Annex 4.2
DSO Strategy

Northern Powergrid: our business plan for 2023-28

Contents

The purpose of this annex is to:

- Explain the range of activities we are undertaking to develop the functions of distribution system operation (DSO).
- Set out proposals for the output delivery incentive.

Supporting documents - please see also:

- Northern Powergrid 2023-28 business plan;
- Northern Powergrid 2023-28 business plan annexes;
  - Annex 3.3 Detailed engagement findings - DSO section;
  - Annex 4.1 Scenarios and investment planning;
  - Annex 4.3 Network visibility strategy;
  - Annex 4.4 Whole systems strategy;
  - Annex 5.1 Innovation strategy;
  - Annex 4.5 Socialisation of costs – access SCR and net zero service upgrades
  - Annex 5.3 Digitalisation strategy and action plan; and
- Engineering Justification Papers (EJPs) – relevant references included within the document.

Introduction

The energy system is changing as we transition towards net zero, and electricity networks are at the heart of this change. For our region to meet the national commitment to net zero emissions by 2050, we need to enable whole energy system decarbonisation, including setting up the power system so that it can play a major part in decarbonising transport, heat and industry.

Our vision, developed collaboratively with our customers and stakeholders over the last four years, is to deliver a smarter and more flexible energy system for our customers to decarbonise efficiently. To achieve this we are expanding our capabilities and taking on the functions of distribution system operation (DSO) to actively manage the increasingly complex power flows on our network that result from decarbonisation, reduce the need for conventional reinforcement, and ensure that transition to net zero is efficient and affordable.

We have already embarked on the transition to DSO and have made significant progress over the current price control period. 2023-28 represents a critical period where we must unlock the value of data and network and customer flexibility in order to mitigate the need for costly traditional network reinforcement and maximise our use of low carbon electricity.

Our DSO strategy sets out our plan for the next price control period. We plan to invest £87 million in our systems and people to undertake 28 deliverables and initiatives – tangible actions that are focused around how we gather, use and share data and how we prepare for and deploy flexibility. This document details these actions, the outcomes they will help achieve, and the benefits they will deliver for our customers and for our region. This is also closely linked to our digitalisation strategy and action plan (DSAP)[1] which sets out the investments we will make in systems and processes that will underpin the transition to DSO.

Investing in the DSO transition will ensure that we are equipped to facilitate all potential decarbonisation pathways at least cost. The activities we describe in this DSO strategy are the enabling actions we will take to support the investment in services and network that will increase capacity and flexibility in the system – particularly the digitalisation with monitoring and analytics that is required on the local low voltage system. Our investment will create whole system benefits that go beyond our network and will continue to enable us to optimise the value of the system for our customers.

These enabling actions are required for us to deliver the investment that we describe in the scenarios and investment section of our plan. The people and systems actions that we take in this DSO strategy enable us to deliver on the system optimisation approach of monitor, manage and reinforce that unlocks the benefits we outline in section three of this document.

Defining and transitioning towards the DSO role

The energy system is changing as we transition towards net zero, and electricity networks are at the heart of this change

For our region to meet the national commitment to net zero emissions by 2050, we need to enable whole energy system decarbonisation. Our network will be paramount in facilitating the decarbonisation of the country and region, regardless of the pathway that materialises. Electricity consumption levels and patterns will change as consumers take up electric vehicles and heat pumps, while an increasing proportion of electricity supply coming from distributed, intermittent generation sources, such as wind and solar, will increase the intermittency of supply.

The role of customers is changing as they more actively manage their consumption and choose to produce electricity at home or on commercial premises. This is happening against a backdrop of increasing digitalisation where technological innovation (such as smart appliances) and commercial developments (such as aggregators) are allowing customers to

[1] Refer to the Data and Digitisation Strategy and Action Plan.

reduce or shift their demand for electricity in response to price signals or other incentives. This change creates challenges, but it also brings opportunities to deliver benefits for our customers and for our region.

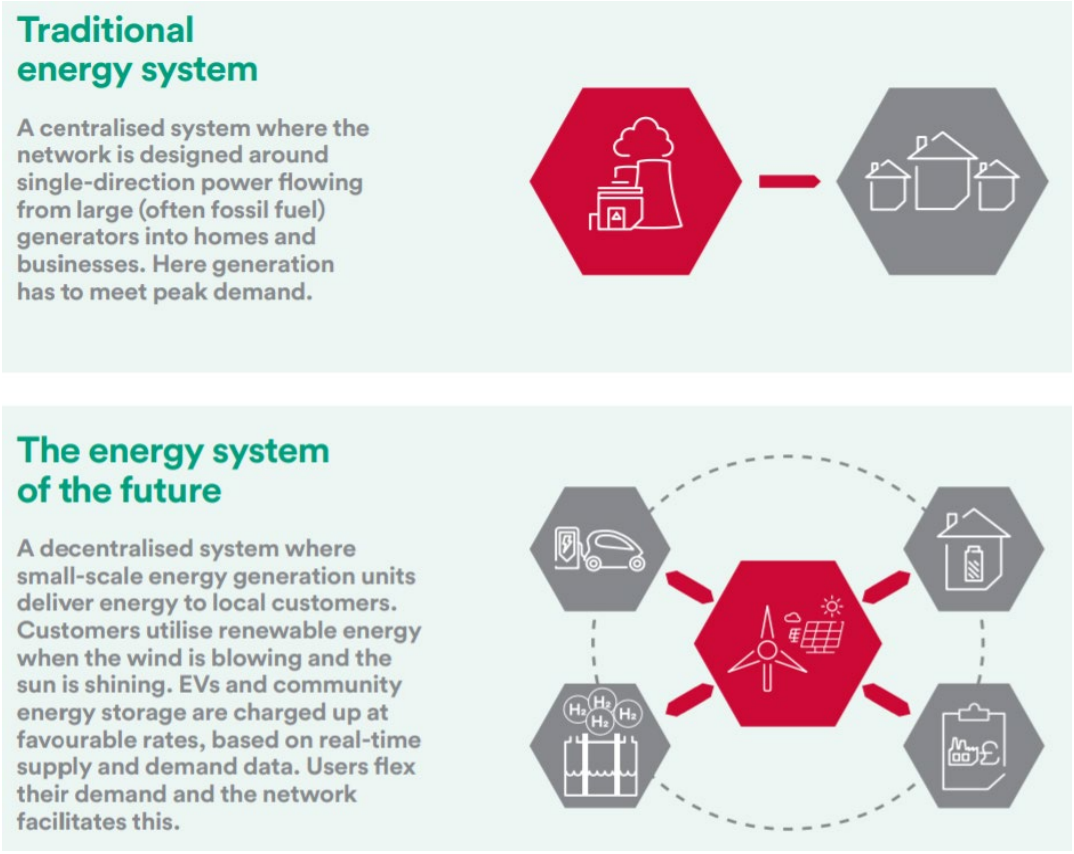


Figure 1: Our energy system is changing

We are expanding our capabilities and taking on the functions of distribution system operation (DSO)

We face the challenge of facilitating an overall increase in demand for electricity as well as manging greater volumes of intermittent generation connecting directly to our network. To decarbonise efficiently and make the transition affordable, we have to enable a smart, flexible energy system where distribution network operators (DNOs) actively manage the more complex power flows on the distribution grids to optimise the value of the system by taking on the functions of a DSO.

Becoming a DSO requires us to develop our network and systems to meet the evolving needs of our customers throughout the low carbon transition (see Figure 2), ensuring we are a trusted and neutral platform through open, transparent and technology-neutral decision making. To deliver reliable supply to our customers, we must manage increasingly complex power flows on our networks through whole system engagement and optimisation, and proactively share data and insights about our networks to facilitate effective decision making across the energy supply chain.

Part of that optimisation will involve us encouraging customers to be flexible in their energy generation and consumption, and enable them to play a more active role in supporting the network. That will include facilitating their participation in existing and new market-based solutions, such as flexibility services (including flexibility from energy efficiency schemes), local energy markets and peer-to-peer trading.[2] Complementary actions in our plan include providing education on energy efficiency (CO3.2) and working with other agencies to help target energy efficiency measures for vulnerable customers (VN4.2). In delivering DSO we will strive to ensure that customers are empowered to

[2] Refer to the whole systems part of the 2023-28 business plan for where we discuss how we will enable peer-to-peer trading by addressing the commercial and regulatory barriers

participate in a smarter and more flexible energy system, and adverse impacts on vulnerable customer groups are mitigated to make sure that no one is left behind in the ongoing energy transition.

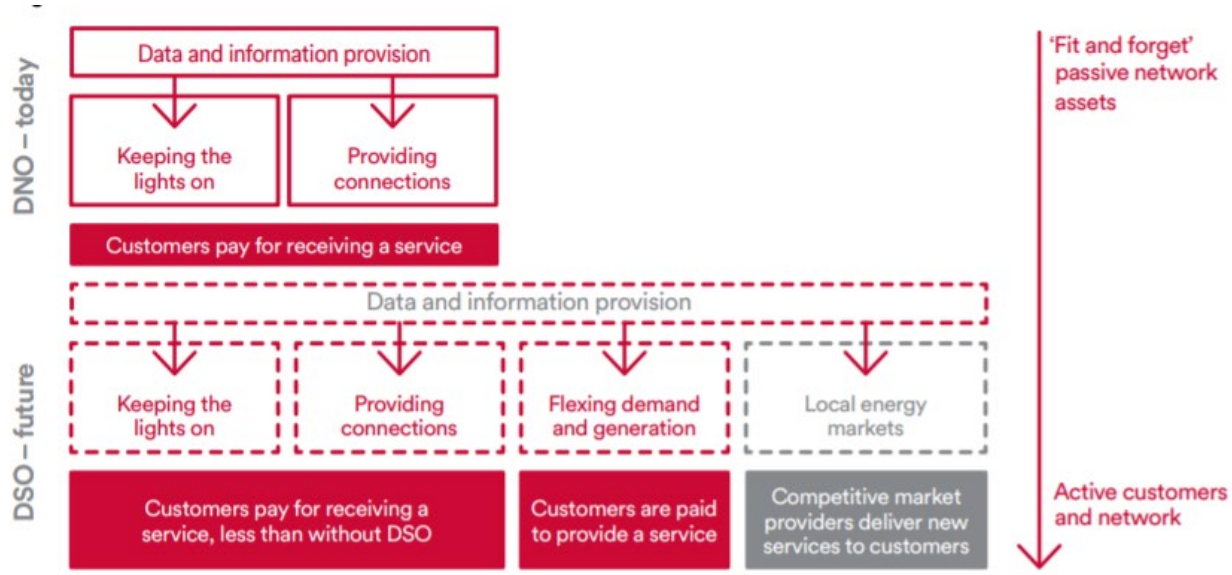


Figure 2: What DSO means for customers

We have already embarked on the transition to DSO and have made progress over 2015-23, working with our customers and stakeholders to develop our thinking, and investing in our capabilities

Whilst we have laid solid foundations for the transition to DSO over in recent years, it is crucial that we build on this to meet the challenges and needs of the changing energy system. To do this we are setting out our plan here to invest £87 million over 2023-28 in developing the functions and capabilities required for DSO. This will unlock benefits for customers and the community by allowing us to decarbonise our network at lowest cost. By taking a flexibility first approach to our network investment strategy we will reduce the need for conventional network reinforcement and endeavour to ensure that every kilowatt hour of renewable energy is utilised. As described in the scenarios and investment section, net benefits of up to £156 million could be delivered by avoiding traditional reinforcement costs over the course of 2023-28. The DSO transition will also enable system benefits that go beyond our network and will continue to enable us to optimise the value of the system to deliver savings in the forthcoming price control period and beyond.

Since 2017, we have been actively exploring the DSO transition with a broad set of stakeholders in the context of addressing decarbonisation. Following an extensive programme of stakeholder engagement we published our first DSO v1.0 thinking in 2018,[3] with 84 per cent of our stakeholders supporting that plan. We then updated this with our development plan (DSO v1.1) in October 2019[4] and again with our 2023-28 emerging thinking document in August 2020.[5] The detailed engagement findings – DSO section contains more information on how we have interacted with and accommodated a wide range of views in preparing this plan.

We have made significant investments in our DSO capabilities in the current 2015-23 price control period (see Figure 3), which has laid the foundations to enable the transition to DSO over the next price control period 2023-28.

[3] DSO v1.0 distribution system operator: next steps and emerging thinking
[4] DSO v1.1 distribution system operator: development plan
[5] Building our plan for 2023-2028: emerging thinking – supporting material

Modernising and digitalising our network and operations	Our smart grid enablers project is the UK's most comprehensive network upgrade programme. It is transforming our ability to monitor, control and communicate with more than 860 major substations, giving us the ability to respond to real-time information about power flows on our network. As part of the programme we have started to rollout LV monitors and will have 2,700 in place by end of the current price control period. This is supplemented by improvements to the digital systems used to manage and analyse the new data sets we are obtaining.
	We have advanced our internal readiness for the smart meter roll out programme, which has continued to face delays at the national level. We have been preparing our internal systems to integrate smart meter data with our customer, network and operational data so that we can proactively respond to outage alerts and enhance demand forecasting on our LV network.
Focusing our innovation on preparing our network for the future	Our £1.8 million customer-led distribution system innovation project is exploring how to accommodate large volumes of new technologies, such as local generation and electric vehicles, at least cost, while enabling customers to earn income by selling energy or services to balance the network.
	We are developing our commercial and technical skills to operate a more flexible system. We have been working to build our data analytics skillset in house by developing the right processes and tools.
Exploring and preparing for flexibility	Our active network management (ANM) solution is providing scalable capability to connect more generation at least cost, as an alternative to conventional reinforcement by offering customers a flexible connection. We expect to have deployed ANM across four areas by the period to 2023, with an estimated 540MW of contracted flexibility from generation curtailment within these zones. We intend to rollout further ANM zones where there is high customer interest in connecting to the network, limited capacity and high reinforcement /flexibility costs.
	We have conducted market testing for customer flexibility services and have run three expressions of interest for reinforcement deferral as well as an e-auction for emergency support. This has allowed us to develop our processes and work with the market to gauge interest and identify potential providers.
	In 2020, we commenced implementation of the Flexible Power operational system to manage the purchase and operation of flexibility services. This collaboration now includes the majority of DNOs and offers flexibility providers an easier, lower cost, standardised route to market.
Working with our peers, other industry parties and stakeholders	We are participating in the Energy Networks Association (ENA) Open Networks project, including work streams pertaining to flexibility services and DSO transition, to collaborate with other DNOs, as well as the ESO, the market and policy makers, to standardise customer experiences and align processes.
	We collaborate with industry bodies and policy makers through several panels and consultations to ensure that technical and commercial industry codes, standards and arrangements are updated to enable and support the industry transition.
	Our distribution future energy scenarios (DFES) assumptions and results are shared through an open data platform with Leeds Open Data Institute,[6] which includes a view for local authorities (LAs), and are accessible to a broad range of stakeholders to use and comment on our assumptions.
	We share a large amount of network data publicly and with the electricity system operator (ESO) and wholesale and retail markets to facilitate its use towards a whole electricity system optimisation.

Figure 3: Investments in our DSO capabilities in the price control period 2015-23

[6] https://odileeds.github.io/northern-powergrid/

We are now looking towards the future and have developed our DSO strategy for 2023-28 by engaging with our customers and stakeholders, and ensuring alignment with regulatory requirements

Our DSO strategy has been informed by the needs of our customers and stakeholders. Since publishing our 2023-28 emerging thinking document in August 2020, we have been engaging on our further developed DSO transition plans through stakeholder panels, industry forms, and bilateral discussions with industry and experts. Our stakeholders have told us that two-way sharing of network data through self-service tools is crucial to helping them with their own decarbonisation plans, understanding our network and managing flexibility. Stakeholders have also emphasised the need for standardisation of flexibility products and transparency in their procurement to stimulate participation in local flexibility markets. These priorities have informed our DSO strategy, which has a twin focus on data and the use of flexibility.

We recognise that we need to develop our DSO functions and capabilities in a manner that is coherent with other stakeholders in the energy system. As a result, we have sought to align our DSO strategy with recommendations coming out of the ENA's Open Networks project, particularly the work streams focused on flexibility services and the DSO transition. For example, the metrics we will use to measure our progress are being developed in collaboration with other DNOs and Ofgem.

Ofgem has set a clear direction for the transition to DSO with a view to reducing uncertainty and ensuring consistency in approach across the sector. Our strategy has been developed to ensure we meet regulatory requirements and are able to perform the three core DSO roles envisioned by Ofgem for 2023-28. We detail how our strategy will ensure we meet Ofgem's expectations for the DSO transition in the DSO deliverables and initiatives sections of this annex and in appendix D. While deliverables are measurable activities, initiatives cannot be measured but are integral to delivering our strategy and meeting Ofgem's regulatory requirements.

We have put together an initial plan to respond to our stakeholders' needs. While this plan makes good sense today we need to keep it under review with our stakeholders and adapt it through the 2020s in accordance with what we hear from them and what we learn. We are encouraging our regulator to give us this room to adapt and to support this view that the plan should be ever-changing to respond to customers' needs and capture the benefits from technologies or other developments that are not yet known.

Our DSO vision

Our vision is to deliver a smarter and more flexible energy system for our customers to decarbonise efficiently

Our region will need to be well on the way to a fully decarbonised energy system by 2028. We therefore need to make significant investment in the DSO transition over 2023-28 to ensure that we are able to facilitate potential decarbonisation pathways in a cost efficient manner. As outlined in the scenarios and investment section, we are aiming to open up all credible pathways to decarbonisation in the next five-year period and beyond, and implementing more DSO functions is fundamental to achieving this.

We are preparing for a future where flexibility plays an integral role in the energy system

We are on a journey towards a smarter, more flexible and increasingly decentralised energy system. Looking ahead, the electricity generation mix will feature an increasing proportion of small scale, low-carbon generation located closer to the point of consumption producing varying levels of electricity depending on the time of day or weather conditions. Electricity consumption and patterns too will change as consumers take up low carbon technologies (LCTs), by choosing to self-generate and use electricity to power their vehicles and heat their homes. Alongside these developments, digitalisation, in the form of smart metering, smart charging devices and energy management systems, is facilitating the wider penetration and integration of Distributed Energy Resources (DER) – ranging from energy storage to various types of dispatchable generation and demand resources – and allowing them to more readily respond to price signals. Commercial developments such as the emergence of aggregators and local flexibility platforms are increasing the extent to which DER can modify their generation and/or consumption patterns to help distribution and transmission system operators balance supply and demand in this future energy system, adding to the existing sources of flexibility (e.g. from large customers /generators) available to system operators.

These developments are recognised as the key drivers of the energy transition and policy developments set out by Ofgem and BEIS in their Smart System and Flexibility Plan.[7] They also lie at the heart of what is driving our transition to fulfil the functions of DSO: in preparation for the near future where we are responsible for efficiently balancing our network using both conventional and non-conventional means, while working in coordination with a broad range of stakeholder and ensuring provision of services that benefit everyone. Making this vision of the future a reality will require us to continue investing in a few key areas set out in the figure below to enable a more flexible energy system.

Facilitating integration: Incentivise widespread connection of DER and LCTs to the network for example through easier connection processes and reduced connection costs and facilitate customers to more actively manage their consumption/production. Enhanced monitoring of LV networks will ensure that required infrastructure is in place to facilitate new connection for DER and LCTs.

Providing DERs a 'route to market': remove barriers to small-scale DER participation in the provision of system services through comprehensive engagements to understand their needs; and facilitating aggregators, peer-to-peer trading, as well as re-assessing participation criteria and ensuring transparency of procurement processes.

Facilitating development of deep and liquid local flexibility markets – Improve market design to provide clear price signals and ensure adequate remuneration for provision of services as well as coordination/integration with other markets where flexibility providers can earn revenue.

Data and digitalisation: improve physical technology and enhance data analytics to more accurately monitor our networks, identify and signal areas where flexibility is needed, and provide clear signals to ensure efficient dispatch of flexibility services.

Encourage innovation in technology and processes

[7] BEIS. Smart Systems and Flexibility Plan 2021. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003778/smart-systems-and-flexibility-plan-2021.pdf

To be effective, we will need to be ready to adapt to an evolving system. As millions of homes and businesses embrace electric vehicles, adopt heat pumps and use battery storage, we envision the consequent constraints on low voltage networks to be increasingly resolved by solutions developed through aggregation of flexibility that these resources have the potential to offer. We are working on deploying a robust and systematic monitoring framework for identifying the changes in the market, understanding how the uptake of LCTs, DER and other flexible technologies is progressing, and openly sharing our data with a broad range of stakeholders to inform their investment and operational decision making processes. For example, enhanced monitoring of our LV networks combined with data analytics will allow us to identify pinch points on our networks which will serve as signals for flexibility providers where to locate on the network and how much they can expect to be paid for their services.

Recognizing that flexibility markets are at a relatively nascent stage as compared to where they will need to be in the future, we are planning changes that are scalable and robust for longer-term systemic change. These changes will lay the foundations that underpin an effective system for flexibility so that we are ready to respond to flexibility market development at whatever pace it comes and are prepared to harness the flexibility our customers can offer as soon as it is available. Our plans will ensure we have fully scalable technology, systems and processes which will allow us to remain responsive and agile in light of the inherent uncertainty around whichever decarbonisation pathway unfolds, and can facilitate flexibility playing an optimum role on that pathway.

Types of flexibility

Network flexibility: smart grid solutions, and field-based equipment that allow us to operate the network in a more active manner, and use near real-time data to optimise power flows and release capacity where needed

Price-driven customer flexibility: customers respond to price signals in their energy tariffs or smart charging incentives to flex their energy usage patterns in accordance with system needs.

DNO-contracted customer flexibility – flexible connections: we offer customers a cheaper, faster connection in a constrained area of the network using techniques like Active Network Management (ANM) which enables us to curtail generation at peak times.

DNO-contracted customer flexibility – flexibility services: customers contract with us and we pay them to turn up or down their demand and/or generation at specific times or under particular circumstances to help us balance supply/demand on our grid

As a result of increasing adoption of LCTs and digital technologies, we expect to see a significant increase in the number of customers on our grid who can actively manage their energy use and production to reduce the bills they pay. We will work collaboratively with suppliers, including through timely sharing of data and information about our networks, to ensure effective time-of-use signals and other smart charging incentives are passed through to the final customer. These measures will unlock the potential for price-driven customer flexibility allowing customers to flex their consumption patterns in response to system conditions, e.g. reducing use through energy efficiency measures; using energy at off-peak times or generating energy at peak times; or electric vehicle owners to charge when there is a surplus of green electricity available. This price-driven flexibility has the potential to not only reduce energy bills for customers, but by shifting consumption away from peak periods also reduce our need to invest in expensive, irreversible network solutions to increase capacity. Price-driven customer flexibility will add to our existing toolkit of network flexibility and smart grid solutions that allow us to adjust to evolving conditions on our network and release capacity when and where it is needed. We expect price-driven flexibility to deliver up to £113 million of savings during the 2023-28 period – refer to the Scenarios and Investment annex for further detail.

In addition, we will help our customers extract maximum value from their assets by receiving remuneration for providing flexibility to help us manage the complex power flows on our network; as well improving their access to a range of other markets. We see the use of this DNO-contracted customer flexibility as a fundamental means to efficiently manage well-targeted network utilisation and reinforcement needs. As part of our Active Network Management (ANM) scheme, our

customers have had the option to enter into flexible connections arrangements where their access to the distribution networks can be constrained during peak periods, in return for a faster and/or cheaper connection due to reduced need for connection specific network reinforcement.

We will contract with customers and pay them to provide flexibility services by either increasing or reducing their electricity use or production. Insights from initiative like our Customer-Led Distribution System (CLDS) project allow us to understand and deliver on our customer needs by identifying ways in which flexibility from different types of DER can be harnessed to optimise the operation of distribution networks and reduce the need for network reinforcement.

At the same time we will ensure that we are both a facilitator as well as a purchaser of flexibility services, improving access to a range of markets through standardised processes and open data. This includes access to DNO and ESO contracted flexibility and ancillary services, as well as wholesale and balancing energy markets, enabling customers to 'stack' revenue streams, improving their business case, and therefore liquidity of local flexibility markets. This will also ensure market actors can participate in secondary trading when favourable.

We have an integral role to play in supporting and enabling deep and liquid competitive local markets for flexibility through co-ordinated actions with both customers and other stakeholders in the sector. Insights from the CLDS initiative have provided clear demonstration of the value that the flexibility offered by DER connected to our networks has for the whole energy system. As such, in developing these markets we will ensure that at times when the cost of managing part of our network though flexibility exceeds the cost of alternative options, then our customers should still be able to offer their services to the transmission system or wholesale energy markets. This will ensure on the one hand that flexibility providers have sufficient revenue streams available to support their business case for offering the services; and on the other hand, enable us to cost effectively manage a significantly increased volume of forecast network constraints over the upcoming price control period. Regular procurement rounds supported by the award of revenue generating contracts to flexibility service providers will enable us to provide clear investment signals and build the trust and confidence required for future expansion of flexibility markets.

Finally, we will need to effectively harness technological innovation and digitalisation to improve monitoring and control of our network and ensure better coordination with stakeholders across the energy sector. Enhanced data and analytics can enable more efficient use of existing assets, for example by identifying pockets of available capacity on the network; and by maximising both network and customer flexibility they can help offset the need for conventional network reinforcement. Timely sharing of real (or close to real) time network data and granular near- to medium-term forecasts will be key enablers for short-term peer-to-peer trading of energy and flexibility services. Over the longer-term, improved visibility from greater data openness can help steer investment into optimal technologies and locations, saving money for customers while cutting greenhouse gas emissions on the path to net zero. Refer to the network visibility strategy for further information.

As we transition to fulfilling DSO functions, we retain responsibility for the integrity of the regional electricity system, operate DNO contracted flexibility and support the provision of flexibility from our customers to other system actors (e.g. energy suppliers, ESO, third party commercial aggregators). This entails us being a trusted and neutral platform able to support optimisation of the whole energy system and underpin the rapid transition to carbon-free electricity, transport and heat; a system with the customer at its heart. We recognise the centrality of openness and transparency in our decision making about flexibility procurement in building our position as a trusted, neutral operator. Towards this end, we have undertaken a comprehensive review of our organisational structure to ensure operational efficiency by separation of responsibilities and improving accountability across different parts of the investment decision making process for both network and non-network solutions (including flexibility services). This will ensure that we will procure for and deploy flexibility, through common approaches developed in conjunction with other networks and stakeholders, to resolve network constraints as/when it is efficient to do so without providing undue preference to any party or particular type of solution. Our transparency plans include the use of a third party to audit and report on the correct functioning of these processes. This is explored further in the DSO governance section below.

Our approach is being shaped by engagement and collaboration with a broad set of stakeholders

In 2018, Northern Powergrid joined other GB DBOs in establishing our flexibility first commitment co-ordinated by the Energy Networks Association (ENA). This means we are committed to assessing flexibility services first when reviewing requirements for building significant new electricity network infrastructure. In addition, as part of the Open Network Project, we are committed to working with ENA members to standardise and align various processes in relation to the evaluation of flexibility as an alternative to network reinforcement, as well as the procurement, contracting and dispatch of flexibility services.[8] For example, in recent years, we have supported the development of four standard flexibility services, which we are now in the process of deploying for use cases set out in the figure below.

Services	Definitions	Use Case
Sustain	A pre-agreed change in import or export over a defined time period to ensure that the loading on network assets would remain within network capability in the event of an outage.	**Traditional reinforcement**: To defer or avoid investment in network reinforcement intended to increase network capacity. **Planned maintenance**: To manage the risk associated with planned outages for maintenance or long running construction work
Secure	A pre-agreed change in input or output that can be implemented based on network conditions close to real-time to ensure that the loading on network assets would remain within network capability in the event of an outage.	
Dynamic	A pre-agreed change in input or output that can be implemented following an outage to ensure that the loading on network assets would remain within network capability.	
Restore	Flexibility providers adjust their import or export from the network for a defined period of time whilst it is in a depleted state. This is to support increased and faster load restoration under depleted conditions.	**Emergency support**: to manage the risks associated with unplanned major outages

Going forward, we hope to combine solutions for network flexibility and customer flexibility to maximise value of all energy assets that make up the local grid and reduce the need for high-carbon back-up power generation. The full set of flexibility options available to us will allow us to develop the optimal solution for resolving a constraint by selecting a subset of options best suited to efficiently address the constraint at least cost and lowest carbon emissions. We expect the set of flexibility options available to us to expand over time alongside increasing maturity of flexibility markets, increasing the possible combinations of suitable options and hence number of optimal solutions we have at our disposal. This will ensure that we make increasingly sophisticated choices about the flexibility options available to us, and efficiently manage the interaction between different types of flexibility, including by establishing fair and transparent principles for flexibility operation.

Our flexibility first commitment is reflected in our consideration of DNO contracted flexibility services as part of our options assessment for all load related network reinforcement schemes proposed for ED2 (Cross-ref to EJP11.4 to 11.22).

[8] We are also engaged in other aspects of the Open Networks Projects that are looking at whole electricity system planning and cost benefit assessment, DSO transition, data exchange and stakeholder engagement.

Alongside procurement of flexibility services to defer load related reinforcement during ED2, our wider flexibility strategy also considers the long term development of markets for flexibility services in our region.[9]

At first we see wider geographic markets providing services for EHV network constraints as demonstrated in our plan assumptions; and over time more local markets, down to an individual street level, for LV constraints, the operation of which we will explore via trials in ED2.

In addition to our ongoing engagement with Open Networks Project, we have joined with other UK DNOs to develop the Flexible Power toolkit, comprises a public facing website for sharing information about upcoming flexibility procurement as well as an online platform for managing the scheduling, dispatch and monitoring of DNO contracted flexibility services. Alongside our corporate website, the Flexible Power website is now our standard route to engaging with the market and setting out our flexibility needs – for example we hosted an expression of interest process from November 2020 to January 2021 on our potential flexibility needs for the ED2 period.[10] More detail is also available within the scenario and investment annex.

