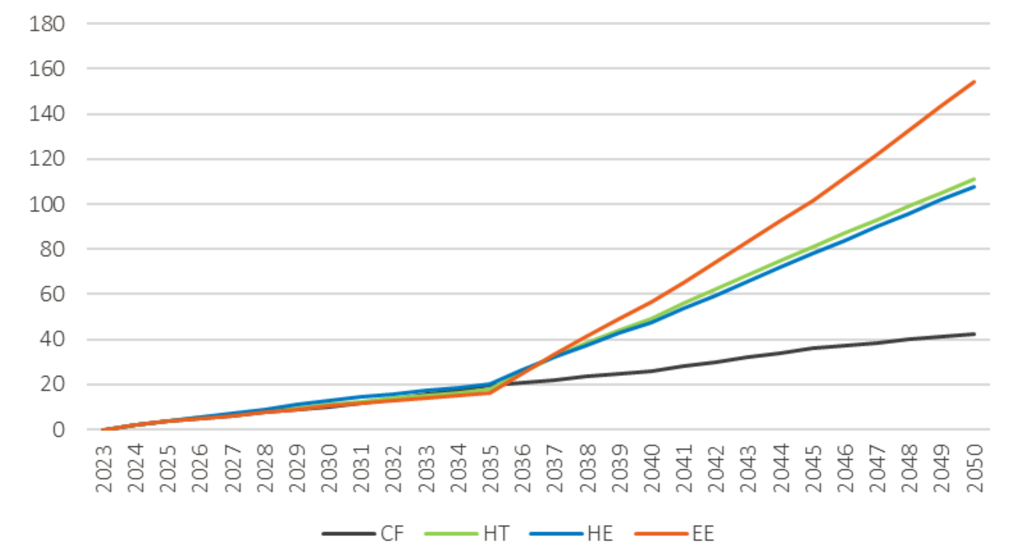


Figure 14 | District heat contribution to peak demand *Peak demand contribution (MW)*



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

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

The degree of geographical clustering of heat pump adoption is less than for EVs, but it is still key to determining the local impact on the network. Although the most populated areas do have larger numbers of heat pumps by nature of there being more properties, we see a higher density of properties with heat pumps in some of the more rural areas – particularly Dumfries and Galloway and Scottish Borders. These areas are associated with high areas of off-gas-grid properties. In our model, heat networks would be least suitable for many of the properties in these areas.

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

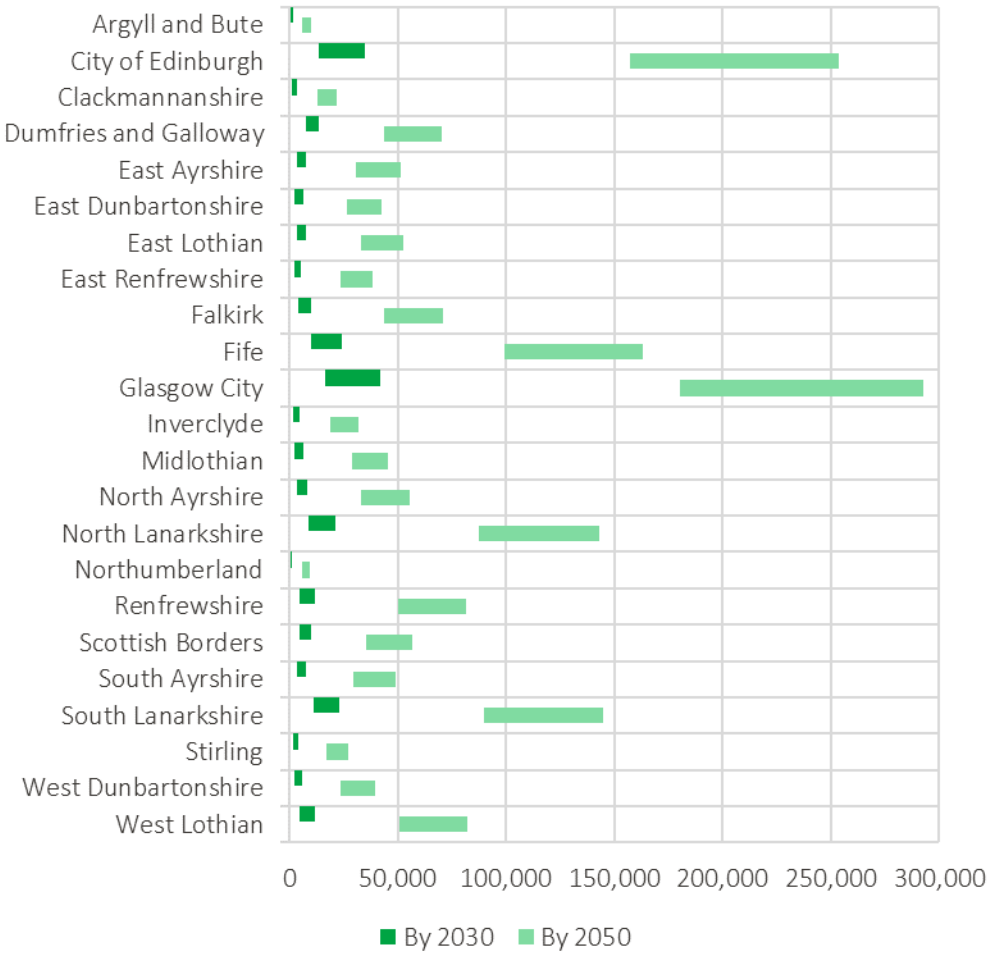
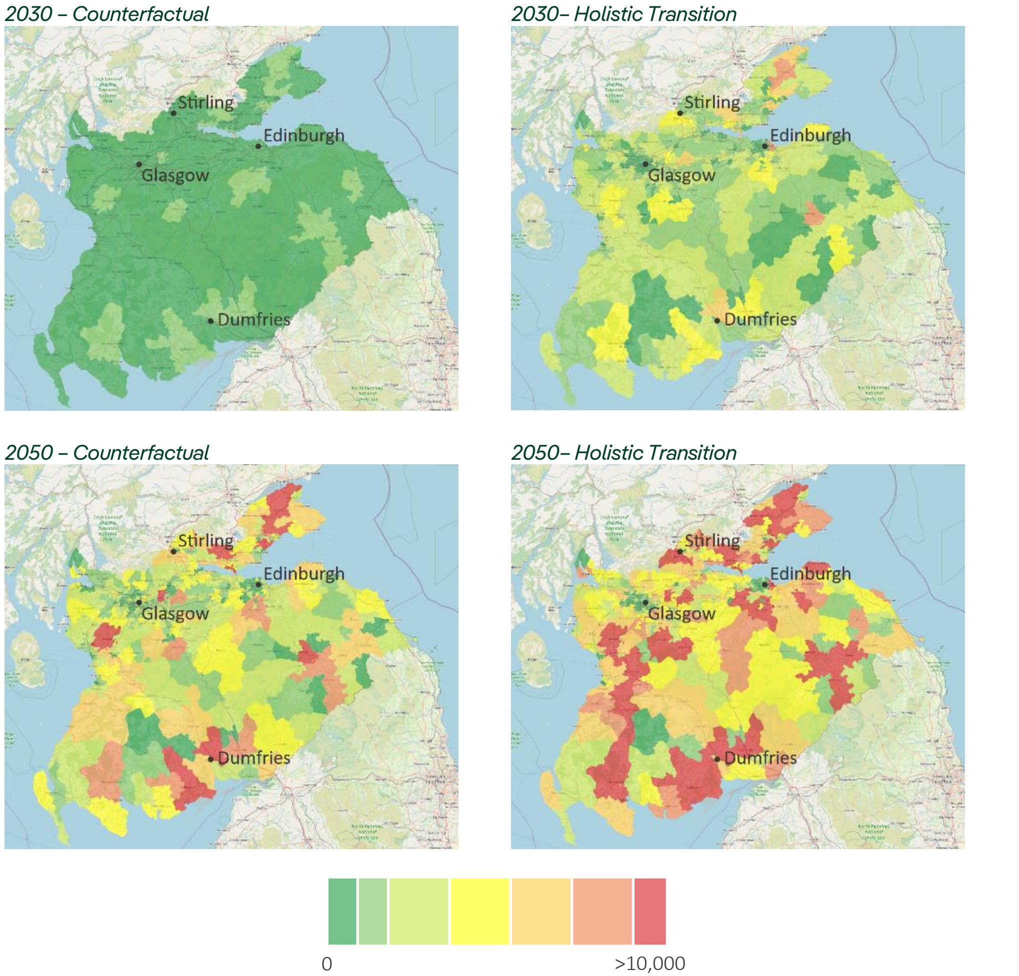


Figure 16 | Heat pump numbers by primary substation area *Number of heat pumps*



4. Electricity generation and storage

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

Understanding how electricity generation and storage could evolve on the SP 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).

