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SP ENERGY NETWORKS

Distribution System Operator Strategy

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Contents

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Foreword

The energy landscape is changing fast as the way our customers generate, distribute, and use energy evolves. This document shares our strategy to respond to these changes, so that we continue to serve our customers and communities.

To tackle the climate emergency and deliver Net Zero carbon targets, a significant proportion of customer transport and building heating will be electrified. We are also going to see a further leap in renewable generation capacity as fossil fuel power stations close, and experience more dynamic and complex power flows as customers become increasingly active participants in the energy system. If we do not continue to adapt to meet our customers' evolving needs, these changes will push the distribution network and wider system beyond what it is currently designed for – this would lead to higher costs and a poorer service for all customers.

The magnitude of these changes means there is a clear need for a set of functions and activities **to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable, and efficient operation of the distribution network and wider energy system for all customers.** Most of these functions and activities are evolutions of existing business-as-usual activities, whilst others are new. These functions and activities in turn require new enabling tools, processes, and capabilities.

This is what Distribution System Operation (DSO) is to us: the set of functions, activities, and enablers that we plan to deliver, so that we can continue to serve our customers and communities. They include delivering smarter and more agile network infrastructure, making extensive use of services delivered by our customers, being a neutral facilitator of an open and accessible distribution energy resources (DER) services market, and coordinating DER services to deliver a safe, efficient, and reliable whole system. These must be delivered at a pace that meets our customers' needs.

We have already started delivering these DSO functions and activities, but there remains much to do on this journey. I am therefore pleased to present our SP Energy Networks DSO Strategy, which sets out how we plan to deliver this vital development for the GB electricity system and what it means for our customers.

We consider that we are best placed to continue leading this delivery of DSO. We have the capability, knowledge, and experience to deliver on time and in a cost-effective way. Our strong links with our customers and communities mean we can quickly understand and respond to their needs. We will build on our industry-leading customer service position to deliver an effective and fair transition that ensures a safe and reliable supply for all customers.

We look forward to engaging with you and hearing your thoughts over the coming weeks. Please do not hesitate to share your feedback and insights with us, so we can ensure our network continues to meet your needs.

Scott Mathieson
Network Planning & Regulation Director

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Impact of Covid-19

Covid-19 has impacted every part of our society and the UK economy. Our ways of working, socialising, and living have all changed. It is important to highlight that, during this challenging time, we are focussed on continuing to provide a safe, secure, and reliable supply for all our customers.

At a system level, Covid-19 has affected GB electricity consumption: electricity demand is materially lower compared to usual, and the transmission network has experienced record low levels of demand. In response, help from ever smaller distributed generation is required to maintain system stability. Looking forward to this summer, National Grid forecasts that GB demand could be up to 20% lower compared to the "pre Covid-19" forecasts[1]. This has exposed the need for more whole system coordination and resilience.

On a human scale, Covid-19 has impacted our customers and caused great hardship. The need to serve our customers well, and at least cost, has never been greater.

To address this individual economic hardship, and to manage our journey to recovery so that emissions do not return to previous levels, advisors to government[2] are already recommending green economic recovery investment in major infrastructure projects, such as the electrification of heat and transport.

We fully support this – we believe that investing to deliver Net Zero targets presents a critical opportunity to restart our economy, deliver much needed jobs, and inject sufficient pace into the Net Zero transition to safeguard the environment for future generations. The DSO functions, activities, and enablers set out in this document will ensure that this investment delivers maximum value.

[1] Source: https://www.nationalgrideso.com/document/167541/download

[2] For example, Sir John Armitt, Chair of the National Infrastructure Commission. His letter to the Chancellor, dated 12 May 2020, is available at: https://www.nic.org.uk/wp-content/uploads/C0160-Sir-John-Armitt-Chancellor-HM-Treasury-12052020.pdf

3 Introduction

We are SP Energy Networks. We own and operate the electricity distribution network in Central and Southern Scotland (our SP Distribution network), and in North Wales, Merseyside, Cheshire, and North Shropshire (our SP Manweb network).

It is through these two networks of underground cables, overhead lines, and substations that we provide 3.5 million homes, businesses, and public services with a safe, reliable, and efficient supply of electricity.

In October 2016, we were the first in our industry to publish a Distribution System Operation (DSO) Vision in response to evolving customer needs and system challenges. This described the whole system operating model which we think is best suited to address these changes, and the roles and responsibilities which this involves. Since then, we have worked alongside industry, government, and our customers, through the Open Networks project and other routes, to progress this evolution in the GB energy system.

This, our SP Energy Networks DSO Strategy document, builds on this work. The purpose of this document is to share with our stakeholders the changing customer needs and system challenges that the distribution networks must meet (Section 4), the DSO functions and activities we plan to undertake to respond to those changes (Section 5), and the enablers that are needed to facilitate those activities (Section 6). We explain what DSO means for our customers in Section 7 and how we plan to deliver these changes in Section 8.

We are aware that our industry contains a wide range of terminology – we have included a comprehensive glossary (Section 10) to clearly explain the terms we use within this document. We have also created a separate high-level summary of this DSO Strategy[3].

Next steps

Our DSO Strategy focusses on the period from now through to the end of the RIIO-ED2 price control (2028), but lays the foundation for the longer-term.

We believe that delivering DSO will bring real benefits to our customers and stakeholders, and is critical to the efficient and timely delivery of Net Zero. The plans set out in this document, and the stakeholder feedback we receive, will directly inform our RIIO-ED2 business plan submission to Ofgem, in which we will seek their approval to continue the investment needed to deliver these activities and enablers for our customers.

Given the importance of these DSO plans, we are keen to engage with a wide representation of our customers and stakeholders. We therefore welcome and encourage your feedback on this DSO Strategy – please see Section 9 on how best to do this.

[3] Our summary DSO strategy document is available at: www.spenergynetworks.co.uk/DSO

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A changing landscape

This section sets out the changing customer requirements that the electricity system must serve, and how these will impact the distribution network and operation of the whole system if we do not respond to them.

4.1 Drivers of change

The energy landscape is changing fast as the way our customers generate, use, and interact with energy evolves. Four key trends are driving this:

Decarbonisation – in response to the climate emergency, we need to achieve Net Zero[4] greenhouse gas emissions by 2045 in Scotland and 2050 in England and Wales. To deliver this decarbonisation, we need to electrify a significant proportion of transport and building heating. We also need to complete the transition of our generation mix from fossil fuel to zero carbon generation. These changes will significantly increase the levels of demand and generation that we need to connect to the distribution network for our customers.

Decentralisation – the proportion of the generation mix which is smaller-scale and sited close to demand is increasing. This means that we will connect an increasing proportion of GB's generation capacity to our distribution networks (known as distributed generation, DG), rather than it being connected to the transmission network. Decentralisation has two effects: we must find ways to accommodate more customer generation than the distribution network is currently designed for; and the electricity system operator (ESO) has an increasing reliance on this DG and other controllable customer assets connected to the distribution network (collectively known as distribution energy resources, DER) to maintain GB system stability.

Democratisation – means the rise of the active domestic consumer (aka prosumer). Smart meters, home energy management systems, intelligent domestic and electric vehicle (EV) storage, specialist aggregators and suppliers – these are all reducing the barriers for consumer participation in the energy system. Democratisation has two effects: consumer consumption profiles are becoming less predictable and more dynamic; and we can increasingly work with many individual consumers and communities, rather than just large DG or industrial customers, to source vital network and system services.

Digitalisation – means that we can better understand and coordinate the above three trends through improved transparency and coordination of data and IT systems between industry parties. Digitalisation significantly enhances our ability to measure, forecast, understand, and address the decarbonisation challenge by utilising a whole new range of data sources and solutions, driving a more efficient outcome for customers.

[4] The UK's different Net Zero targets are explained in the 'Net Zero' entry in the glossary.