Where we see things going in the future:

We are committed to helping build a flexibility market that works for all users of the network, providing confidence to the market that every decision is made on the basis of sound judgement. During and beyond ED2, we remain committed to actively engaging with the market for Flexibility Services in our region with a wide range of stakeholders including flexibility providers, energy suppliers, community energy groups and research and insight bodies. The feedback we have gathered from stakeholders has played an important role in shaping our approach to flexibility and the development of DSO capability in our plan. Some of the major themes which have emerged from this engagement and shaped our planning are detailed below:

- **Geographical restrictions:** requirements for DNO contracted flexibility services are highly locationally specific. Suitable assets must not only be connected at the right location(s) on the distribution network but also at an appropriate voltage level. Engagement with providers has repeatedly highlighted this as a key barrier to flexibility market participation and liquidity growth. Increasingly the geographical availability of flexibility opportunities will be key to encouraging greater market participation and provider confidence in the availability of revenues. Our investment of £3m in 'go further, faster' flexibility market stimulation during ED2 is an acknowledgement of this consistent feedback. We are committed to investing in flexibility markets in our region to build provider confidence, enhance our capability and increase the availability of flexibility as a network management tool.

- **Visibility of future opportunities:** early visibility of opportunities has been consistently cited as important to allow for appropriate planning and preparation. This allows potential flexibility providers the best chance to take advantage of market opportunities and maximise revenue opportunities for their DERs. Openness and transparency are key pillars of our approach to flexibility and DSO, underpinned by our proposed investments in open data and our commitment to joint planning to ensure optimal whole system outcomes.

- **Standardisation:** ensuring simple, standardised approaches to procuring and operating flexibility across GB DNOs was repeatedly highlighted by stakeholders as key in lowering barriers to entry for DNO flexibility markets. We remain committed to working closely with our fellow GB DNOs and the ESO through key industry collaborations (such as the ENA Open Networks project and the Flexible Power collaboration) to develop aligned, effective approaches to evaluating, procuring and operating flexibility.

[9] See EJP-11.24 DNO Contracted Flexibility Services Market Stimulation
[10] Detailed information about Flexible Power can be found at: https://www.flexiblepower.co.uk/flexibility-services; More details on our existing distribution flexibility procurement processes can be found here: https://www.northernpowergrid.com/asset/0/document/6104.pdf

- **Investment in technology and automation:** stakeholders were clear that investment in data and automation were key in maximising the future efficiency of DER utilisation in flexibility markets. The ability to procure and dispatch flexibility closer to real time on a 'machine to machine' basis will be important in driving the evolution of short term flexibility markets and encouraging consumer participation via technically advanced aggregation providers. The wide ranging investments in data, forecasting and DERMS processes in our DSO strategy are a recognition of the requirement for us to significantly upgrade our technical capabilities to maximise our efficacy as a future procurer and operator of flexibility.

In addition to stakeholder engagement, there are several ongoing initiatives that will help inform and develop our flexibility procurement strategy going forward:

Our technology agnostic approach to flexibility procurement means that we are open to exploring how energy efficiency can be a source of DNO contracted flexibility including as a possible alternative to network reinforcement alongside DNO-contracted customer flexibility described above. We plan to work collaboratively with other stakeholders to overcome some of the barriers facing energy efficiency at the moment (e.g. dispersed benefits, funding streams, service models). For example, we plan to continue our engagement with the Boston Spa Energy Efficiency Trial, which aims to trial voltage management on the local network as a method of minimising long-term energy demand as well as engaging with the relevant policy developments and research in this area, including exploration of any modal shifts in customer behaviour post-pandemic.

Moreover, in an increasingly decentralised energy system of the future, complex power flows will require us to take on multiple roles as a DSO - not just as a procurer of flexibility for our needs but sometimes jointly with or in service of the ESO, and even using our network to provide flexibility to the transmission network, for example via reactive power services from network assets. We are ready and willing to take whatever role is necessary to maximise the effectiveness of flexibility in the journey to net zero and to minimise whole system consumer costs.

To that end, we are already committed to work on engagements that will see us provide services to the ESO, including for example:

- We are currently support the ESO on the Distributed Restart initiative that is exploring how DER can provide black start services from distribution up to the transmission level. Black start is currently a transmission-led service using large fossil fuel generators to restart the transmission network.[11]

- During the 2023-28 period, we will work with the ESO to understand how we can best deliver value through the lessons learnt from CLASS (Customer Load Active System Services) an ENW innovation that uses voltage management to reduce electricity consumption at peak times. We will seek to provide this form of load reduction as an ancillary service to the ESO if we establish that it will deliver value (Refer to deliverable DSO 4.6).

More generally, we have embraced Ofgem's recent decision to implement the Whole System License Condition in our DNO licence and are well positions to meet its requirements. We are convinced of the value of coordinating our planning, investment and operational decisions with a broad range of stakeholders within the energy sector and across other sectors, both for the operation of our networks and for the whole energy system**.**

[11] https://www.nationalgrideso.com/future-energy/projects/distributed-restart

Our DSO strategy

We have five strategic objectives – guiding principles which have shaped the development of our DSO strategy and will continue to guide our decision making as we transition to DSO

Our strategy will deliver on five strategic objectives (see Figure 4) that have been informed by the needs of our customers and stakeholders and by regulatory requirements. These were tested, reviewed and refined through numerous engagements we had with customer and stakeholder groups, particularly over the last six months.

Flexibility first	Develop and deploy agnostic flexible solutions as an alternative to network reinforcement where it is economic and efficient to do so, ranging from energy efficiency solutions to dispatchable generation and demand turn down. Promote and establish deep and liquid markets for flexibility alongside investment in systems and processes that enable growth in our use of flexibility as the markets mature. *This strategic objective links to and supports the decarbonisation scenarios and investment section of our business plan.*
Whole system collaboration	Enable whole energy system solutions by engaging with the wider market on our network investment, system management, and flexibility requirements and capabilities. *This strategic objective links to and is supported by the whole systems section of our business plan.*
Data and digitalisation	Facilitate fast, efficient and optimised decarbonisation through open data, insight capability and digital tools, without losing sight of data safety and security. Invest in software and hardware that allows us to closely monitor the network, capture more relevant data and execute solutions to constraints as they materialise. *This strategic objective links to and is supported by the data and digitalisation section of our business plan and the DSAP.*
Openness and transparency	Earn trust through open and transparent decision making by publishing our investment decisions and flexibility needs and procurement results, and collaborating in joint planning with our local stakeholders. *This strategic objective links to and is supported by the openness and transparency section of our business plan.*
Workplace and workforce fit for the future	Build in-house, regional and national skills and value through developing knowledge, transferrable skills and an innovative culture. *This strategic objective links to and is supported by the workforce section of our business plan.*

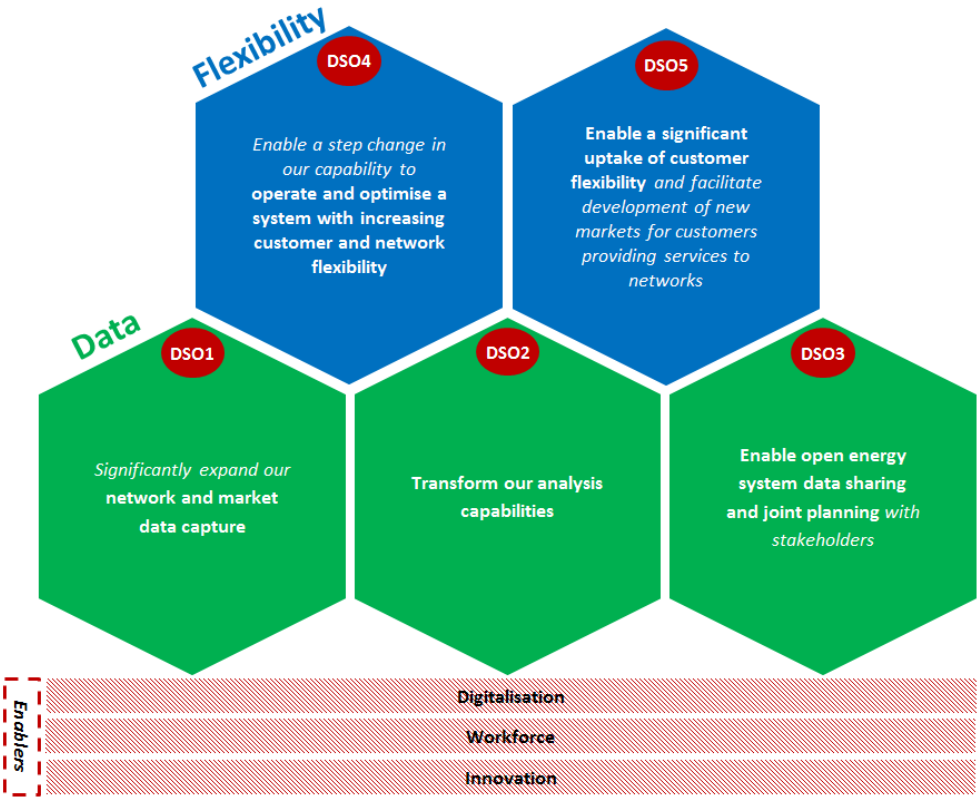
Figure 4: Our five strategic objectives

These strategic objectives are linked to and supported by other parts of our 2023-28 business plan. They have shaped the development of our DSO strategy outcomes and the tangible activities we are committing to undertake in 2023-28, and they will continue to guide our decision making on the DSO transition.

The five objectives lead to five groups of outcomes that will deliver benefits to customers in 2023-28 and beyond

Our strategy links our vision for the future with tangible DSO actions we will undertake to get there and sets out the investment required to deliver these actions, as well as the benefits that will flow from them. It is geared around our flexibility first approach: ensuring we are able to identify and deploy flexible solutions when it is efficient to do so, instead of conventional reinforcement. To do this we will need to invest in updating our systems and skills as well as enhancing our data capture, use and sharing to enable optimal use of our assets and facilitate the most cost-effective route to decarbonisation.

Our DSO strategy will deliver outcomes in five areas (see Figure 5), focused around how we gather and use data, and how we prepare for and deploy flexibility. These build on our significant progress to date in embedding data and flexibility at the heart of how we operate during the current price control period. Each outcome enables us to deliver across a number of strategic objectives, as indicated by the symbols. ● indicates that the outcome is directly applicable to the strategic objective, while ○ indicates that the outcome is an enabler of the objective.



DSO1	We will significantly *expand network and market data capture* to establish a vital building block for the smarter and more active energy system. This will improve the volume, availability and accuracy of the information that we track and share about our network, which underpins the transition to DSO.
DSO2	We will *transform our analytical capabilities* to enable more data-driven decision-making in planning and operational timescales. Better data and analytics will drive more accurate forecasting and informed decision-making, leading to more efficient investment to enable a range of decarbonisation pathways – refer also to annex 4.1 scenarios and investment planning.
DSO3	We will *enable open energy system data sharing and engage in joint planning* with our stakeholders. Joined-up working with regional stakeholders and two-way data sharing will enable more dynamic and robust regional planning, facilitating whole systems decarbonisation - refer also to annex 4.3 whole systems strategy.
DSO4	We will enhance processes and systems for network operations to enable a step change in our capability *to operate and optimise a system with increasing customer and network*

	flexibility. Preparing our business operations, network and people will enable us to maximise our ability to identify and deploy customer and network flexibility over 2023-28 and beyond.
DSO5	We will *facilitate the development of new markets for* ***customers*** providing services to networks in order to enable significant uptake of customer flexibility. Stimulating the flexibility market and procuring flexibility will optimise the use of the existing network and support cost-effective decarbonisation.

Figure 5: DSO strategy outcomes

Our DSO outcomes will be supported by investment in other areas of our business plan (our cross-cutting enablers)

Our DSO outcomes are supported by investment in the cross-cutting enablers of our business plan as shown in Figure 6.

Digitalisation is a central plank of our DSO strategy. In fact, the digital elements of the DSO strategy make up a significant proportion of our total investment in data and digitalisation – around 47 per cent of the total spend planned for 2023-28 (see Figure 6). Our DSAP details the systems investment of £49.9m where we need to invest in 2023-28, including data and system security and resilience, while our DSO strategy details how and why we will use these systems.

Investment in improving our systems will enable us to capture, manage, analyse and share data – both for our own use and for our customers. It will also support us to better manage flexibility procurement and stimulate the flexibility market. Throughout the details of the strategy in the following pages we signpost the relevant DSAP initiatives for each DSO deliverable and initiative. Detailed mapping of the linkages between the two strategies is included in appendix A.

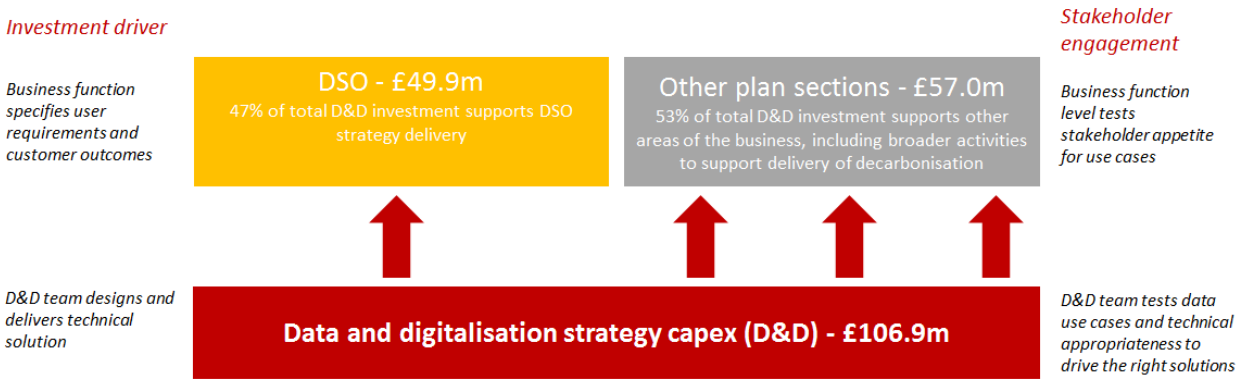


Figure 6: Interaction of DSAP with DSO

Workforce development is also a key component of our DSO strategy. We will upskill existing colleagues through training and education, maintaining skills through continuous development, and recruiting new people with relevant analytical and commercial skills, as explored in more detail the workforce section of the business plan and in the DSO deliverables and initiatives sections of this annex.

Innovation will also support our outcomes: facilitating decarbonisation, and in particular identify opportunities to accelerate the benefits of flexibility. We will build on successful innovation activities in 2023-28 and continue to find new approaches that are funded both as part of business as usual (BAU) activity and as well as specific innovation funding (see our innovation strategy for further detail). Specific innovation activities proposed as part of delivering the DSO strategy are included in the DSO deliverables and initiatives sections of this annex.

Benefits and costs

Our DSO strategy will drive benefits for customers and society

Transitioning to DSO will ensure that we are equipped to facilitate potential decarbonisation pathways at most efficient cost. Our DSO strategy will:

- Enable total energy costs to be kept as low as possible as our region decarbonises, including by unlocking cost savings for customers as we build a smart system that is more efficient, reliable and cost effective. We estimate that up to £201 million of traditional reinforcement costs will be avoided over the course of 2023-28, delivering net savings of £155.5 million over the five-year period, as we embed a flexibility first approach to network investment[12] (see Figure 7).

- In addition, where we do have to invest to repair and upgrade our network, better data and analytics will drive more efficiency as we are better able to identify and predict areas in need of investment, and ensuring that we spend customers' money efficiently.

- Maximise the value of existing infrastructure, and endeavour to enable every low carbon kilowatt hour of electricity that is generated to be used. Local energy markets incentivise customers with flexible load to follow and buy locally produced renewable energy. Owners and users of distributed energy resources (DERs) can get significantly more value from their assets by participating in local energy markets compared to providing services only to the distribution network. Our customer-led distribution system project[13] has found that the benefits to DERs from participating in local energy markets are between 20 and 63 times greater than the benefits from participating in the network services market.

- Further rollout of ANM and access to a new enterprise ANM will ensure that customers can get connected quicker and without the need for significant reinforcement works and associated costs as an enterprise ANM provides a resilient and easily extensible platform.

- Allow our customers to earn revenue through participating in flexibility markets facilitated by our DSO activities which will also deliver value to all customers by reducing the cost of our distribution network and of the wider national energy system. A study[14] of the value in 2050 of local flexibility found that for each pound of savings in the local distribution network there is the potential to realise two pounds of savings in the wider system.

[12] See our Scenarios and Investment plan section
[13] https://www.northernpowergrid.com/asset/0/document/5414.pdf
[14] Flexibility in GB report by Carbon Trust and Imperial College, May 2021 - https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Flexibility_in_GB_report.pdf

	£m
Network intervention costs before flexibility-based solutions [a]	689.1
Plus costs DSO strategy investment, including LV monitoring [b]	+92.4
Less savings from price driven flexibility [c]	-107.9
Plus costs of DNO-contracted customer flexibility	+1.8
Less savings from DNO-contracted customer flexibility [d]	-14.0
Plus cost of smart solutions	+8.4
Less savings from smart solutions [e]	-64.9
Expected network intervention costs after flexibility-based solutions [f]	**512.4**
Plus investment in flexibility market stimulation [g]	3.2
Total cost - in DSO enablers + network investment (b+f+g)	**608.1**
Gross savings in 2023-28 from flexibility-based solutions(c+d+e)	**186.8**
Net savings in 2023-28 from flexibility-based solutions(a+b-f)	**155.5**

Figure 7: The impact of flexibility-based solutions on network reinforcement costs over the 2023-28 period[15]

Note - numbers in tables throughout this document are subject to rounding.

The savings shown in the table above are deferrals of network expenditure in the 2023-28 period. Some of this investment may be required in future periods, depending on the rate and nature of the decarbonisation pathway that unfolds, whilst some may be avoided altogether by using flexibility and other smart solutions. Due to the uncertainty surrounding the future pathway, it is not possible for us to determine how much is avoided altogether rather than deferred; however deferring gives the added benefit of keeping more options open to make better informed decisions in the future when the nature of the transition will be clearer, and therefore avoids inefficient investment.

Our outcomes will deliver efficient investment in decarbonisation by:

- maximising system capacity: connecting more low carbon distributed generation to the grid and maximising the use of lower carbon electricity supplied;
- maximising value of existing energy assets: combining network and customer flexibility solutions to use the electricity network more efficiently and reduce costs for customers;
- facilitating energy optimisation: empowering customers to maximise use of electricity from low carbon sources; and
- facilitating resource optimisation: enabling customers to extract maximum value from their energy assets.

The DSO transition will also enable system benefits that go beyond our network, as data and analytics made available for other participants in the energy and related sectors may unlock further whole system value in the future by optimising regional planning. In addition, by enabling the efficient decarbonisation of our network, our DSO strategy will help to achieve emissions reductions across our network.

[15] For more information on costs and benefits refer to the scenarios and investment section of the plan

To successfully deliver this transformation, we need to invest £87 million in 2023-28

We plan to invest £87 million in DSO activities across our five outcome areas over the next five-year period, as shown in Figure 8. Our planned investment is described in detail in the DSO deliverables and initiatives sections of this annex where we set the tangible activities we will undertake in 2023-28 to deliver our DSO strategy. A consolidated table of costs at the deliverable/initiative level is provided in appendix B.

Ref.	Area	Outcome	Data and Digital-isation* £m	Network costs £m	Work-force £m	Total £m	FTE (end of period total)
DSO1	Data	Network and market data capture	7.3	21.1	1.6	**30.1**	4.5
DSO2	Data	Transform our analytical capabilities	19.0	-	3.7	**22.7**	110.0
DSO3	Data	Enable open energy system data sharing and engage in joint planning	8.1	-	3.8	**11.8**	9.5
DSO4	Flexibility	Operate and optimise a system with increasing flexibility	12.9	-	6.1	**19.0**	7.0
DSO5	Flexibility	Facilitate the development of new markets for customers	2.6	-	6.1	**8.7**	17.0
Total			**49.9**	**21.1**	**21.3**	**92.4**	**48.0**

Figure 8: Investment in DSO strategy outcomes over 2023-28 (£ million/full time equivalents (FTEs))

* This cost is included in our capex total of £113.5m for data and digitalisation.

DSO governance arrangements

We are making changes to instil confidence and earn the trust of our stakeholders

We set out in Figure 99 why stakeholders can be confident there is no potential for actual conflicts of interest to arise in relation to our emerging role as a system operator.

The most important thing to ensure is in place is a set of properly designed incentives that provide strong encouragement to find and adopt the most efficient solution – whether traditional network reinforcement, flexibility or some other solution – when we need to address any specific system requirement. This incentives framework applies to our entire electricity distribution business, both the established elements of DNO and the new DSO functions. Our incentives are aligned with our customers' interests and we have every reason to foster and nurture flexibility markets. A well-designed regulatory incentive combined with our DSO strategy creates a strong foundation for us to deliver a highly efficient and optimised set of outcomes.

However, we recognise that despite this, there remains the risk of a *perceived* conflict of interest, particularly in relation to the role we expect to play in the development of flexibility markets and in making investment planning decisions across network and non-network (including customer flexibility) solutions. It is also vital that we operate in a way that builds confidence in the potential participants in these new market arrangements – and transparency is key to that.

Our approach to mitigating those concerns is to combine operational effectiveness with openness and transparency. The deliverables and initiatives set out in our business plan and DSO strategy are designed to ensure we have the systems and processes in place to support efficient and technology-neutral decision-making across planning, operation and market facilitation functions, and that this is clearly and transparently communicated to our stakeholders and customers.

Our DSO Business Unit will drive **operational efficiencies** by embedding flexibility first and whole systems approaches, and ensuring appropriate separation of duties and accountabilities across the organisation	**Flexibility first** We are embedding a "flexibility first" approach to investment, actively engaging with flexibility providers and improving the development and procurement of flexibility services (DSO Outcomes 4 and 5). We are implementing a framework for neutral assessment of network and market solutions and are increasing resources for assessing flexibility solutions (DSO Initiative 2.6)
	Whole systems approach We are embedding a whole systems approach by undertaking cross-sector and cross-vector planning and removing barriers to whole energy system initiatives (WS Outcomes 1 and 2)
	Organisational accountability We are strengthening accountability for the DSO transition with a new business unit which clusters core DSO functions underneath an accountable director
Openness and transparency is a strategic objective of our DSO strategy. We will build customer and stakeholder confidence that our decision making is neutral and unbiased	**Information sharing** We are investing in open energy system data sharing which will give customers and stakeholders greater insight into, and scrutiny over, our network and decision making (DSO Deliverable 3.1)
	Assurance We will provide visibility of both our transition programme and our investment planning, including undertaking an annual independent audit of our decision-making and publishing the results (DSO Initiative 3.3)
Provisions in the **regulatory framework** prevent conflicts of interest from arising and help to instil confidence in the sector	**Totex mechanism and benchmarking** The RIIO model provides strong incentives for DNOs to find the lowest cost solution across capex and opex
	Ring-fencing measures and ownership constraints Licence conditions preserve the independence of DNOs from affiliated businesses and prevent DNOs from carrying out generation or storage activities, except in exceptional circumstances
	Competition and ex post enforcement DNOs face competition in connections and distribution from ICPs and IDNOs, and face the threat of ex post enforcement if a breach of competition law occurs

Figure 9: Our business plan and the regulatory framework act to mitigate perceived conflicts of interest

Organisational changes will strengthen accountability for the DSO transition and maximise operational effectiveness and transparency

We are making organisational changes that are designed to allow these new processes to become normal, and to mature and become increasingly influential. Firstly, we believe that clear leadership is essential to any organisational change, so we will ensure that there is clear executive accountability. There will be a member of our executive leadership team with a clear and unambiguous accountability to lead the development and deployment of the DSO strategy.

Also, in order to maximise transparency, the DSO functions relating to flexibility market development and long-term investment planning are either sufficiently separated from the established engineering and commercial functions that need to operate in conjunction with those newer DSO activities in order to optimise the balance of flexibility, smart grid solutions and reinforcement.

This involves clustering key DSO functions into a new DSO Business Unit that will have critical mass that not only creates transparency; it will help to accelerate deployment. The unit will report to the executive with accountability to lead the deployment of the DSO strategy and associated changes across the organisation. At the same time we are ensuring that synergies between system and network operations are preserved alongside an appropriate level of oversight and assurance to instil stakeholder confidence in a fair and transparent decision making process.

Key elements of these organisational changes include:

- Executive-level accountability for the DSO transition will sit with the executive director responsible for a new DSO Business Unit.
- The dedicated DSO Business Unit is being established with primary responsibility for the DSO transition. Key DSO functions will be clustered within this unit.
- A DSO Assurance function, sitting within the DSO Business Unit, will have responsibility for auditing compliance across the organisation, monitoring progress and external reporting, including facilitating an independent audit of investment decision-making processes and publishing the results. In common with other assurance functions that we operate, the work of that group will be supplemented by internal and external audit, and it will be subject to oversight and scrutiny by the CEO, the Board and our parent company.

The changes we are proposing have been developed alongside our ongoing engagement with Ofgem and other DNOs, as well as industry wide initiatives such as the Open Networks Project.[16] We have also ensured they reflect the expectations of our customers and other key stakeholders; for instance, engagement through bilateral discussions with flexibility providers has played an important role in shaping our approach to flexibility procurement and other aspects of our DSO strategy. As well as strengthening operational effectiveness, these changes will help to build stakeholder and customer confidence.

The proposed allocation of DSO functions across our organisation structure will support stakeholder confidence in our emerging role as a system operator, while ensuring that important synergies are preserved

Figure **10**10 illustrates how DSO functions will be located across our organisational structure.[17] Core DSO functions will be clustered within the DSO Business Unit, particularly those relating to flexibility market development (Services & Market Facilitation and Service Optimisation), and the DSO-related aspects of Pricing and Connections policy (e.g. relating to the management of increasing demand for connection to areas of the distribution network). The DSO Assurance & Reporting function will be located within the unit, with a direct executive-level reporting line to the accountable director, and will provide oversight of DSO functions that remain located in other parts of the organisation.

The DSO Business Unit will also have responsibility for forecasting that involves understanding our region's decarbonisation pathways, what these mean for the local network and what data and information we need to share with external stakeholders. This will involve engagement with stakeholders on forecasting (including local area energy plans – DSO3.2). This forecasting and information provision function co-located with flexibility service development creates an externally-facing part of the organisation to engage with the market and drive forward our flexibility ambitions.

Investment Planning and System Co-ordination functions will remain part of the engineering function. That will help to preserve synergies, information flows and the ability to optimise investment across network and non-network solutions. We consider this to be critical to realising the substantial benefits of the DSO transition, supporting a flexibility first optimisation where the continued use of the monitor, manage and reinforce routine is used to efficiently deliver our required investment in both network and non-network solutions (explained further in our Scenarios and Investment Annex). However, to ensure and demonstrate fair and robust selection of investment options, oversight will be provided by the DSO Assurance function within the DSO Business Unit, including the facilitation of an independent external audit and annual report of investment decision-making processes.

Data & Digitalisation functions relating to data governance and the management and maintenance of platforms will sit in the IT group, which is their natural home alongside our other IT and data-related activities. However, external engagement to determine open access to enhanced DSO data and information will be located within the DSO Business Unit. This will provide a degree of separation between functional aspects of data storage/management/governance;

[16] Notably one aspect of Workstream 3: DSO Transition is focused on ensuring progress to mitigate risks of Unintended Consequences and Conflicts of Interest.

[17] The DSO functions set out in this organisational chart largely reflect the DSO functions identified under Workstream 3 of the ENA Open Networks Project.

versus the data processing and analytics that will feed into the investment and operational decision making and shared with our stakeholders.

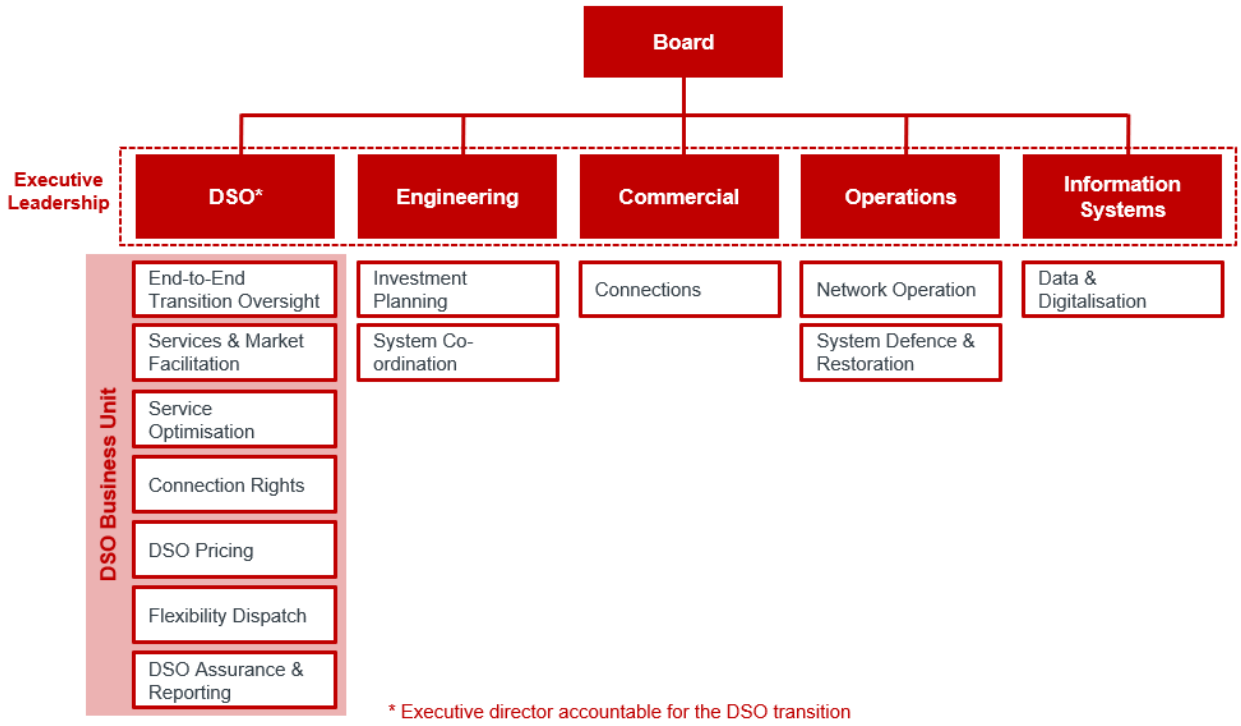


Figure 10: Location of DSO functions across the organisation

As our DSO functions develop we will continue to ensure that we optimise our organisation to strengthen operational effectiveness and transparency.