Generation and Storage Overview

Figure 17 shows the geographic location of our currently connected generation capacity. Our current capacity outlines the scale of generation and storage technologies connected to our SP Distribution licence area - the starting point for our forecasts. This starting point value is constant for all of our DFES scenarios. Our pipeline of contracted projects outlines the capacity generation projects currently contracted to connect to the distribution network in SP Distribution which is a key driver of our short-term forecasts. The amount of this contracted capacity forecast to connect to the network per technology varies in our forecasts depending on a scenario's level of ambition.

Our currently connected capacity contains circa 3.3GW of connected generation and storage of which approximately 60% is onshore wind. Solar and storage are the next most prominent technologies, each with over 10% of connected generation and storage – a notable increase in small scale solar since DFES 2023. Non-renewable technologies such as non-renewable Combined Heat and Power (CHP) or non-renewable engines account for circa 10% of the currently connected capacity.

With the significant increase in connections activity, our pipeline of contracted generation and storage capacity has continued to grow to 9.1GW. A high proportion of the pipeline – 61% - is driven by contracted storage projects. Clean Power 2030 states this contracted connections pipeline is currently oversubscribed, with NESO's research showing contracted connections are over double the required amount needed to achieve clean power targets. Historically, connections requests have been accepted on a first-come, first-served basis. Achieving Clean Power 2030 will require a shift to a more strategic approach which prioritises projects that align with government targets for network reinforcement and expansion, alongside local authority priorities and initiatives. This pipeline of contracted projects is currently under review as part of the government's CP2030 target.

We have updated our assumptions to reflect the analysis within CP2030 and the proposed connections reforms. At present these are applied at a licence level. We will continue to work closely with NESO to assess the impact on specific pipeline schemes as these connection reforms develop and maintain close relations with customers and stakeholders. More detail on our process for DFES 2024 can be found in Section 5.

Figure 17 | Geographic view of connected generation and storage (1MW+)

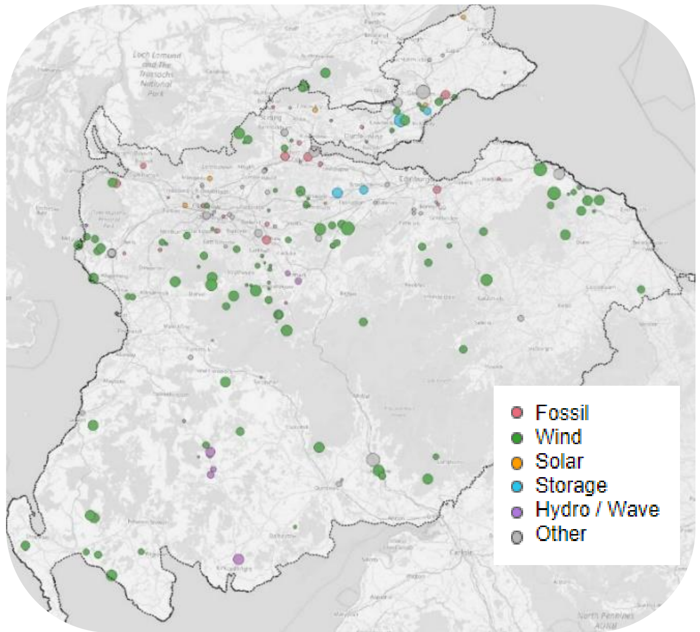


Figure 18 shows how the total generation and storage capacity connected to the Central and Southern Scotland distribution network will vary for the four scenarios. As previously stated, we have refreshed our generation forecasts to align with the 2030 and 2035 caps published in Clean Power 2030. Currently DESNZ sets out DNO licence level targets for wind, solar and batteries for the 2030 and 2035 time periods. These caps outline the DNO licence area generation targets required to meet GB's clean power targets, as determined by NESO's Clean Power 2030 analysis. We have ensured that our high forecasts are capped at these targets for Wind, Solar, and Storage. For other generation technologies we have aligned to FES 2024 forecasts.

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

In our more ambitious scenarios, a significant increase in new generation capacity is expected in the next ten years. These scenarios forecast that – in addition to projects currently in their delivery phase – schemes in our contracted project pipeline are delivered by their target energisation date. Beyond this, future growth is expected to be modest in the SPD Counterfactual and SPD Hydrogen Evolution scenarios but could continue to grow to over 12GW in the SPD Holistic Transition scenario by 2050. To better illustrate what is driving the changes in generation, Figure 19 shows a breakdown of the generation and storage forecasts from Figure 18 by technology type, for 2030 and 2050.

Figure 19 shows that significant growth is expected, particularly from renewable generation. The majority of the increase in capacity to 2030 is expected to come from wind, solar PV, and storage. Given that wind and solar PV generation output is weather dependent, it is unlikely to always occur at the same time as periods of high demand[25]. This means that the distribution network may need intervention to accommodate wind and solar PV generation capacity. It also means that there may be a greater export of power from the distribution network up onto the transmission network, and greater transfer of power across the transmission network, at times when generation output is high, and demand is low.

Figure 18 and Figure 19 show increasing electricity generation for all scenarios out to 2050. However, different regions will see different increases in generation, based on a range of factors.

OVERALL GENERATION AND STORAGE TRENDS:

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

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

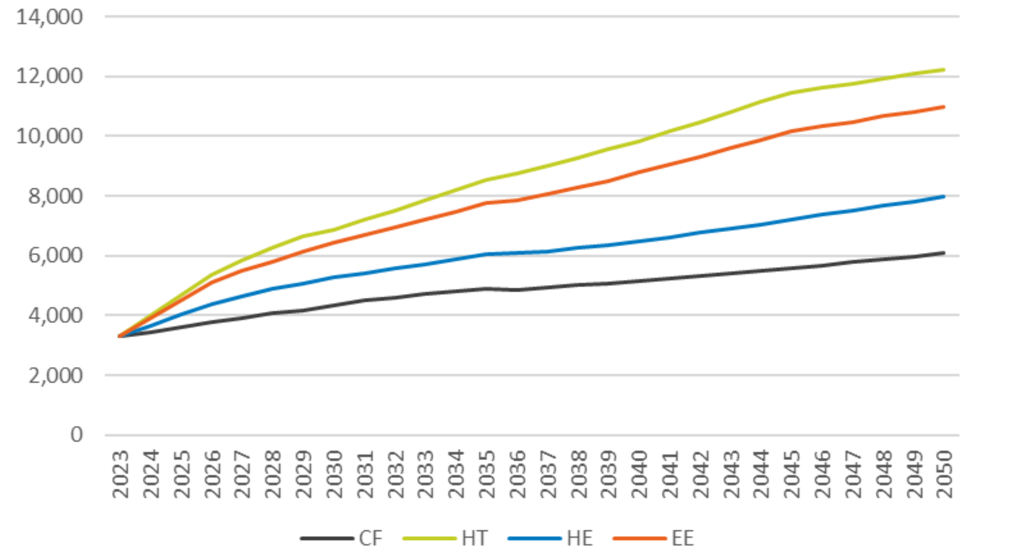
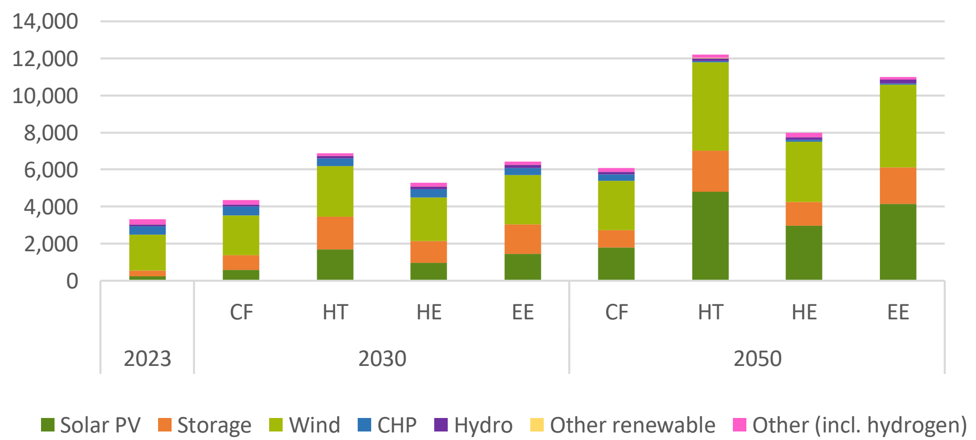


Figure 19 | Breakdown of installed generation capacity by technology *Installed capacity (MW)*



[25] 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 20 shows the geographical breakdown of how the generation and storage capacity connected to the distribution network could change by 2030 and 2050 from current levels for the highest and lowest forecast scenarios.