4.2 Forecasting the change

To better quantify these four drivers and ensure we meet our customers' changing electricity needs, we forecast what their electricity requirements are going to be into the future. These Distribution Future Energy Scenarios (DFES[5]) forecasts cover how much electricity existing and new customers might consume (demand) and how much they might produce (generation). Given the range of uncertainties out to 2050, we create forecasts for four main energy scenarios – these four scenarios[6] represent differing levels of consumer ambition, government/policy support, economic growth, and technology development.

These forecasts show a material increase in the volume of customer demand and generation that we will need to serve on our two distribution networks. Compared to our current combined position of 6.6GW peak demand and 4.6GW of DG connected on our two networks, the forecasts highlight that:

- All scenarios show customer demand increasing beyond existing network capacity. By 2030, customer demand could increase by 10-14% (this figure assumes we can enable demand flexibility – without this the impact would be materially greater). Demand forecasts for our SP Distribution and SP Manweb distribution networks are shown in Figure 1 and Figure 2.
- Within the next ten years, the number of EVs we supply on our two distribution networks may increase from 10,000 now to up to 1.2m. On a domestic scale, an EV can double the demand of a customer property. On a broader scale, by 2050 customer EVs could add 1.6GW to our network peak demand if EV charging is not managed. This is significantly beyond existing network capacity.
- How heat is decarbonised is a key variable – the widespread use of heat pumps will have a very different network impact to other heat decarbonisation options. For example, in a high roll-out scenario, heat pump impact on our network peak demand could be 9-11 times greater than EVs.
- All scenarios show that we will connect for customers more generation[7] than the network is currently designed to accommodate. Over the next ten years, the volume of generation we connect to our SP Manweb network could double; it could triple on our SP Distribution network. By 2050, we could have connected over five times more customer generation than we have to-date. Generation forecasts for our SP Distribution and SP Manweb distribution networks are shown in Figure 3 and Figure 4.
- Future increases in storage are significant across all scenarios. In the next five years there is likely to be more storage growth than all other generation technologies combined.
- Enabling flexibility is key. Flexibility is where demand and generation customers actively moderate their output during peak periods. This reduces network power flows, which can help prevent network constraints and so defer the need for network interventions.

Figure 1 | Demand forecasts, with and without flexibility, for SP Distribution

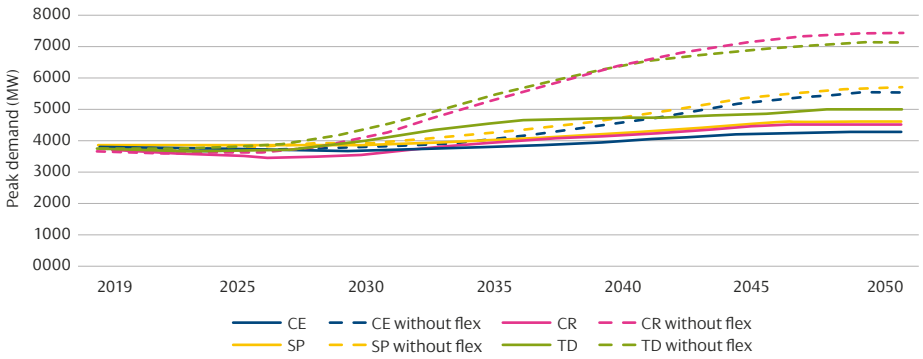
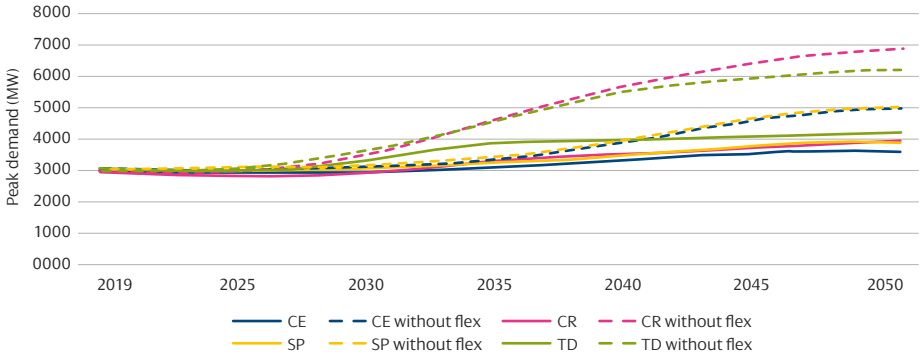


Figure 2 | Demand forecasts, with and without flexibility, for SP Manweb



[5] Our DFES forecasts are detailed forecasts for a range of demand and generation metrics (e.g. EVs, heat pumps, different generation technologies) out to 2050. They are available at: https://www.spenergynetworks.co.uk/pages/distribution_future_energy_scenarios.aspx

[6] The four scenarios are Steady Progression (SP), Consumer Evolution (CE), Community Renewables (CR) and Two Degrees (TD). Please refer to our DFES for more information (see Footnote 5 for a weblink).

[7] Storage is legally deemed to be generation, so is included within the generation forecasts.

Figure 3 | DG forecasts for SP Distribution

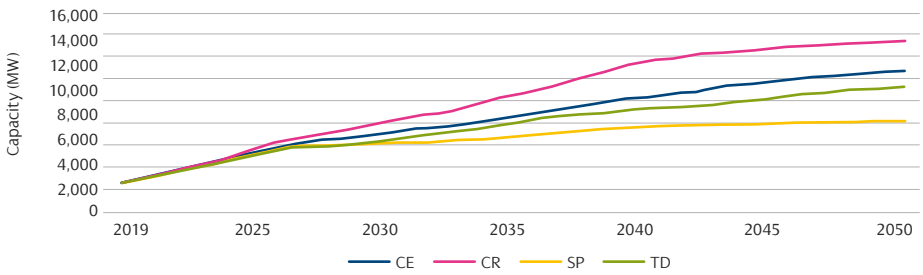
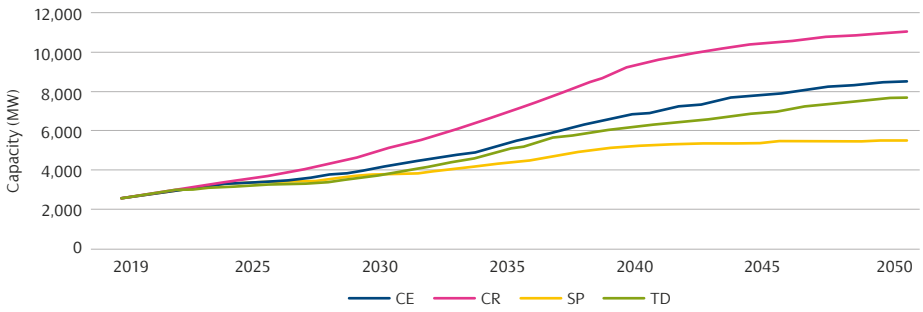


Figure 4 | DG forecasts for SP Manweb



Our DFES forecasts and Covid-19

Our DFES forecasts were created before the Covid-19 pandemic. It is too early to be able to accurately assess the impact of Covid-19 on our DFES forecasts, as it will depend on a complex range of societal and economic factors. However, based on discussions with industry peers, we consider that the DFES forecasts are still valid. This is because the four DFES scenarios cover a wide range of decarbonisation scenarios, which should accommodate the range of possible outcomes from Covid-19; for example:

- If Covid-19 has a material impact on the economy, which reduces available investment in Net Zero, it will likely result in a slower transition to Net Zero. This could be aligned to the Steady Progression scenario.
- If Covid-19 results in an acceleration of Net Zero investment, potentially as a result of government infrastructure investment to stimulate the economy and/or increased societal prioritisation of environmental issues, it will likely result in a faster transition to Net Zero. These could respectively result in scenarios aligned to Two Degrees and Community Renewables.

We will keep Covid-19 under review and, as the understanding of it develops, we will incorporate any impacts in future updates. We would also welcome stakeholder views on the impact of Covid-19 on our DFES forecasts.