Our DSO governance arrangements have been informed by consideration of the costs and benefits of different options

In determining our DSO governance arrangements, we have qualitatively considered the merits and limitations of different options, including alternative structuring or separation of DSO functions. Figure 81 sets out the potential costs and benefits of DSO separation that we have identified and considered. While there are potentially some benefits of greater DSO separation (such as potential efficiencies from organisational focus/specialisation and potential for greater whole system efficiencies), with best practice regulation, a lot of these benefits can still be realised without DSO separation, and business separation also brings with it significant associated costs, ranging from one-off and ongoing separation costs to the loss of synergies, incentives and accountability.

Costs	**One-off separation costs** One-off, upfront costs associated with DSO separation, including capital costs (e.g. initial purchase of new buildings or hardware) and non-capital costs (e.g. legal and project costs associated with separation). The nature and magnitude of costs incurred would depend on the DSO separation model.
	Ongoing separation costs Ongoing costs associated with DSO separation, such as additional staff (to perform duplication functions such as HR, finance and procurement) and duplicate goods and services (such as software licences). The nature and magnitude of costs incurred would depend on the DSO separation model.
	Loss of DSO/DNO synergies A separated DSO and DNO will face reduced incentives and ability to optimise costs across system and network operations. Further, reduced information flows between DSO and DNO may adversely affect operational and strategic decision making. Loss of DNO/DSO synergies will be greatest under full DSO

	separation models, however synergies may also be lost under "lighter" separation models: for example, if DSO/DNO planning functions are internally separated and ring-fenced. These costs are material and would be incurred in perpetuity.
	Loss of efficiencies from benchmarking If DSO functions were separated from DNOs and consolidated into a single organisation then the regulator would lose the ability to use benchmarking to set cost allowances and incentivise efficiency improvements.
	Loss of ability to incentivise across DSO/DNO functions If the balance sheets of DSO and DNO operations were separate, through accounting unbundling or a stricter form of unbundling, this will undermine incentives under the totex regulatory framework to optimize costs/benefits across the DSO and DNO functions.
	Loss of accountability A combined DSO/DNO is wholly accountable for issues which could arise from either DSO or DNO actions (such as power cuts, which could stem from inadequate strategic planning or poor asset maintenance). Legal or ownership unbundling (or even internal functional unbundling) would remove this clear accountability and cloud organisational responsibility for customer outcomes.
Benefits	**Potential efficiencies from organisational focus/specialisation** Improvements in the efficiency and effectiveness of DSO functions may be realised if they are separated from DNO functions (which may command greater focus in a combined entity) and become the sole focus of an organisation. However, key benefits may equally be realised under "lighter" separation models: for example, with the creation of dedicated DSO areas of the organisation.
	Potential for greater whole system efficiencies The potential for system-wide efficiencies to be achieved may be enhanced by DSO separation with a separate organisation able to take a more system-wide perspective and engage widely.
	Greater transparency over costs DSO separation could provide greater transparency over specific costs, which may help the regulator to set incentives for specific activities.
	Cost savings from consolidation Cost savings may be achieved under a DSO separation model where the DSO functions of 14 licensees were consolidated into a single organisation, with potential for some economies of scale to be realised.

Figure 81: Potential costs and benefits of greater DSO separation

We do not consider that further structural changes, such as legal separation between DSO and DNO functions, are justified. Indeed, they would be damaging for customers interests. As a combined entity we are uniquely placed to leverage synergies between the system operation and network operation components of our business. Further separation would undermine these synergies and weaken the incentives in the regulatory framework we currently face to optimise costs across our system and network operations. It would also undermine the significant benefits that can be unlocked from optimising investment across the range of feasible capex and opex solutions. Our approach greatly values and preserves this important regulatory incentive, while ensuring that DSO functions are appropriately located, with clear executive accountability and oversight, so that cost savings and system-wide benefits can be fully realised.

Our approach to DSO governance values and preserves this important regulatory incentive while ensuring that DSO functions are appropriately located, with clear executive accountability and oversight, so that cost savings and system-wide benefits can be fully realised. This is why we have opted to co-locate DSO and DNO Investment Planning and System Co-ordination functions, with requisite oversight and assurance by the DSO Assurance to instil stakeholder confidence in a fair and transparent decision making process. Further, the clustering of DSO functions (such as those relating to flexibility market development) in the DSO Business Unit will ensure that we are able to capture the key benefits of organisational focus/specialisation, while our whole systems strategy will help us to drive system-wide efficiencies.

Key focus areas for our DSO implementation

This DSO strategy contains an ambitious set of deliverables and initiatives to deliver significant customer outcomes in the areas of data and flexibility. The following information is provided to aid understanding of how this will be delivered and the link to the underlying investment in data and digitalisation enablers. We are setting out some of the key areas with some of the phases anticipated over the five years including decision points and interdependencies with associated investment. The 2020s will be a period of major change for customers, the energy system and for Northern Powergrid. We have a plan that we think manages this uncertainty by delivering efficient investment that is necessary for a range of pathways and is capable of adapting as we proceed.

Our implementation of key DSO functionality is explored in relation to the following areas upon which our success in the 2023-28 period may be judged:

- Capturing, using and sharing significantly more data (DSO1, DSO2 and DSO3)
- Generating LV visibility to direct investment and support new flexibility markets (DSO1 and DSO2)
- New analytical capability for forecasting and planning (DSO2)
- Collaboration at the heart of our forecasting (DSO3)
- Growing flexibility markets and organisational capability for deploying flexibility solutions (DSO4 and DSO5)

Capturing, using and sharing significantly more data (DSO1, DSO2 and DSO3)

A key feature of the 2023-28 period is the need to capture, use and share significantly more data than we do today. We will build our existing information management capabilities to enable our commitment to open data. This will be supported through setting up a Data Transformation Office by 2023 (DSO 1.1) and working on our data structures and governance in the early years of the ED2 period. This function will reside within our Information Systems team and the uplift in data availability and capability is a major enabler for our DSO Business Unit. These are all key enabling actions need to be materially progressed prior to some of the key systems changes described below that must be constructed in a complementary manner with these established data norms in the organisation.

We are committed to continuous improvement of our data quality with data cleanse activity being carried out prior to and throughout ED2 (DSO 1.2). This is one of the activities explored in our plans for data and digitalisation that will drive best practice data management as a bedrock of our DSO capability.

Externally, we will be sharing our data and insights through our Open Insights data portal development (DSO3.1) with initial data published at the start of 2023, growing to provide more analytical capability with access to ourAutodesign system as we increase functionality of it and then to our static strategic planning model in 2026 (DSO2.4). The significance of the Open Insights development is emphasized through its recognition as one of our Consumer Value Propositions in our plan – that sets out the plans to add functionality incrementally in seven areas through the course of 2023-28.

We recognise the uncertainty that is inherent in the fast-paced movement of industry collaborative programmes where standard and scalable solutions are being developed such as the national energy systems map and LTDS reform. To manage that uncertainty we are using flexible technology where we can (e.g. cloud-based hosting) and also investing in data structures and internal governance that will be required no matter what hosting is used. As such, our activity is no or low regrets through a future that will be determined by the availability of technology, market developments and standardisation/collaboration.

Generating LV visibility to direct investment and support new flexibility markets (DSO1 and DSO2)

The significance of LV visibility in the 2020s cannot be underplayed. It is vital for us to efficiently direct the investment needed at the local level to manage the impact of customers switching to electric vehicles and electric heat. The development of flexibility services from customers connected at LV is a priority area for 2023-28 and we expect it to be more viable at scale with the increased adoption of LCTs, technology and market developments.

Our ED1 smart grid enablers programme including deployment of LV monitors and analysis of smart meter data means that from the start of ED2 we will be able to capture and act on data to inform decision making at the LV level (DSO 2.1). Data will be obtained from a blend of internal and external sources to inform forecasts and network utilisation (DSO2.3). The installation of LV monitors that commenced in 2021 is set to continue through the ED2 period (DSO1.3). The new LV insight is particularly important during a period of rising investment need to ensure timely and efficient delivery of network interventions.

Our analysis techniques will be initially developed through 2022 to provide access to the LV monitoring data and combine this with a new data analytics platform combined with existing tools to provide insights via our data portal (DSO3.1). Through ED2 we will progressively build our capability to build LV datasets using more advanced analytics and machine learning (DSO2.1).

New analytical capability for forecasting and planning (DSO2)

As described earlier, our Data Transformation Office will be established prior to the start of the 2023-28 period. Our plans also include building new skills in the team to manage data and its analysis. Together, these provide the base layer for an ambitious programme of analytical capability upgrade.

In addition to the work on LV visibility, at the higher voltage levels we will be increasing our ability to draw on a wider range of internal and external sources for accurate network modelling, using our new power system tools (DSO2.4), and load forecasting (DSO2.2). The analytical capability will deliver improved planning and operational forecasting to support the growth in flexibility (DSO2.3). We are implementing new power system tools in late ED1/early ED2 that will form the basis of our static strategic planning tool, the functionality of which will be developed in an agile manner over ED2 (DSO2.4).

Our standard reports will expand in scale, scope and technology with, for example, Ofgem Long Term Development Statement reform expected to be rolled out in the first half of ED2 (DSO2.5). More generally, the enhanced analysis will benefit our stakeholders in these upgraded external interfaces to gain data, information and insight (data analytics platform – DSO 3.1). We expect the benefits to be growth in flexibility markets and connections activity.

Collaboration at the heart of our forecasting (DSO3)

Building on the step up currently on exploring local area energy plans with our local authorities, we are increasing this support further in 2023-28. We plan to build a small team in 2022 that will then increase in size through ED2 as more local authorities seek to produce place-based decarbonisation plans (DSO3.2) alongside our established processes to create regionalised Distribution Future Energy Scenarios (DFES). In addition to local authorities, consistent with the thinking in our Whole Systems annex, we will be collaborating more with other regional utilities or key projects to ensure that our plans are mutually compatible and any differences in forecasts are understood. This work will ensure we meet our key ED2 ambitions to not only deliver the investment required to keep pace with decarbonisation requirements in the 2020s but also ensure we are on a pathway to net zero to 2050 or earlier.

A key toolkit for our people supporting local authorities in energy planning will be the Open Insights data portal (DSO3.1). We will deliver a free online portal for the provision of network data and tools to help a wide variety of customers and stakeholders make decisions in relation to the energy network. Building on the prior work with Open Data Institute Leeds where we already host energy forecasting data, we are already working in the release of initial functionality of our self-serve platform in ED1 and will continuously enhance and extend these capabilities throughout the ED2 period.

Growing flexibility markets and organisational capability for deploying flexibility solutions (DSO4 and DSO5)

A new DSO business unit with core DSO functions will be established by the start of ED2. It will drive the change programme with colleagues across our organisation to grow the use of flexibility as well as assure operational effectiveness and transparency of our actions. A focus on accountability for the different steps in investment decision making and an independent audit to report externally on compliance with our procedures is a key action to build stakeholder trust from the start of the period (IN2.6 and IN3.3).

We start ED2 with implementation and ongoing development of the Flexible Power toolkit to carry out end-to-end operation of flexibility services. As we develop this capability, we will be investigating the functionality that may be delivered by enterprise solutions. In line with this overall information and technology development pathway for the 2020s we expect to migrate and grow more of our toolkit to manage flexibility to an enterprise solution.

A key decision point in the first half of ED2 will be how and when we should progress to develop from our current flexibility management system (Flexible Power) and take advantage of new functionality from an enterprise solution Distributed Energy Resources Management System (DERMS). DERMS will also bring together the technologies we use to manage both DNO contracted flexibility and customer flexibility provided through Active Network Management (ANM) connections. Our planning assumption is that this move to an enterprise system will be available to us from 2025. Such an upgrade pathway will significantly increase the sophistication and insight delivered and is a key decision for us in the early part of ED2. The final implementation pathway decision will depend on the customer and network needs and the evaluation of the costs and benefits of this increased level of sophistication and functionality.

As we develop DERMS we will manage the uncertainty of future DSO governance arrangements by ensuring that any future system separability is built into our implementation.

Further, we expect to further enhance our flexibility information provision and engagement platform by the start of 2027 (DSO5.3). This next phase of development acknowledges the need to change our means of interfacing with the market with more machine-readable interfaces that will particularly be necessary to support growth in LV flexibility.

Appendix E to this document also adds to the description above by showing the linkage between DSO outcomes and the associated focus areas of data and digitalisation expenditure:

- DD1 Open data
- DD2 Improved network management
- DD8 Self-serve web
- DD9 Advanced analytics

More information on our enabling investment in data and digitalisation is contained in the Data & Digitalisation - Investment justification and benefits. The following information in this DSO strategy on deliverables and initiatives includes references to the underlying data and digitalisation investment.

Deliverables and initiatives: overview

Our investment will enable 29 DSO deliverables and initiatives that we have committed to undertaking in 2023-28 – tangible actions that will help to achieve the outcomes of our DSO strategy

Our plan sets out 29 deliverables and initiatives over the next five-year period. These are tangible actions that will help us to achieve the five outcomes of our DSO strategy and unlock benefits for customers and our region. While deliverables are measurable activities, initiatives cannot be measured but are integral to delivering our strategy and meeting Ofgem's regulatory requirements.

We will need to measure and evaluate our performance against our DSO deliverables in order to continuously improve

In order to monitor and assess the delivery of our DSO strategy, we are proposing a range of metrics which cover our five outcome areas, the majority of our deliverables and full coverage of the baseline requirements set by Ofgem in its business planning guidance.

In total, we are proposing:

- 11 sub-metrics metrics which should be associated with a financial output delivery incentive (ODI-F);
- 7 sub-metrics associated with a reputational output delivery incentive (ODI-R);
- as our own additional category, a range of measures which we intend to report on annually to stakeholders comprising 9 sub-metrics. (Note that this category of metric does not appear in the main business plan proposition table.)

In appendix C we set out our proposed metrics and categorise these as part of either the ODI-F or ODI-R mechanism. At the time of completing this plan we continue to work with Ofgem and the DNOs on developing a common approach to assessment and the metrics that would form part of that assessment. This work is expected to continue into 2022.

We will use our metrics, alongside stakeholder engagement, to evaluate our progress against our DSO strategy and foster continuous improvement.

The work we are planning in 2023-28 will ensure we fulfil Ofgem's DSO roles

Ofgem has envisioned three DSO roles, with associated activities, that networks will need to perform over the next price control period:

- Role one: Planning and network development
  - Activity 1.1: Plan efficiently in the context of uncertainty, taking account of whole system outcomes, and promote planning data availability.
- Role two: Network operations
  - Activity 2.1: Promote operational network visibility and data availability; and
  - Activity 2.2: Facilitate efficient dispatch of distribution flexibility services.
- Role three: Market development
  - Activity 3.1: Provide accurate, user-friendly and comprehensive market information; and

- Activity 3.2: Embed simple, fair and transparent rules and processes for procuring distribution flexibility services.

These roles and activities have shaped our plan. It is through our DSO deliverables and initiatives that we will deliver the standard of service outlined in the activities and baseline expectations. In appendix D we map how the deliverables and initiatives in our strategy will allow us to meet Ofgem's baseline expectations. The performance measures set out in appendix C will enable evaluation of our progress in delivering our DSO strategy and meeting (or exceeding) specific baseline expectations.

The graphic below shows, at a high level, how our deliverables and initiatives map to Ofgem's DSO roles. This Venn diagram view demonstrates that in the vast majority of cases, we have designed our DSO deliverables and initiatives to address more than one of Ofgem's roles.

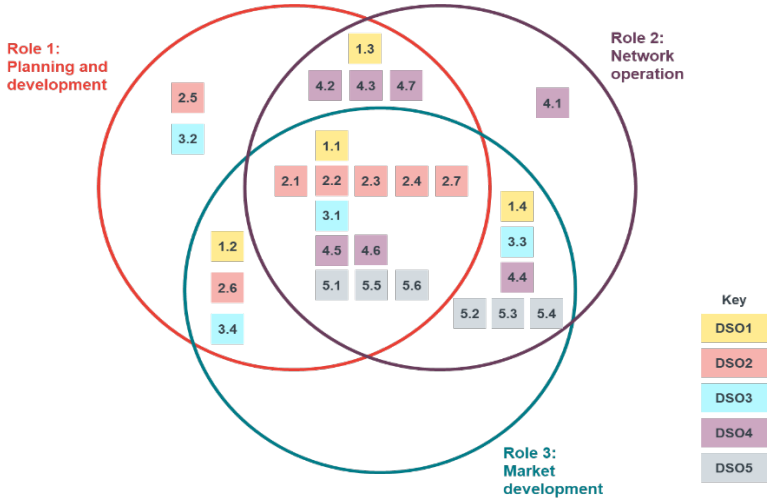
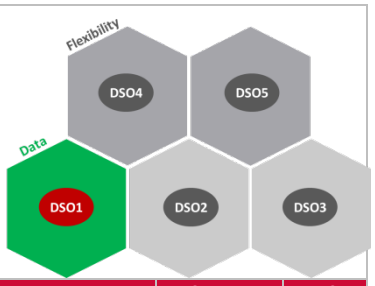


Figure 12: Deliverables and initiatives mapped against Ofgem DSO roles

References to deliverables and initiatives in the above diagram are described in detail in the following pages.

Overview of deliverables and initiatives

The following tables set out our deliverables and initiatives for 2023-28, grouped by the five outcomes they will help us achieve. While each deliverable or initiative represents a specific, funded activity that we will undertake over the price control period, many link to and support other deliverables and initiatives, both in the DSO strategy and in other areas of our business plan such as the Data and Digitalisation section of the business plan and the DSAP. Consequently, there is a degree of overlap between some activities. The linkages between the DSO strategy and the DSAP are outlined in Appendix A. Further detail on the deliverables and initiatives is given in the subsequent supporting information to which the page numbers in the table refer.

Outcome	
DSO1 Significantly expand network and market data capture to establish a vital building block for the smarter and more active energy system	

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO Roles			Ref
	£m	FTE[18]		1	2	3	
DSO1.1 Enhanced technical data capture and integrated data management We will augment and integrate datasets and systems across different aspects of our business including: our network and assets, demand and generation, connections and customer information. We will do this by enhancing the digitalisation and automation of data capture and management, increasing data storage capacity and capability, and linking existing and new databases and systems through a data integration platform. This will result in more, better quality data that is organised and easily accessible for sharing and planning purposes, including for the development of flexibility services. DSO1.1 underpins other deliverables such as DSO2.3, DSO2.4 and DSO3.1.	8.4	3.0	N/A	✓	✓	●	Page 43
DSO1.2 Improved two-way stakeholder information exchange and collaboration We will work with stakeholders – such as the ESO, other DNOs, local authorities, existing and potential connected customers, aggregators and flexibility services providers – to improve collaboration and information exchange, test assumptions, build localised knowledge and understand flexibility service requirements. This will include continuing to work with stakeholders to define flexibility services and dispatch instructions.	0.2	0.5	N/A	✓		✓	Page 46
DSO1.3 Targeted low voltage (LV) monitoring Fundamental to our flexibility first approach to first monitor our network, we will install 10,000 LV monitors across our network, prioritised based on sites anticipated to require intervention first, allowing us to monitor power flows and network performance and enhancing visibility of our LV network. This will enable us to use our existing network assets more efficiently (by identifying and releasing capacity) and target investment in asset condition and reducing network losses, as well as provide network data that we will share and use internally to facilitate the development of flexibility services and markets.	21.1	0[19]	% ground mounted substation network directly monitored (50%) Number LV load monitors installed (12,700)	✓	✓		Page 47[20]
Initiative 1.4 Enhanced flexibility services market data capture	0.3	1.0	N/A		●	✓	Page 32

[18] This is the anticipated total FTE number by the end of the price control period

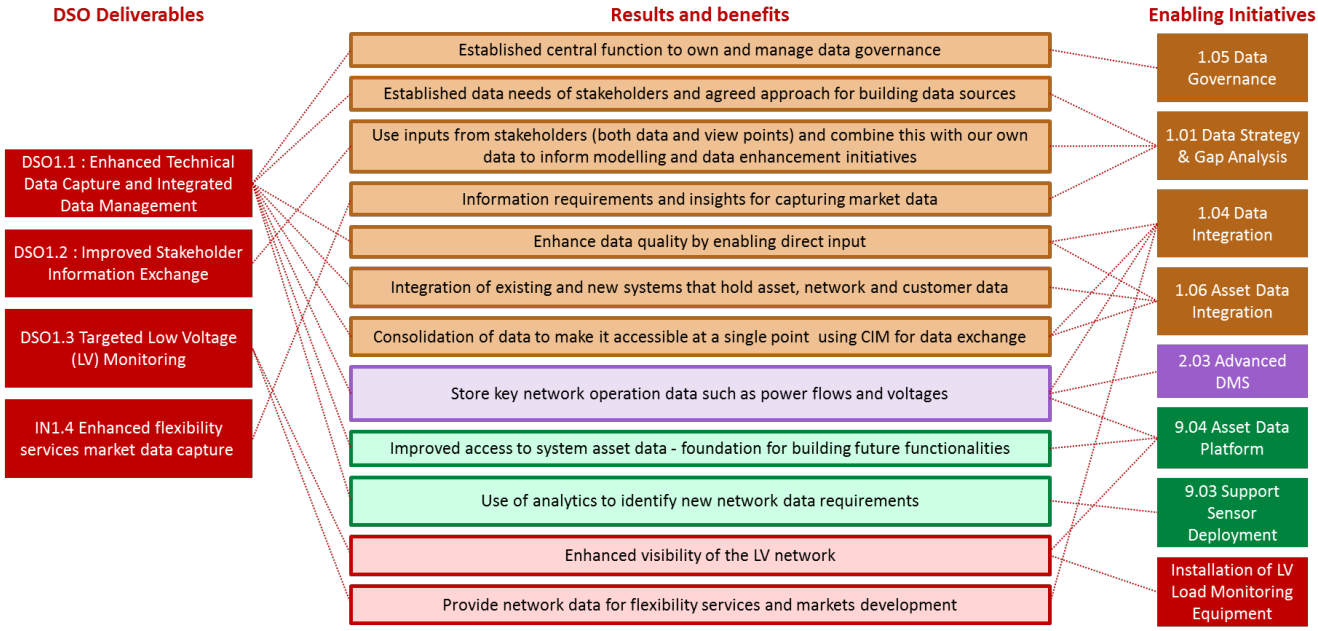
[19] Resourced through contractors

[20] Refer to the Engineering Justification Paper EJP-5.3a Low Voltage Monitoring.

We will develop our internal capability to continuously monitor developments in the market for flexibility services and keep track of the anticipated growth in the volume of market data available during the period. We will replace the current ad hoc, manual approach to gathering market data with increasingly systematic and automated processes. The insights gained will inform the flexibility services we offer and procure. This initiative complements DSO1.2 which will facilitate data capture from stakeholders.							
	Role 1: Planning and network development *Role 2: Network operations* *Role 3: Market development* ✓ *Directly applicable* ● *Enabler*						

Results and benefits: DSO1

The diagram below, and equivalent diagrams for each DSO outcome on the following pages, summarise the results and benefits we expect to deliver from DSO1 deliverables, supported by enabling initiatives predominantly from the data and digitalisation plan (refer to the DSAP for further information).

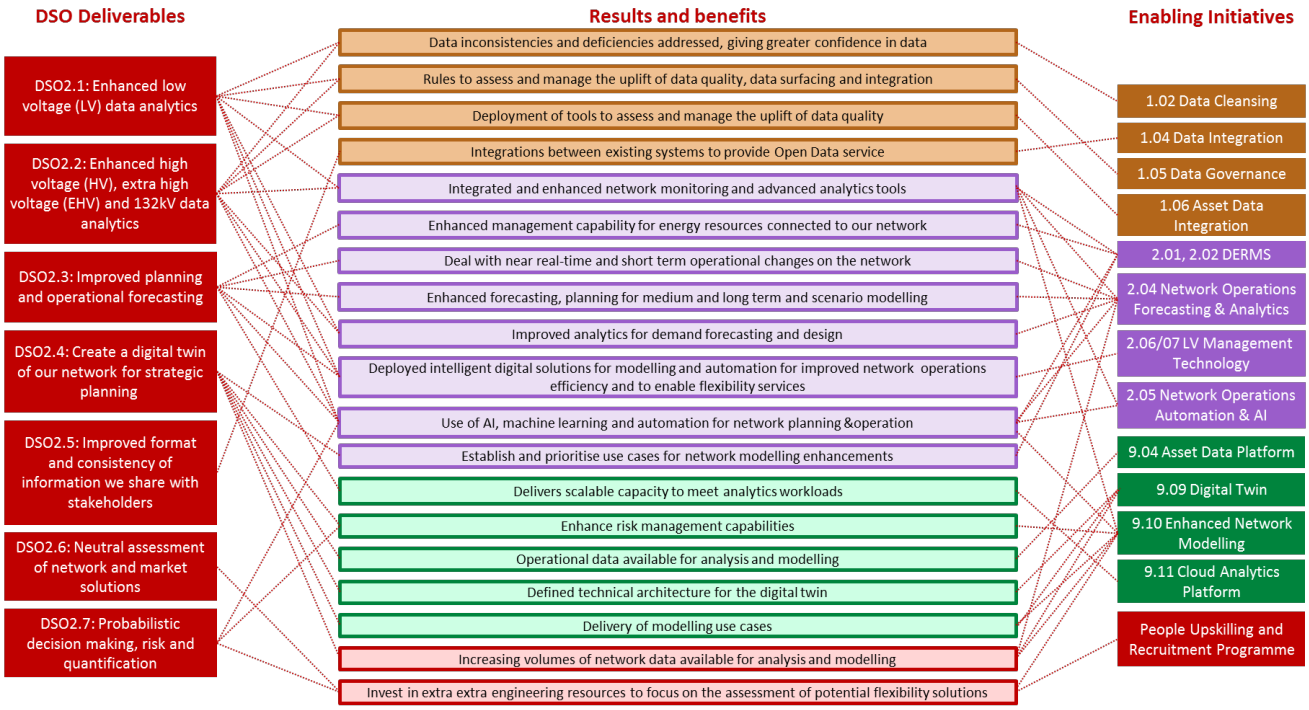


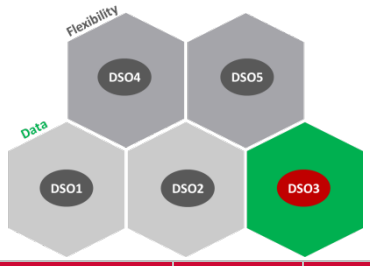
Outcome	
DSO2 Transform our analytical capabilities to enable data-driven decision-making in planning and operational timescales	

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO Roles			Ref
	£	FTE		1	2	3	
DSO2.1 Enhanced low voltage (LV) data analytics We will upgrade our data analytics capabilities, by investing in software and data scientists, so we can better understand how our LV networks are performing as they evolve alongside increased penetration of LCTs and DERs. We will develop statistical analyses for different types of data (e.g., smart meters and the data captured through DSO1.3 LV monitoring roll-out) which will help us plan for reinforcement needs and identify and size flexible connections and flexibility service requirements. DSO2.1 underpins other deliverables such as DSO2.2, DSO2.3, DSO2.4 and DSO3.1.	4.9	0.5	N/A	✓	✓	●	Page 50
DSO2.2 Enhanced high voltage (HV), extra high voltage (EHV) and 132kV data analytics We will use analytics and machine learning to enhance our HV, EHV and 132kV network data. We will draw on data from a range of sources (such as substation and feeder data, disturbance recorders and fault level monitors, and assets installed mid-stream of feeders) and cleanse, validate and calibrate models for accurate network modelling and load forecasting. We will use machine learning to pre-empt or manage fault and power quality issues. This will result in more and better quality information on our HV, EHV and 132kV networks, for sharing and planning purposes. DSO2.2 underpins other deliverables such as DSO2.3, DSO2.4 and DSO3.1.	2.2	0.5	N/A	✓	✓	●	Page 50
DSO2.3 Improved planning and operational forecasting We will improve our planning and operational forecasting capabilities. We will do this by investing in systems and people to refine our load models and integrate LV, HV, EHV and 132kV network data (DSO2.1 and DSO2.2) as well as data from third parties such as local authorities and central government (e.g. demographic data). This will support medium and long term planning and improve the production of demand load estimates (DLEs) and distribution future energy scenarios (DFES), as well as real-time and short term operational decision making by control engineers	5.4	2.0	Standardised DFES inputs (by 2023/24) Accurate forecasting of network needs: reconciliation of outturn vs forecast (report annually)	✓	✓	✓	Page 50

DSO2.4 Create a digital twin of our network for strategic planning We will create LV and HV planning models of the network which integrate historical and real time data. These digital twins will enable accurate modelling of our network, allowing us to test connection of anticipated volumes of LCTs and DERs, providing insights to identify where and when we should target investment in flexibility or reinforcement so that it is timely and efficient.	7.3	2.0	N/A	✓	✓	✓	Page 55
DSO2.5 Improved format and consistency of information we share with stakeholders We will improve the format and consistency of the information we share with stakeholders by working with other DNOs – for example, through the ENA Open Networks project – to develop common and standardised approaches to reporting. This will increase the likelihood that customers and stakeholders use the data and information accurately and effectively in planning and decision making. In particular, this will assist market participants operating across multiple network areas. We will share forecasting information and information on the customer energy resource connected to our network via our network development plan, long-term development statement, embedded capacity register and network availability heat maps.	2.5	4.0	Historical operational and outage planning data ESO/DSO (>90% shared) Planning and operational network forecasting stakeholder feedback survey and report (annually)	✓	●	✓	Page 61
Initiative 2.6 Neutral assessment of network and market solutions We will ensure that identification of network constraints is separate from the development of network or flexibility solutions. We will solve constraints through an internal tender process where potential solutions such as flexibility services, conventional reinforcement, ANM (flexible connections) and network flexibility are assessed using a common CBA methodology.	0.4	1.0	N/A	✓		✓	Page 62
Initiative 2.7 Probabilistic decision making, risk and externality quantification We will invest in our decision making capabilities to implement a whole systems approach to our planning and operational choices and continue to move towards probabilistic decision making. We will develop the capability to undertake whole systems cost-benefit analysis (CBA), drawing on the ENA Open Networks CBA analysis project, factoring in externalities such as the cost of carbon and better quantifying network risks.	-	-	N/A	✓	●	●	Page 63
			Role 1: Planning and network development *Role 2: Network operations* *Role 3: Market development* ✓ *Directly applicable* ● *Enabler*				