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

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

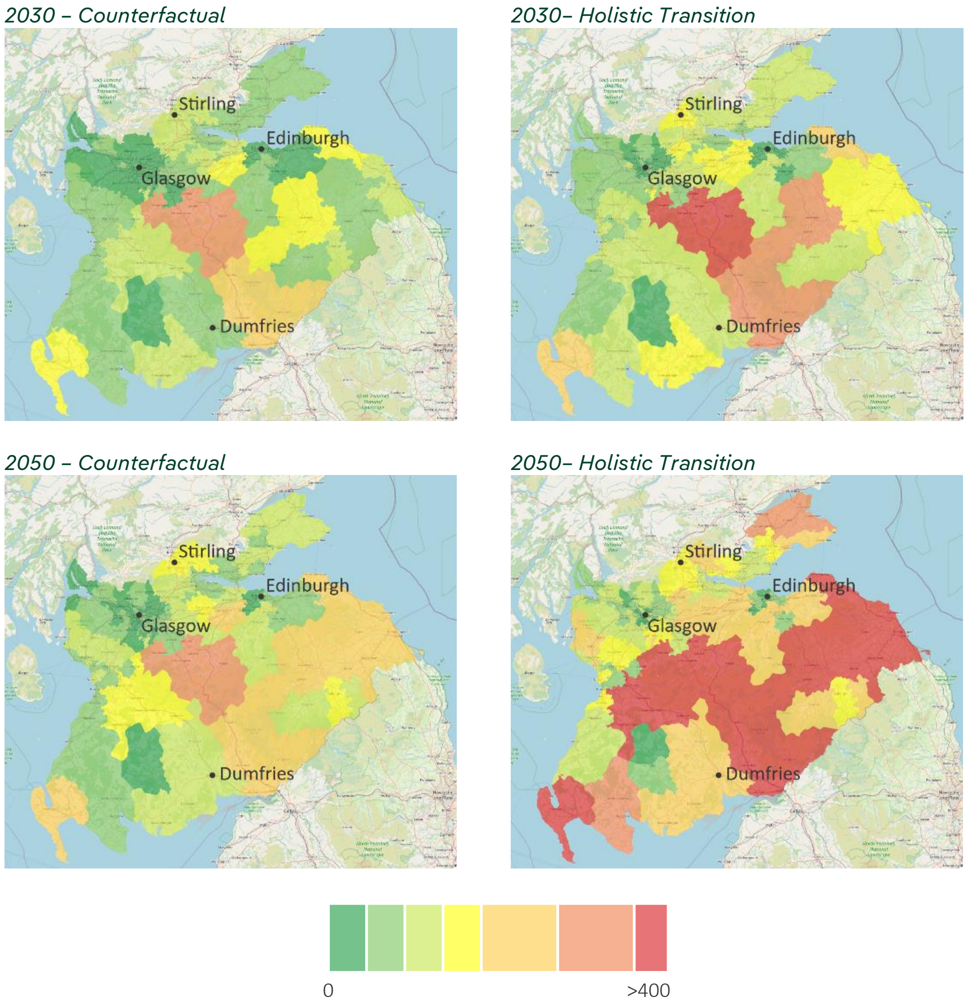
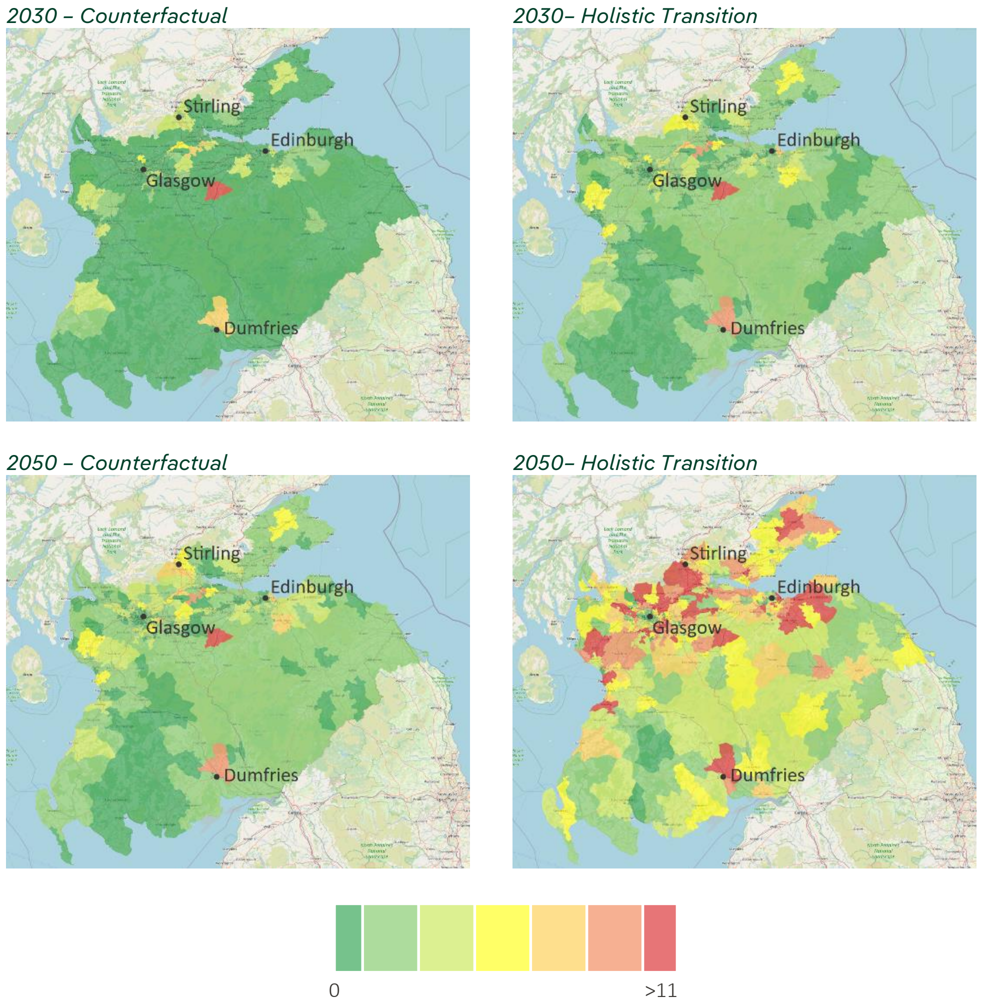


Figure 21 | Domestic-scale and smaller-scale installed generation and storage capacity by primary substation area *Installed capacity (MW)*



Solar PV

Over the past five years, our distribution network has seen a 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.

In our previous DFES, we uplifted both our short-medium term solar forecasts (due to our growing pipeline of solar projects) and our longer-term forecasts in line with regional drivers. Since our previous DFES, we have updated the short-term uptake to ensure this better reflects projects that are in delivery and expected to connect by 2026 and the targets for SP Distribution in Clean Power 2030. This has slightly reduced the first three years of our forecast, but this recovers to previously forecast values by 2030. There is minimal impact on the long-term outlook, where we are largely aligned with our DFES 2023 across scenarios.

In addition to aligning with the Clean Power 2030 targets, we believe it is important our forecast also reflect the reported Scottish Government ambition for up to 4-6GW of solar power by 2030. In our high uptake scenario forecasts, we have approximately 1.7GW of connected solar by 2030. Based on the proportion of solar currently connected at transmission level and to other areas of Scotland, we believe this captures Scottish Government ambition for our SP Distribution licence area.

Figure 22 shows the forecast uptake of solar PV for the four scenarios. It shows significant future increases in solar PV capacity across all scenarios, potentially increasing over seven times from current levels by 2030 and 20 times by 2050. The increase in solar PV across all four scenarios is due to it being a low-cost and tried and tested technology, with a lower visual and noise impact than other forms of renewable generation.

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

Solar PV capacity can be split into two categories: small-scale building rooftop schemes, which are connected behind the meter, and larger-scale ground-mounted solar PV farms, which connect directly to the distribution network. Figure 23 shows a breakdown of the Figure 22 solar PV forecasts for these two categories, for 2030 and 2050. Figure 23 shows that, for all scenarios, the largest growth is expected to come from larger-scale ground mounted solar PV. New capacity for behind the meter solar PV is expected to be focused in areas that have already had some uptake due to subsidy support from Feed-in-Tariffs. Larger-scale ground-mounted solar PV schemes are expected to be deployed in more rural areas, due to the additional land area needed.

Solar PV generation could be over seven times greater than today by 2030.