4.3 The impact of these changes

The forecasts show that we are no longer talking about incremental changes. If we are not allowed to adapt, these will adversely impact customers in two main ways:

1. Distribution network capacity:
the volume of new demand and generation, combined with the effect of customer consumption patterns becoming more dynamic and complex, will push power flows well beyond what the distribution network is currently designed for. These changes impact every voltage level: from LV[8] networks, to which the low carbon technologies (LCTs) needed to deliver Net Zero primarily connect, to HV and EHV networks, which supply the LV networks and must accommodate increasing levels of DG (our forecasts show that DG could exceed available network capacity by up to 400% by 2030). Without radical intervention, these changes will cause thermal, voltage and fault level constraints which dangerously overload the network. These will lead to customer supply interruptions, delays in delivering customer requirements, shortening of network asset life[9], higher overall costs for customers, and possible safety concerns[10].

2. Whole system coordination:
decentralisation means that the ESO will need to utilise more services from DER. This service use affects power flows on the distribution network, and so overlaps with our responsibility to operate a safe, reliable, and efficient distribution network. At the same time, greater levels of customer demand and generation on the distribution network may create increased transmission network power flows which the ESO will need to manage. Without greater planning and operational coordination, and consideration of whole system costs, there will be increasing risk to system stability and safety, inefficient system operation, and poor use of customer money.

These changes are already having a tangible impact on the electricity system. On 9 August 2019, a lightning strike on the transmission network resulted in the loss of 1.3GW of transmission connected generation. Shortcomings in the understanding of whole system operation by various asset owners and equipment specifiers resulted in the loss of a further 500MW of DG. This resulted in over one million customers losing supply. The record low transmission demand during Covid-19 further shows the importance of whole system coordination to ensure resilience and the ability to cope with unforeseen system needs.

However these changes can also provide us with new solutions. Democratisation and decentralisation mean that there may be a far greater pool of service providers than currently, which we can work with to increase system resilience whilst keeping network operating costs efficient. Digitalisation means we can share information and better coordinate with other parties, facilitating these new solutions.

[8] LV, HV, and EHV are defined in the glossary.

[9] Significant increases in asset loading can reduce asset life and increase maintenance requirements. These both increase network costs for customers.

[10] Potential safety issues include overloading of network equipment, which could cause failure or fire. This fire risk is particularly important for LV service cables and cut-out fuses as they often run into our customers' homes. Another potential safety issue is conductor sag, which is where overhead lines are thermally overloaded, which causes them to expand and so hang lower to the ground; this reduces the safe clearance distance.

4.4 Responding to the challenge – DSO

Our overarching purpose as a network operator is to safely, reliably, and efficiently serve our customers' needs.

So that we can continue to do this, the magnitude of the changes means there is a clear need for us to deliver an updated set of functions and activities. These are fundamental to meeting our customers' evolving requirements, delivering Net Zero, and ensuring the continued safe, reliable and efficient operation of the distribution network and wider system for all customers. Most of these functions and activities are evolutions of existing business-as-usual activities, whilst some are new. These functions and activities in turn require new enabling tools, processes, and capabilities.

Industry often refers to this set of functions, activities, and enablers as DSO. Using this meaning, we plan to deliver DSO so that we can continue to serve the needs of our customers and communities. The remaining sections of this DSO Strategy document set out how we will do that and what it means for our customers.

In developing this DSO strategy, we have considered our customers' evolving needs, the network challenges we must address, and a wide range of industry and government work to-date. This work includes the Open Networks project, Ofgem and BEIS publications, industry projects (including the three TEF projects[11]), and technological and commercial developments. We continue to monitor Ofgem's Significant Code Review in Access and Forward-looking charges, as this will likely impact how our customers choose to use the network.

What do we mean by "efficient" and "least cost"?

In this document, we stress the need to deliver Net Zero and serve customer needs in an "efficient" manner and at "at least cost". What do we mean by this?

To maintain a safe and reliable electricity supply to our customers, we need to invest in our network on an ongoing basis. This investment covers everything from routine maintenance to procuring DER services and major network reinforcement projects.

This investment is approved by Ofgem and recovered from customers via their electricity bills.[12] We have a clear obligation, and a price control framework, to ensure that this investment is efficient, i.e. ensuring that investments are necessary, that they are the best value intervention for customers, and that we deliver the resulting intervention cost-effectively.

[11] These are three projects led by distribution licensees that support the transition to DSO. The three projects are Transition (led by SSEN), Electricity Flexibility and Forecasting Systems (led by WPD), and Fusion (led by us).

[12] Transmission and distribution network costs together account for 23.15% of a typical GB electricity bill. Source: https://www.ofgem.gov.uk/publications-and-updates/infographic-bills-prices-and-profits?utm_medium=email&utm_source=dotMailer&utm_campaign=Daily-Alert_31-07-2019&utm_content=Infographic%3a+Bills%2c+prices+and+profits&dm_i=1QCB,6ERQC,WAOSP7,PE0FA,1

5

Distribution System Operation

To serve our customers' evolving needs and meet system challenges, and ensure that we continue to provide a safe, reliable, and efficient service, we plan to do a range of activities.

These activities can be categorised into four functions which, along with their component activities, are set out in Table 1. Functions 1, 2 and 4 are predominantly existing or evolved activities; function 3 predominantly consists of newer activities.

In all cases, the need for these functions and activities is driven by the need to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable, and efficient operation of the distribution network and wider energy system for all customers.

Table 1 | DSO functions and their component activities

Function	Component activities
1. Smart networks **We are coordinating DSO and network actions to optimise the capacity, security, and reliability of the network.** These activities enable us to get the best out of the existing network capacity, and so defer the need for new network capacity; this helps keep bills low for customers.	Activities include the coordination and control of: • Automated network monitoring, management, and control (including active network management (ANM), active fault level monitoring and management, and flexible connection management). • Automated customer interruption response. This is where the network automatically reconfigures itself to minimise the number of customers impacted by a fault. • Network monitoring. • Condition based risk management (CBRM) and asset optimisation. This is how we calculate and monitor the risk of distribution network assets. • Enhanced forecasting and automated design. • Using flexible connection arrangements to help keep network power flows within limits. • Network losses management.

Function	Component activities
2. Flexibility contracted from our customers **We are working with our customers' ability to operate flexibly.** These activities help us keep distribution power flows within existing network capacity, and so defer the need for new network capacity. These activities provide our customers with additional revenue opportunities and/or quicker and lower cost connections.	• Using DER MW services to manage thermal constraints to defer or complement load related investment. • Using DER MW and MVAr services to manage voltage constraints to defer or complement load related investment. • Investigate a DER fault current limiting service to manage fault currents. • Using DER services to provide additional network security during planned outages. • Using flexibility from EV chargers, either directly or via market mechanisms[13], to manage thermal and voltage constraints to defer or complement load related investment.
3. Neutral market facilitator and DER services coordinator **We will be a neutral facilitator of an open and accessible DER services market, enabling DER to access markets whilst coordinating the optimal use of DER services for distribution and transmission needs to deliver a safe, efficient, and reliable whole system.** These activities enable: DER to participate in a range of markets; us and the ESO to access DER services in a coordinated manner; us to safely operate the distribution network in real-time; and the distribution network and whole system to be operated efficiently and safely. These activities allow DER to earn services revenue whilst ensuring the reliability of the whole system at least cost to all customers.	• Facilitating an open and accessible DER services market, which gives visibility to distribution licensees and the ESO of DER service pricing and availability. • Coordinating with the ESO and other network parties to ensure that DER services are used to meet distribution network, transmission network, and whole system needs at the overall lowest cost to customers. • In real-time: dispatching and managing DER services to ensure the distribution network remains within limits. • Making distribution network data and needs available to the market, including via Long Term Development Statements, the System Wide Resource Register, and long-range DFES forecasts. • Coordinating with the ESO, other network parties, and other energy vectors to ensure efficient whole electricity system and whole energy system planning and operation. • Enhanced planning and operational data exchange with other network parties, both before real-time and in real-time.