Results and benefits: DSO2

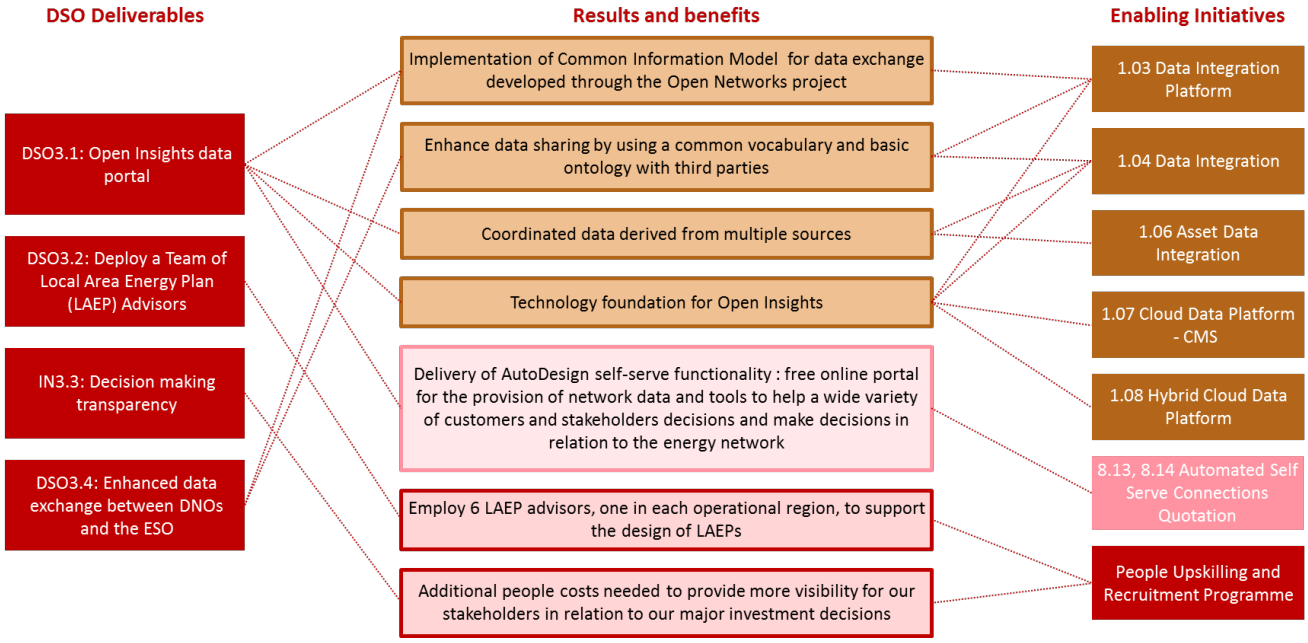


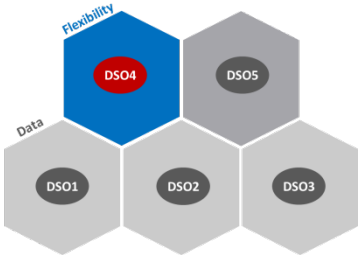
Outcome	
DSO3 Enable open energy system data sharing and joint planning with stakeholders	

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO Roles			Ref
	£	FTE		1	2	3	
DSO3.1 Open Insights data portal We will develop a free online portal which will allow customers and stakeholders to access network data and analytical tools through a centralised, spatial platform. The portal will be an application layer which gives public access to network datasets and our digital twin strategic planning tool (DSO2.4). It will be aimed at customers and stakeholders who do not have electrical engineering expertise, supporting them to make investment decisions involving consumption/generation and connections.	6.7	2.0	Availability of energy system data products (+70%) New network asset data self-service (by 2026/27) Network asset data stakeholder feedback survey and report (annually)	✓	✓	✓	Page 65
DSO3.2 Recruit Local Area Energy Plan (LAEP) advisors We will recruit six LAEP advisors who will provide useful input and feedback to local authorities on their plans using knowledge of the network, customers and the wider environment. These advisors will also support our network planning by generating better and more comprehensive local insights. To ensure a requisite level of granularity and local knowledge, we will employ one advisor in each of our six operations regions.	2.4	6.0	Number of LAEP engagements reported (annually)	✓			Page 52
Initiative 3.3 Decision making transparency We will provide opportunities for stakeholders, via a stakeholder panel, to comment on and challenge our major investment decisions, including both traditional reinforcement and flexibility. We will also ensure that we publish the results and underlying assumptions of CBAs and that our flexibility services development and procurement process is transparent and participatory. Measures to build trust also include independent audit of decision making with results published.	0.2	0.5	N/A	✓		✓	Page 73
Initiative 3.4 Enhanced data exchange between DNOs and the ESO We will implement the Common Information Model (CIM) identified through the ENA Open Networks programme as the preferred industry standard for data exchange with the ESO and other DNOs for network planning purposes. Implementing the CIM will ensure that data is exchanged in a standard electronic format using a common vocabulary and basic ontology, allowing for it to be quickly	2.6	1.0	N/A	✓	✓	●	Page 74

incorporated into existing network models.							
	Role 1: Planning and network development *Role 2: Network operations* *Role 3: Market development* *✓Directly applicable* *● Enabler*						

Results and benefits: DSO3



Outcome	
DSO4 Enhance processes and systems for network operations to enable a step change in our capability to operate and optimise a system with increasing customer and network flexibility	

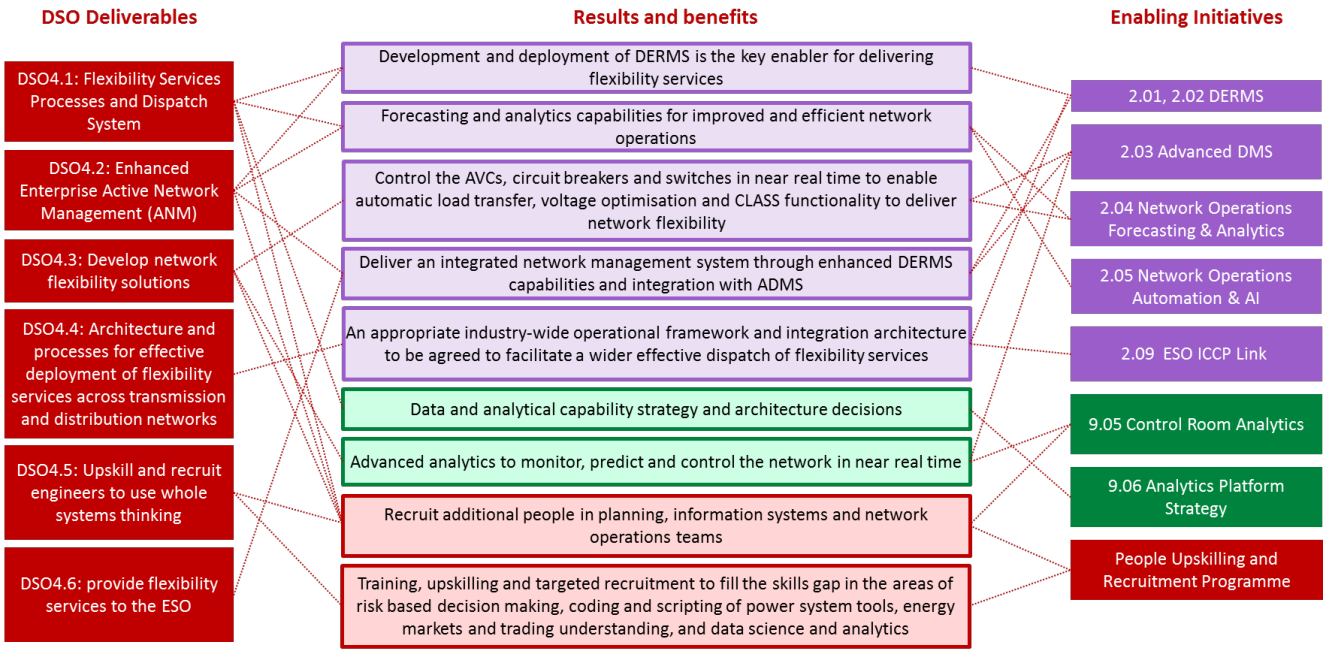
Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO Roles			Ref
	£	FTE		1	2	3	
DSO4.1 Flexibility services processes and dispatch system We will develop systems and processes which enable automatic dispatch of flexibility services by integrating existing systems with our flexibility platform. This will include the automatic billing and payment for services (currently a manual process), allowing for a fully automated procurement, dispatch and settlement of flexibility services.	3.9	2.0	Error corrections issued for dispatch (<10%) Late issuance of dispatch data (<10%)		✓		Page 76
DSO4.2 Enhanced enterprise Active Network Management (ANM) We will enhance our ANM capabilities to manage constraints on the network by integrating our enterprise solution with our network management and customer flexibility dispatch systems. This will allow real-time data exchange and enable a more secure and resilient system.	5.2	2.0	ANM flexibility capacity connected to our network (reported annually) Number of connections with ANM agreements (reported annually)	✓	✓		Page 78
DSO4.3 Develop network flexibility solutions We will establish network flexibility solutions, enabled by improved control systems, to manage thermal, voltage and fault level constraints. We will leverage previous investments – such as in automatic power restoration and advanced control of major substation transformers – by adding additional functionality to existing projects.	4.5	1.0	N/A	✓	✓		Page 80
DSO4.4 Architecture and processes for effective deployment of flexibility services across transmission and distribution networks We will enable local flexibility services to interface indirectly with the ESO to allow for joint procurement of flexibility between the ESO and DSO where possible. We will establish a communications system between the ESO, DSOs and service providers to ensure coordinated dispatch and control and avoid conflicting deployment. This will also allow flexibility service providers to stack revenue from different sources while making sure they deliver reliably.	1.5	-	Operational data exchange ESO-DSO (>90% system up-time) Constrained data exchange ESO-DSO (>90% system up-time[21]) Common flexibility dispatch principles (by 2025/26)		✓	●	Page 82

[21] System up time is the reliability of the data link and its technical availability.

DSO4.5 Upskill and recruit engineers to use whole systems thinking We will upskill and continue to recruit engineers to use whole systems thinking to provide increasingly complex solutions to address decarbonisation. We have identified skills gaps in areas including: risk based decision making; coding and scripting of power system tools; energy markets and trading expertise; and data science and analytics. We will target these areas – either through skills maintenance, upskilling or recruitment – to ensure that our workforce is fully equipped to deliver the DSO functions.	3.7	1.0	N/A	✓	✓	✓	Page 84
DSO4.6 Provide flexibility services to the ESO We will provide Customer Load Active System Services (CLASS) to the ESO to provide efficient whole system solutions where they are complementary to our voltage optimisation deliverable (see WS3.2 in whole systems strategy). Following trials to be completed before the start of the price control, we aim to provide load increase and reactive power services. *Note: costs and headcount excluded from totex – directly remunerated service*	3.5	2.0	N/A	✓	✓		Page [x]
Initiative 4.7 Emergency assistance and contingency planning We will develop emergency assistance services and the process by which we will deploy them when required. This will provide a critical fall-back plan in cases where flexibility markets fail to balance the network. We will develop and procure emergency assistance services and develop the principles/methodology to apply to circumstances when DSOs can overrule dispatch market-based flexibility services.	-	-	N/A	✓	✓	●	Page 86
Initiative 4.8 Validation of existing network resilience systems We will validate low frequency demand disconnection (LFDD) plans to ensure that they are fit for purpose and continue to be reliable and necessary as decarbonisation changes the use and operation of our network. We will identify where legacy network protection systems may need changing to allow new flexibility services to contribute to network resilience.	0.2	-	N/A	✓	✓		Page 89[22]
			Role 1: Planning and network development *Role 2: Network operations* *Role 3: Market development* *✓Directly applicable* *● Enabler*				

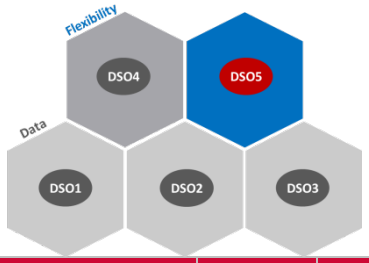
[22] Refer to LFDD Engineering Justification Paper

Results and benefits: DSO4



Outcome

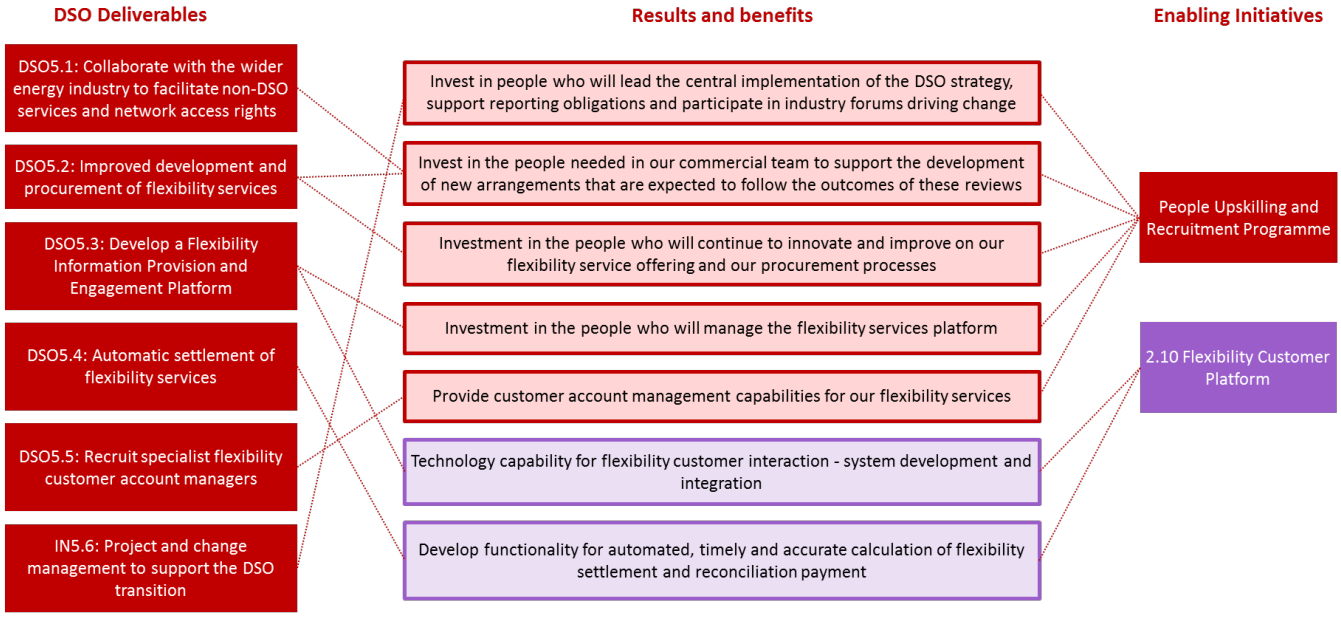
DSO5 Enable significant uptake of customer flexibility and facilitate development of new markets for customers providing services to networks



Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO Roles			Ref
	£	FTE		1	2	3	
DSO5.1 Collaborate with the wider energy industry to facilitate non-DSO services and network access rights We will collaborate with the wider energy industry, through the ENA, to implement the outcomes of regulatory and code changes that are currently underway, including the Ofgem Access and Forward-Learning Charges Significant Code Review (SCR) and the ENA Open Networks project on non-DSO services.	0.6	2.0	Network access amendments (report annually) Re-adjustment of existing connection agreements (report annually)	✓	✓	✓	Page 91
DSO5.2 Improved development and procurement of flexibility services We will continue to develop our flexibility product offering and procurement processes, which will enable us to secure the flexibility we need. This will include exploration of trends such as: automated tendering and procurement, week and day ahead trading, competitive contract pricing, technology agnostic procurement, and industry alignment.	1.2	3.5	EHV substation areas in flexibility market evaluations (80 by end of period) Common registration processes (by 2024/25)		✓	✓	Page 92
DSO5.3 Implement a flexibility information provision and engagement platform We will implement an external facing platform that gives third parties such as flexibility providers and aggregators single-point access to flexibility services related information, either by expanding Flexible Power or by developing a new platform altogether. Users will also be able to express interest in providing flexibility services and register assets or metered units. This will support the procurement of flexibility services and flexibility market development. We will continue to develop our Flexible Power collaborative venture and explore other standardisation opportunities to lower barriers to increased customer participation in flexibility.	2.2	1.0	Flexibility provider registration acceptance time (<30 days) Procurement events response time (<3 months) Local flexibility stakeholder engagements (120) Efficient dispatch of flexibility audit (report annually) Procurement stakeholder feedback survey and report (report annually)		✓	✓	Page 73
DSO5.4 Automatic settlement of flexibility services We will develop the functionality to automatically validate flexibility service provision, calculate remuneration and issue compensation. This is linked to DSO4.1 which will enable the automatic dispatch of flexibility services. Automatic settlement will be done either by expanding the capabilities within the existing Flexible Power system, or through a separate integrated system. Automation will replace the current manual system where flexibility service providers upload and reconcile metering information.	1.2	1.5	N/A		✓	✓	Page 74

DSO5.5 Recruit specialist flexibility customer account managers We will recruit and train staff with strong customer and market awareness to actively engage with different customers such as flexibility providers and aggregators. By providing tailored support this will help facilitate effective procurement of flexibility services and support market development.	0.8	2.5	Dispatch stakeholder feedback survey and report (annual)	✓	✓	✓	Page 965
Initiative 5.6 Project and change management to support the DSO transition We will invest in change management capability to facilitate the implementation of and reporting on our DSO strategy. The DSO transition represents a major change for the industry, and it is critical that our organisation drives and effectively responds to change. We will establish a team of people who will manage the implementation of our DSO strategy, including internal stakeholder and change management, ensure we meet our reporting requirements, and lead our participation in DSO related aspects of the ENA's Open Networks programme.	2.6	6.5	N/A	✓	✓	✓	Page 976
			Role 1: Planning and network development *Role 2: Network operations* *Role 3: Market development* ✓ *Directly applicable* ● *Enabler*				

Results and benefits: DSO5



Deliverables and initiatives: supporting information

The deliverables and initiatives summarised above are described in detail in the following pages. In figure 13, although not intended to be exhaustive, we illustrate the interaction of data, operational technology (OT)[23] and information technology (IT) systems, processes and examples of internal and external data users which underpin the transition to DSO, and the outcomes they relate to.

At a high level, enhanced OT management systems will allow the control of network and customer assets to provide whole system services and ultimately reduce the requirement to undertake traditional reinforcement. The control of network assets is achieved through a set of capabilities collectively referred to as advanced distribution management system (ADMS), which monitor and control network assets such as voltage control devices, circuit breakers and switches (see DSO4.3). The control of customer assets on the other hand, including DERs, is achieved through a set of capabilities referred to as distributed energy resource management systems (DERMS). DERMS enables optimised and proactive network management and stretches from planning to operations for the management and control of customer assets. These integrated processes encompass the appraisal, provision, procurement, dispatching and settlement of flexibility services through customer assets (see DSO4.1, DSO5.4). DERMS also has a high degree of integration and automation activities such as ANM (see DSO4.2) and manages potential conflict between connection contract obligations and flexible service arrangements between ESO and a DSO (see DSO4.4).

Enhanced data management allows the gathering, storing and structuring of existing data (e.g. consumption, National Grid (NG) Week 42), additional data from different sources, such as smart meters, LV monitoring, asset registers or statistical analysis as well as procured data (see DSO1.1 and DSO1.3). Additional data will require better analytics capabilities to make sense, improve insights and inform decisions (see DSO2.1 and DSO2.2) which will inform planning and operational forecasting (DSO2.3) as well as help us transition from a deterministic to a probabilistic analysis (Initiative 2.7). Our enhanced data management and processing capabilities, as well as the extraction of data from the relevant OT systems, will form the bedrock of our digital twin, open insights and flexibility services systems (DSO2.4, DSO3.1, DSO5.3 and DSO5.4). These IT systems will enable more detailed network modelling and better solution development, better use, access and sharing of data as well as support customers make informed investment decisions.

[23] OT is made up of the hardware and software dedicated to detecting or causing changes in physical processes through direct monitoring and/or control of physical devices. This includes all processes in a loop between sensing and output of operational actions including communication, storage of received data, holding working copies of network data and real time/ near real time processing of data prior to application back to system operation. For design or reporting purposes the data is transferred to IT systems.

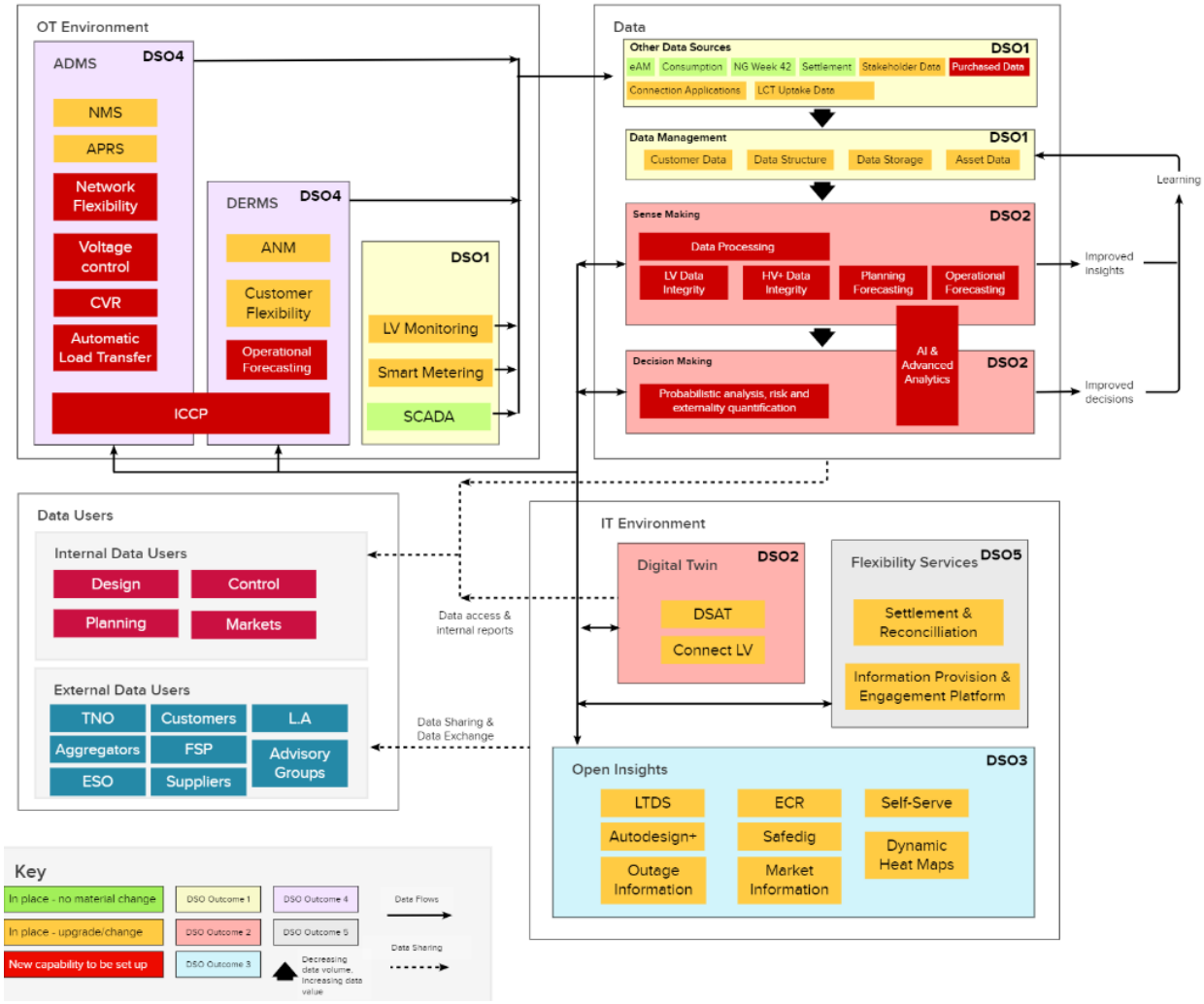


Figure 13: DSO system interaction map (see Glossary for all acronyms)

There are significant system investments planned to enable DSO functions through our Data and Digitalisation initiatives. Whilst many of the systems supporting DSO will be new, others will be upgrades to our existing systems, as shown in the systems diagram Figure 13 above. When developing these initiatives, we have taken into account the requirement that our operational systems must be capable of being cost effectively assigned to another party in future if this is needed. As we have set out in the DSO governance section of this strategy, however, separation of these functions would lead to poor outcomes for customers, even where our design allows for future separability.

We have considered and designed solutions that are: scalable, so can grow as our needs change; extensible, to allow us to take a modular approach to plugging in new capabilities; and interoperable, to drive an architecture that is flexible both internally and when connecting with external sources and stakeholders.

For instance, we plan to utilise cloud-based analytical services to make this capability available early in our plans, including enhancing our ability to ingest and understand our LV network data. Whilst it is planned that this will use the same analytics solution that will support customer service, connections and field operations, as a cloud-based system, separation will be possible by simply implementing the platform across separate tenancies. Our customer flexibility platform will be an integrated but stand-alone platform which, if required, could be separated. Forward integration into DNO systems would still be possible via the API integration implementation layer.

DSO1 Significantly expand network and market data capture to establish a vital building block for the smarter and more active energy system

DSO1.1 Enhanced technical data capture and integrated data management

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO1.1 Enhanced technical data capture and integrated data management	8.4	2.8	N/A	✓	✓	●
Related DSAP core areas and initiative(s)[24]						
1.01, 1.04, 1.05, 1.06, 2.03, 9.03, 9.04						

Introduction

Traditionally distribution networks were partially monitored by sensors located at specific sites such as large substations and commercial and industrial properties of certain size. Network users were largely passive, and operators held and maintained relatively static network and customer data such as seasonal asset ratings, electrical parameters and customer capacity requirements captured in connection agreements. Systems for storing and managing this data were developed separately with minimal communication and integration between them, and typically feature manual data extraction and update processes.

For example, our power flow data is currently stored across various systems,[25] such as iHost for LV monitoring and PI Coresight for half-hourly metered and SCADA[26] data, and accessed through separate dashboard interfaces. Static asset and network data (including spatial data) is stored separately (in eAM Spatial, design tools) to live network running state (in PowerOn Fusion/NMS) and is regularly updated manually or as and when required. Customer data, including their assets, is spread across different systems (eAM Spatial, generation database, connection agreements and connection notification forms, QPID) with mostly manual routine processes of system and master record keeping updates.

The increased penetration of DERs over the last decade has changed the way network companies manage their networks, relying more and more on accurate and granular data. Although significant steps have been taken to automate certain processes, scale up and partially integrate systems, there is still some way to go towards greater automation of data gathering and improved communication between systems. The anticipated penetration of even more DER, LCTs such as battery storage, electric vehicles and heat pumps, as well as the introduction of more flexibility services, generates a need for additional system integration and the collection and efficient management of additional data. Sensor deployment and revision of relevant customer application forms and connection agreements to capture additional information are ongoing activities. We are planning to digitise the customer application and notification process to provide more timely and efficient response to customers (see DSAP section eight, Enabling customers to self-serve). To extract more value and ensure better asset utilisation, the efficient storing of additional static and real-time data is paramount. This includes the capturing, structuring and storing more granular power data, dynamic network asset data, and information on customer assets such as location, size, mode of operation and demand/generation profile of LCTs, especially on low voltage networks.

In an increasingly complex power system the benefits of an integrated system will lead to more efficient processing of data with reduced opportunity for errors and inconsistencies.

[24] The DSAP has 10 core areas (or functional groups), each made up of several initiatives. See Appendix A for more information on how the DSO strategy maps against the DSAP.
[25] See Glossary for further definition of system terms.
[26] Supervisory Control and Data Acquisition.

Context and requirements

The journey to digitalisation and open data has already started through various activities[27], as we are improving and expanding our data capture to increase visibility of assets. This in turn enables improved network utilisation, optimisation of future investment and forms an important foundation for the creation of flexibility markets. Going forward, our need for access to reliable network data to further enhance our capabilities and facilitate flexibility markets will grow exponentially. We will therefore need to capture and store additional data in order to better utilise assets and operate a flexible network. This is reflected in our DSAP initiative 1.05, which describes the requirement for a central function to own and manage data governance. Please also refer to our Network Visibility Strategy for further detail about our overall approach to network monitoring.

To do this effectively we will need to structure and store data in a way that can be easily extracted and used by internal and external stakeholders. We will build on existing information management systems and capabilities to augment and integrate existing datasets such as asset and network data systems (eAM Spatial and PowerOn Fusion), demand and generation data (real-time network, half-hourly metered data, annualised consumption and smart meter data) and customer connection agreements (e.g. technology type, agreed capacity). To do so we need to digitalise further our data capture and data management capabilities, increase storage capacity (size) and capability (fields) to allow for additional data to be stored, and integrate existing and new databases and systems together. This links to a data integration initiative within 1.06 of our DSAP.

For HV, EHV and 132kV networks we expect this to be an incremental improvement. For LV, however, this will be a step change as the rollout of smart meters and LV monitoring[28] (up to circa 50 per cent of distribution substations by 2028) will increase visibility of LV network exponentially, collecting significant volumes of data. Our plans include, but are not limited to:

- consolidation of data to make it accessible at a single point;
- capture of more detailed static and dynamic data of both network and customer assets. For example, additional plant and generator parameters to accurately model different scenarios and conditions or build in dynamic transformer and cable ratings;
- capture and more regular updating of dynamic asset settings. For example, transformer tap position setting, protection relay settings and low voltage link box arrangement;
- consideration of capture of higher resolution power flow data where possible. For example moving from 30 minute to five to 10 minute averages and/or storing additional fields per time interval (e.g. max, min) to build a richer picture;
- data storage in an operational time series database;
- integration of network monitoring systems (e.g. HV regulators and auto-reclosers, LV monitoring, fault level, fault detection, fault prediction, disturbance recorders) into wider asset systems;
- digital standard and non-standard customer connection agreements with granular operating details such as details on flexibility service provision arrangements to allow easy access and analysis at scale;
- purchasing of data to enhance network visibility and improve operation. For example, EV charge point, aggregator and weather data; and
- identification and linking of third party data and how it links to end-to-end planning.