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

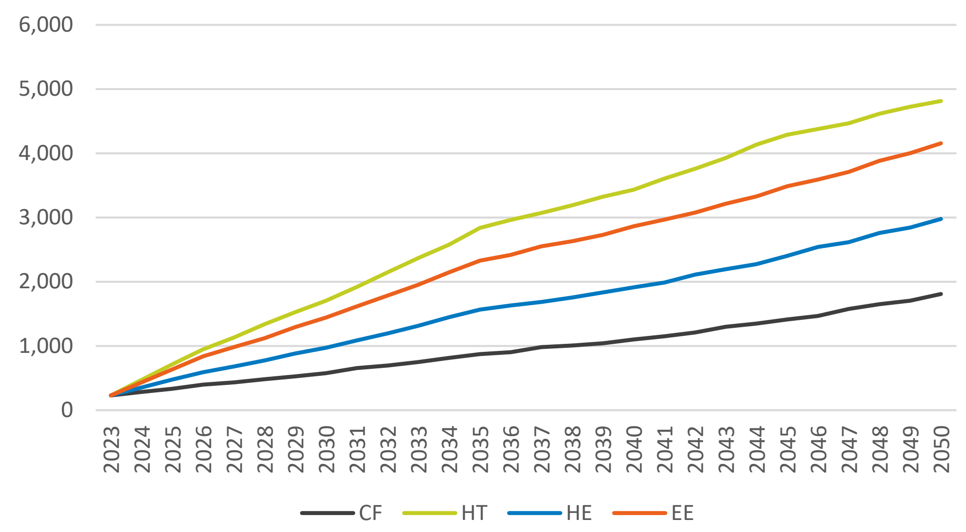
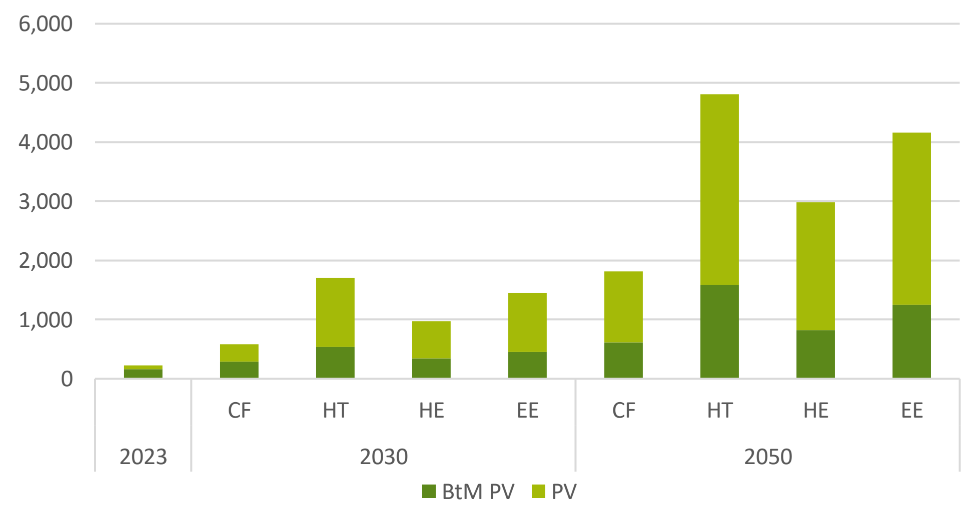


Figure 23 | Distribution connected and BtM solar capacity *Installed capacity (MW)*



Wind

Over the last ten years, there has been steady growth in wind capacity on the SP Distribution network leading to circa 1.9GW of installed capacity – the largest connected capacity of any generation technology.

Wind generation is commonly split into two categories: onshore wind and offshore wind. Very few large-scale offshore wind projects are expected to connect to the distribution network. There are currently no offshore wind projects connected or contracted to connect within our SP Distribution licence area. As a result – and to align with FES - we forecast zero growth in offshore wind capacity in all four of our DFES 2024 scenarios; the growth outlined in Figure 24 is expected to be onshore.

Any major increases to distribution connected wind are expected to be sited in rural areas, taking advantage of more favourable wind conditions. Our pipeline of generation projects reflects this with a further 1.5GW contracted to connect to our SP Distribution network, mostly in our rural area with the closest proximity to demand centres. This pipeline of contracted projects drives our short-term growth, of which we could see up to a 40% increase by 2030.

In the long term, Figure 24 shows significant variance in the levels of wind generation across the four scenarios. However, these refreshed values within our updated DFES scenario range are largely aligned to our DFES 2023 and remains in line with FES 2024 and Clean Power 2030 targets.

As wind generation is a cost-effective established technology, the extent of new wind generation post-2030 will likely depend on the onshore planning regime, government/policy support, and local support for individual schemes. These factors are scenario specific and are reflected within our DFES scenario range.

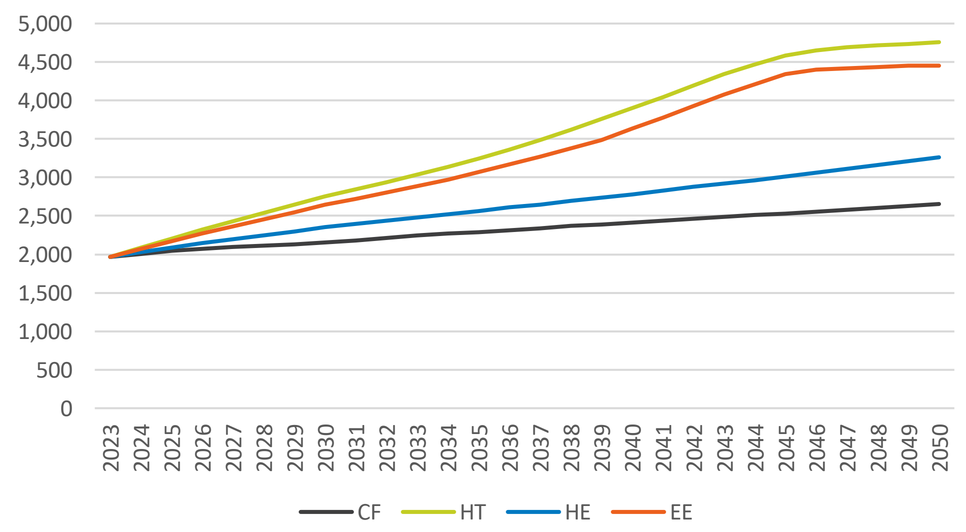
The maximum installed capacity in SPD Electric Engagement and SPD Holistic Transition are still reached in the mid-2040s, which maintains alignment with Scotland's 2045 Net Zero target.

Installed wind capacity is forecast to be the largest generation technology in all DFES scenarios. This continues to highlight that wind is expected to play a key role in electricity generation in any view of the future.

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

Wind generation could increase by up to 40% by 2030.

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



Storage

Electricity storage represents 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.

In 2022, SPD experienced a step-change in battery storage applications, leading to over 5GW of contracted storage projects. This significant increase in activity led to a substantial uplift between our DFES 2021 and DFES 2022 storage forecast. DFES 2023 slowed the short-term growth to better reflect the current rate at which we observed projects transitioning from our contracted pipeline of projects to the delivery stage. This update was driven by a full review of our connections data and findings from the ENA Storage working group.

Figure 25 shows our updated DFES 2024 forecast which draws in learning from previous DFES publications and the targets set with Clean Power 2030 to forecast uptake of storage projects, particularly in the next ten years. In this period, we expect a large uptake of storage projects that are currently in our contracted pipeline. Due to the number of projects currently in delivery which are expected to be connected in the next 18 months, we have made an adjustment to the 2026 and subsequently, the 2030 value. We are working with NESO on assessing the impact of these 'in delivery' projects on the Clean Power 2030 targets.

By factoring in these projects, we expect there to be rapid growth in uptake until approximately 2030 in our more ambitious Net Zero compliant scenarios. In SPD Counterfactual, growth in storage capacity is limited with a continued reliance on fossil fuels. Beyond 2030, we expect to see minimal growth across all scenarios.

Storage capacity can be split into two categories: small-scale storage at individual properties, which are connected behind the meter, and larger scale standalone storage, which connects directly to the distribution network. Behind the meter storage is generally assumed to be sited alongside rooftop solar PV installations; this does not include vehicle to grid storage capacity.