[13] The route by which DNOs can modulate EV chargers is currently being considered by Smart Energy Code modification MP0046. This is available at: https://smartenergycodecompany.co.uk/modifications/allow-dnos-to-control-electric-vehicle-chargers-connected-to-smart-meter-infrastructure/

Function	Component activities
4. DSO value added services **We will offer additional value to our customers through bespoke services or being a provider where the market fails to deliver.** As small groups of customers typically benefit from these activities, it is not appropriate to socialise these costs across all users, so we will not be seeking price control funding for these; these will instead be recovered directly from customers who wish to use them.	• Providing CLASS services to the ESO (pending the outcome of Ofgem's February 2020 CLASS consultation). • Service provider where the market fails to deliver (for example, our work to coordinate a DER response to the ESO Mersey Ring tender). • Using our project delivery capability and resource base to deliver decarbonisation infrastructure where the market fails to deliver. • Provision of enhanced services (e.g. bespoke modelling analysis and forecasts, and operating a platform for customers to exchange capacity) to customers on request.

In addition to these operational functions, we consider that we have an important responsibility and opportunity to inform and educate customers and stakeholders through our well-placed stakeholder engagement. This ensures that customers, community groups, businesses, academia, and government are aware of the changes in the energy sector and the resulting opportunities. This will empower these parties to maximise their engagement, realise local and national benefits, and keep energy costs as cost-effective as possible. As a company, we are already committed to supporting current and future stakeholders to meaningfully engage with the opportunities presented by a Net Zero future; for example, through our Zero Carbon Communities Hub[14], helping customers understand EV charging points[15], and by supporting local educational projects such as Community Energy Scotland's Community Energy Futures[16] training via our dedicated £20m Green Economy Fund. Going forward, we intend to explore how we can further educate and advocate through our own awareness raising activities, and through consumer and industry representative bodies.

Before funding is sought to deliver any of the activities in Table 1 via our RIIO-ED2 price control process, stakeholder engagement and cost benefit analysis will be undertaken to ensure that the activity delivers quantifiable net benefits for customers.

[14] More information is available at: https://www.spenergynetworks.co.uk/pages/zero_carbon_communities.aspx

[15] We have a dedicated webpage and handbook to help different customer types (e.g. domestic, car park owner) understand the process to install EV chargers: https://www.spenergynetworks.co.uk/pages/electric_vehicles.aspx

[16] More information is available at: https://cef.scot/

6

Enablers for Distribution System Operation

Section 5 sets out the range of activities that are needed in response to the changing energy landscape. To enable these activities, we require an increasing number of tools, processes, and capabilities. This section sets out these key enablers, and explains how we are already delivering them.

In all cases, the need for these enablers is driven by the need to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable, and efficient operation of the distribution network and wider energy system for all customers.

We will roll out this capability on a needs-based approach. It will involve significantly expanding secondary substation monitoring and control, and will leverage smart meter data and connectivity models to increase coverage.

6.1 Network monitoring, telecommunications and control

While the HV and EHV networks already have monitoring, communications and control capability, this functionality is virtually non-existent on the LV network as historically there has not been strong justification for it.

To accommodate decarbonisation and more active prosumers we require, especially on the LV network:

1. Greater monitoring capability, so we have real-time visibility of the network.
2. Enhanced control capability, so we can make real-time changes to the network and communicate with our customers.
3. A reliable, secure, and low latency communication network to enable this monitoring and control.

These allow us to accurately establish spare capacity and so safely get higher utilisation out of the existing network; they provide more insight as to where and when interventions are required; and they underpin our more targeted and effective use of flexibility services from third parties. These all help us more efficiently operate our network for our customers and enhance competition.

We are already starting to deliver this change:

- Our **Enhanced LV monitoring project** is deploying secondary substation monitoring to improve our network visibility and ensure that we are ready for the uptake of LCTs.
- Our **LV Engine project** is trialling smart transformers. These use network monitoring and communicate with each other to assess network needs in real-time. This enables them to intelligently control LV voltage and make better use of existing network capacity, allowing more LCTs to connect to the LV network.
- Through our industry-leading work on monitoring fault level, we have pioneered the first **real-time fault level measurements**. This is significant for customers as fault level constraints can prove to be a barrier to new connections. A widespread understanding of fault level, particularly when combined with ANM, will enable us to provide quicker, cheaper connections to new customers, and more safely operate the network near limits.

6.2 Forecasting and modelling

Network power flows are increasing in complexity as consumption patterns change due to the electrification of heat and transport, and with more DG and domestic prosumers. This trend will continue to increase over the coming decades. This increasing complexity could be a barrier to the efficient and reliable operation of the network; this would adversely impact our customers.

To support activities which address this, we require:

1. Detailed locational forecasting capability, to understand how our customers' demand and generation requirements will change in particular areas of the network.
2. Enhanced modelling, to understand the network impact of those customer changes and assess possible network interventions.

These enablers, combined with data from network monitoring and other sources, mean that we can model network flows in detail to deliver a better understanding of:

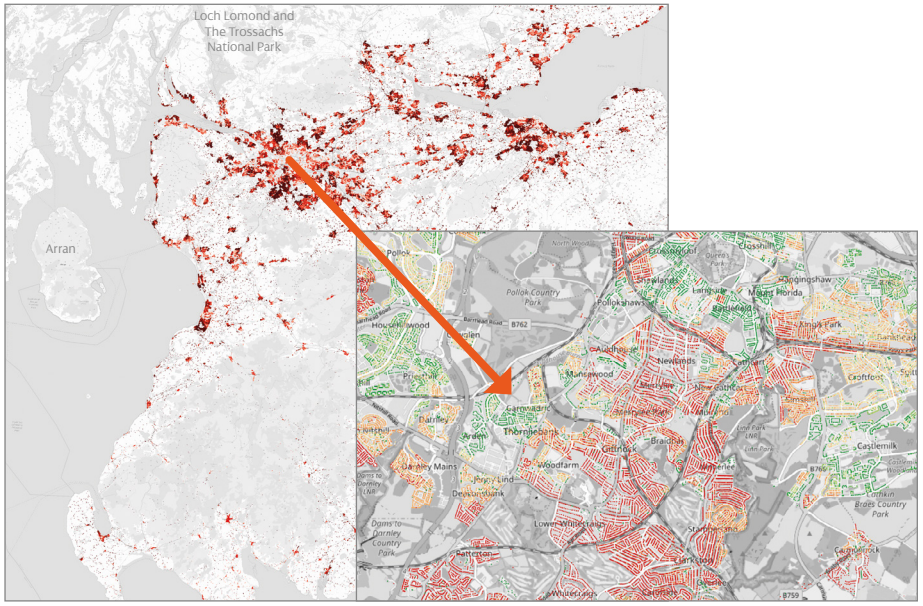
- near-time network capacity – we can get more out of the existing network by operating closer to limits to maximise capacity available for customers, and more efficiently dispatch flexibility services to keep network costs lower.
- our EV-Up project (Figure 5) improves our understanding of customers' ability to transition to EVs, based on off-street parking opportunity and customer demographics. This learning will feed into network forecasting and modelling.
- longer-term network capacity requirements – we can consider whole system needs when network planning, better understand where and when interventions are required to enable capacity for customers, and give more notice to the market of network requirements.

The operational activities these enablers support mean they deliver a more economical and efficient network for our customers, and promote competition by enabling the use of flexibility services.

We are already starting to deliver this change:

- Our **EV-Up project** (Figure 5) improves our understanding of customers' ability to transition to EVs, based on off-street parking opportunity and customer demographics. This learning will feed into network forecasting and modelling.
- Our **Weather Normalised Demand Analytics (WANDA) project** uses historical data, generation, and discretised weather data (1km squares) at a primary substation level, to help better understand the effects of weather on network power flows. This learning will feed into network forecasting.
- Our **Enhanced Network Forecasting project** has developed a four day-ahead forecasting tool, which gives us a much greater insight into how distribution demand and generation will operate depending on their fuel source. The tool allows the user to view forecasted load flows on 11kV & 33kV feeders.
- Our **DFES** work has produced detailed, geographically granular forecasts for a range of demand and generation metrics (e.g. EVs, heat pumps, different generation technologies) out to 2050.