More accurate and better integrated data will give us a more comprehensive understanding of the power flows across the whole network and allow us to identify pockets of available capacity and integrate flexibility services. Additional data

[27] Smart grid implementation programme and DSAP in the current price control period.
[28] LV monitoring refers to granular time-series LV transformer and feeder current and voltage readings, described further in DSO1.3.

will also allow us to better capture LCTs, particularly at low voltage, and accurately track their growth rate and concentration density to inform our load forecasting models. This will in turn allow us to facilitate more connections, anticipate future network constraints further into the future with greater confidence, something that will form the basis for accurate signals to stimulate flexibility markets in our region.

To be able to do this analysis we need a structured and fully integrated data platform. This will form the bedrock of a number of data activities to deliver our DSO outcomes, such as analysing data to inform decisions using different tools (e.g. DSO2.1-3 analytics, DSO2.4 Digital Twin) and, sharing data with internal and external stakeholders through standard data formats (e.g. initiative 3.4 CIM) and APIs, that enable interoperability based on certain security and privacy access rights (e.g. DSO3.1 Open Insights).

Our proposal

The increasing volumes of data therefore make the activity for efficient data management and integration of systems a necessity as without accurate and comprehensive data we will fall short of Ofgem's DSO expectations. Our approach proposes a stakeholder centric view to data and we are already undertaking a gap analysis (DSAP initiative 1.01) to understand what data internal and external stakeholders need and how we will build the relevant data sources. Stakeholder requirements will be defined and data will be delivered through single or multiple data towers. These will be the single points of accountability for data integrity, quality and in real time and will work collectively to deliver all data requirements. Network, asset and customer are examples of data towers. Details of our stakeholder engagement for data can be read in the stakeholder engagement section of our latest iteration of our DSAP (June 2021).

To handle the vast amounts of data efficiently, we will build a data integration platform which will allow data from multiple sources to be collected, arranged and transformed so that they can be applied to various business ends and routed to different users. The platform will use standard data formats (e.g. CIM) and be API driven to implement a hybrid solution of on-premises and cloud capabilities, to integrate data across our own landscape and provide access to data with ease from outside our organisation. Connecting eAM Spatial data for example to new integration platforms will enrich datasets but also surface asset data for open sharing through DSO2.4 (digital twin) and DSO3.1 (open insights). This will enhance data quality through direct input and reduce reliance on spreadsheets and other methods currently used for collecting and sharing data. For additional detail on systems and data integration refer to the DSAP initiatives 1.04 and 1.06 which discuss how this will be implemented, for example through APIs.

The wider sensor deployment initiatives including LV monitoring rollout (DSO1.3) will be supported by providing enterprise class back-end data handling capabilities and integrations to allow for more efficient utilisation of resources and target capital investment. This will run in conjunction with network planning and investment initiatives based on predictive algorithms and additional sensor deployment (DSAP initiative 9.03). Furthermore, we will update and enhance the current asset data platform and eAM tools to provide improved access to system asset data and provide a new architecture that sets the foundation for building future functionalities. Activities include eAM database upgrades, modernisation of architectures, database structure and interface upgrades are covered in the DSAP initiative 9.04, all benefitting better decision making.

The costs of this are anticipated to be £8.4 million, which include costs associated with increased resources of 3.0 FTE by the end of the period to accommodate the processing of additional data and IT/OT requirements. The costs exclude those for establishing a central function that owns and manages data governance and acts as a central point of accountability by playing a coordinating role for all data requests and deliveries as well as setting the rules for data quality and availability.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	2.2	2.2	2.2	0.3	0.3	**7.3**
People (£m)	0.2	0.2	0.2	0.2	0.2	**1.1**
						8.4

Table 1: DSO1.1 Associated costs

DSO1.2 Improved stakeholder information exchange

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO1.2 Improved two-way stakeholder information exchange and collaboration	0.2	0.5	N/A	✓		✓
Related DSAP core areas and initiative(s)						
1.01						

Context and requirements

Working more closely with our stakeholders, we intend to build on the great work already done to capture stakeholder data on the possible decarbonisation energy pathways to generate understanding on what this will mean for our investment and services. To make optimal system planning decisions we need to ensure that we are using inputs from stakeholders (both data and viewpoints) and combining this external intelligence with our own data. This initiative is all about ensuring we are set up to capture this external intelligence in our routine planning processes. This activity is closely related to the flexibility market engagement (see initiative 1.4) and the assistance to collaborate on production of local area energy plans (LAEPs) (see initiative 5.3).

We carry out stakeholder engagement through various routes. Core to our system planning is production of our annual distribution future energy scenarios (DFES) where we work closely with a variety of stakeholders to provide data inputs to inform our modelling. These include:

- the electricity system operator (ESO) on future energy scenarios (FES) data inputs;
- local authorities on local area energy plans (LAEP);
- customers – either in groups or individual larger users;
- local enterprise partnerships; and
- local housing planning.

For the publication of our DFES we have also worked closely with the Open Data Institute to develop a DFES visualisation[29], which provides a heat map of our network that further enriches information through which our stakeholders can engage with us. Going forward, we expect to develop these interfaces so that we may collaborate effectively.

Our proposal

We constructed this plan using stakeholder feedback through bilateral conversations and group interactions to develop our DSO strategy proposals and continue to see the value that stakeholder insight brings. Therefore, in the forthcoming period, we are proposing to invest £0.2 million to add resources to our stakeholder engagement program on system planning and formalise our stakeholder engagement processes across the organisation.

We will continue develop internal processes for stakeholder interactions (see DSAP Initiative 1.01), meeting content and reporting to manage our stakeholder engagement plans. As a result, we seek to avoid the risk of stakeholder fatigue as we increase the amount of stakeholder engagement we do across the organisation and ensure that we are asking the right questions and receiving the most valuable information. This reciprocal information exchange will help both Northern Powergrid and our stakeholders. Better information from customers will mean that we can forecast the network need more accurately at a more localised level, therefore meaning we can plan more efficient investment. In

[29] https://odileeds.github.io/northern-powergrid/2020-DFES/

turn, it could also help our stakeholder with their own planning (e.g. transmission network constraints and local authority energy plans).

In order to ensure that our conversations remain relevant and beneficial for all parties we will also implement a feedback loop that will allow for continual updates of the process. This will also include scanning the market in a defined period to ensure that we are capturing all of our key stakeholders. We will build on our core existing relationships with the ESO, LAs and larger system users and also create new information exchange with stakeholders that emerge through the development of new technologies or markets.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	-
People (£m)	0.04	0.04	0.04	0.04	0.04	**0.19**
						0.19

Table 2: DSO1.2 costs

DSO1.3 Targeted low voltage (LV) monitoring

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO1.3 Targeted low voltage (LV) monitoring	21.1	-	% ground mounted substation network directly monitored (50%)	✓	✓	
			Number LV load monitors installed (12,700)			
Related DSAP core areas and initiative(s)						
N/A						
Note: See Engineering Justification Paper EJP-5.3a Low Voltage Monitoring for a full analysis, including CBA.						

Context and requirements

Low voltage (LV) monitoring is located at ground mounted (GM) substations to monitor our LV network parameters which include current, voltage, real and reactive power, harmonics and transformed tank temperature. We need to expand monitoring in order to increase the visibility of our LV network and obtain better, more granular data which can be used in analytics (e.g. DSO2.1) and inform network planning and investment decisions. LV monitors replace maximum demand indicators (MDIs) which display the maximum demand recorded since last reset, which are not appropriate for the future network: they do not provide sufficient LV network visibility as they do not provide information on LV feeders, voltage, load profile or time of peak.

LV monitoring is particularly important as power flows on our LV network become more complex with increasing connection of DER and LCTs. Monitoring is key to our flexibility first approach to network investment to deliver decarbonisation, by first equipping our network so that we can monitor load growth to identify areas of constraint. This deliverable is integral to DSO1.1 described above, providing us with essential data about power flows on our network to enable targeted efficient investment. Please also refer to the Network Visibility Strategy for further information about our overall approach to network monitoring.

We have made progress in LV monitoring over the 2015-23 period, and have installed LV monitors at around 1,150 GM substations as of 2020. We anticipate that we will have installed 2,700 LV monitors by 2023 as part of our smart grid enablers programme.

Our proposal

To continue this important work, we are proposing to spend £21.1 million over 2023-28 to install 10,000 low voltage (LV) monitors across our network. We will install 6,000 LV monitors in our Yorkshire licence area (1,200 per year) and 4,000 in

our northeast licence area (800 per year). We are prioritising cost-effective monitoring. Monitors will be installed for GM substations (of which there are 29,484 across our network[30]) as this is more cost-effective given the large number of customers connected, while aggregated smart meter data and portable ad-hoc monitoring will be used for pole mounted substations given the difficulty and cost of installing permanent monitors.

Monitors can be installed without the need for power outages, therefore minimising cost and disruption.

Note that there is a risk that smart meters, whilst already limited in their reach, as their installation is not mandated, and the capability of smart meter infrastructure in general may not be as anticipated in the northern region. This is presently being investigated and discussed with the DCC. LV monitors therefore provide a key means of mitigating the risks associated with smart meter performance being lower than anticipated.

This initiative will deliver the following benefits:

- Increased network capacity (use existing assets more efficiently). This initiative will give us better visibility of our LV network and allow us to make more timely and efficient investment decisions. LV monitoring data will provide feedback to our existing statistical techniques and allow us to validate our demand estimation. Combining this with smart meter data, we can obtain a baseline for demand forecasting to analyse LV network capacity, as well as to identify areas of network with high penetration of low carbon technologies (LCTs) and network areas that are high in losses. We can also use monitoring data to better understand the capability of our assets (i.e. transformers and cables), which may allow us to release more capacity from the network than we would otherwise have done, and therefore to increase the efficiency of our network;

- Network data for sharing and flexibility markets. Enhanced monitoring will give us better data on our LV network which underpins a number of other DSO activities such as DSO2.1, DSO2.3 and DSO2.4. There is currently a significant amount of data available for our HV network, but our LV network is a gap. Given that the majority of our customers connect to this part of the network, and many LCTs are domestic-scale, LV data provision is becoming a necessity for DSOs. Data sharing will allow customers to make better, more informed decisions about connecting to and using the network, while we will also use this information to develop and procure flexibility services products;

- Improved condition of network assets. Enhanced monitoring will allow more targeted, timely and, ultimately, efficient investment in asset condition. Over the course of the period we will look to merging our LV monitoring with foresight[31] technology – our 'pre-fault' detection capability which we successfully trialled during this period;

- Reduced network losses. By giving us better visibility of our LV networks, this initiative will allow us to undertake targeted action to mitigate network losses, including electricity theft, of which 25% occurs on LV feeders.

DSO1.3 is covered in further detail in the engineering justification paper EJP-5.3a Monitoring. Our planned investment of £21.1 million over five years is based on an average unit and installation cost of c. £2,000 per unit.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Network investment (£m)	4.2	4.2	4.2	4.2	4.2	**21.1**

Table 3: DSO1.3 Costs

[30] There are 26,784 GM substations which feed multiple customers and where LV monitors are appropriate.
[31] See Glossary.

Initiative 1.4 Enhanced flexibility services market data capture

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 1.4 Enhanced flexibility services market data capture	0.3	1.0	N/A		●	✓
Related DSAP core areas and initiative(s)						
1.01						

Context and requirements

We will need to continually monitor developments in the wider market for flexibility services, seeking insights to inform our offering and build our capabilities from a range of sources (DSAP initiative 1.01). Enhancing our capability to capture market data will complement the investment in stakeholder engagement set out in DSO 1.2 – Enhanced Stakeholder Data Capture. Capturing and interpreting market data will create insights that help to ensure we are as efficient as possible in the operation of our network and playing a central role in the decarbonisation of the electricity system.

A significant volume of market intelligence relating to flexibility services is already available today. Currently we use a manual, ad hoc approach to gathering market data with activity taking place across a range of business functions, often in response to specific project needs or reporting requirements. Where need arises, we also engage third parties (e.g. academia, consultancies, research organisations) to complete market data gathering and analysis in our behalf. We anticipate further growth in the volume and breadth of market data available during the period as flexibility markets mature and adoption of low carbon technologies (LCT) grows. Our approach will need to evolve in line with this anticipated growth in market information, requiring increased focus and dedicated resourcing as well as likely evolution in the techniques we use to gather information.

Our proposal

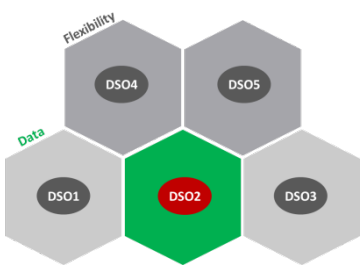
We have included £0.3 million of spend in our plan across the period, to support the development of our tools and techniques for information gathering.

We believe this investment in enhanced market data capture is important to ensure efficient operation of flexibility services at Northern Powergrid. Continuing with our ad hoc, manual approach would leave us unable to effectively process and gather the market data that we anticipate will become available. This would create the risk of incurring additional costs that significantly outweigh our proposed investment in market data capture. For example, failure to procure cost effective flexibility services could force us to resort to expensive network reinforcement due to procurement failure or the signing of contracts which are not commercially or operationally optimal. Another alternative option to our proposal would be to rely more heavily on third parties, but given our need for market data capture will become greater and the associated activity need to be carried out on a near continuous basis, this is likely to be an expensive option relative to developing internal capability.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.0	0.0	0.0	**0.0**
People (£m)	0.0	0.0	0.1	0.1	0.1	**0.3**
						0.3

Table 4.1 Costs of initiative 1.4

DSO2 Transform our analytical capabilities to enable data-driven decision-making in planning and operational timescales



DSO2.1 Enhanced low voltage (LV) data analytics

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO2.1 Enhanced low voltage (LV) data analytics	4.9	0.5	N/A	✓	✓	●
Related DSAP core areas and initiative(s)						
1.02, 1.05, 1.06, 2.01, 2.02, 2.04, 2.05, 2.06, 2.07						

DSO2.2 Enhanced high voltage (HV), extra high voltage (EHV) and 132kV data analytics

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO2.2 Enhanced high voltage (HV), extra high voltage (EHV) and 132kV data analytics	2.2	0.5	N/A	✓	✓	●
Related DSAP core areas and initiative(s)						
1.02, 1.05, 1.06, 2.01, 2.02, 2.04, 2.05, 2.06, 2.07						

DSO2.3 Improved planning and operational forecasting

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO2.3 Improved planning and operational forecasting	5.4	2.0	Standardised DFES inputs (by 2023) Accurate forecasting of network needs: reconciliation of outturn vs forecast (report annually)	✓	✓	✓
Related DSAP core areas and initiative(s)						
2.01, 2.04, 2.05, 2.06, 2.07, 9.11						

Context and requirements

Once relevant dynamic and time series data is captured, structured and stored (DSO1.1), it must be analysed to extract value (make sense) and inform decisions. We will achieve this through a blend of separate deliverables DSO2.1-2.3 outlined above; the context and requirements are relevant for each of these analytics-related activities. As described in further detail below, we have made provision to invest £12.5 million in systems and people to deliver enhanced analytics capabilities across voltage levels and in planning and operational timescales. (Please also refer to the **Network Visibility Strategy** for information about our overall approach to network monitoring.)

Currently, power systems data is stored across various systems (such as iHost for LV monitoring and PI Coresight for half-hourly metered customer and SCADA data) and accessed through separate dashboard interfaces.

- At LV, demand for managing voltage regulation and sizing of network assets is based on a statistical approach that considers the diversity and imbalance between customer types and their annualised consumption data. This approach is widely adopted by the industry to design LV networks using customised tools and forms the basis of our online AutoDesign tool. Where LV monitoring data is available (circa 3 per cent of our distribution substations), it is manually processed to inform assessments.

- At HV and above, maximum and minimum demands are manually inserted in power system design tools for network improvement and connection designs or extracted and processed using basic programming in products such as Microsoft Excel and Microsoft Access for planning purposes. This involves semi-automated cleansing and sense-checking of data to inform load estimates and long-term development plans, as well as other forecasting analytics undertaken internally or contracted out to expert consultants (e.g. for the development of DFES).

- Unprocessed SCADA data is also used by control engineers to plan outages or, reconfigure the network to manage unplanned outages.

- In some cases, time-series data is extracted into customised spreadsheets for bespoke assessments such as sizing flexible connections, determining flexibility services requirements, calculating dynamic ratings of assets or calculating protection settings.

Traditionally, visibility of LV network demand and voltage data has been low with such data typically being measured using very low sampling monitors (e.g. maximum demand indicators), temporary monitors installed as part of a design assessment or analysed as part of time-bound innovation projects. The national rollout of smart meters and LV monitoring[32] being installed on up to circa 50 per cent of ground mounted distribution substations by 2028 and described in DSO1.3 above, will enable the collection of significant volumes of data and hence increase visibility of LV network exponentially. Such volumes will require smarter and more powerful analytics capabilities and enhanced skills.

For HV, EHV and 132kV networks, the increase in data volumes will be incremental (e.g. transformer temperature, real time capacity assessments, flexibility services compliance monitoring) therefore although analytics capabilities and skills will still be required, catering for the increase is likely to be less onerous. The analytics capabilities to cleanse, correct and aggregate data to model and predict network utilisation, capacity availability and demand/generation profiles may therefore vary by voltage.

Prior to analysing data to identify trends, answer questions and draw conclusions, data must be cleansed to detect and correct corrupt or inaccurate readings and also normalise the data for any non-standard network operational configuration. Once cleansed, data can be processed and examined to undertake network assessments, provide insights or develop predictive models. The anticipated significant increase in data volume, which in some cases will require quality assurance, will make this activity more complex, requiring both powerful systems and highly skilled data scientists (refer to DSAP Core Area 1.0 initiatives and the data vision and best practice section for more information). The capability requirements will depend on the actual data volumes, customer behaviour (e.g. the extent to which customer engage with time of use tariffs) and will vary by voltage levels and will be delivered through the following deliverables which are in turn enabled through a number of the core areas included in our DSAP:

- DSO2.1 Enhanced low voltage (LV) data analytics – using analytics and machine learning to cleanse and emulate high quality and granular time-series data sets for low voltage networks;

- DSO2.2 Enhanced high voltage (HV), extra high voltage (EHV) and 132kV data analytics – using analytics and machine learning to cleanse, enhance and verify time-series data sets for high and extra voltage networks; and

- DSO2.3 Planning and operational forecasting analytics - Further refine power flow models and supplement forecasting and scenario data by using analytics engines to predict future power flows for operational purposes and under different scenarios for planning purposes.

[32] LV monitoring refers to granular time-series LV transformer and feeder current and voltage data.

DSO2.1 Enhanced low voltage (LV) data analytics

The increased penetration of DERs and other LCTs such as EVs and HPs has an impact and alters the typical customer demand profiles currently used for the design of LV networks. As data sources related to the LV network will increase (for example smart metering, LV monitoring and settlement data), various datasets can be used to inform and refine LV power flow and voltage calculations, calibrate and improve demand profiles and models. For example, smart meter data can be analysed to develop individual customer profiles or aggregated to estimate demand profile on LV feeders and distribution substations that are not monitored. Similarly, LV monitoring time-series data can be analysed to estimate capacity and utilisation levels more accurately or disaggregated to estimate load distribution along a feeder. A statistical analysis based on a combination of these datasets could be used to emulate, refine and calculate revised demand profiles and network utilisation. This will allow us to close the gap between statistical and measured values so that we have better confidence in areas where full instrumentation is not present. Additionally, data from LV fault restoration, and fault prediction monitoring equipment could also be analysed to identify trends and provide a different perspective to fault analysis. Cleansed and processed data will then feed into the digital twin (DSO2.4), open insights (DSO3.1) or used for planning and load forecasting (DSO2.3).

Given the increased volume of data points, structured data and analytics - including machine learning and artificial intelligence (AI)[33] necessary for more accurate and detailed insights from high volume data - are difficult to obtain with existing capabilities and systems. Such functionality could automate the manual process currently carried out by engineers to correct missing, corrupt or inaccurate data, identify connectivity between assets and potential non-compliances with design policies. These technologies could also help create forecasts and predictions based on time-series granular data, a process that can help design the network, plan for reinforcement needs and identify and size flexible connections and flexibility service requirements.

DSO2.2 Enhanced high voltage (HV), extra high voltage (EHV) and 132kV data analytics

For HV, EHV and 132kV networks, the additional data will be incremental and although analytics requirements are similar, the processing capability needed is likely to be less than that for LV due to lower data volume. At higher voltages, the requirement is to efficiently process and analyse consolidated SCADA data from various sources including substation and feeder data, disturbance recorders and fault level monitors, as well as readings from assets installed mid-stream of feeders such as auto-reclosers and voltage regulators. Data analytics will cleanse, corrupt or inaccurate data, validate and be used to calibrate models for accurate modelling and load forecasting. Machine learning capability will pre-empt or manage fault and power quality issues by suggesting proactive network operations.

Similar to LV, this functionality will also allow for automated processes currently carried out by engineers to correct missing, corrupt and inaccurate data and identify connectivity between assets and potential non-compliances with design policy. Such capabilities will be used to refine and calculate revised demand and generation data for load forecasting by feeding into activities such as demand load estimates (DLEs), DFES, as well as feed into the Digital Twin (DSO2.4) and Open Insights (DSO3.1). These capabilities can also help create forecasts and predictions based on time-series granular data, a process that can help design the network, plan for reinforcement needs and identify and size flexible connections and flexibility service requirements. The analytics needs for LV, HV, EHV and 132kV can be delivered through a single or multiple engines.

DSO2.3 Improved planning and operational forecasting analytics

Planning forecasting

Cleansed data and analytics capabilities (both in terms of systems and people skills) will also enhance our planning and forecasting abilities, improve and make our analysis techniques more efficient with the potential to bring them in house. They will further refine our load models and make sense of huge amounts of significant volumes of more granular data derived from smart meters, LV monitoring, SCADA and other half-hourly data, as well as demographic information and data from third parties such as local authorities and central government. These will form part of and enhance our forecasting and scenario planning activities, building on research that we and others have done to develop LV forecasting

[33] Machine learning is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention.

techniques[34]. This capability will create medium and long term planning capabilities (e.g. one year, five years, 10 years) and enhance the production of DLEs and DFES, inform our flexibility service requirements such as scheduled constraint management[35] as well as allow us to undertake long-term techno-economic analysis to determine the best and most cost effective interventions (i.e. long-term planning and scenario modelling).

A machine learning engine for example, could be configured to factor forecasting and asset information to determine the likely future demand and generation trends at a local and GSP level. Highlight asset capacity and utilisation at the present time and in the future, identify flexibility service requirements and availability taking into account weather and seasonal demand variations, or help improve losses using time-series smart meter and LV monitoring data. To ensure ESO/DSO coordination and a whole system approach, long term plans and forecasts will be shared with ESO and other relevant stakeholders.

Operational forecasting

Our network control team is responsible for the safe and reliable operation of the distribution network and for managing planned and unplanned outages based on real time network conditions. Typically this involves network reconfiguration and potentially instructing customers to reduce their demand consumption (including permanent energy efficiency improvements) or generation production before a planned outage or during an unplanned outage. Similar to planning, operational forecasting will use granular time-series datasets (smart meters, LV monitoring, SCADA and other half-hourly data) but this time to deal with near real-time and short term (e.g. one hour, one day, one week, one month) operational changes on the network. This will be a transformational change for control engineers which will be used to determine capacity availability and requirements and assess network reconfiguration or flexibility services solutions. Flexibility service requirements could be procured for example for pre-fault and post-fault constraint management, or restoration support management[36]. Flexibility service requirements could, for example be identified and declared one week ahead, with a dispatch notice issued minutes ahead of need.

To ensure ESO/DSO coordination, operational forecasting plans will be shared with ESO via an agreed communications method. Flexibility services should also be coordinated so that they do not interact with agreed outages for planned work between distribution and transmission operators.

System functionality, costs and benefits

To meet the requirements described above, smarter and more powerful tools will be required to process the data going forward and improve the quality of data by addressing any inconsistencies and deficiencies between datasets. Provision of cleansed and complete data will enhance the value of the data as an asset and will allow greater business and external stakeholder confidence when the data is used for modelling and decision making. This is supported by our DSAP initiatives 1.02, 1.05 and 1.06, where the plan for the deployment of tools and the rules to assess and manage the uplift of data quality, data surfacing and integration is set out.

We plan to invest £11.3 million in IT and OT costs to deliver these capabilities, broken down by each deliverable in the table below. Our investment plan has been developed as part of the work undertaken to formulate the initiatives contained within our DSAP, the cost validation undertaken as part of its development and past experience of procuring and developing similar systems and capabilities. Refer to appendix A for further information on the interaction between the DSO and DSAP.

In addition to the system needs, we also expect to invest £1.2 million to add to our company people with skills in data science and information systems skills to deliver the enhanced analytics capabilities facilitated by a step-changed in data and analytics systems.

[34] Review of low voltage load forecasting: Methods, applications, and recommendations - https://doi.org/10.1016/j.apenergy.2021.117798

[35] Scheduled constrained management is an Open Networks definitions adopted and used by the Flexible Power platform. This service is used to manage peak demand loading on the network and pre-emptively reduce network loading. Such requirement is likely to be scheduled and fixed at the point of contract.

[36] Pre-fault constraint management, post-fault constraint management and restoration support management are Open Networks definitions adopted and used by the Flexible Power platform. These services are used to manage faults or support with power restoration following rare fault conditions. Such services will typically be more dynamic than scheduled services.

The investment we are planning will deliver the following benefits:

- The deployment of tools to assess and manage the uplift of data quality;
- Deploy intelligent digital solutions for modelling and automation for improved network operations efficiency and enable flexibility services;
- Improve analytics for demand forecasting and design;
- Integrate and enhance network monitoring and advanced analytics tools within control room; and
- Provide enhance network modelling capabilities including probabilistic assessment.

The benefits are enabled through a set of initiatives discussed in the DSAP; namely 2.01, 2.02, 2.04, 2.05, 2.06 and 2.07. These initiatives discuss the discovery and deployment of enhanced management solutions for energy resources, the design and implementation of information systems and artificial intelligence tools for improved efficiency, forecasting and analytics capabilities.

We are currently undertaking several initiatives to improve forecasting models and analytics which we will use to build on to scale up our capabilities. We will test and confirm opportunities to augment modelling and analytics and analyse existing data sets to identify what data is available within existing systems to be used for analytical purposes or that can be extracted and loaded into alternative systems. Advanced analytics enabled by AI and machine learning will improve data quality and accuracy, increase operational efficiencies, reduce human error, provide customer benefits through quicker response as well as more targeted, low regrets investment. This data will be opened up to external stakeholders as per the stakeholder engagement and data vision sections of our DSAP.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
DSO2.1						
Systems (£m)	0.9	0.9	0.9	0.9	0.9	**4.7**
People (£m)	0.0	0.0	0.0	0.0	0.0	**0.2**
						4.9
DSO2.2						
Systems (£m)	0.4	0.4	0.4	0.4	0.4	**2.0**
People (£m)	0.0	0.0	0.0	0.0	0.0	**0.2**
						2.2
DSO2.3						
Systems (£m)	0.9	0.9	0.9	0.9	0.9	**4.6**
People (£m)	0.2	0.2	0.2	0.2	0.2	**0.8**
						5.4

Table 5: DSO 2.1, 2.2 and 2.3 Costs

DSO2.4 Create a digital twin of our network for strategic planning

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO2.4 Create a digital twin of our network for strategic planning	7.3	2.0	N/A	✓	✓	✓
Related DSAP core areas and initiative(s)						
2.01, 9.01, 9.02, 9.04, 9.09, 9.10						

Introduction

The digital twin capability we propose to deliver is able to continuously identify available capacity within our network, thereby supporting the connection and, where necessary, control of LCTs without either compromising the electricity network or resorting (by default) to costly traditional reinforcement. The digital twin concept will leverage classical power system models by combining historically static models with dynamically measured and predicted energy demand/generation all the way down to individual connections to yield repeatable data on which to base both short term decisions and longer term investment planning. In addition to supporting internal processes, it is a key enabler for our open insights deliverable (DSO3.1), which allows third parties access information about our network.

We believe the proposed solution is compatible with one of the digital twin definitions from the Centre of Digital Built Britain[37] as *"A static strategic planning model of a system, with input of long-term condition data from the physical twin via corporate systems; feedback into the physical twin via the capital investment process".*

Context and requirements

We are reaching the limits of what static power flow models can achieve and believe the results that flow from these models bias users to make deterministic decisions of the condition of the network and hence the intervention required. For example, if the network is shown to be outside of parameters the proposed intervention is usually to enhance the network so it is adequate for the condition.

Whilst static power flow models have their place, and our strategy is still to use them in the first stage of assessments, it is when the power flow models indicate an out of parameter condition that dynamic energy flow studies are required.

Power system modelling tools and historical measured data are not new but what is absent is the capability to combine them in a timely fashion together with forecasts to provide a continuously updated assessment of available capacity. The reasons these systems have not been integrated is two-fold: there has not been the widespread requirement as energy system studies (i.e. curtailment studies) can be done manually as required; and the integration of the tools is costly and complex.

In the past the benefits of this upgrade and integration has been outweighed by the cost; however the following factors are increasing in prevalence meaning the balance is shifting towards a positive NPV for an energy system model based on time series models:

- curtailment studies for potential ANM customers;
- thermal models of network assets (rating assets in time and temperature instead of static seasonal current flow);
- voltage compliance in probabilistic terms (such as EN50160[38]); and
- identifying flexibility opportunities is in energy terms rather than power terms (MWhs vs MW).