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

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

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

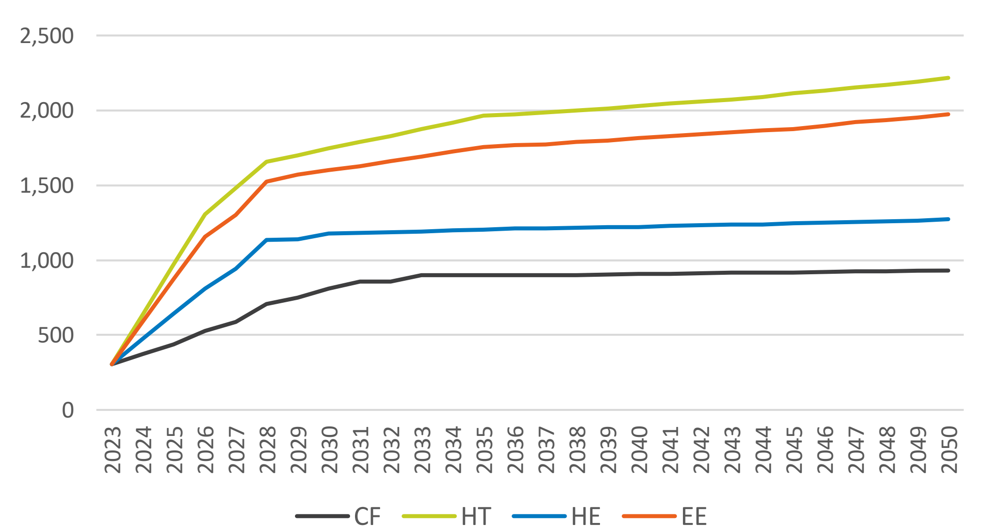
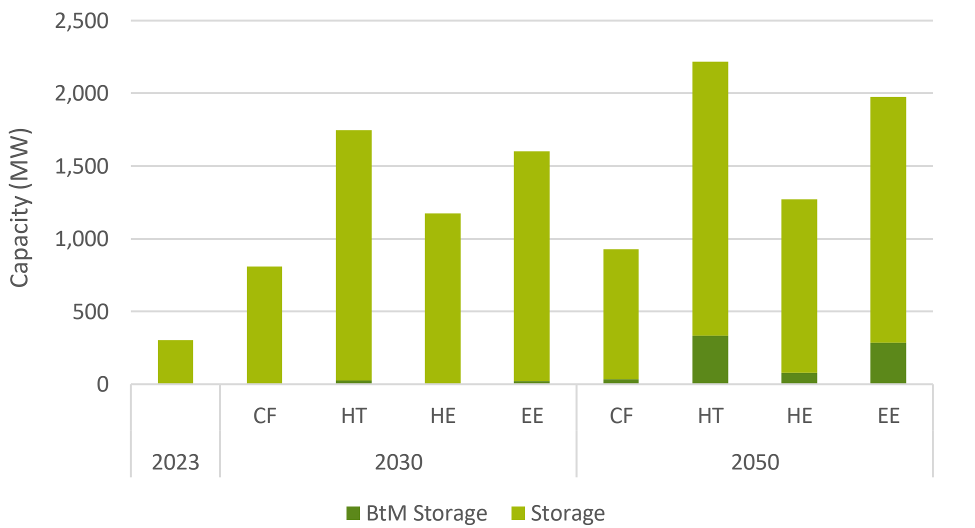


Figure 26 | Distribution connected and BtM storage capacity *Installed capacity (MW)*



5. Comparing back to FES

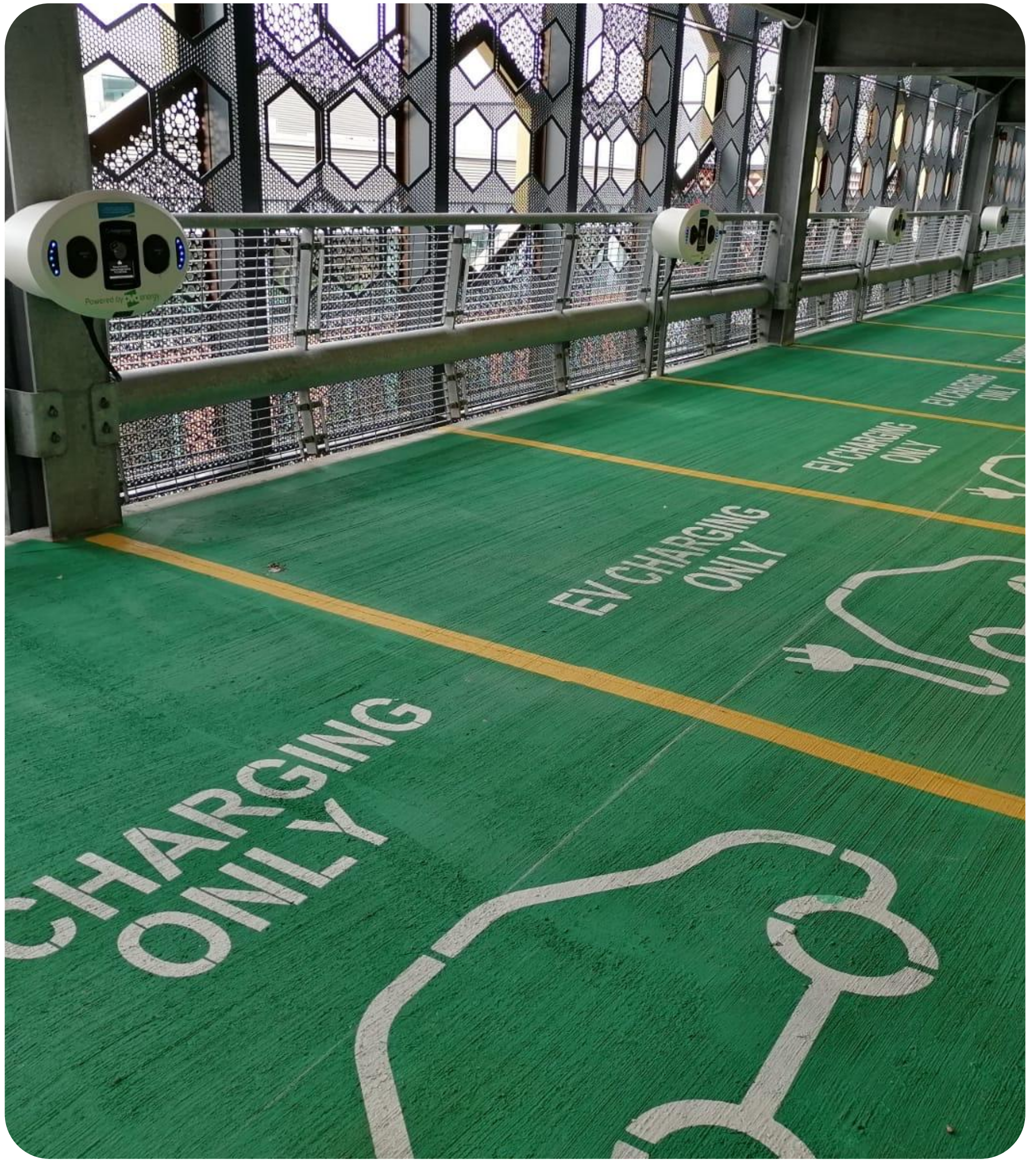
This section provides a comparison between the SP Distribution forecasts and the ESO's 2024 FES for key building blocks.

As we explained in Section 3, we use NESO'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 NESO's FES. This is to identify any significant discrepancies. We reconcile back using common building blocks[26] and FES regionalisation[27] to compare our DFES forecasts to the FES forecasts.

This section provides a comparison of our DFES forecasts to the regionally equivalent NESO's 2024 FES for key building blocks. Other building block data is available in the DFES data workbook[28].

Since the publication of NESO's 2024 FES in July, NESO have subsequently published their Clean Power 2030 recommendations. For Distributed Generation forecasts, we have aligned with NESO's Clean Power 2030 licence level recommendation where these differ with FES projections.



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

[27] 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.

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

Electric vehicles

Our forecasts for the uptake of BEVs in the SP Distribution network are broadly aligned with FES, as shown in Figure 27.

However, based on the Scottish Government's own detailed assessment work and feedback, we have updated our scenarios to include an accelerated EV uptake.

This is because their legislated target of Net Zero by 2045 is five years earlier than the rest of the UK, and interim greenhouse gas emission reductions could feasibly accelerate EV uptake beyond the FES forecasted scenarios. We have, therefore advanced the uptake of EVs in our SP Distribution licence area by two years.

Table 1 provides a comparison with FES for BEVs by 2030.