Figure 5 | Our EV-Up project, which provides highly granular EV forecast uptake



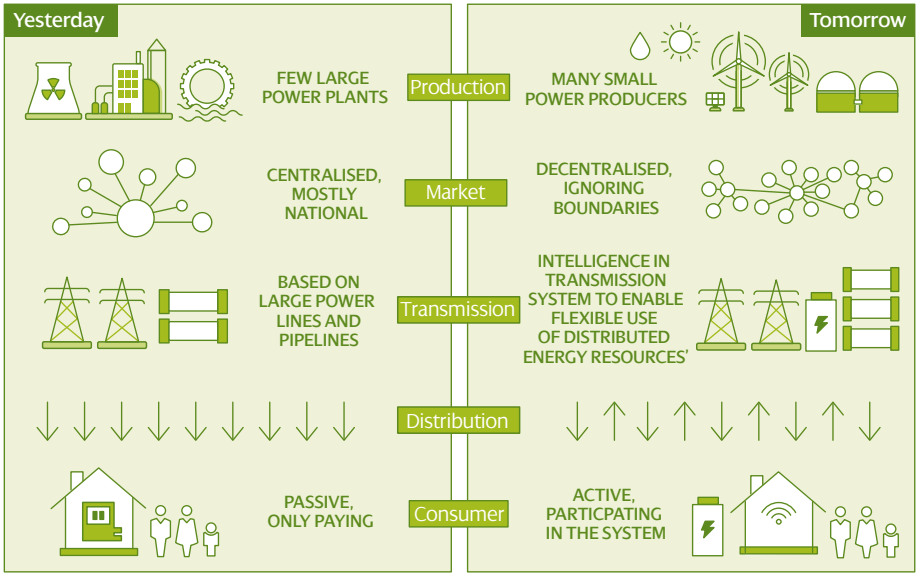
6.3 Data and digitalisation

Data is the key to fully unlocking the value of the network for our customers. This includes data from our network assets through increased network monitoring, improved operational and planning data from forecasting, data from the markets we facilitate and data from third parties (including smart meters).

We will also be gathering and communicating data with far more sources, from simple network monitors to sharing whole network models with customers. So that we can effectively record, store, analyse and share data, and deliver the benefits it offers, we are undergoing a digitalisation transformation[17]. This digitalisation transformation includes hardware, software, processes and IT/cyber security, and interoperability between our platforms and systems (such as ANM and flexibility platforms). Our data and digitalisation work is focussed on making data visible, accessible, and interoperable.

Together, data and digitalisation underpin all network activities and wider system coordination, from allowing us to make more informed operational decisions to helping markets better understand network opportunities. These deliver benefits from the micro (predicting a cable fault and repairing it before the customer loses supply) to the macro (a new whole system operating model which enables the continued safe, reliable, and efficient operation of the whole electricity system). Every activity we undertake and every service we provide depends on this enabler (Figure 6).

Figure 6 | Expected energy system changes made possible by data and digitalisation



We are already starting to deliver this change:

- Our **Smart Data Integration Fabric (SDIF) project** is already underway and is delivering infrastructure to enable data to be collected, analysed, and shared in a consistent manner. SDIF includes the creation of a fully integrated network model, which will provide a consistent data set across the business.
- Our **Network Constraints Early Warning System (NCEWS) project** provides a model of the LV network which can be imported into different analysis tools (and so avoids the need to build the model in each tool). It uses advanced machine learning algorithms to extract the specification of missing cable assets and predicts network behaviour. This has reduced design time by two thirds. This project won the prestigious IET and E&T Innovation of the Year prize in November 2019.
- We **digitalised our Network Asset Management System (NAMS)** in 2018 and it is now fully operational. The principle of NAMS is to bring multiple asset management strands together in one integrated work management system. This has improved the transparency and accuracy of our information.
- We are currently working with other DNOs to implement the **Flexible Power portal**. This will enable us to automate some of the processes needed for dispatching, billing, and settling flexibility services. These platforms can facilitate the growth of the services market by clearly setting out our service requirements, and provide a secure mechanism for us to coordinate and communicate with our service providers.

[17] Please see our Digitalisation Strategy for more information about our data and digitalisation plan. Available at: https://www.spenergynetworks.co.uk/pages/our_digitalisation_strategy.aspx

6.4 Distribution to transmission coordination

Decentralisation means that the ESO is increasingly dependent on services from DER to balance system frequency and keep transmission power flows within limits. The use of these affects power flows on the distribution network, yet we do not have visibility of this service use and it does not consider distribution network constraints. At the same time, we are increasingly dependent on the output of these same DER assets to deliver decarbonisation whilst minimising connection delays and network costs for customers. This will impact the ESO's ability to use these services.

This growing dependency on DER services by us and the ESO, and the resulting distribution to transmission interactivity, mean that continuing the existing separated approach to DER services is not feasible – it will increasingly result in risks to system stability and safety, inefficient system operation, and poor use of customer money.

We need to deliver greater distribution to transmission coordination, especially around DER use, to ensure more efficient whole system planning and operation. We think operational coordination is best achieved by the 'World A'[18] operating model, developed by the Open Networks project.

We are already starting to deliver this change:

- Our **Project FUSION** is a live trial of a local DER flexibility market, trialling the trading of flexibility through the creation of a competitive market. This market is structured around the Universal Smart Energy Framework, of which whole system coordination is an inherent capability.
- We are a project partner with the ESO in their **Distributed Restart project**. In the unlikely event of a nationwide blackout, the ESO would mainly work with transmission connected generators to restore power and bring the system back online. This project is exploring how DER could help with this process. Such a solution requires close coordination between the ESO and ourselves.
- We are in the process of deploying **wide scale ANM** across the Dumfries and Galloway network area. This will regulate the output of DG to avoid transmission constraints – this is a UK first.
- We actively participate in the **Open Networks project**, in which we work with the ESO and other distribution licensees to improve whole system coordination. This coordination includes data exchange, forecasting, and how distribution based solutions could solve transmission constraints.

[18] In 2018, the Open Networks project consulted on five possible future 'worlds'. These five worlds described different models for who should manage DER services and act as the market facilitator. This consultation document is available at: https://www.energynetworks.org/assets/files/14969_ENA_FutureWorlds_AW06_INT.pdf.

An impact assessment of the five worlds is available at: https://www.energynetworks.org/assets/files/ON-PRJ-%20IA%20consultation%20document%20-%20Master%20060319%20(For%20publishing).pdf

6.5 Holistic conflict management regime

Given the magnitude and breadth of the changes on the distribution network, we are evolving existing activities and plan to undertake new activities. A number of these involve interacting more closely with our customers, other network parties and other markets. This could give rise to real or perceived conflicts of interest, given our existing core responsibility as the impartial provider of network connections and capacity.

It is essential to address any real or perceived conflicts of interest that arise across any activity. Our customers and service providers must have confidence in us and the markets we interact with – their involvement is essential to maintaining network and system stability in an economical manner and promoting competition in service provision; customers benefit from both of these.

There is therefore a need for us to implement a comprehensive conflict management regime to mitigate real and perceived conflicts of interest. This will be complemented by changes to our organisational structure. This is needed to enable and underpin all four DSO functions. This will be in place by the start of RIIO-ED2.

We are already starting to deliver this change:

- We have led industry work to create a transparent process to **value flexibility services**. Based on this, we were the first DNO to publish site-specific pricing in our flexibility tenders, showing the market exactly what the value was to the network. This promotes transparency and reduces perceptions of conflict of interest by enabling our reinforcement versus flexibility decisions to be audited.
- When we run flexibility tenders, we are starting to **publish clearing prices** and other information, so the market can see where we did and didn't use flexibility, the rationale for those decisions, and the number of bids received. This promotes transparency and reduces perceptions of conflict of interest by enabling our reinforcement versus flexibility decisions to be audited.