[37] https://www.cdbb.cam.ac.uk/
[38] A European standard that defines the voltage characteristics of the electricity supplied by public distribution systems.

We believe the energy system studies tool, which moves beyond MW to MWhrs, fits a digital twin, as it more closely resembles the physical twin than our existing models. This is because:

- the quality of the data is much higher as it will be integrated with static asset data and dynamic time series data, leveraging our data management and analytics deliverables (DSO1.1, DSO2.1, DSO2.2, DSO2.3);
- the fidelity of the algorithms will be much higher; and
- the quality of presentation of the output will be enhanced and accessible to third parties via our open insights (DSO3.1) deliverable.

Building on Progress

The move to digital twin is an evolutionary progress, with many enablers required. During the current period we have significantly progressed on integrating and updating data sets and systems within the business including:

- updated SCADA visualisation tool (PI Coresight);
- LV monitoring (into the iHost system);
- full digitalisation of asset records (eAM Spatial);
- online budget tool (AutoDesign);
- localised DFES forecasting;
- distribution system analysis tools (DSAT) phase 1; and
- integrating our asset data into the Connect/LV software.

The latter two projects are the core foundations of the two new digital twins and require more explanation into how we are going to build on these two models during the period.

DSAT phase one progress

We are in the process of replacing our DINIS and IPSA models with the powerfactory tool. This has the several benefits including the integration with our static asset data sources, a modernised interface, add-on modules option upgrades and scripting facilities. We are planning a full rollout of DSAT phase one towards the end of the current price control period. A functional architecture is shown in figure 14.

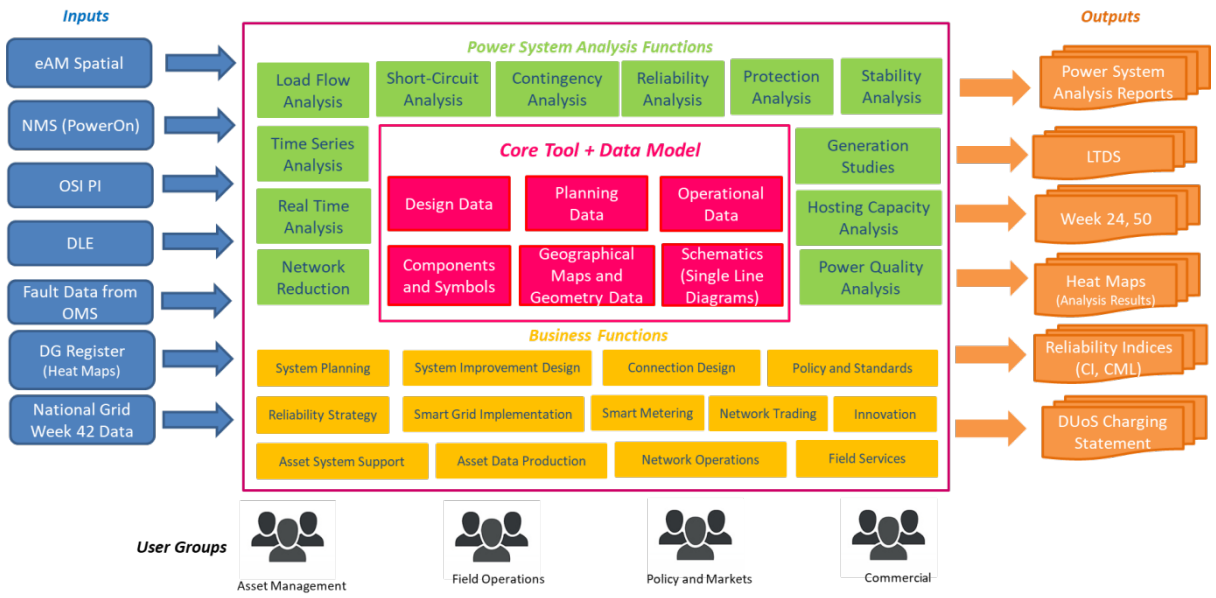


Figure 14: Functional architecture

Connect/LV progress

We are in the process of replacing existing low voltage design tools with the Connect/LV tool. Connect/LV is a web based replacement for the widely used DEBUT LV design software.

Existing LV design processes are time consuming and involve the use of multiple tools and sources of information. The introduction of Connect/LV will consolidate many existing design tools into one package. Connect/LV will import the existing LV network into the application to present the operator with the target network model immediately. Multiple studies can be run including voltage drop, voltage rise and power quality assessments. This will be an industry standard tool which will be constantly developed and improved.

Connect/LV will be the catalyst for a number of other initiatives. As well as a comprehensive design package it also allows large scale studies to be run across the full Northern Powergrid LV network model. This will have wide spread benefits for the business as a whole, providing greater LV network visibility and allowing future energy scenarios to be modelled.

Analysis, costs and benefits

The digital twin will comprise two main areas: LV, and HV/EHV/132kV. We have made the distinction between the two for the following reasons:

- The network configuration and data available at LV is very different from the deterministic SCADA derived information available at higher voltages;
- There is the potential for considerably larger quantities of data once the smart meter rollout and LV monitoring (DSO1.3) is complete; and
- The potential impact on our network of an incorrect assumption being applied is higher at higher voltage as more customers are ultimately affected.

Therefore we have been developing two approaches in two main areas in our work to date. These are:

- LV capacity based on a blend of measured and statistical techniques incorporating network configuration, metering (consumption), monitoring and demographic data; and

- HV/EHV/132kV using classical methods leveraged by timely data from both SCADA and aggregations of the previous LV modelling.

LV component

At present we use two software packages for LV design; DEBUT and a spreadsheet based model. The two packages do not share the same approach to modelling however do share the following principles:

- loading conditions are populated using estimates of customer loading, based on statistical approaches. Measured data is added on an ad-hoc basis;
- the static network data is updated in parallel with the central asset data or a study by study basis;
- the load flows conducted are user defined but generally seasonal worst case (usually maximum demand, minimum generation, and vice versa);
- assumptions are made about the phase connectivity;
- forecasting of demand changes are inputted manually; and
- the results of the modelling are exported manually to separate reports.

We are proposing to make the following updates to transform these models into an LV digital twin:

- Expand the use of system-wide network studies which underpin our AutoDesign online budget tool via the use of a more capable calculation engine available within Connect/LV that will facilitate studies encompassing low carbon technologies and temporal scenarios.
- The loading conditions are automatically populated from smart meter and LV monitoring data. As it is not possible to measure conditions at every point on the LV network it will be necessary to employ statistical and artificial intelligence techniques applying adjustments where actual data is available (analytics engine – DSO2.1).
- The twin would also have the ability to run temporal load flows to undertake probabilistic modelling. To gain maximum value, this would also run temporal thermal modelling of assets and voltage conditions - allowing our assets to be worked harder.
- Long term planning and scenario modelling (see planning modelling in DSO4.3 above).
- Inherently allow for constraints to be modelled in *watt-hour* terms - allowing flexibility to be explored more readily.
- Direct integration with central asset data – leading to efficiency savings and introducing less human error.
- API functionality into the Open insights initiative (DSO3.1) – allowing easy third party access to our data.
- In short this is an energy flow model.

As mentioned in DSO1.3, that there is a risk that the capability of smart meters and their associated infrastructure may not be as anticipated in the northern region. This is presently being investigated and discussed with the DCC. LV monitors therefore provide a key means of mitigating the risks associated with smart meter performance being lower than anticipated. Refer to the Network Visibility Strategy for further information.

HV+ component

At present we use two software packages for HV, EHV and 132kV designs; DINIS and IPSA for network planning and connection studies. The two packages are characterised by the following:

- They are load flow and fault level analysis tools.
- They require user input to define the dynamic loading conditions, either per analysis or periodically as part of the planning update cycle. This involves interpreting SCADA data to determine worst case demand conditions.
- The static network data is manually updated in parallel with the central asset data.
- The load flows conducted are user defined but generally seasonal worst-case (usually maximum demand, minimum generation, and vice versa).
- Forecasting of demand changes are inputted manually.
- Certain fault levels calculations and power quality assessments are not fully supported.
- The results of the modelling are exported manually to separate reports.
- Reliability assessments are carried out using a separate tool.
- Relay protection settings are not available in the design tool and maintained elsewhere.
- In short this is a power flow model.

We are proposing to make the following updates to transform these models into an HV+ Digital Twin:

- The loading conditions are automatically populated using the analytics engines to determine the seasonal worst case conditions from the SCADA data - leading to more efficient use of our network.
- The twin would also have the ability to run temporal load flows to undertake probabilistic modelling. To gain maximum value, this would also run temporal thermal modelling of assets and voltage conditions.
- By modelling the network energy flows (instead of worse case power flows), this would inherently allow for constraints to be modelled in watt-hour terms and hence allow flexibility to be explored more readily.
- Schematics representing single line diagrams of the network.
- Geographical maps and geometry data that includes the components' geographical coordinates and circuit routes and their geometry.
- Planning data such as future expansion plans and network switching schemes.
- Operational data such as switch statuses, running arrangements, protection types and settings, demand data and asset fault rates and repair times.
- In addition to the existing load flow and fault level module, the new design tool will provide a number of power system functions such as.
    - contingency analysis;
    - reliability analysis;
    - protection studies;

- stability analysis;
- hosting capacity;
- power quality analysis;
- time series analysis;
- real time analysis; and
- network reduction.

- Including modules for make level calculations and power quality – avoiding separate spreadsheet tools which reduces errors being introduced.
- Direct integration with central asset data – leading to efficiency savings and introducing less human error. This includes linking to static asset data, dynamic data and operational configuration data.
- API functionality into the open insights initiative (DSO3.1) – allowing easy third party access to our data.
- In short this is an energy flow model**.**

The key DSAP initiative which underpins both the LV and HV+ components is 9.09. This initiative defines the technical architecture for the digital twin. Other technology capabilities which will implement are explored in initiatives 9.01, 9.02, 9.04 and 9.10 and cover risk management, probabilistic assessments and the updating of existing tools.

We have made provision to invest £7.3 million to transform these models into the LV digital twin and the HV+ Digital Twin, comprising of £6.5 million for systems and £0.8 million for the people we need to add to our team to deliver this proposal.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.3	1.3	1.3	1.3	1.3	**6.5**
People (£m)	0.2	0.2	0.2	0.2	0.2	**0.8**
						7.3

Table 6: Creation of digital twin costs

DSO2.5 Improved format and consistency of information we share with stakeholders

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO2.5 Improved format and consistency of information we share with stakeholders	2.5	4.0	Historical operational and outage planning data ESO/DSO (>90% shared) Planning and operational network forecasting stakeholder feedback survey and report (annually)	✓	●	✓
Related DSAP core areas and initiative(s)						
1.04						

Context and requirements

As we transition to DSO we are shifting from a centralised system, where we are a one-way supplier of electricity to customers, to a decentralised system where distributed energy resources (DER) and low carbon technologies (LCTs) are connected to the grid and flexibility services are supplied by customers and third parties. It is essential that customers and stakeholders have access to quality data and information so that they are able to effectively participate, which in turn will support the development of the flexibility services market.

Our proposal

Over 2023-28 we plan to spend £2.5 million to improve, in collaboration with other DNOs, the format and consistency of the information we share with stakeholders. We will expand our forecasting to be more granular at LV level where possible, reflecting LCT uptake. It is important that we achieve a level of quality and consistency across the sector in terms of the information we share with stakeholders, so that market participants operating across multiple network areas face common approaches and quality, standardised outputs.

We will work with other DNOs – for example, through the ENA Open Networks programme – to develop common and consistent approaches to reporting through network development plans, the embedded capacity register and enhanced long-term development statements.

We will share improved forecasting information with stakeholders through publication in:

- Our network development plan, which sets out our plan over a five to 10 year period for network reinforcement and use of flexibility services, and will give an indication to the market of our future flexibility plans; and
- Our long-term development statement, which is being expanded from the EHV level down to the HV level, which contains network information that can be used to assess the feasibility of connections to our network and helps existing and future users of the network to assess opportunities for development projects that require new or additional connections.

We will also share information on the customer energy resources connected to our network via:

- Our embedded capacity register, which provides information on generation and storage resources greater than 1MW that are connected, or accepted to connect, to our network. The register is presented in an industry agreed format that was developed by the ENA Open Networks programme; and
- Network availability heat maps – our generation and demand heat maps shows where there is capacity to connect large-scale generation to the network and where there is capacity for large-scale demand projects.

Improving the format and consistency of the information we share will increase the likelihood that customers and stakeholders use our data and information in planning and decision making, and that data and information is used accurately and effectively. This will allow our customers and other stakeholder to make better informed and more

efficient decisions about connecting to our network and participating in flexibility markets, which will in turn support our network planning and investment decision and development and procurement of flexibility services. This will help to unlock whole systems benefits by supporting the development of flexibility markets and the efficient connection of flexible resources to our network. This will be realised through our Open Insights (DSO3.1) and flexibility services information provision and engagement platform (DSO5.3) deliverables. DSAP initiative 1.04 covers how the integrations between existing systems to provide Open Data service will be built.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	0.4	0.4	0.4	**1.1**
People (£m)	0.2	0.2	0.3	0.3	0.3	**1.3**
						2.0

Table 7: Cost of consistency of information for shareholders

Initiative 2.6 Neutral assessment of network and market solutions

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 2.6 Neutral assessment of network and market solutions	0.4	1.0	N/A	✓		✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

Central to our DSO strategy is the approach we will take to develop our capability to assess, procure, dispatch and settle customer flexibility as an alternative to more traditional or smart network asset-based solutions. This initiative involves the development and operation of processes that enable us to carry out the assessment of these flexibility and network solutions in an unbiased manner. This is closely related to the steps we are taking to be transparent in our decision making (see initiative 3.3) and more generally what we set out in the plan section on openness and transparency.

Ahead of the 2023-28 period, we are implementing standard processes to ensure that the network needs assessments are carried out as a separate activity to the assessment and development of network and customer flexibility options. The investment appraisal process within the engineering function triggers the start of the process by setting out the requirements for an area of network. Network asset solution options created by the system design function within the engineering area are then produced alongside customer flexibility options developed through DSO Business Unit market engagement. Procurement professionals will continue to ensure that compliant and effective processes are followed – be that for obtaining best prices on network solutions or operating flexibility market exercises to attract bids from service providers. The system optimisation decision making for selecting the appropriate solution is then carried out within the engineering function. The separation of duty principles and key process steps for determining the network or customer solution to address network constraints are depicted in Figure 15.

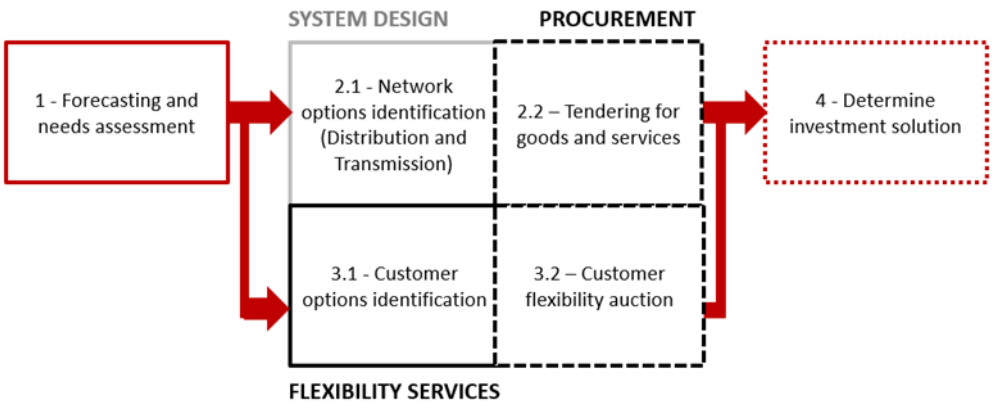


Figure 15: Investment appraisal decision making process

Our proposal

The need for any intervention for capacity and to resolve network constraints has been limited in the current period. We are forecasting that this need will increase in the 2023-28 period and further still into the 2030s (see the scenarios and investment section of our plan). Accordingly, we are proposing to increase our optioneering and decision making capability as set out above. We are proposing to invest £0.4m to provide extra engineering resources to focus on the assessment of potential flexibility solutions.

We first published this thinking on our investment decision making process[39] in 2019 and we expect to continue to develop it as part of delivering our DSO strategy:

- The investment solution should be solved through the most economic and efficient manner by allowing network and customer solutions to compete.
- A common methodology using a CBA is used for assessing the use of flexibility vs. network solution and we will continue to develop this with the other network companies and stakeholders.[40]
- We will ring-fence our decision making processes.
- In order to ensure transparency and consistency in our decision making, we will carry out an external audit on an annual basis to assess the independence of our governance process for assessing customer flexibility solutions vs. network solutions (see DSO Initiative 3.3).
- Decision making processes will be available for stakeholder scrutiny.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.0	0.0	0.0	**0.0**
People (£m)	0.1	0.1	0.1	0.1	0.1	**0.4**
						0.4

Table 8: Neutral assessment of network and market solutions

Initiative 2.7 Probabilistic decision making, risk and externality quantification

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 2.7 Probabilistic decision making, risk and externality quantification	-	-	N/A	✓	●	●
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

As our energy system changes and we are increasingly managing more complex power flows on our network, it is important that when making planning and operational choices we are cognisant of the full range of potential impacts and identify solutions that are economic and efficient over the long term. To do this we need to develop our capabilities in probabilistic decision making and ensure that network risk and externalities are factored in.

[39] https://www.northernpowergrid.com/asset/0/document/5261.pdf

[40] The Common Evaluation Methodology (CEM), co-developed through the ENA Open Networks project, has already been used to assess our flexibility pricing for the 2023-28 period as described in our Scenarios and Investment section of this decarbonisation plan.

Our proposal

We have already begun the journey from deterministic to probabilistic decision making over 2015-23 through a suite of asset ratings policies[41], but we need to continue to improve in 2023-28. In DSO2.3, we outlined how we will enhance our network modelling capabilities including probabilistic assessment. We will then translate and integrate this into our standard decision making processes.

We will build on our pragmatic security assessment innovation project which aims to develop tools and methods to inform decisions about providing security of supply through a combination of network and non-network assets, creating a level playing field on which all solutions can compete equitably. The method will:

- enable planning engineers to evaluate the security contribution of one-or-more non-network solutions;
- create a level playing field on which both network and non-network solutions can be compared equitably; and
- provide transparency about the applicability of the method and its accuracy.

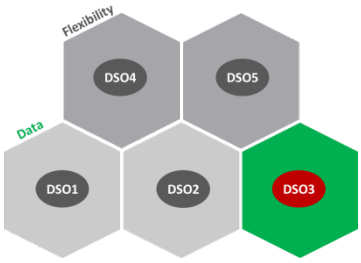
We will also assess the full impact of our investment decisions by undertaking cost-benefit analysis (CBA) from a whole systems perspective and ensuring we factor in key externalities such as carbon emissions and the positive and negative externalities that may arise from flexibility services, including for different customer groups. We will also embed analysis of network risk in our options appraisal. With power flows and network solutions becoming more complex, we need to better quantify the increased network risks arising from solutions such as traditional reinforcement, smart grid solutions, customer flexibility and flexible connections.

We will draw on the ENA Open Networks whole system cost-benefit analysis project which has developed a methodology for undertaking whole system CBA and broadly aligns with the HM Treasury Green Book. We will also look to emulate the ESO Network Options Assessment (NOA) at distribution level (DNOA). By publishing the results and assumptions of our CBAs we will ensure full transparency in our decision making and create a level playing field that ensures the best value solutions are taken forward.

There are no additional costs associated with this initiative as it will be delivered through funding including a targeted £0.7 million-£1.3 million from specific innovation allowances.

[41] IMP/001/011, IMP/001/013, IMP/001/918

DSO3 Enable open energy system data sharing and joint planning with stakeholders



DSO3.1 Open Insights data portal

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO3.1 Open Insights data portal	6.7	2.0	Availability of energy system data products (+70%) New network asset data self-service (by 2026/27) Network asset data stakeholder feedback survey and report (annually)	✓	✓	✓
Related DSAP core areas and initiative(s)						
1.04, 1.06, 1.07, 1.08, 8.13, 8.14						

Context and requirements

We have set out the need for significant change in our data capture and analysis. This deliverable details how this information will be shared with customers and stakeholders.

We are seeking to encourage flexibility markets and we recognise that some of the data we hold could unlock the potential for more flexibility as it could identify where flexibility is of use to the local network or it could identify where reinforcement will be needed to enable flexibility to be provided to the wider energy system. This is true with today's (national) energy market structure. In the future, we expect new local energy markets to be created – our own research on the customer-led distribution system (CLDS) has demonstrated that the value to customers from local energy markets as set out in section four of this annex. We anticipate that our data will be more valuable through time as market structures change.

We currently provide a range of data on our website including our long term development statements (LTDS), heat maps, and embedded capacity registers (ECR). Ofgem has set out that open data is a core part of DSO Role 1 with the focus on being user friendly. We know that simply publishing more data in disparate formats to satisfy individual requirements doesn't unlock the value that having a co-ordinated spatial data set provides. Whilst we envisage existing data availability is primarily used by expert stakeholders, who have a good grasp of electrical engineering principles, we feel it doesn't directly benefit most of our customers who may struggle to understand how electricity networks operate and the parameters in which they are managed.

This is why the online tools element is crucial for helping a more typical customer to get the best value out of our data. Our experience with AutoDesign since its launch in quarter one 2020 has shown that providing tools to customers helps them to explore and optimise the size and location of their new demand.

Our proposal

We are proposing a free online portal (open insights) for the provision of network data and tools to help a wide variety of customers and stakeholders make the best investment decisions. We see this is analogous to a personal finance comparison site, where customers can quickly compare many options, whilst adjusting their requirements to see what effect it has on their price. We feel that although the traditional connections route can and does accommodate

optioneering it can be time consuming and costly for both parties, with fewer options being considered due to the back and forth nature of these discussions. The open insights project will speed up this iterative process significantly.

We envisage the open insights project providing the following coordinated data derived from:

- rating information derived from asset registers (including GIS);
- historical and trend data derived from HV/EHV PI Coresight;
- historical and trend data derived from telemetry attached to LV circuits;
- available capabilities from the embedded capacity register;
- visibility of distributed energy resources from future DER Management systems;
- visibility of distribution system status/capacity derived from advanced distribution management solutions (ADMS) upgrades to existing DMS;
- smart metering gateway; and
- provide an ANM portal which will provide a view of existing and potential future curtailment.

We envisage the open insights initiative leveraging the digital twins (DSO2.4) and analytics initiatives (DSO2.1-3).

The open insights platform will provide the following functionality in order to satisfy several customer use cases. This is shown at a high level in Figure 16 and described in more detail for each functionality below. Different use cases will require different access levels to the system based on customers' type and experience.

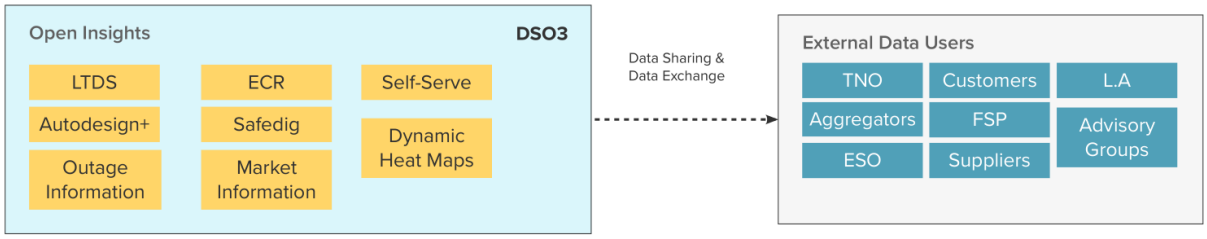


Figure 96: Open Insights functionalities diagram and example users

AutoDesign+

We plan to build on the progress we've made to date, in which we developed the self-serve budgeting tool called AutoDesign. This online system combines our static low voltage network data and statistical analysis with an estimating tool to provide customers with quick and easy budget estimate for their new connections projects. The user friendly system allows the customer to interrogate the LV network and identify the optimum connection location.

As of 2021, this tool is capable of providing budget demand estimates of up to 210kVA, however during the remainder of the current period we are planning to allow the tool to provide firm demand quotations up to 210kVA.

During the period the AutoDesign tool will be incrementally augmented to fulfil some of the following functionality:

- becoming a viewer for the entire Northern Powergrid network, showing asset records and loadings where possible. This will include raw data as well as curated data from our analytics engines. See section eight of the DSAP which discusses the customer insight and interaction portal;
- allowing the creation of budget estimates for all new connections of demand and generation (from LV to 132kV);

- allowing the creation of budget estimates for the retrofitting of LCTs (and other demand and generation increases) to existing connections;
- allowing the creation of diversion budget estimates; and
- showing real time operational status information.

At all voltages the tool will become a route into the connections process, so that multiple requests are not required to initiate a project. For example, a large generation customer could begin their connections journey by finding the optimum point of connection and the optimum export size. Once they are satisfied with the budget cost which is generated they can convert this enquiry into a full quotation request, without having to submit duplicate information - only the additional detailed information which is required to ensure a connection offer to be prepared.

The tool will also encourage whole system optioneering by encouraging distribution and transmission costs to be compared. Above a certain threshold the system will suggest a transmission application may be more suitable and therefore link to the DSO/TO connections portal to initiate a transmission connection enquiry.

At present our demand and generation availability maps display the traffic light status of our network for GSP, SP and Primary substations. These are coloured based on their suitability of accepting a fixed capacity of demand or generation. The RAG colour scheme symbolised the likely timescales and cost of a new connection. Whilst this is useful for initial optioneering it isn't a live system, it only gives the point of connection RAG colour and doesn't allow the user to change the demand or generation they are seeking to connection from the pre-defined capacity figure.

It is therefore proposed to build on the user defined heat maps at LV, which are created in AutoDesign. We envisage the incremental improvements will include:

- providing substation, feeder level and customer centric heat maps;
- providing customisable heat maps consistently from LV to 132kV incorporating forecast future loading;
- automatically updating heat maps aligned with the update of our core systems;
- allowing customers to use demand 'sliders' to optimise the size of demand or generation requested to provide the most efficient use of the assets. This will also include 'nudge' suggestions from the system to encourage this behaviour;
- assessing fault level contribution for typical generation types; and
- independent Connections Providers Point of Connection self-serve functionality.

Safedig

The Safedig system currently sits in a separate portal on our website, allowing contractors and other utilities to view and print our geographic records. As the open insights will be based on a geographic system showing our asset records, it will largely make the Safedig system redundant and will absorbed into the wider open insights portal. This will provide our customers with a more user-friendly experience.

Flexibility opportunities

The benefits that moving towards energy system model based digitals twins gives us the opportunity to allow third parties to understand what the existing and future market opportunities are likely to be. The visualisations will show our asset ratings and their utilisation in apparent power and also energy terms which will allow potential providers to assess the suitability of flexibility in magnitude and duration. The model will allow future flexible connections customers to understand likely curtailment and customer flexibility providers to understand which localities are likely to require flexibility before an invitation to tender is advertised, as well as facilitate secondary trading. For example an aggregator could prioritise signing up several communities for flexibility services where the future likelihood of a local constraint

being reached is higher. The service will also facilitate peer-to-peer trading by highlighting the network constraints between two connected parties.

Open interfaces

Whilst we intend to build on the momentum from the AutoDesign rollout, we appreciate the longer term direction of travel is for a digital twin of 'digital twins'[42]. This might be in several forms such as an ENA model, a utilities model, augmented reality systems or urban planning models. However, the enabler for these further integrations is common in the form of APIs. These APIs will allow the data to be used by third party systems and will be key to unlocking best value from the data. We also see this being an exciting 'known unknown' whereby developers and entrepreneurs combine our data with other data sets for purposes we hadn't envisaged. We've already started to see this with volunteer based open infrastructure maps showing worldwide telecoms and electricity infrastructure and grid level energy generation/consumption for profit services which link land use data with electricity infrastructure data.

As mentioned in initiative 3.4 our network data will be accessible in CIM format to allow for stakeholders such as the ESO and IDNOs to incorporate into their network models.

Outage information

We already publish our present outage information on our website; however it is currently not integrated into the heat maps or AutoDesign. We therefore propose to integrate it into the Open Insights portal.

We are also proposing to publish historical outage information to allow customers to challenge us regarding the outages they've experienced. It will also allow future connections customers to look at the impact of security of supply arrangements in regards to frequency and duration.

Open decisions

We are also proposing to publish the results of our network investment decisions alongside our existing 'investments in your area' map. This will also help stakeholders to see what was considered and why the proposed investment was ultimately chosen. There will be an option for customers to feedback their thoughts to both shape our future decisions and help the customers understand why we've made particular decisions.

Education resource

The move to net zero will require a considerable level of new highly skilled entrants into the power sector. These STEM skills are already in short supply and we have a part to play to encourage more people to be interested in how the energy systems works and go on to study STEM subjects. The role that Open Insights will play is to allow users to explore the information and tools, find how their individuals' homes are powered and the impact of connecting large and small LCTs has on the network.

Our approach to open data is a transformational programme of work, integrating many systems together the following risks and mitigations have been identified:

- Some of the functionality may not be possible within the budget and/or timeframe as proof of concept work for some of this work has not yet been undertaken. We expect that the exact definition of these plans will need to change as we learn more; however these are reasonable five-year planning assumptions.
- There are data protection and privacy issues regarding individual customers' consumption which may make some of the functionality difficult to implement as we will be unable to publish the data in question. We will continue to engage with our network colleagues in other companies as well as with stakeholders and external experts to work out how to run triage processes alongside the principle of presumed openness to which we subscribe.

[42] https://www.cdbb.cam.ac.uk/

- Although there are no known providers of this tool, the act of providing this tool may distort the market and discourage new market entrants from participating. Dialogue with Ofgem, BEIS and stakeholders will continue to review the boundaries that are appropriate between our role and that of the market participants. There is a need to keep this under continual review as we push on with our plans.

The technology which forms the foundations of Open Insights is described in the DSAP, in particular around data integration between existing and new systems and implementation of hybrid cloud data platform (1.04, 1.06, 1.07 and 1.08). Initiatives 8.13 and 8.14 describe how the AutoDesign self-serve functionality will be delivered.