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

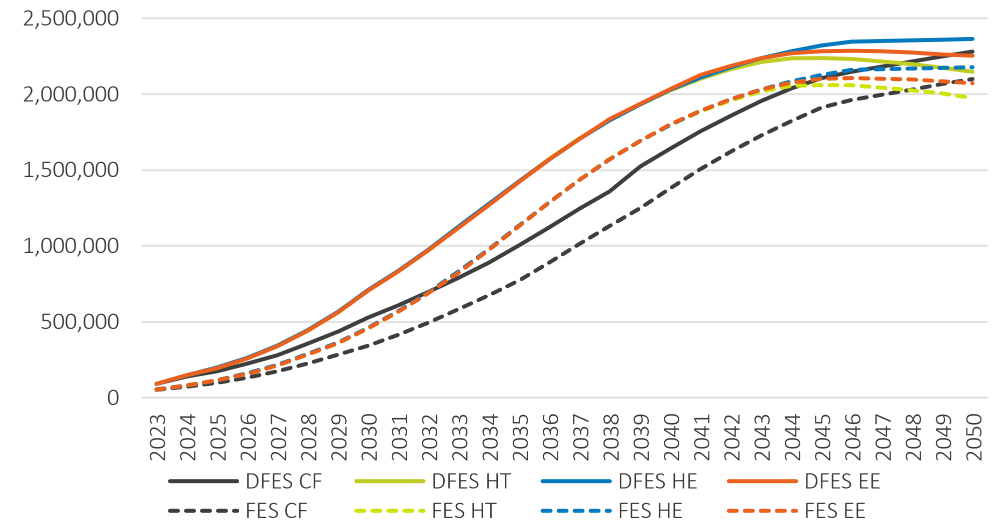


Table 1 | Battery electric vehicle volumes by 2030 *Thousands*

		Cars, vans and motorbikes *Lct_BB001*	Other vehicle types *Lct_BB003*
DFES	Counterfactual	525	3
	Hydrogen Evolution	706	5
	Electric Engagement	700	6
	Holistic Transition	700	7
FES	Counterfactual	342	2
	Hydrogen Evolution	457	3
	Electric Engagement	452	4
	Holistic Transition	453	4

Heat pumps

Our forecasts differ from FES in forecasted uptake of heat pumps in our most ambitious DFES scenarios, as shown in Figure 28.

The FES forecast for the uptake of heat pumps has notably dropped in the short term from the FES 2024 in our SP Distribution licence area across the forecasted range. In the short-term, FES has greatly reduced uptake in all scenarios; this is notable until circa 2027.

According to actual uptake of heat pumps within our SP Distribution licence, we have a higher proportion of the early adopters per customer than GB average. Our stakeholders' ambition reinforces this trend, and we believe it will continue in the short to medium term. Therefore, we have advanced short-term uptake in line with this data.

Our forecasts have been revised previously to align with the Scottish Government's Heat in Building Strategy. This sets out their plans to achieve Net Zero emissions in buildings by 2045, and the pace of transition over the next 10 years. We have continued to consider the impact of this ambition when developing our DFES 2024 scenarios.

Within the FES forecasts, we have also seen a reduction for all scenarios by 2050. Our stakeholders believe that this long-term perspective leaves too many customers within our SP Distribution licence without a realistic low carbon heating option – particularly SPD Electric Engagement. We have therefore adjusted the 2050 heat pump adoption rate to align with DFES 2023.

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

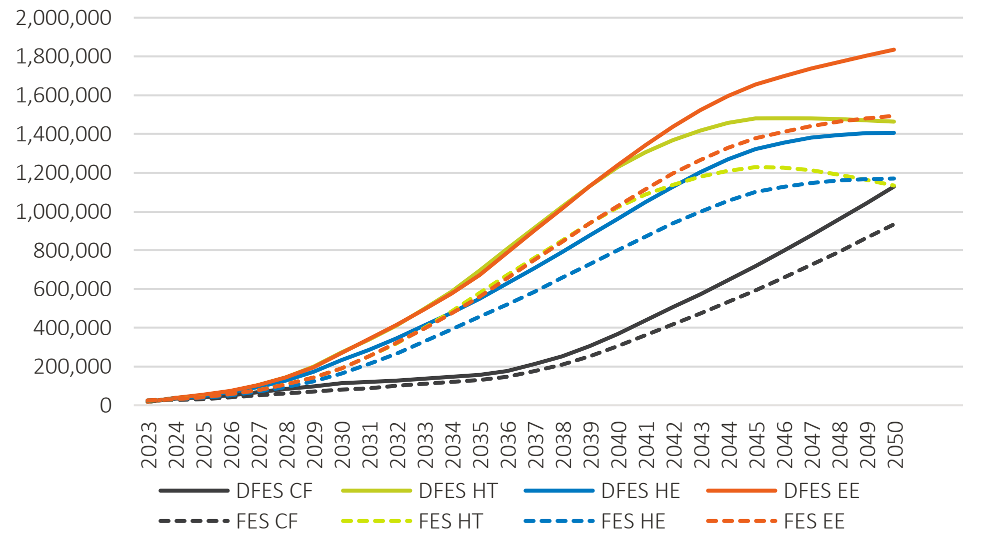


Table 2 | Heat pump volumes by 2030 *Thousands*

		Non-hybrid Lct_BB005 & Lct_BB007	Hybrid Lct_BB006 & Lct_BB008
DFES	Counterfactual	101	14
	Hydrogen Evolution	213	21
	Electric Engagement	184	86
	Holistic Transition	229	43
FES	Counterfactual	70	11
	Hydrogen Evolution	149	16
	Electric Engagement	129	61
	Holistic Transition	160	31

6. Integrating the CCC scenarios

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

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

This section provides an overview of the forecasts from the CCC, and compares them to NESO's 2024 FES, and our SP Distribution DFES forecasts.

CCC's Sixth Carbon Budget

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

The Sixth Carbon Budget 22 (for the period 2033-2037) is the first carbon budget publication after the UK introduced a legally binding target to achieve Net Zero by 2050, and Scotland by 2045.

In 2025, the CCC will publish the 7th Carbon Budget, which may impact the 2038-42 period. We will continue to assess the impact of these targets on our forecast and look forward to the publication.

Regionalisation of CCC scenarios

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

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

These regionalised CCC scenarios enable stakeholders and us to understand what they mean for our networks. We have not applied any adjustment to the assumptions behind the CCC scenarios. This section provides a comparison between the DFES forecasts, the regional GSP results from NESO's 2024 FES, and for the regionally equivalent CCC forecasts for the SP Distribution network from BEVs and heat pumps. We have shown these two metrics as they are the main drivers of increasing demand.

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

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

Tables and charts of these scenario comparisons are shown overleaf.

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

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

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

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

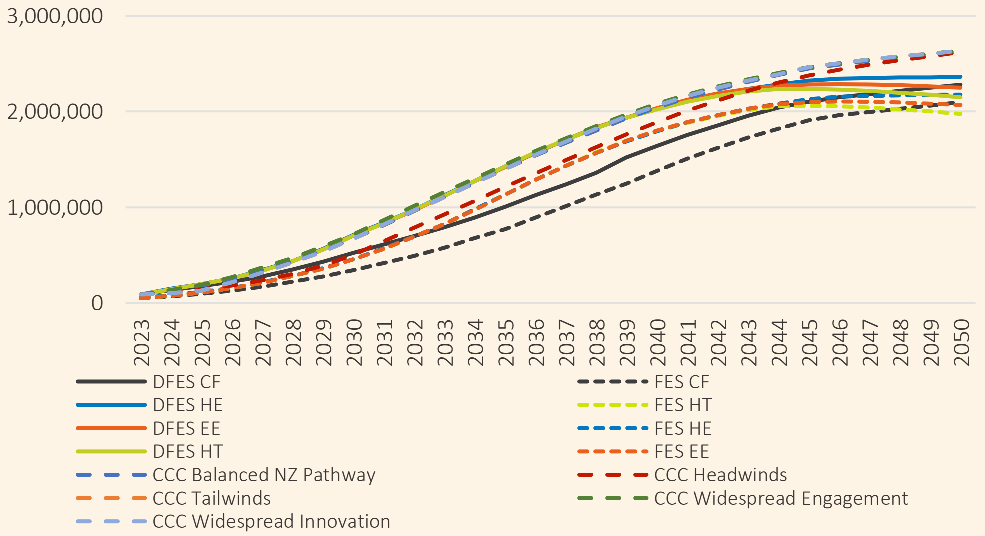


Table 4 | Industry forecasts for BEVs *Millions*

		2030	2040	2050
DFES	Counterfactual	0.53	1.64	2.28
	Hydrogen Evolution	0.71	2.03	2.36
	Electric Engagement	0.71	2.03	2.25
	Holistic Transition	0.71	2.03	2.15
FES	Counterfactual	0.34	1.38	2.10
	Hydrogen Evolution	0.46	1.80	2.18
	Electric Engagement	0.46	1.80	2.07
	Holistic Transition	0.46	1.80	1.97
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.67	2.04	2.63
	Headwinds	0.50	1.89	2.62
	Widespread Engagement	0.72	2.08	2.64
	Widespread Innovation	0.67	2.07	2.64
	Tailwinds	0.67	2.07	2.64