6.6 Organisational change

The extent of activities and enablers that need to be delivered to ensure the continued safe, reliable, and efficient service is significant. We are working to have the right organisational structure and the right people to successfully deliver these:

- **Organisational change.** It is important to retain institutional optionality where ownership for DSO activities has yet to be decided – we understand this and will structure our organisation accordingly. This organisational change will help deliver transparent information and decision making.
- **Investing in our people.** We are investing in our existing staff and recruiting new talent to ensure that we deliver the DSO functions whilst continuing to provide industry leading customer service. This includes building a digital-ready workforce and embracing more effective ways of working.

We are already starting to deliver this change:

- We have already set up a **new DSO business team** with an independent head. This is to provide confidence to the market for our flexibility service procurement decisions.

7

What DSO means for our customers

It is essential that the functions, activities, and enablers we plan to deliver meet our customers' needs.

Table 2 sets out, for different customer types, how we foresee our customer requirements evolving through to the end of RIIO-ED2, and how DSO will deliver on these requirements. We've used the four customer types developed by the Open Networks project.

Table 2 | Customer requirements and the benefits of DSO

Customer type	Customer requirements	How DSO delivers
All customers These requirements and benefits can apply to all four customer types described below.	A safe network	Greater use of network monitoring and data will allow potential safety issues to be identified earlier and mitigated.
	A reliable supply	DSO will enable a reliable and resilient supply through improved whole system planning and operational coordination (including coordinating the optimal use of DER services for transmission and distribution needs), greater distribution asset monitoring, and smarter network infrastructure.
	Cost-efficient network capacity	DSO will enable a cost-efficient supply by using a wide range of activities and enablers to get the best out of existing network capacity, defer the need for new network capacity, and minimise losses.
	Delivery of Net Zero	Some customers will value playing their part in delivering Net Zero and the environmental benefit which that delivers. DSO enables Net Zero to be delivered safely, on time, and in the most cost-efficient way.

Customer type	Customer requirements	How DSO delivers
Passive customer Normal demand customers with little or no interest in time of use tariffs, proactively managing consumption, or providing services. These are typically domestic or business customers on a single standard tariff. They may have LCTs, but for reasons other than energy management (e.g. they were issued an EV as a company car). Vulnerable and fuel poor customers typically sit in this category.	In the event of a loss of supply, supply is quickly restored.	Enhanced network monitoring, data and network analytics mean faults can be quickly identified. Automation means the network can automatically reconfigure itself to minimise the number of customers impacted by a fault.
	Any works (e.g. road closures to bury cables) are done with minimal inconvenience to the customer. General desire for minimal visual, noise, and environmental impact from network assets.	DSO will enable us to get the best out of existing capacity, and defer the need for new network capacity. This reduces the need for network reinforcements and new network infrastructure.
Passive participant Energy conscious customer generally offsetting demand using 'off the shelf' passive 'fit and forget' systems in order to reduce their energy bills. Would likely be interested in reducing costs via time of use tariffs from their energy supplier. These are typically domestic or business customers who have invested in solar photovoltaic (PV), heat pumps, EVs, or smart appliances to reduce energy bills. Also includes customers who have a customised time of use tariff with their energy supplier.	**In addition to the passive customer's requirements:** Easy and quick process to connect LCTs such as heat pumps and EV chargers. Customers will seek to charge EVs at home, places of work, destination parking locations or on long journeys. Commercial sites with a large work force or high customer numbers (e.g. retail parks) may require bulk EV charging capacity.	DSO will enable us to get more out of existing capacity, meaning more connections and capacity can be offered to customers immediately. Enhanced forecasting (such as our EV-Up project) and modelling will give more insight into where capacity will be needed in the future; combined with the right regulatory framework, this gives more confidence to efficiently invest ahead of need, meaning that customer ambitions aren't delayed by insufficient network capacity. Coordinating transport planning and distribution network planning, such as via our Charge project, accelerates the connection of EV charging points.

Customer type	Customer requirements	How DSO delivers
Active participant Customers who have invested in generation, storage, demand side response (DSR), or other low carbon products to actively participate and earn revenue from the energy system, reduce operating costs, and reduce their carbon footprint. These customers do not have service contracts directly with network companies or the ESO, but instead participate via aggregators, power purchase agreements, or time of use tariffs. These are typically standalone DG, behind the meter generation/storage/ DSR for peak lopping and triad avoidance, or actively participating domestic customers.	**In addition to the passive customer's and passive participant's requirements:** A quicker connection application process. Flexible connection arrangements where this results in a quicker or lower cost connection.	Innovations, such as our NCEWS project which has reduced design time by two thirds, means we can more quickly assess connection options for customers. ANM and wide-scale communications will enable customers to access flexible connection options, resulting in quicker and lower cost connections. More network monitoring and more detailed network modelling will enable the network to be safely operated nearer limits, reducing the periods that flexible connections are constrained.
	Access to non-service market revenue opportunities (either directly or via an aggregator).	The DSO's role as a neutral market facilitator will enable connected customers to access a range of markets, whilst ensuring a safe, efficient, and reliable whole system.
	To earn additional revenue, these customers might enter into service arrangements with us and the ESO where this is simple and can be done via an aggregator or using an automated system to deliver the service.	DSO will deliver platforms which enable most aspects of DER service provision to be automated. This reduces the cost and administrative barrier for us and customers, helping customers access these revenue opportunities.

Customer type	Customer requirements	How DSO delivers
System service provider Customers for whom actively managing their DSR, generation, or storage to sell services to network companies and the ESO is a core activity and a key part of their business model. These customers participate via bilateral contracts, ancillary service tenders, and the balancing mechanism. Customers include asset owners, and parties which manage assets on behalf of others (e.g. aggregators).	**In addition to the requirements of the other customer types:** A range of connection options to choose from to best meet their operating model. For example, some customers might value unrestricted network access, whilst others will value a lower cost flexible connection.	Greater data provision and sharing of network models (via initiatives such as SDIF) will enable customers to better assess what a flexible connection means for them.
	Minimal barriers to providing services to us and the ESO. This includes being able to easily understand service requirements and participate in tenders.	Enhanced forecasting and modelling mean we can more accurately define our service needs. The ability to share network models means we can more clearly articulate our service requirements to the service market. The common service products and contract developed under the Open Networks project will provide a common service experience across different network companies.
	A near-time (e.g. day-ahead and week-ahead) understanding of likely network capacity availability and likelihood of service use.	Forecasting, modelling, and analytical developments, such as our Enhanced Network Forecasting project, mean we have more accurate near-time forecasts. Platforms mean we can share this information with our customers in a secure manner.
	The ability to participate in multiple markets. Alignment of different service markets where possible to facilitate service stacking.	The DSO's role as a neutral market facilitator will enable connected customers to access a range of markets. The DSO's role coordinating the optimal use of DER services for distribution and transmission needs means that customers can participate in a range of markets without risking system stability.

In addition to the requirements listed in Table 2, for some customers there is likely to be a requirement for network use of system charge signals that are clear and visible, and can be understood by energy management systems. The most influential industry development in this respect is Ofgem's ongoing Significant Code Review in Access and Forward-looking charges, which is reviewing connection and use of system charging. We continue to monitor this as it will likely impact how our customers choose to use the network.

Our Vulnerability Strategy aims to look at the barriers that customers, in particular those who are vulnerable, face in accessing LCTs, and support them in this transition so they can gain the greatest benefits into the future. In all cases, we will support our customers in becoming more active and engaged in the energy system, so that they realise benefits.

8

Delivering the change

This section sets out our high-level roadmap for how we plan to continue delivering DSO functions and activities (Section 8.1), the guiding principles we follow when developing the shape and detail of the changes (Section 8.2), and our role in delivering the changes (Section 8.3).

8.1 Roadmap to deliver

Given the key role the distribution network plays in our customers' lives, timely delivery of the functions and activities in Section 3 is essential to meeting our customers' requirements. Figure 7 sets out our high-level roadmap to deliver these functions and activities. Most of these activities will be built up over time on a needs-based approach, and will also evolve over time in response as network challenges change.