In total we envisage that we will need to invest £5.8 million in systems and £0.8 million in people to deliver our Open Insights plans.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.2	1.2	1.2	1.2	1.2	**5.9**
People (£m)	0.2	0.2	0.2	0.2	0.2	**0.8**
						6.7

Table 9: Costs - Open Insights data portal

DSO3.2 Deploy a team of Local Area Energy Plan (LAEP) advisors

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO3.2 Recruit Local Area Energy Plan (LAEP) advisors	2.4	6.0	Number of LAEP engagements reported (annually)	✓		
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

To achieve the net zero target, policies for facilitating decarbonisation will need to be a part of a coherent energy policy framework that optimises the UK energy system as a whole – addressing the synergies between, and the issues faced by, transport, heat, and power sectors alike; and not in isolation, whilst also facilitating a cost-effective and socially inclusive low-carbon transition. An effective, affordable, timely, and fair transition to a low-carbon energy system will require coordination between local and national government, network operators, energy suppliers, businesses, and individual consumers. Currently, there is no structured, whole system planning process in place to help manage this transition.

National policy decisions and funding will, to great extent, dictate the approach local authorities will be taking to decarbonisation, which includes the development of Local Area Energy Plans (LAEPs). LAEPs are a relatively new concept, introduced by the Energy Systems Catapult. A LAEP is the product of collaborative planning, involving a wide range of stakeholders to agree on the optimal long-term energy solution for an area. It considers the entire energy system – heat, electricity and transport and the supply chain from energy generation to transporting it into homes and businesses – and looks at what the best value-for-money approach is at the local level.

LAEPs are seen as a key practical tool to meeting the net zero emissions target, recognising the heterogeneity of local areas. LAEPs could play a role in creating a joined-up regional consensus and call for coordinated action that is required, and providing robust evidence for planning for (and investment in) net zero energy systems.

There is, as yet no universal definition of what LAEPs could and should comprise, whether they should be part of the spatial planning process, or how they should be funded. This is echoed in the recent research carried out by Citizens Advice[43].

[43] https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Local%20Energy%20Report.pdf

- Energy Systems Catapult have placed the emphasis on local government to act as a leader and enabler, in conjunction with other stakeholders who can help to achieve area visions and targets, bringing energy considerations into the planning process to facilitate emissions' reduction, especially when it relates to decarbonisation of heat.

- Ofgem expect that LAEP should include elements of:

    - wide-range stakeholder engagement;

    - cross-vector approach for heat decarbonisation (whole system solutions); and

    - improve (local) investment planning decisions.

- As outlined in Ofgem's guidance, a LAEP should possess the following attributes: transparent; independent; consensus-based; based on robust evidence; aids decision-making; uses a whole-systems approach.

- The Climate Change Committee (CCC) recently endorsed the production of LAEPs[44.]

While not yet clearly defined, this is not an entirely new idea: we have consistently heard from our stakeholders that there is an appetite to do something beyond the usual scope of investment planning and enable greater collaboration and coordination.

As no single model of best practice is clear, we have been engaging with our stakeholders on this subject to understand our role in supporting LAEPs, recognising that 'one size does not fit all' for our stakeholders or regions and bespoke frameworks for each of our local authorities (LAs) would also not be efficient or pragmatic.

- Taking the lead role is likely beyond our remit. We think local governments are the ones who have the mandate to lead and take decisions. We recognise that there are roles we could take on, from project management and logistical support through to data provision and drawing conclusions.

- Our area of expertise is confined to one energy vector, i.e. electricity, and going beyond that would result in a conflict of interest. It is not our role to advocate which technologies should be adopted by customers to decarbonise our region. Our customers and BEIS have agreed that networks should see themselves as a key stakeholder in LAEPs but not a key financer for LAEPs.

- Provision of information and data is a major contribution that is present in all definitions of what LAEPs could comprise. Our modelling, open data and engagement approach to Distribution Future Energy Scenarios (DFES)[40] is a useful platform or 'pump prime' for LAEPs. We are sharing detailed information on future energy scenarios that is being used to guide our development of plans for the local electricity network and enabling collaboration on plans. It also acts as a tool to illustrate and expose the scale of change necessitated by providing a localised view of low-carbon technology uptake.

- We are already seeking to align our plans with our stakeholders' through their feedback on DFES; more robust, better, and comprehensive evidence to support our network planning is welcomed.

Our area covers more than 30 LAs; five combined authorities and seven Local Enterprise Partnerships (LEPs). We have been working closely with the local government representatives to understand their plans for decarbonisation. Our engagement on LAEPs includes:

- LAs, CAs and LEPs through our LA Forums on 21 October 2020 and 11 March 2021, co-hosted with Northern Gas Networks;

[44] Climate Change Committee, June 2020. Reducing UK emissions. Progress Report to the Parliament. "LAs should have a key role in LAEPs, alongside network operators [and Ofgem], especially in relation to building community consensus on plans for decarbonising heating".

- LA officers and regional political leaders through our political engagement programme and in writing.
- Bilateral discussions with Newcastle City Council, City of York Council, Durham County Council, Hull City Council, York and North Yorkshire LEP, Greater Lincolnshire LEP, Combined Authorities, Northern Gas Networks (NGN), Cadent, Energy Systems Catapult, BEIS Regional Hub, and BEIS Local Energy team;
- Wider stakeholders through our net zero events on 29 September and 16 October 2020, and through a dedicated breakout session in regional net zero leader's forums in 2020; and
- General feedback on net zero planning gathered from consumer panel, SME panel, community energy stakeholder panel, future customers panel, stakeholder panel, emerging thinking colleague survey, customer base survey, among others.

More than half of LAs in our region are aspiring to meet net zero emissions' target ahead of 2050. They will need bespoke approaches to achieve these challenging decarbonisation targets.

- The availability of expert resources in LAs remains a key issue; financial considerations are also often stifling the ambitions of our local stakeholders. In a number of cases, there is not yet a plan for the plan.

Figure 17: Participant feedback to the question: What would you need to enable your area to produce a LAEP? (Northern Powergrid's Local Authority Forum, 21 October 2020).

- There is a strong appetite for an even closer working relationship with Northern Powergrid and a recognition of the need for more collaboration at a strategic level to ensure effective planning and increased confidence in deliverability of projects.
- More than 10 LAs are looking to pilot a LAEP.
- BEIS have funded the development of local enterprise partnership (LEP) Energy Strategies. We are working with the LEPs in our region to understand, and contribute to, their work in this area. While the Energy Strategies capture the aspirations and outline the bespoke proposals suggested for the respective LEP areas, we believe they are not definitive action plans and as such cannot be viewed as LAEPs; and
- We are working with Northern Gas Networks to coordinate our approach for this purpose and have published a joint Charter,[45] outlining four principles and actions we will be applying over the next year to support the evolution of LAEPs in our region. Our joint commitments include supporting a single conversation, in which local government does not need to navigate between the networks; providing expert advice to local projects that

[45] https://www.northernpowergrid.com/asset/0/document/6056.pdf

seek to explore and plan for a range of pathways; developing a joint plan for how to most effectively share data that will support LAEPs; and working closely with Ofgem and central government, to identify funding for LAEPs.

Our proposal

Recognising the need for expert resources, demand for ongoing engagement and coordination, as well as the merits in offering more bespoke support to our local stakeholders, we are proposing to support the design of LAEPs by employing LAEP advisors. To maintain an optimal level of granularity and local knowledge, we are proposing to invest £2.3 million to employ six LAEP advisors, one in each of our operational regions. We expect these colleagues would:

- Work in collaboration with LAs and the wider energy sector, utilising knowledge of the network, loading projections, customer activity and the wider environment to provide useful feedback to LAs on their plans for future development.
- Understand the range of processes that local authorities use to map out their decarbonisation pathways and actions.
- Be able to couple their network design engineering expertise with the strategic decarbonisation objectives and local knowledge.
- Work closely with the local design teams, the respective regional team, and collaborate with the policy and the stakeholder engagement teams, including the Community Energy Advisors (further information on which can be found in the our communities section of our business plan).
- Coordinate the provision of data and information to inform stakeholders (through Open Insights DSO3.1).
- Inform our network planning by generating better and more comprehensive local insights or evidence to improve our forecasting and DFES (DSO2.3).

These people could be re-deployed existing colleagues, new recruits, or a mixture of both. Whatever their background, the people need to have a blend of technical knowledge and relationship building skills. To be effective, these roles are about linking external and organisation datasets and knowledge such that different plans are complementary and co-ordinated. Our stakeholder feedback has been that it is only through working together that we will be able to tackle the significant challenge that is urgent regional decarbonisation. These new positions to enhance regional collaborative energy planning are a key aspect to realising this goal.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	**-**
People (£m)	0.5	0.5	0.5	0.5	0.5	**2.4**
						2.4

Table 10: Costs LAEP advisors

Initiative 3.3 Decision making transparency

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 3.3 Decision making transparency	0.2	0.5	N/A	✓		✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

As described in initiative 2.6, we have set out how we will deliver unbiased decision making for customer and network investment solutions as the use of our network increases in line with decarbonisation. **We also want to provide more visibility for our stakeholders to allow them to give feedback on our major investment decisions for both traditional reinforcement and flexibility services.**

Our proposal

This initiative outlines what we will do to ensure that there is the necessary transparency for our stakeholders so that they may see how we are developing the use of flexibility and managing perceived conflicts of interest between our market facilitator and network ownership role.

Our activity will be focussed in the following areas:

- engaging with stakeholders – providing information, external ideas and the opportunity to ask questions;
- providing independent view – using external auditors and our internal audit function; and
- reporting – data to demonstrate the effectiveness of our actions including external visibility of the results of audits.

In refreshing our stakeholder engagement we will include for a stakeholder panel to be given enhanced insight on our flexibility actions. This will provide the opportunity for more feedback to guide our developments as well as scrutiny and challenge of the detail of our actions. It will enable a well-rounded view of how our actions on developing flexibility are also being implemented alongside priorities to assist vulnerable customers (for example)

As set out in initiative 2.6, we have already taken steps to make clear our approach to making investment decisions. To promote transparency, we are planning to conduct an annual independent audit of this decision making and will publish its findings.

The reporting we propose covers both the planning and operation of flexibility:

- For planning, we propose to publish our cost benefit analysis (CBA) that supports our decisions to procure customer flexibility or implement a network solution.
- As required by our flexibility services procurement statement, we will continue to publish our forward-looking plans for the use of flexibility and report on actions in the previous year. Further, the results of procurement events will be shared.
- Our operational reporting will include details of flexibility dispatch decision criteria and learning from dispatch and settlement processes.

We will publish the results of flexibility markets, to ensure transparency and a level playing for our appraisal and decision making processes. This will apply to both long term system planning and short term/close to real time outage management including major system risk.

We are proposing to invest £0.2 million to provide dedicated resource to support this initiative which will be located in the new DSO Business Unit and will be functionally separate from the operation of decision making on network and customer solutions (is located in the engineering function).

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	-
People (£m)	0.04	0.04	0.04	0.04	0.04	**0.19**
						0.19

Table 11: Costs of decision making transparency

Initiative 3.4 Enhanced data exchange between DNOs and the ESO

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 3.4 Enhanced data exchange between DNOs and the ESO	2.6	1.0	N/A	✓	✓	●
Related DSAP core areas and initiative(s)						
1.03, 1.04						

Context and requirements

The visibility and availability of data is crucial to building and operating a smart energy system. We will enhance our data capture, data management and analytics capabilities (see 1.1, 2.1-2.3) as well as improve the way we share data with stakeholders and customers (see Open Insights DSO3.1).

We are currently required to provide planning data to ESO twice annually to fulfil Grid Code[46] requirements or when making a request for a statement of works[47]. In both instances, the data provided is in the form of MS Excel workbooks and spreadsheets. The preparation and sharing of this data is a manual manipulation of source data collected from different systems. Once sourced, the data is submitted either by email or saved on an online data exchange platform. Similarly, ESO provides planning data to us annually to fulfil its Grid Code obligations in a similar way.

Although this method has proven to be effective for many years, it is becoming no longer suitable and efficient due to the increasing volume of data being exchanged and the increasing frequency of that exchange, particularly in relation to statement of works requests. One of the recommendations from the Energy Data Task Force report is that data needs to be made available in an open and interoperable format. It is therefore a requirement for planning data to be exchanged in a standard electronic format such that it can be quickly and automatically incorporated into existing network models, creating a whole system model that can be executed within any standard power system analysis software tool.

Our proposal

We will use a common vocabulary and basic ontology to exchange information with third parties such as ESO and other DNOs to facilitate efficient planning of networks. Through the Open Networks project we identified the common information model (CIM) approach as the widely preferred industry standard for data exchange and we will work towards implementing that. We will work with the rest of the industry to agree the most appropriate CIM standard and version, the data items to be exchanged and the Interface Point Definitions that identify the boundaries of a CIM model. We will assess the data implications of CIM adoption and adapt accordingly. We will agree triggers for data exchange and establish the appropriate portal to host the data and test the end to end data exchange solution. Data to an agreed CIM standard and version can be made available to other parties through Open Insights (DSO3.1) and used as an interface

[46] The Grid Code details the technical requirements for connecting to and using the National Electricity Transmission System
[47] SOW is the statement produced by National Grid as System Operator (in conjunction with the relevant Transmission Operator) for the DNO, which indicates whether there is a need to carry out additional reinforcement works on the transmission network as a result of the new small embedded generator.

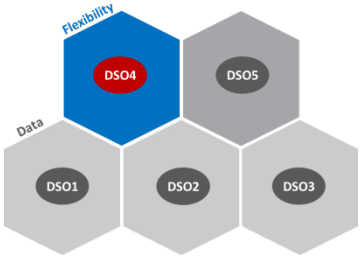
with different internal systems. This initiative is inherently about integration and portability of data and is discussed within initiatives 1.03 and 1.04 of the DSAP.

The costs are anticipated to be £2.6 million, which includes costs associated with building and testing the new systems and the people associated with updating and maintaining the data.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.0	1.0	0.1	0.1	0.1	**2.2**
People (£m)	0.1	0.1	0.1	0.1	0.1	**0.4**
						2.6

Table 12: Costs of enhanced data exchange

DSO4 Enhance processes and systems for network operations to enable a step change in our capability to operate and optimise a system with increasing customer and network flexibility



DSO4.1 Flexibility services processes and dispatch system

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.1 Flexibility services processes and dispatch system	3.9	2.0	Error corrections issued for dispatch (<10%) Late issuance of dispatch data (<10%)		✓	
Related DSAP core areas and initiative(s)						
2.01, 2.02, 2.04, 2.05, 9.06						

Introduction

For flexibility services to be an integral part of system design and operation, new processes and technologies need to be established. To date, we have been focusing on the processes and team roles for the decision making required for all flexibility use cases and these are being included in our codes of practice for use when a need arises. These codes of practice include the exploration, design and costing of network solutions as well as exploration, design and market engagement to establish costings for flexibility service solutions (See DSO3.3). We have also joined forces with four other DNOs to collaboratively deliver flexibility services through the Flexible Power platform. Our aim is to create a single point of information in respect of flexibility service requirements across all participating DNO licence areas. Flexible Power also provides a portal and API for flexibility service providers (FSPs) to enable them to register meterable units[48], make availability declarations and to enable DNOs to dispatch flexibility services.

The integrated processes encompassing the appraisal, provision, procurement, dispatching and settlement of flexibility services through customer assets is one module of a DERMS[49] for a DSO. These includes operational forecasting capabilities such as the identification of real-time flexibility needs, declaration of availability windows ahead of real-time and the dispatch of flexibility services based on network conditions close to real-time. In addition to flexibility services, DERMS has high degree of integration and automation activities such as ANM (see DSO4.2) and interfaces with Advanced Distribution Management System (ADMS), which enables network flexibility through the control of network assets (see DSO4.3). A fully integrated DERMS would also manage any potential conflict between connection contract obligations and flexible service arrangements between ESO and a DSO (see DSO4.4) as well as facilitate efficient settlement and reconciliation of provided services (see DSO5.4).

Context and requirements

DERMS encompasses a number of capabilities to manage DERs effectively and efficiently in an integrated way coordinated to meet whole system requirements. These capabilities include the identification of real-time flexibility

[48] A meterable unit is an asset or a group of assets with reasonably precise and granular (frequency) data that would allow confirmation and reconciliation of flexibility service provision.
[49] DERMS for DSO encompasses different modules to manage DERs effectively and efficiently in an integrated and coordinated way to meet whole system requirements. It enables optimised and proactive network management and stretches from planning to operations for the management and control of customer assets. See Figure 13 and relevant text

needs, declaration of availability windows ahead of real-time and the dispatch of flexibility services based on network conditions close to real-time. Significant steps have been taken to date by network companies both independently and collectively through the Open Networks project to enable the development of flexibility services markets in GB. We will continue the work to further evolve our decision-making process and the team roles required for delivering flexibility services as well as facilitating better interaction between the business units responsible for planning and operational activities. As the number of DERs connected to our network increases, there will be more opportunities to support the efficient operation of our network using flexibility services and to realise the value offered by them. Understanding the required functionality of and investing in DERMS will be an important enabler in unlocking this value.

DERMS can be used to optimise network power flow and enable faster acting optimisation routines to address local aspects of operating the system in response to real time network conditions. For example, flexibility services could be secured and deployed to reduce the impact on customers when a network fault occurs during a planned outage. Formalised process and systems are therefore required to ensure that there is a shared understanding of the role of flexibility services within planning and operational teams, to ensure that where flexibility services are incorporated into the design of the network, by network planners, the operational teams are aware. For example, where flexibility services are an alternative to reinforcement, this should be clear to the operational teams who will need to dispatch the required flexibility services in defined scenarios. This will require systems to provide information to operational teams of the scenarios when flexibility should be expected to be deployed and the valid flexibility contracts in place at any one time. Network operations will also need to be able to utilise flexibility services to support the network during network capacity shortage due to complex network faults that are beyond the scope of network planning standards.

The ability to undertake power system studies in operational timeframes to better understand local network conditions and determine any need to deploy flexibility services (e.g. planned outage assessment and alternative network running arrangements) will therefore be required (delivered through DSO2.3 and DSO2.4). Finally, processes to improve the interface with flexibility service providers and introduce a way of working where flexibility requests are signed off and agreed by all parties are also necessary and need to be documented within one central system.

Progress to date

At present, we are using the Flexible Power platform to engage with flexibility service providers[50]. The platform allows contracted flexibility services providers to register metered units and set up dispatch groups. We would declare availability windows where providers offer their services. When a flexibility service is required a dispatch signal would be sent to the service provider via an API and the delivery of that service reconciled and paid for following service provision. The platform is also capable of registering, dispatching, billing and paying flexibility service providers for the services they deliver. However, Flexible Power is a standalone product and is not integrated to our network management or procurement systems. Greater integration of Flexible Power (or a similar platform) with core business systems will be required as the number of flexibility services procured and dispatched increases.

Our proposal

We will continue to work with the industry and solution providers to develop a system that meets network and customer needs. Going forward, the chosen platform must be integrated with our network management system to use network data, automate the dispatch of technology agnostic flexibility services by considering network configuration, network load, network contingencies and flexible connections[51] and automatically dispatch, reconcile and calculate compensations.

Any fit for purpose solution therefore must be scalable, fully integratable with our planning, operational, procurement and settlement systems and able to push information out (e.g. requests for expressions of interest through an API) to interested stakeholders such as customers and the ESO. In addition to refining existing processes and developing new systems and capabilities, these additional responsibilities will require additional people in our planning, information systems and network operations teams. The key enabler for delivering flexibility services is the development and deployment of DERMS which is covered in initiatives 2.01 and 2.02 of the DSAP. It is supplemented with forecasting and analytics capabilities for improved and efficient network operations, both captured under initiatives 2.04 and 2.05.

[50] https://www.flexiblepower.co.uk/
[51] Flexible connections may have limited flexibility mandated through their Connection Agreement.

The costs are anticipated to be £3.9 million, which includes costs associated with existing or new system development and integration and the people needed to fulfil the new roles in information systems and control room that will be focused on implementing and operating such systems (e.g. equivalent of a Balancing Engineer). Our spending profile is based on the assumption that our investment remains through the Flexible Power collaboration, at least in the early part of the period. We will keep our investment profile under continual review to ensure investment is well timed to get up to date product solutions as markets scale up. A key decision point for the early part of ED2 is the pathway we choose to upgrade to an enterprise DERMS solution that offers greater sophistication and functionality to meet growing market needs to operate customer flexibility.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.5	1.5	0.0	0.0	0.0	**3.1**
People (£m)	0.2	0.2	0.2	0.2	0.2	**0.8**
						3.9

Table 13: Costs of flexibility services

DSO4.2 Enhanced enterprise Active Network Management (ANM)

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.2 Enhanced enterprise Active Network Management (ANM)	5.2	2.0	ANM flexibility volume connected to our network (reported annually) Number of connections with ANM agreements (reported annually)	✓	✓	
Related DSAP core areas and initiative(s)						
2.02, 2.03, 2.08						

Introduction

The rapid growth in DERs over the last decade has put an immense pressure on network operators to provide timely and cost effective connection to the network. We achieved this through a variety of solutions such as flexible connections, where customers can have a small portion of their maximum import/export capacity limited at times when the grid is congested, or real-time control and active network management (ANM), all bespoke solutions to address specific problems and manage DERs as per customer requests. Coordinating their development, integrating and aligning it with distribution network planning, development and operations can add value to utilities and customers and potentially create a market. This will require new technologies and a new set of capabilities as network planning, operations and market development should be tightly coupled and integrated.

To date we have 433MW of contracted flexibility from generation curtailment across four areas and are expecting to connect another 104MW within the same zones by the end of the 2015-23 period. A further 633MW of flexible connection capacity has been accepted by customers across three new areas and not yet built out. The progress of these connections (and others) in the 2023-28 period will be determined by the customers involved.

A high degree of integration and automation activities such as ANM can be combined into a control system often referred to as distribution energy resource management system (DERMS) which enables optimised and proactive network management (see Figure 13). As discussed in previous sections, DERMS could be incorporated or be distinct from network management systems, known as advanced distribution management Systems or ADMS, used primarily to manage and control network owned assets (see DSO4.3). For Northern Powergrid, the two are likely to be distinct systems but to ensure DERs are managed and controlled in-line with network capacity and configuration (for example affected by planned and unplanned outages), the two must share live information. Full system integration will also allow conflict management between various connection and contract arrangements.

Context and requirements

Our ANM scheme is a separate and not a core functionality of our operational NMS system. The servers supporting the scheme are suitable for the assigned task, however they are not specified for expansion into an enterprise solution. A change to DCUSA from April 2020 altered the funding arrangement for ANM systems from being customer funded to DNO funded. This alteration enables DNOs to be less reactive in their development of ANM systems allowing greater consideration to be given to an enterprise approach and associated integration with wider systems such as NMS and customer flexibility dispatch systems. Although our existing ANM scheme is suitable for its assigned task, it is not suitable for hosting additional ANM deployments and has limited off-site disaster recovery provision. We are already transitioning towards an enterprise processing capacity for future ANM schemes, which will allow a more secure and resilient system with efficient and cost-effective scalability. This will enable us to deploy ANM in our Operational Technology (OT)[52] environment without constant additions of hardware and ancillaries. In developing this, we will also consider its relationship with and constraints imposed by existing systems such as PowerOn, Energy IP smart metering monitoring and corporate IT. The existing systems, with the exception of the ANM, are only capable of data receipt with minimal facility to store incoming data, no working copies of network data and no facility for real/near real time processing. Establishing a strategically secure and resilient platform which dovetails with existing systems and secures both incoming data and working copies of the electrical model, is a necessary foundation for developing systems to support DSO operations going forward. The need for a platform which can support future ANM systems is also necessary for managing low carbon technologies to support DSO operations. ANM historical and forecasted curtailment information would also be pushed out to customers through open insights (see DSO3.1). Such platform would also have to interact with the flexibility services dispatching platform (see DSO4.1), which is another component of DERMS.

Our proposal

Considering the existing abilities and the headline future requirements, we would require to move away from a standalone ANM system by incorporating the core HV+ digital twin, establish an internal communication link between DERMS and ADMS (for example using an Inter-control Centre Protocol, ICCP[53]) to obtain analogue values and exchange other data such as scheduling data, operator messages and status updates. Additionally, we would need to integrate any additional external communications into existing and new systems such as additional local DER monitors and controllers. Similar to DSO4.1, this is capability is underpinned by DERMS but also requires integration with a future ADMS, both covered in DSAP 2.02 and 2.03 respectively.

Although not common yet, there is a growing interest in microgrids (e.g. community microgrids) – for example see whole systems initiatives 2.5 and 3.3 and deliverable 3.1 as well as the related Consumer Value Proposition. Microgrids are decentralised group of electricity sources and loads that operate in island mode or connected to the local grid. Microgrids can drastically improve resilience, particularly for remote customers. They are local energy grids which operate normally while connected to the wider grid, but have the capability to disconnect and operate autonomously when needed. Microgrids can also potentially facilitate peer-to-peer energy trading, and enable customers to maximise the value of their energy assets (e.g. solar panels) by providing energy to both the local microgrid and the wider system. Microgrid should be able to integrate with DERMS and incorporate their control as an entity with the operation of other DER on the same network (feeder or substation). Microgrid control can be centralised, decentralised or coordinated and will need to satisfy requirements of voltage and frequency stabilisation and synchronisation. Given their early stage, it is unclear whether this will be a new functionality or part of this enhanced ANM. Regardless, the system will need high fidelity monitoring and able to control load, generation and frequency in real time. The enablers for the management and control capability of local microgrids is covered in DSAP initiative 2.08.

The costs are anticipated to be £5.2 million, which include costs associated with upgrading existing systems and the people who will work on the development, delivery, integration and management. This includes £50,000-£100,000 in BAU commercial innovation funding.

[52] The hardware and software dedicated to detecting or causing changes in physical processes through direct monitoring and/or control of physical devices. This includes all processes in a loop between sensing and output of operational actions including communication, storage of received data, holding working copies of network data and real time/ near real time processing of data prior to application back to system operation. For design or reporting purposes the data is transferred to Corporate IT systems.

[53] ICCP is a standard protocol which provides a managed structure for real-time data exchange. Such protocol standardises the data exchange between network management systems from different vendors inside utility systems as well as between utilities, system operators and DERs.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.9	1.9	0.2	0.2	0.2	**4.4**
People (£m)	0.2	0.2	0.2	0.2	0.2	**0.8**
						5.2

Table 14: Costs of enhanced ANM

DSO4.3 Develop network flexibility solutions

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.3 Develop network flexibility solutions	4.5	1.0	N/A	✓	✓	
Related DSAP core areas and initiative(s)						
2.03, 2.04, 9.05						

Introduction

In the scenarios and investment section of our business plan we define four types of flexibility as the basis of our flexibility first approach to our decarbonisation-related investment strategy: flexibility services, price-driven customer flexibility, flexible connections and network flexibility. The latter is explored in this section. We define network flexibility as the control of existing network assets to provide whole system services and ultimately reduce the requirement to undertaken traditional solutions. We are maximising the flexibility of the assets by installing bolt-on smart technology or capability that enables us to operate the network in more active manner and accommodate the new low carbon uses.

We already perform some of these functions such as our automatic power restoration system and have been enabling the more advanced control of our major substation transformers through our smart grid enablers investment. These existing actions ensure that our system can automatically reconfigure itself in certain operating conditions. During the period we plan to leverage these previous investments by adding additional functionality that will provide additional value to both our customers and the whole system.

Context and requirements

In the hierarchy of decision making to manage system constraints, once an asset or part of the network has been confirmed to be out of parameters[54], the lowest cost option before contracting customer flexibility is often to leverage network flexibility. Network flexibility has an extremely low marginal cost, as the assets, communications system and control system are largely already in place.

At present, we use network flexibility in an automated way to perform APRS, and in a manual sense to perform load transfers.

As we anticipate widespread demand increases on the network we see large benefits in expanding the use of network flexibility. We are proposing to perform several new functions including:

- Automatic load transfers to optimise network power flows, resulting in de-load assets based on their real time ratings. In particular, we have explored the use of enhanced transformer ratings using HV network automation within the network investment EJPs. An enhanced control scheme will be deployed and will include an automated HV demand transfer scheme to cover shortfalls in the transformer real time rating and support long-term demand growth.

[54] In probabilistic terms.

- Voltage optimisation for conservation voltage reduction and increasing the amount of voltage headroom for distributed generation (refer to our whole systems strategy, deliverable WS3.2 voltage optimisation.

- Implementation of CLASS[55] to provide services to the ESO and the whole system deliverable WS4.3 distribution asset-based ancillary services to ESO.

- Investigate the use of ANM (i.e. network flexibility infrastructure) in order to unlock customer flexibility to provide whole system benefits (including services to ESO), whole system deliverable WS1.4 customer-led system balancing.

The benefits of these new functions are mainly to keep the network conditions of the whole system (i.e. including the transmission network) within parameters through controlling real and reactive power flows and voltage control set points. As mentioned above these actions can (and sometimes are) done manually but the forecast increased frequency of these interventions and the higher utilisation of the network mean that this is no longer practical.

Progress to date

PowerOn Fusion is the software package used to provide our network management system (NMS) which monitors and controls the HV/EHV/132kV distribution system. It is a critical package necessary for the safe and effective operation of the HV and EHV electrical networks. During the current period NMS has been upgraded to facilitate automatic supply restoration (APRS) and automatic load transfer.

As part of the smart grid enablers programme we have replaced AVCs in many of our major substations, upgraded their RTUs and the associated communications infrastructure and continued to install remote control and monitoring on our distribution substation fleet. We are also running an innovation project called Boston Spa energy efficiency trial (BEET). This is investigating the use of distributed voltage readings from smart meters to optimise network voltages in near real-time, which forms the basis of our voltage optimisation deliverable and customer value proposition (CVP) described in the whole systems strategy (refer to the main business plan and our whole systems strategy for further detail).

Our proposal

In the 2023-28 period we plan to build on the enabling work we will have already carried out to deliver increased amounts of network flexibility. To add this new functionality we are planning to upgrade our NMS system to evolve into an advanced distribution management system (ADMS). This is detailed within initiative 2.03 of our DSAP.