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

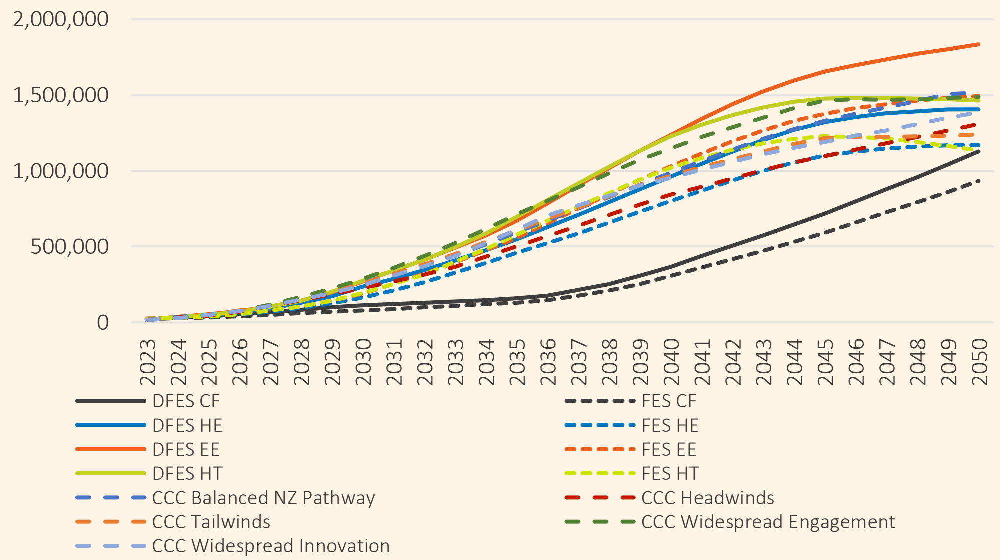


Table 5 | Industry forecasts for heat pumps *Millions*

		2030	2040	2050
DFES	Counterfactual	0.11	0.37	1.13
	Hydrogen Evolution	0.23	0.96	1.41
	Electric Engagement	0.27	1.24	1.84
	Holistic Transition	0.27	1.23	1.46
FES	Counterfactual	0.08	0.31	0.93
	Hydrogen Evolution	0.16	0.80	1.17
	Electric Engagement	0.19	1.03	1.49
	Holistic Transition	0.19	1.02	1.13
CCC 6th Carbon Budget	Balanced Net Zero Pathway	0.26	0.99	1.52
	Headwinds	0.23	0.84	1.31
	Widespread Engagement	0.29	1.15	1.49
	Widespread Innovation	0.24	0.95	1.39
	Tailwinds	0.25	0.97	1.24

7. Range of Net Zero compliant pathways

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

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

DFES: the starting point for network planning

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

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

The Net Zero range and Baseline View

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

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

To develop the 2024 Net Zero compliant range, we consider our DFES forecasts alongside other industry scenarios (including the CCC 6th carbon budget scenarios). We then discount DFES scenarios that do not achieve Net Zero or interim targets.

THE FOLLOWING SCENARIO IS DISCOUNTED:

Counterfactual (CF): this scenario does not meet Net Zero and so it is excluded.

THE REMAINING SCENARIOS ARE INCLUDED IN OUR ASSESSMENT OF PLANNING SCENARIOS:

Electric Engagement (EE), **Hydrogen Evolution (HE)**, **Holistic Transition (HT)**, and the **five CCC Sixth Carbon Budget scenarios** collectively form the Net Zero compliant scenario range. This range meets UK Government and Scottish Government legislative targets, policies, and proposals.

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

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

Our Baseline View scenario is set to achieve Net Zero, including interim targets and devolved government policies, and 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.

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

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

Category 2: Justification criteria for stakeholder engagement inputs.

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

More on these criteria is discussed overleaf.

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

Category 1: Alignment with existing/announced policies

This range of Net Zero compliant scenarios meets UK and Scottish Net Zero legislation; the requirements of the UK Government's Ten-Point Plan and Energy White Paper, 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.

Category 2: Stakeholder engagement inputs

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

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

Category 3: Regional and local characteristic inputs

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

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

Net Zero target	UK 2050	Scotland 2045
% GHG emission reduction target	68% by 2030 78% by 2035	90% by 2040
EV targets	End the sale of new petrol and diesel vehicles by 2030.	
Heat targets	Ban on gas boilers in new homes from 2025. Install 600,000 heat pumps every year by 2028.	By 2025 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	50GW offshore wind by 2030. A five-fold increase in solar power (up to 70GW) by 2035. Significantly increasing the renewable energy capacity in the next CfD. By 2035 the UK to be powered entirely by clean electricity, subject to security of supply.	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.

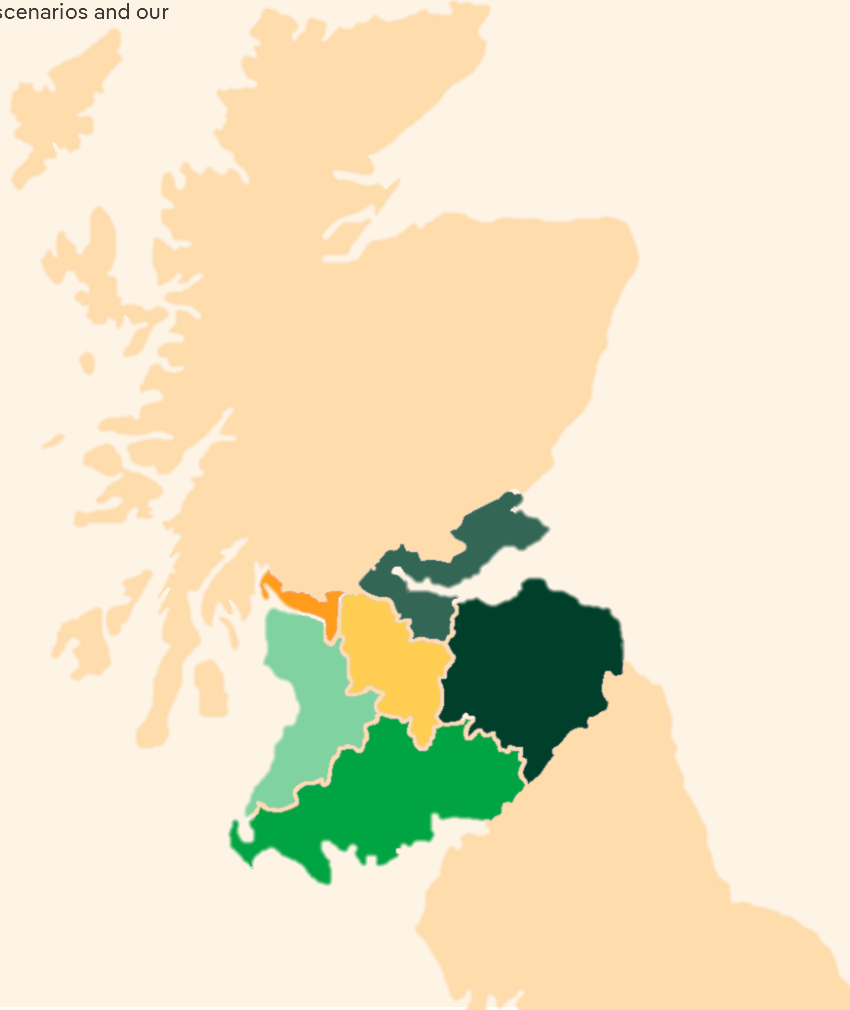


Figure 36 | Total BEV Net Zero range *Number of vehicles*

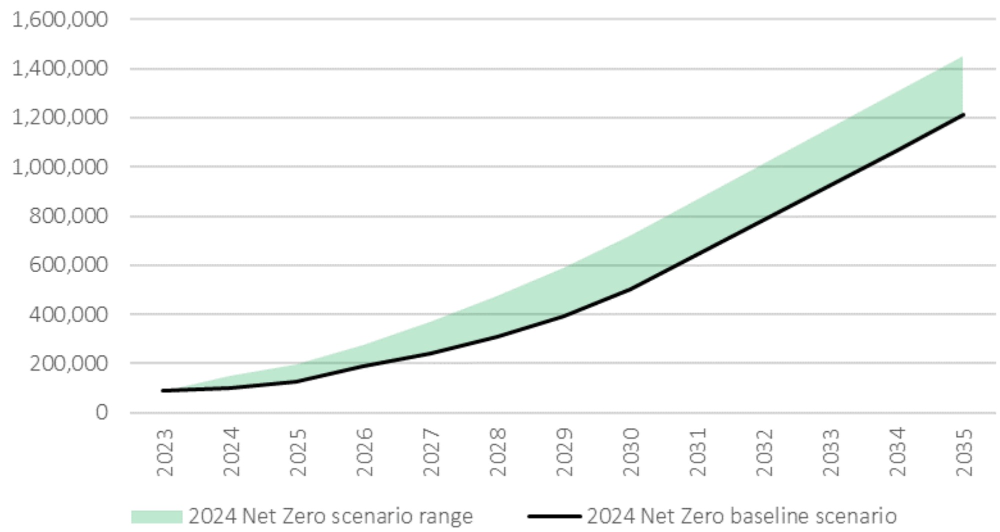


Figure 36 and Figure 37 show our baseline scenario and the range of the Net Zero compliant industry forecasts for the uptake of BEVs and heat pumps respectively. We have shown these two metrics as they are the main drivers of increasing demand.