Figure 7 | Roadmap to deliver DSO functions and activities

	Remainder of ED1 Now – March 2023 →	ED2 April 2023 – March 2028 →	ED3 onwards April 2028 onwards
Smart Networks	North Wales and D&G ANM deployments	BAU widescale ANM roll-out	
	Development of active fault level management	BAU deployment of active fault level monitoring and management	
		Increasing deployment of network monitoring, automation and control	
		Increasing automated customer interruption response	
	Increasing LV monitoring		
		Condition based risk management (CBRM) and asset optimisation	
		Enhanced forecasting and automated design	
	Continuous development and deployment of new losses management techniques		
	Continuous development and deployment of flexible connection arrangements		
Flexibility contracted from our customers	BAU flexibility to manage HV and LV constraints		
		Flexibility to manage HV and LV constraints	
		Investigate flexibility to manage fault level	
	BAU flexibility during planned outages		
		Modulation of EV chargers*	
Neutral market facilitator	Development of processes to facilitate an open and inclusive DER services market		BAU whole system operating model
	Development of whole system operating model to coordinate with the ESO		
		Increasing management of DER services to ESO	
	Continuous development and deployment of methods to make network data available		
	Continuous development and deployment of enhanced data exchange with other network parties		
Value added services		Provision of CLASS services to the ESO*	
	Aggregator of last resort		
	Last resort provider of decarbonisation infrastructure		
	Provision of enhanced services		

*These activities will depend on the outcome of Ofgem consultations.

The roll-out of DSO enablers will be driven by customer and network requirements and the need to enable functions and activities. Before customer funding is sought to deliver any function, activity or enabler, stakeholder engagement and cost benefit analysis will be undertaken to ensure that it delivers quantifiable benefits for customers.

8.2 Our guiding principles

In developing both the shape and detail of the DSO functions, activities, and enablers, we have always kept in mind their overarching purpose: to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable, and efficient operation of the distribution network and wider energy system for all customers. To guide our work, we translated this purpose into four core guiding principles.

1. Safety

Our responsibility: Safety of our staff, customers, and the general public is our first priority and built into everything we do. We have a clear responsibility to ensure that everyone who interacts with and relies on our network is not harmed by that interaction.

How we are responding: In the future, we will operate our assets in new ways, increasing the utilisation of our network to get greatest value for customers. These smarter networks will improve our customer and staff safety. We will increase asset monitoring, gather more asset data, and operate new asset management standards that not only maintain the safe operation of our assets, but the safety of anyone who interacts with our network.

2. Security, resilience, and reliability

Our responsibility: Our primary operational responsibility is to keep the electricity on for our customers – we all depend on it to enable our modern lifestyles. Looking to the future, the importance of electricity in our customers' lives will increase even further as we use it to heat our homes and power our transport. In addition, as essential system balancing services increasingly connect to the distribution network, the security and stability of the wider GB energy system is also at stake. We have a responsibility to maintain the security, resilience and reliability of the distribution network and wider energy system.

How we are responding: This responsibility informs our activities, from cyber security and asset management, to how we manage external factors, such as the impact of shallow flexibility service markets and whole system resilience during low-probability high-impact events. As we begin to operate the network in new ways, we must maintain the security, resilience and reliability of the system in response to changing system characteristics, new customer operating profiles and technologies, an ever-evolving range of external factors and threats, and the risks of higher asset utilisation and greater operational complexity.

3. Customer value

Our responsibility: All electricity system and network costs are ultimately recovered from customers. We know that for some fuel poor customers, these costs can be a significant proportion of household income. We have a responsibility to serve our customers' needs, whilst keeping network costs as low as possible. The Net Zero transition must not penalise or leave behind vulnerable and fuel poor customers.

How we are responding: Increasing efficiency, using competition, and deploying innovation are essential tools for delivering customer value, but we plan to go further – this responsibility has informed the way we have categorised our four core DSO functions:

- Smart networks – is about getting better value for customers from assets they have already funded by maximising the use of network assets, and providing quicker and lower cost connections.
- Flexibility contracted from our customers – is about lowering distribution network costs by using our customers' capabilities as lower cost network interventions.
- Neutral market facilitator – is about more efficient whole system operation costs, by delivering much needed coordination to distribution and ESO network operations.
- DSO value added services – is about recovering some costs, such as those for bespoke services, only from customers that use these services.

This responsibility has also informed our enablers, which help us make the best use of what we've already got, make more targeted and lower-cost interventions, and allow our customers to directly participate and benefit by providing services.

4. Delivering Net Zero for our customers and communities

Our responsibility: Distribution networks are key to delivering Net Zero – the decarbonisation of heat and transport, and the increasing levels of renewable generation capacity, depend on distribution network capacity. We therefore have a clear responsibility to deliver this decarbonisation safely, and at least cost to customers.

How we are responding: This responsibility has shaped our approach to DSO functions, from providing flexible connection arrangements like ANM so new renewable generation can connect more quickly, to enabling the use and sharing of DER services to provide additional revenue streams for LCTs. In addition our underpinning enablers, like enhanced forecasting and modelling, mean we can intervene ahead of time to ensure there are no delays in connecting LCTs.

We have just 30 years to achieve Net Zero. In network terms, this is not a remote horizon: the majority of the assets we install today will still be operational in 2050. This means that our journey to deliver decarbonisation has already started.

8.3 Our role in delivering the change

3.5 million homes, businesses and public services depend on our two distribution networks for a safe, reliable, and efficient supply of electricity. We recognise the critical role that our distribution networks will play for our customers long into the future, regardless of the decarbonisation pathway that our customers end up treading. To ensure we meet our customers' changing needs, we are already evolving the way we design, build, and operate our networks, implementing innovative solutions, and embracing new technologies.

Looking to the future, we consider that we are best placed to continue leading the delivery of the functions, activities and enablers set out within this DSO Strategy document.

- **Delivering safely and reliably:** we have the infrastructure, processes, and deep knowledge of how complex and highly localised distribution networks work. These mean we can continue to safely and reliably operate the networks to maintain supply to customers, whatever the future holds.
- **Delivering competitively:** our use of flexibility tenders, independent contractors, external expertise, and multiple equipment vendors mean that competition and external providers will be embedded throughout distribution network functions, activities, and enablers. For example, 84% of our regulated distribution construction activities are already delivered by the market.
- **Delivering on time:** we have the organisational capability, processes, and resources needed to manage complex projects and multiple vendors. We can deliver on time the functions, activities, and enablers needed to maintain a safe, efficient, reliable, and decarbonised supply for our customers.
- **Delivering on good value:** in addition to using competitively tendered external providers throughout, we are benchmarked by Ofgem against other distribution licensees. This means that poor performance and high costs will be quickly exposed and penalised.
- **Delivering for all customers:** we have the existing relationships with our customers so we can quickly understand and respond to their needs. Our regulatory framework and economies of scale mean we are a low-cost provider that can deliver where the market might not, leaving no customer behind. Distribution licensees are one of the few industry parties who have a clear legal responsibility to customers.

We have the capability, knowledge, and experience to deliver at least cost for our customers. This will build on our strong track record – since incentive-based price controls were introduced, network companies have delivered a 17% real terms reduction in network prices; over the last ten years, the number of customer power cuts has been reduced by 34% and the duration of these power cuts reduced by 43%. These have been achieved whilst supporting economic growth with increased jobs, facilitating the decarbonisation of the UK, and delivering industry-leading customer service.

9

Your views and next steps

The plans set out in this DSO Strategy document, and the stakeholder feedback we receive, will directly inform the content of our RIIO-ED2 business plan submission to Ofgem. This business plan is how we will seek Ofgem's approval to make the investment to deliver these functions, activities, and enablers.

Given the importance of these plans, we are working strategically to engage with a wide representation of our customers and stakeholders to get your views.

Feedback from customers and stakeholders is vital to ensure that our DSO Strategy reflects the plans and ambitions of the wide variety of communities we serve. We will use this feedback to update our DSO plans and to help shape our strategy for RIIO-ED2.