Figure 38 shows our baseline scenario and the range of the Net Zero compliant industry forecasts for distributed generation and storage. These planning forecast have been driven by the Clean Power 2030 targets and ensure alignment across industry.

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

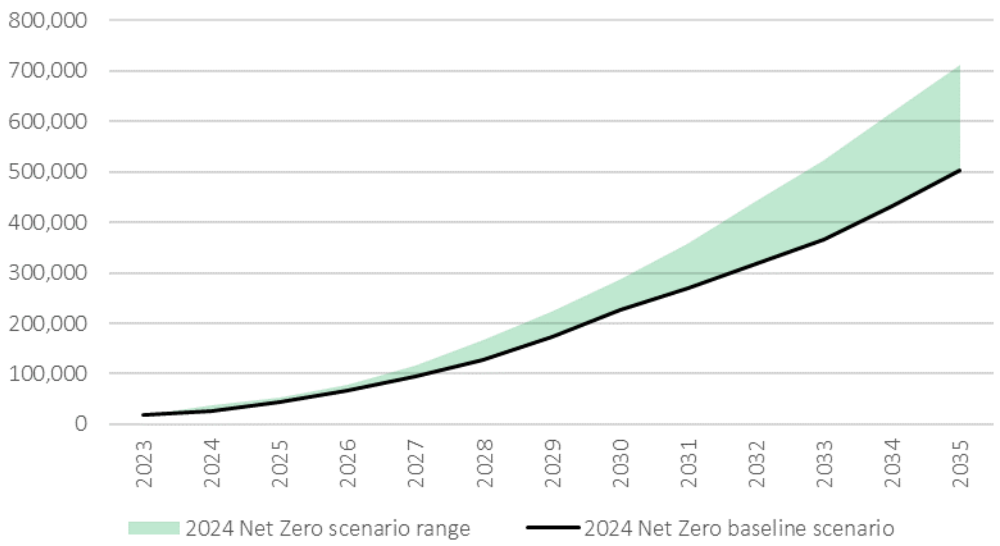
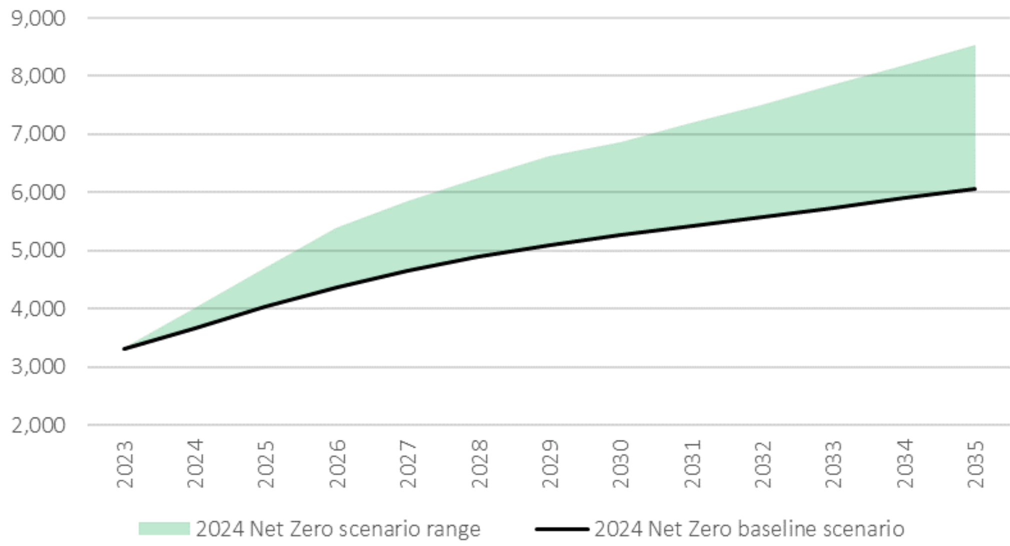


Figure 38 | Generation and storage Net Zero range *Capacity (MW)*



8. Stakeholder engagement

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

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

Summary of feedback

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

Electric vehicles: Based on the Scottish Government's own detailed assessment work and feedback, we updated our scenarios to include an accelerated EV uptake. This is because their legislated target of Net Zero by 2045 could feasibly accelerate EV uptake beyond the FES uptake scenarios. There was broad support amongst stakeholders for the range of scenarios covered.

Most stakeholders think there is increased momentum in support of EVs 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 EVs. One stakeholder thought that EV 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. Some stakeholders thought fleet vehicles would be amongst the early EV 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. Although there was general agreement amoungst stakeholders that the previous dip in personal vehicle ownership post-2024 was too pronounced. SPD Electric Engagement, SPD Hydrogen Evolution and SPD Holistic Transition scenarios continue to reflect this decrease from the late 2030s to early 2040s but less so than previous forecasts. One stakeholder also sees an increased adoption of fuel cell cars contributing to a reduction in EVs, potentially from 2030.

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

Our stakeholders generally agreed that EV 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 EV 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 Electric Engagement and SPD Holistic Transition scenarios to include an increased heat pump uptake in medium term. This is because their legislated target of Net Zero by 2045 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 heating. 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 introduction of the New Build Heat standard. 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 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 Electric Engagement 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.

How we updated our forecasts

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

Electric Vehicles

Stakeholder feedback	Actions we have taken
It is important to ensure Local Authority (LA) electric vehicle charging projects and ambitions outlined within Local Heating and Energy Efficiency Strategies (LHEES) flow into SP Energy Networks planning process and DFES.	Along with our Strategic Optimiser team, we have created the Strategic Project Tracker. This captures projects in early planning which can flow into our DFES known project pipeline. This allows us to capture projects within our scenarios for DFES, NDP and investment planning. Alongside our Strategic Optimiser team we have also conducted a full review of LHEESs as part of our DFES process. We are actively engaging with LAs to streamline the data sharing process.
Consider a more rapid uptake of EVs to help achieve the legislated target of Net Zero by 2045 in Scotland and associated interim targets.	We have updated the EV forecast scenarios 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 SPD Counterfactual shows a decrease in total EVs from 2040. This is most pronounced in our Holistic Transition scenario, which sees the biggest transition towards other forms of transport and home working. This is in line with the trends in NESO's 2024 FES and has a reduced impact compared to previous DFES forecasts.
Whilst total EV numbers may decrease beyond 2040, the peak demand contribution is not likely to follow similar trends as number of industrial and commercial EVs would continue to grow.	We have also ensured a greater impact of industrial and commercial electric vehicle contribution to peak demand in our updated forecasts.
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 Electric Engagement and SPD Holistic Transition 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 EVs 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 NESO’s 2024 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.

Heat pumps

Stakeholder feedback	Actions we have taken
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 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 SPD Counterfactual scenario already provides a low heat pump uptake view that does not meet carbon targets. Additionally, it is assumed that 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 Net Zero by 2045 in Scotland and associated interim targets.	We have updated the heat pump forecast for the SPD Electric Engagement 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. We continue to reflect this in our updated forecasts, in line with NESO FES 2024.

Generation

Stakeholder feedback	Actions we have taken
In rural areas high uptakes may be more prevalent, whereas this would not be realistic for urban areas.	We have improved our rurality assumptions used in the allocation of the different generation technologies and storage. All scenarios have been updated with this change.
Storage is likely to develop in high energy industrial and commercial (I&C) and urban areas for peak shaving.	In our forecasts, storage uptake in the short term is driven by our pipeline of known future projects. These tend to cluster around urban and industrial areas in our SP Distribution licence area which is shown in Figure 17.
No large-scale solar PV and wind generation is likely to be sited in Areas of Outstanding Natural Beauty (AONBs).	We have improved our allocation methodology for generation to limit the size of the developments close to National Parks and AONBs. All scenarios have been updated with this change.
Non-renewable generation is likely to reduce to achieve Net Zero, as it would require negative emissions.	We have updated our forecasts to incorporate hydrogen-fuelled generation and a reduction in non-renewable generation.
Hydrogen could be used for electricity generation in the future.	Our forecasts include growth in hydrogen-fuelled generation from the late 2020s in our SPD Holistic Transition, SPD Electric Engagement and SPD Hydrogen Evolution scenarios.
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.

9. Glossary

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

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

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

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

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

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

GW – gigawatt - 1,000MW (see 'MW)

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

kW – kilowatt – 0.001MW (see 'MW')

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

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

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

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

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

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

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

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

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

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

SP Energy Networks
Distribution Future Energy Scenarios 2024

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