Responses to the questions below, and any other feedback on this document, would be welcomed by 10th July 2020 and can be emailed to RIIO_ED2@spenergynetworks.co.uk

1. Our overarching objective is to meet our customers' evolving needs, deliver Net Zero, and ensure the continued safe, reliable, and efficient operation of the distribution network and wider energy system for all customers. Do you agree that this overarching objective is correct? If not, why not and what would be a more appropriate objective?

2. The requirement for the DSO functions and activities is built on the need to meet our customers' evolving needs, and to address a range of system challenges and the impact they have on the distribution network and wider energy system (summarised in Section 4). Are there any major challenges or impacts that we should be planning to accommodate which we have not detailed in this document?

3. In Section 7 we set out four customer types, our understanding of their requirements, and how DSO can deliver those requirements. What customer type do you identify with? Have we correctly understood your requirements? Are there any customer requirements we have missed?

4. Regardless of who delivers them, do you agree that the functions and activities set out in Section 5 are needed? Are there any functions or activities which we have not detailed?

5. Regardless of who delivers them, do you agree that we have correctly identified the key enablers (Section 6)? Are there any key enablers we have missed?

6. Do you agree that SPEN is best placed to deliver the DSO functions, activities, and enablers we've presented? If not, why not and which other parties would be better placed to deliver these?

7. Section 8 explains how we plan to deliver DSO. Do you have any feedback on our roadmap and guiding principles?

8. Is there any other feedback or comments that you would like to make?

10 Glossary

Active network management (ANM) – ANM schemes are monitoring and control platforms which sit above the physical network, and reduce constraints by regulating the output of ANM-connected customers during times of system constraints.

Condition based risk management (CBRM) – a software solution commonly used by distribution licensees to calculate and monitor the risk of distribution network assets.

Consumer – means a domestic customer.

Customer – means anyone connected to our network and who depends on us for an electricity supply. This includes demand, generation, and storage sites, and iDNO networks.

Customer Load Activation System Services (CLASS) – CLASS is a type of service where DNOs provide balancing services to the ESO. This is usually achieved by the DNO lowering distribution network voltage to reduce network demand. This demand reduction is sold by the DNO to the ESO as a balancing service.

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 (DG) – generation connected to the distribution network, as opposed to the transmission network.

Distribution energy resources (DER) – means any asset that is connected to the distribution network which can change its import/export position in a controlled manner in response to a signal. DER will likely include DG, demand side response, and storage. See also 'Services'.

Distribution Future Energy Scenarios (DFES) – DFES forecasts are detailed forecasts we publish annually for our two distribution networks. We work with an external party to determine and produce them. They cover a range of demand and generation metrics (e.g. EVs, heat pumps, different generation technologies) out to 2050. They are available at: *https://www.spenergynetworks.co.uk/pages/distribution_future_energy_scenarios.aspx*

Distribution network – in England and Wales this is the overhead lines, underground cables and other network infrastructure that operate at 132kV and below; in Scotland it is the infrastructure that operates at 33kV and below. The distribution network delivers electricity from the transmission network and DG to end users (consumers/demand). Nearly all demand in GB 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 GB 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.

DSO – depending on context, means the act of distribution system operation, or the distribution system operator (the party carrying out the act of distribution system operation). From the Open Networks project, the definition of distribution system operator is:

"a DSO securely operates and develops an active distribution system comprising networks, demand, generation and other flexible DER. As a neutral facilitator of an open an accessible market, it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of while system optimisation. A DSO enables customers to be both producers and consumers; enabling customer access to networks and accessible markets, customer choice and great customer service."

Electricity System Operator (ESO) – the company responsible for operating the GB transmission network. They have two main functions: balancing the total demand and generation on the system to maintain system frequency at 50Hz, and ensuring transmission power flows remain within transmission network capability and statutory limits.

Extra high voltage (EHV) – all distribution voltages greater than 22kV.

Flexibility – the ability of a customer to change their import/export position in a controlled manner 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. See also '**Services**'.

High voltage (HV) – all voltages above 1kV up to and including 22kV.

Grid supply point (GSP) – the interface points (usually substations) between the transmission network and distribution network.

GW – equal to 1,000 MW.

Long term development statement – a set of documents which detail all distribution network assets from EHV up to the connection point with the transmission network. They also set out network fault levels, connected and forecast DG (excluding domestic-scale DG), and historical and forecast demand. They are published annually in November, with an interim update published annually in May.

Low carbon technologies (LCT) – means the range of customer technologies that are needed to deliver decarbonisation. For example, EVs, heat pumps, storage, and renewable generation.

Low voltage (LV) – all voltages up to and including 1kV.

MVAr – mega volt amps (reactive) is a unit of reactive power. It can be useful to help manage network voltage levels. It can describe both the amount of reactive power that a user is importing (e.g. this generator is importing 1MVAr of reactive power"), and the amount of reactive power that a user is exporting (e.g. "this generator is exporting 1MVAr of reactive power").

MW – megawatt is a unit of power (not energy). It can describe both the amount of power that a demand user is consuming (e.g. "this town's peak demand has increased by 3MW due to an increase in EVs 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").

Net Zero – means the legislated target of reducing greenhouse gas emissions to net zero. For the UK, there are three Net Zero targets:

i. The UK Government has introduced the Climate Change Act 2008 (2050 Target Amendment) Order 2019. This legislation introduces a legally binding target for the UK to have net zero greenhouse gas emissions by 2050. The legislation is available at: *http://www.legislation.gov.uk/ukpga/2008/27/contents*

ii. The Scottish Government has introduced the Scottish Climate Change (Emissions Reduction Targets) Act 2019. This legislation introduces a legally binding target for Scotland to have net zero greenhouse gas emissions by 2045. The legislation is available at: *http://www.legislation.gov.uk/asp/2019/15/contents/enacted*

iii. The Committee for Climate Change recommends a target of at least a 95% reduction of greenhouse gas emissions by 2050 for Wales. The Welsh Government has accepted this advice but declared the ambition to go further and achieve Net Zero greenhouse gas emissions by 2050. This ambition is available at: *https://gov.wales/written-statement-response-committee-climate-changes-net-zero-report*

Open Networks – this is a pan-industry project involving transmission and distribution network companies, the ESO, the Department for Business, Energy, and Industrial Strategy (BEIS), Ofgem, and other stakeholders. It has done much work developing DSO models, the customer experience, whole electricity system planning and distribution to transmission data exchange, and flexibility services.

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

Primary substation – see 'Substation'.

RIIO-ED2 – means the distribution network price control period which runs from 1st April 2023 to 31st March 2028. Before this period starts, we will agree with Ofgem the outputs we will deliver during this period, and the funding, incentives, and penalties for delivering those outputs.

Secondary substation – see 'Substation'.

Services (aka DER services or flexibility services) – DER can change its import/export position in a controlled manner in response to a signal. This capability can be utilised for the benefit of the network or wider system (e.g. a DER reducing their import to reduce the overall level of demand the network must supply). Where we utilise this capability, the DER is providing us with a 'service'. See also 'Flexibility' and 'Distributed energy resources'.

SP Distribution – the distribution network operator for Central and Southern Scotland, we own and operate the distribution network at 33kV, 11kV and LV into the home.

SP Manweb – the distribution network operator for Merseyside, Cheshire, north Shropshire, and north Wales, we own the distribution network at 132kV, 33kV, 11kV and LV into the home.

Substation – a building or outdoor compound which contains one or more transformers and switchgear protection. The primary purpose of a substation is to change the network power flow from one voltage level to another. In a primary substation the highest voltage is EHV (primary substations are typically 33kV/11kV); in a secondary substation the highest voltage is HV (primary substations are typically 11kV/LV).

System wide resource register – a publicly available register which lists all DG which is 1MW or greater, and all assets which provide flexibility services to network companies. The register plans to extend the data it shows to include listing network reinforcements which are underway to enable DG to connect to the network.

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.

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