The proposed ADMS system will incorporate new modules to monitor power flows and voltages in order to control the AVCs, circuit breakers and switches in near real time in order to provide this new functionality. This functionality requires advanced analytics to predict and control the network which are described in DSAP initiatives 2.04 and 9.05.

The new modules will benefit from the other DSO initiatives such as DSO2.2 in order to provide high quality and trusted data and DSO2.4 to create a digital twin of our network in order to model the network in operational timescales.

The table below shows how each of the proposed new functionalities will build on our investments and the benefits this will realise.

[55] Including tap-staggering for (reactive power) voltage support and voltage adjustments to provide (active power) frequency support.

Functionality	Leveraged enabler	Proposed enabler	Benefit
Automatic load transfer	RTU replacements, HV remote control of switches	NMS to ADMS upgrade	Deferment of traditional reinforcement, enhance network flexibility to remove barriers to customer connections
Voltage optimisation	AVC replacements BEET innovation project	NMS to ADMS upgrade	Customer energy savings and deferment of traditional reinforcement
CLASS	AVC replacements	NMS to ADMS upgrade	Deferment of traditional reinforcement on transmission network (and to a lesser extent on the distribution network). BSUOS savings for the ESO and therefore customers

Table 14: Building on investments

Please refer also to DSO4.6 where we explain our plans in relation to trialling and operating CLASS in 2023-28. Note that costs for ADMS which provide CLASS functionality would be incurred irrespective of whether we offer CLASS services as detailed in deliverable DSO4.6.

More generally, the scale of the data and digitalisation transformation set out in DSO4.1 (customer flexibility/DERMS), DSO 4.2 (ANM/DERMS) and DSO 4.3 (network flexibility/ADMS) is recognised as a major systems implementation upgrade programme for 2023-28. The steps required for control and assurance including managing integration risk is addressed in our approaches for data and digitalisation (see DSAP and Data and Digitalisation Justification Annex).

The costs are anticipated to be £4.5 million, which include costs associated with incorporating new modules and the employment costs of the people associated with their development, delivery, integration and management.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.8	1.8	0.2	0.2	0.2	**4.1**
People (£m)	0.1	0.1	0.1	0.1	0.1	**0.4**
						4.5

Table 15: Costs of developing network flexibility solutions

DSO4.4 Architecture and processes for effective deployment of flexibility services across transmission and distribution networks

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.4 Architecture and processes for effective deployment of flexibility services across transmission and distribution networks	1.5	1.0	Operational data exchange ESO-DSO (>90% system up-time)		✓	●
			Constrained data exchange ESO-DSO (>90% system up-time)			
			Common flexibility dispatch principles (developed by 2025)			
Related DSAP core areas and initiative(s)						
2.09						

Context and requirements

To facilitate a wider effective dispatch of flexibility services, there needs to be tighter integration between DERMS (including ANM for super grid transformer (SGT) constraints), ADMS, DER, FSP and ESO as well as an agreed operational framework across the industry. Such integration and architecture would allow the dispatching of DER and FSP to address local issues but also enable the ESO to procure services for wider system issues (e.g. ancillary services) through the DSO

without necessarily specifying particular units. In the latter case, the DSO would act as a service provider to the ESO by using the established link it has with FSPs to provide ancillary services the ESO needs. For the successful delivery of this service there needs to be:

- near-real-time data exchange and an agreed hierarchy incorporated so that DERs and flexibility services are dispatched accordingly to prevent conflicting operations;
- common framework across industry participants to prevent interference and conflicts between the operation of different services such as the National Grid balancing mechanism, the ESO ancillary services and DSO flexibility services; and
- commercial, contracting and payment processes.

As FSP will provide these services indirectly through the DSO, the DSO will need to interface with the ESO in real time. This is a completely new activity which requires a communications system between the DSO and ESO (communication between DSO and FSP should already be established). The currently accepted communications technology for real-time data exchange between DSO and ESO uses an Inter-control Centre Protocol (ICCP), a standard protocol which provides a managed structure for real-time data exchange between utility control centres. Such protocol standardises the data exchange between network management systems from different vendors. Data exchanged will need to be agreed and typically covers alarms and plant status, analogue values, and control requests.

Our proposal

From a security standpoint, we will need an ICCP gateway device to connect to the ESO and potentially other interested parties such as IDNOs or DSOs through a dedicated communications link. Such communication medium roll-out will achieve near real-time coordination and manage conflicts of interests, allowing customers to stack revenue whilst meeting the transmission and distribution system technical requirements. Flexibility dispatch plans and forward planning will be shared in advance between the two parties, possibly through a web API, to avoid concurrent planning of operations. This capability would also allow the ESO to issue operational tripping arming instructions under rare N-3[56] conditions of a degrading grid supply. This is directly enabled by DSAP initiative 2.09.

In addition to the communication medium, an appropriate framework will need to be established and agreed to facilitate the effective operation of such service and avoid conflicts. We will work with the industry to understand the existing framework and governing codes and develop them further so that they can enable this. We will also develop and implement commercial, contracting and payment processes which will be reflected in bilateral or where necessary a tripartite agreement between DER, DNO and ESO to ensure co-ordination.

The costs are anticipated to be £1.5 million, which include costs associated with existing or new system development and integration.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	1.1	0.0	0.0	0.0	0.0	**1.1**
People (£m)	0.1	0.1	0.1	0.1	0.1	**0.4**
						1.5

Table 15: Costs of architecture and processes

[56] An N-3 scenario could occur when two unplanned outages follow a planned outage.

DSO4.5 Upskill and recruit engineers to use whole systems thinking

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.5 Upskill and recruit engineers to use whole systems thinking	3.7	1.0	N/A	✓	✓	✓
Related DSAP core areas and initiative(s)						
N/A						

Introduction

The move towards a DSO will require a significant review of the skillset of the roles within our business. In some areas this will be incremental in nature and in other areas where we have limited experience it will resemble a paradigm shift. To manage this change we are planning a three staged approach depending on the nature of skills gap required. These are:

- maintain – minor/incremental skills improvement;
- upskill – major skills improvement; and
- recruit – targeted recruitment.

Context and requirements

The DSO roles prescribed by Ofgem largely affect the existing roles in System Planning, System Design, Control, Markets and Connections. Whilst some of the DSO functions are being incrementally fulfilled by these existing teams, increasingly we are recognising a skills gap to be filled as we continue to transition towards a DSO. The skills gap to be addressed is primarily in the following areas:

- risk based decision making;
- coding and scripting of power system tools;
- energy markets and trading understanding; and
- data science and analytics.

Risk based decision making

As part of Initiative 2.6 and 2.7 we are required to undertake an increased understanding of both network constraints and any potential interventions at a more granular level. This largely involves looking in detail at the constraints and subsequent management in probabilistic terms (valuing risk). Inherently engineers are well versed in understanding the risks of either a constraint being reached or the risk of an intervention not delivering. The former is being formalised through our suite of asset rating policies[57], however the latter is becoming more complex especially regarding customer flexibility not delivering compared to traditional reinforcement. Given this will largely be covered in future updated policies, the skills improvement is thought to be incremental.

Coding and scripting of power system tools

The move towards energy system modelling (digital twin, DSO2.4) from static power flow modelling will require the skills to script multiple load flows to be performed on a more regular basis. As the digital twin should largely automate this process, it is seen as an incremental skills update.

[57] IMP/001/011, IMP/001/013, IMP/001/918

Energy markets and trading understanding

There will be an increased requirement to understand the energy and flexibility markets and the interaction between the two. We currently have a good understanding of the connections market and have a moderate energy and flexibility market capability. We feel this understanding will require a major upskill of some of our existing staff and additional resource to meet the needs of the increasingly flexibility-focused approach to managing network constraints.

Data science and analytics

The influx of increased, low fidelity data is increasingly going to need a different approach to its interpretation. This is captured in DSO2.2 analytics. However as we moved from low volume, high quality SCADA data sources to include high volume, low fidelity LV data we need to be able to use data science techniques to mine data, develop and refine analytics models. As this is a paradigm shift we believe it will largely be filled with new specialist recruits in this field rather than upskilling our existing engineers.

Our proposal

Given the skills change areas mentioned above we have split the deliverable into three categories:

- maintain – minor/incremental skills improvement;
- upskill – major skills improvement; and
- recruit – targeted recruitment.

Maintain

This will be a programme of tailored training to maintain engineers' existing skills and provide incremental new skills. An example of this would be an internally run course to refresh and update skills around cost benefit analysis. This is envisaged to be undertaken as part of short annual training courses by internal or external providers.

Upskill

In some cases we will be required to provide significant upskilling of existing engineers. We expect this to take place as a formal qualification undertaken by external providers. An example of this might be a masters-level qualification in energy trading.

Recruit

In certain areas (especially data science) we think the gap between the majority of our engineers' existing skills and those required is too wide to reasonably be closed by an upskilling qualification. In those circumstances we see the most cost effective method being to recruit new employees with the existing skills to fill these roles. As these types of skills are in high demand in finance, technology and engineering, we expect to have to work hard to attract the best talent.

The costs in this section are associated with the training and development of our people and the salary cost of a DSO training and recruitment manager. The salary costs of individuals engaged in delivering the DSO Strategy are identified in each of the individual deliverables.

The costs are anticipated to be £3.7 million, which includes the costs associated with the people who will develop internal programmes to maintain skills (~35 per cent of costs), and to oversee external upskilling (~30 per cent of costs) and recruitment (~35 per cent of costs).

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.0	0.0	0.0	**0.0**
People (£m)	0.7	0.7	0.7	0.7	0.7	**3.7**
						3.7

Table 16: Costs to upskill

DSO4.6 Provide flexibility services to the ESO

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO4.6 Provide flexibility services to the ESO	3.5	2.0	N/A	✓	✓	
Related DSAP core areas and initiative(s)						
2.03, 2.04, 9.05						

Context and requirements

Flexibility services can be provided to the ESO which leverage the capability of network assets, via techniques trialled as part of ENWL's Customer Load Active System Services (CLASS) innovation project. These flexibility services to the ESO are subsequently referred to as 'CLASS' services. CLASS services cover both active power and reactive power services; where the control of active power can provide a frequency service to the ESO, and control of reactive power can provide a voltage service to the ESO.

Frequency services can be based on either: a) implementing a demand decrease (to increase system frequency); or b) implementing a demand increase (to decrease system frequency). Frequency services can be provided by adjusting the voltage received by customers, leveraging the concept of conservation voltage reduction (CVR), whereby lower voltages yield demand reduction (and vice-versa)[58]. Each service is considered further:

- The demand decrease service can be provided via two main methods depending on the speed of response required (i.e. tripping of a transformer for a faster response, or tapping of transformers for a slower response), and both were proven to be successful by ENWL's CLASS trials.

- The demand increase service ('high' frequency response) was not tested as part of CLASS, and would therefore require further investigation. The methods of service provision could similar to those for the demand decrease service, but it is envisaged that the voltage 'tapping' method will be most appropriate.

Voltage services are provided to ESO as a reactive power service. This service can be provided by 'tap-staggering' transformers, which results in an increase of the reactive power demand (i.e. Mvar absorption) for the transformers. The increase in reactive power demand is then experienced by the transmission network, and translates into a voltage reduction. Reactive power is crucial to managing voltage on the transmission network, and this service could support the management of high voltages, which are becoming increasingly problematic in our region.

Both the frequency and voltage services make use of existing assets (transformers, SCADA and the smart grid enablers installed during the 2015-23 period), and therefore could be offered at a low marginal cost. The alternative in many cases is that the ESO pays significant costs to generators for a similar service, potentially requiring 'bid'-'offer' actions to ensure that a generator is available in the first place (in a given location for reactive power services, given that reactive power is a locational service).

[58] With a typical response rate of a 1.3% demand change for every 1% of voltage change; i.e. a CVR factor of 1.3.

The potential value of CLASS services provision has been considered in light of ensuring optimisation of whole system benefits overall. The principal CLASS service, and that which is believed to offer most value (and is currently the only service offered by ENWL) is the demand reduction service. This service directly conflicts with our voltage optimisation proposal which is a key 2023-28 deliverable outlined in both the whole Systems Strategy (deliverable WS3.2) and is one of our Consumer Value Propositions. The two conflict because both seek to minimise voltages to reduce demand; where voltage optimisation would seek to do this continuously, whereas a CLASS demand reduction service would seek to do this only when required to manage frequency on behalf of the ESO. Voltage optimisation is estimated to benefit customers more overall (in the region of £20 p.a. per customer; with a Net Present Value (NPV) of £249m), than provision of CLASS services (estimated NPV for our customers of £40m[59]); and therefore voltage optimisation is to be prioritised. The result of prioritising voltage optimisation is that our underlying assumption is that CLASS will not be offered as a demand reduction (upward frequency response) service. This conflict is to be reviewed as part of our 2015-23 Boston Spa Energy Efficiency Trial project, and will inform subsequent actions to be undertaken during 2023-28. Please refer to the whole Systems Strategy WS3.2 for further detail.

The increasing volume of flexible, inverter based distributed energy resources (DERs), also provides an opportunity for our customers to provide services to the ESO using their inherent flexibility (frequency services) and capability (voltage services). Given that the principal CLASS service (of demand reduction) is unlikely to offer optimal value from a whole system perspective, and that the increasing volume of DERs connected to our network could also provide similar service provision, including both reactive power and downward frequency response; further collaboration with the ESO is required to ensure that the offering of these services is in the best interest of customers.

Our proposal

The prioritisation of voltage optimisation across our region (given the higher benefit to customers), results in there being a highly uncertain whole system benefit of the provision of (the remaining) CLASS services. These services, however, are complementary to voltage optimisation, and the whole system benefits will be explored during the first two year of the 2023-28 period as part of our Whole System Strategy (specifically, initiative WS3.2), to ensure that services are only provided where there is an overall benefit.

This uncertainty of the specific services to be provided is reflected in there being no funding requested for this deliverable. Any service provision offered during 2023-28 is assumed to be a value added service (directly remunerated service 8). The costs detailed be low therefore are not included as part of the total DSO strategy costs detailed in this strategy and are excluded from totex.

The CLASS services that are complementary to voltage optimisation are assumed as a potential for 2023-28 provision (subject to confirmation of the whole system benefits during 2023-28), with the rollout aligned to the voltage optimisation rollout strategy. The key metrics are as follows, with winter and summer forming the upper and low bounds respectively:

a. **Load increase** ('high' frequency response):
   i. **Winter peak:** 86 MW | 156 primary substations.
   ii. **Summer minimum:** 21 MW | 156 primary substations.
b. **Reactive power** (high voltage support services):
   i. **Winter peak:** 200 MVAr | 100 supply point substations.
   ii. **Summer minimum:** 200 MVAr | 100 supply point substations.

Note 1: In total: 256 substations, providing between 21 MW and 86 MW of downward frequency response, and 200 MVAr of voltage support.

Note 2: The service provision is based on a rollout rate of one third of the above metrics in the third, fourth and then fifth year of the price control.

[59] Baringa's cost benefit analysis undertaken as part of CLASS identified a NPV of £266m for rollout for DNOs beyond ENW, which equates to roughly £40m for Northern Powergrid's customers. Refer to https://www.enwl.co.uk/globalassets/innovation/class/class-documents/assessing-the-impact-of-class-on-the-gb-electricity-market_redacted.pdf

The total (2023-28) cost envisaged for provision of CLASS services, which is not included in our baseline funding is £3.5m (capex £2.5m and opex £1m) consisting of:

- £2.5m for substation upgrades and configuration and a CLASS dashboard (capex);
- £1m for a CLASS project team (opex).

The costs described above for this deliverable are for operating CLASS, whilst the system capability is part of a wider system upgrade. We describe in DSO4.3 (develop network flexibility solutions) our plans to invest in an advanced distribution management system (ADMS) which would provide functionality to deliver CLASS. The costs for ADMS which provide CLASS functionality would be incurred irrespective of whether we offer CLASS services as detailed in deliverable DSO4.6 as the incremental spend to enable this functionality is considered to be negligible. The cost for this system therefore remains part of the total DSO strategy baseline funding, totalling £4.4m.

CLASS trials are planned for the remainder of the 2015-23 period, which will include determining the performance available, the conflicts and potential mitigations, the costs of subsequent rollout, the commercial case (including whether the proposals provide benefit overall), and defining the further actions required at the beginning of 2023-28 to ensure any offering provides a net benefit from a whole systems perspective (WS3.4). Until these actions are completed, the provision of CLASS services remains to be confirmed until the middle of the 2023-28 period, and ahead of the rollout of voltage optimisation in the third year of the price control.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.5	0.5	0.5	0.5	0.5	**2.5**
People (£m)	0.2	0.2	0.2	0.2	0.2	**1.0**
						3.5

Table 16: Costs to offer CLASS services

Initiative 4.7 Emergency assistance and contingency planning

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 4.7 Emergency assistance and contingency planning	-	-	N/A	✓	✓	●
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

As the power flows on our network become increasingly complex, we may need to develop emergency assistance services and the process by which we deploy them.

While our development and procurement of flexibility services is intended to be robust to manage capacity and demand on our network, it is crucial that we have a fall-back plan in place to deploy emergency assistance services in cases where flexibility markets fail to balance the network and critical failure is imminent. This is a last resort solution which should be deployed infrequently, only coming into force once flexibility markets have been exhausted or if there is an emergency where flexibility markets will not be able to respond in time.

Our proposal

Over 2023-28 we will:

- Work to define and agree the concept of emergency assistance services across the industry, and their requirements on our network.
- Develop principles/methodologies to apply to circumstances when DSOs can overrule market-based flexibility services with interventions to safeguard the network (emergency assistance services), to ensure that emergency assistance can be dispatched when required but that this does not hinder the development of flexibility markets.
- Develop emergency assistance services so they are in place to be deployed in case of flexibility market failure. This may include the development and integration of processes for controlling smart appliances to provide emergency response to network issues, such as constraining non-essential household demand (e.g. EV charging) to prevent critical network failure.

We will collaborate with other DNOs, through the ENA Open Networks programme, and consult with government and industry to discuss and agree the use cases for the deployment of emergency assistance services across networks.

This will deliver the benefit of protecting the network from a worst case scenario where flexibility markets fail to deliver, and the significant costs that would be associated with this.

There are no costs or investment specifically allocated to this action. This is predominantly a person cost that is already contained in our plan in the operations function.

Initiative 4.8 Validation of existing network resilience systems

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 4.8 Validation of existing network resilience systems	0.2	-	N/A	✓	✓	
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

We need to review low frequency demand disconnection (LFDD) plans to ensure that they are fit for purpose and continue to be reliable, sufficient and necessary under changing system conditions as power flows on our network become more complex and increasing numbers of DERs and LCTs are connected to the network.

Changes to our network such as reinforcement, flexibility services and connection of DERs and LCTs – can impact on the effectiveness of LFDDs. LFDD relays operate to disconnect demand in the event of falling system frequency, and the effectiveness of LFDD relays to disconnect sufficient demand in order to halt falling system frequency can be hindered, for example, by export from DERs reducing the net demand on the system resulting in the LFDD relay disconnecting less demand than anticipated. Conversely, increased adoption of LCTs and smart appliances may provide opportunities to reduce demand through flexibility services rather than traditional disconnection.

Our proposal

We are providing for £0.2m to undertake periodic modelling and forecasting to identify system conditions that are new or unusual and may impact on the effectiveness of demand disconnection arrangements, the local generation availability, weather conditions to assess wind and solar generation and local demand available to be disconnected. We will also identify where legacy protection systems (such as LFDD relay locations and loss of mains (LoM) settings) may

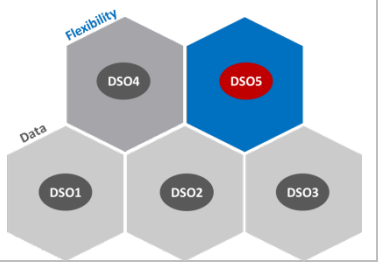
need adjustment to allow flexibility services to contribute to system resilience. See EJP-9.4 low frequency demand disconnection (LFDD) for detailed analysis, including CBA.

This initiative will ensure that demand disconnection plans are appropriate to our changing energy network and that flexibility can be effectively used to balance the network where feasible.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.04	0.04	0.04	0.04	0.04	**0.2**
People (£m)	-	-	-	-	-	**-**
						0.2

Table 17: Costs of validation of existing network resilience systems

DSO5 Enable significant uptake of customer flexibility and facilitate development of new markets for customers providing services to networks



DSO5.1 Collaborate with the wider energy industry to facilitate non-DSO services and network access rights

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO5.1 Collaborate with the wider energy industry to facilitate non-DSO services and network access rights	0.6	2.0	Network access amendments (report annually) Re-adjustment of existing connection agreements (report annually)	✓	✓	✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

The energy industry is undergoing an unprecedented amount of regulatory and code change. We expect that commercial contracts with customers will need more active engagement in order to optimise the allocation and use of capacity in the system. Network charging reform and more use of ANM will cause customers to move away from the concept of 'whole-life' connection access rights. Instead, we will support customers to get the most from their connection arrangement, minimise their energy bills and open up opportunities for new revenue streams by engaging in trading of some of their rights in secondary markets. This initiative is closely related to the work in the Ofgem Access and Forward-Looking Charges Significant Code Review (SCR) and the ENA Open Networks project on non-DSO services[60].

Looking further into the future we anticipate that new local energy markets could develop with peer-to-peer trading using the local distribution network as opposed to requiring the installation of private wire network. This will open up new possibilities for customers and a requirement from us to support such markets. This support will take the form of policy engagement in the first instance to work with policy makers and stakeholders to shape policy to provide beneficial customer outcomes[61]. We anticipate that the provision of data and information (see DSO3.1 and DSAP) as well as support to change connection contracts will also be required.

Our proposal

We are proposing to invest £0.6m during the period to cover the costs of the people needed in our commercial team to support the development of new arrangements that are expected to follow the outcomes of these reviews.

Key areas of focus of this work is likely to be on timed access, queue management and the stacking of flexibility services in order to facilitate the secondary trading of curtailment. We will develop and manage the processes around the amendment, documentation and implementation of customer contractual changes. We will continue to support this work through the ENA industry collaboration.

We also look forward to Ofgem's further decisions on access reforms (expected in Q1 2022), along with any associated changes to use of system charges (being taken forward in 2022). We will continue to work closely with Ofgem to assist

[60] Workstream 1A Product 6 is investigating the trading of capacity and curtailment obligations in 2021.
[61] The production of a local electricity bill that is advocated by Community Energy England is one such current initiative.

with implementation practicalities, including any required code, licence and legislation changes. We will continue to support this work through the consultation process and any Ofgem working groups.

For both of these reviews, we see data capture playing an important role in delivering successful implementation. As we seek to better understand our customers' behaviours, we will continue to engage with our customers through company and industry forums and on a bilateral basis to understand their requirements and accordingly tailor our approach to the delivery of secondary trading and other non-DSO services, including Power Purchase Agreements (PPAs) and Virtual Power Plants (VPP). Although these are outside the direct scope of DSO responsibility, we have a role to play in enabling and facilitating them. As part of the DSO strategy we are going to formalise this process of stakeholder data capture and more information on this can be found in Initiative 1.2 and 1.4.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.0	0.0	0.0	**0.0**
People (£m)	0.1	0.1	0.2	0.2	0.2	**0.6**
						0.6

Table 17: Costs of energy industry collaboration

DSO5.2 Improved development and procurement of flexibility services

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO5.2 Improved development and procurement of flexibility services	1.2	3.5	EHV substation areas in flexibility market tenders (80) Common registration processes (by 2024/25)		✓	✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

We expect the 2023-28 period to see significant growth and innovation in the procurement and use of DNO contracted customer flexibility services. This will be necessary for us to be able to procure the flexibility we need and develop our capabilities for the future. Whilst we have already devoted significant time and resources to developing our approach to flexibility services, further investment will be necessary.

At time of writing we expect three major trends to shape the future development of flexibility services products and procurement:

Maturing markets for distribution flexibility services

Increasing procurement of flexibility services by DNOs should lead to flexibility markets maturing. As flexibility markets grow deeper and more liquid, procurement practices will need to evolve in response. Likely areas of development include increasing automation of tendering and procurement, exploration of week and day ahead trading and increasingly competitive approaches to contract pricing as the supply of flexibility grows.

Widening use cases and a deepening pool of flexibility service providers (FSPs)

We expect growing adoption of low carbon technology (LCT) to increase network load in specific geographies and at lower voltage levels. The increasing presence of LCT on our network also presents a potential source of flexibility services to alleviate constraints which are beyond the capability of FSPs connected at higher voltage levels. We expect that

development of LV (230/400V) flexibility to benefit the LV and HV (11-20kV) networks will continue such that it becomes a key pillar in ensuring economic and efficient management of our network in the future.

As a procurer of flexibility services we are committed to being technology agnostic in our procurement. This means that we are open to procuring flexibility from energy efficiency schemes as well as through generation turn up or demand turn down. We recognise the need for innovation in product offering and procurement processes to support their participation in flexibility procurement during the coming period and beyond.

Increasing alignment across the UK electricity sector

All UK DNOs and the Electricity System Operator (ESO) already participate in the Energy Networks Association Open Networks project. At time of writing, a number of projects are exploring opportunities for alignment in procurement and operation of flexibility services with multiple recommendations from previous projects already implemented. We expect this drive for industry alignment to continue and we remain committed to playing an active role as a key member of the Open Networks project.

Our proposal

We propose to invest £1.2 million during the period to secure resources to continue to innovate and improve on our flexibility service offering and our procurement processes. This includes up to £0.1m in BAU innovation funding. We must invest to secure the flexibility we need in the 2023-28 period and to continue to prepare for the significant increases in electricity consumption (and therefore network loading) that we anticipate during the 2030s. The phasing of this investment reflects our belief that the rate of change and associated innovation requirement will increase as adoption of low carbon technologies and changing consumption patterns drive and liquidity and depth in flexibility markets.

The alternative to investing proactively in our development of flexibility services products and procurement is to either delay this investment until the 2028-33 period or not invest at all. However, failure to adapt our flexibility approach to the market changes we anticipate is likely to lead to either inefficiencies in the procurement and operation of Flexibility Services or failure to procure adequate flexibility through tendering. In both cases this is likely to lead to us incurring higher costs through inefficient network management – either from poorly operated Flexibility Services or having to resort to expensive traditional network solutions in the event of procurement failure.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	-
People (£m)	0.2	0.2	0.3	0.3	0.3	**1.2**
						1.2

Table 18: Costs of development of flexibility services

DSO5.3 Develop a flexibility information provision and engagement platform

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO5.3 Develop a flexibility information provision and engagement platform	2.2	1.0	Flexibility provider registration acceptance time <30 days		✓	✓
			Procurement events response time <3 months			
			Local flexibility stakeholder engagements (120)			
			Efficient dispatch of flexibility audit (report annually)			
			Procurement stakeholder feedback survey and report (annual)			
Related DSAP core areas and initiative(s)						
2.10						

Context and requirements

In addition to dispatching flexibility services, Flexible Power (discussed in deliverable DSO4.1) has a public facing website that sets out flexibility requirements and associated documents to flexibility service providers. The platform however does not host a dynamic purchasing system (DPS) or support bidding, something that is done separately on DNO systems or through third party platforms such as Piclo.

Our proposal

To further improve customer experience, we will continue to work with the industry to develop and integrate as much as possible the different activities together, either by expanding Flexible Power or by developing a new platform altogether. Our aim is to link our flexibility service requirements to our tendering and procurement processes in a single customer facing platform to make things simpler for customers. This communication engagement and trading platform will:

- hold relevant information openly and transparently;
- allow flexibility providers and aggregators to register metered units or assets or express interest to provide flexibility services;
- allow operators to publish service requirements and characteristics such as min MW thresholds, locational requirements, specified service windows (e.g. time within the day, week, month, season etc.);
- hold information on contract length, payment schedules, penalties, multiple offerings (if applicable);
- report on procurement methods, assessment criteria, decision making and timeline;
- report on tender results, price bid and paid, DER usage and volume; and
- report on flexibility procurement (year ahead, historical, post tender report).

The portal will be the primary flexibility services stakeholder engagement platform to keep stakeholders engaged and connected and information provided will be reviewed continuously.

The costs are anticipated to be £2.2 million, which include costs associated with existing or new system development and integration and people costs to manage the platform. Initiative 2.10 of the DSAP captures how the technology capability for flexibility customer interaction will be delivered. Costs include £50,000 in BAU innovation funding.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.6	0.6	0.6	**1.8**
People (£m)	0.1	0.1	0.1	0.1	0.1	**0.4**
						2.2

Table 19: Costs flexibility information provision and engagement platform

DSO5.4 Automatic settlement of flexibility services

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO5.4 Automatic settlement of flexibility services	1.2	1.5	N/A		✓	✓
Related DSAP core areas and initiative(s)						
2.10						

Context and requirements

Currently the settlement and reconciliation of flexibility services is a manual process done through Flexible Power (described in deliverable DSO4.1). Service providers upload and reconcile metering information to calculate actual flexibility provision and compensation made up of an availability (where applicable) and utilisation payment. As the number of flexibility services increases, such functionality will need to be automated to ensure settlement, reconciliation and payment is timely and accurate.

Our proposal

We will continue to work with the industry to develop this functionality, either by expanding the capabilities within Flexible Power or by delivering it through a separate fully integrated system. Regardless of the solution, the system will need to interface with wider systems such as CRM and NMS for better information exchange to confirm service utilisation, calculate compensation, and issue relevant reports and invoices. This action is associated with scaling up our capability to manage the increase in flexibility procurement we expect in the back end of the 2020s as LV flexibility becomes more viable and commonplace. Our Flexible Power collaboration opens up opportunities to achieve this new functionality cost effectively as costs may be shared across all participating DNOs.

The costs are anticipated to be £1.2 million, which include costs associated with existing or new system development and integration and increased people costs in the areas of trading, billing and payments. As with DSO5.3, initiative 2.10 of the DSAP captures how the technology capability for flexibility customer interaction will be delivered.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	0.0	0.0	0.3	0.3	0.3	**0.8**
People (£m)	0.0	0.0	0.1	0.1	0.1	**0.4**
						1.2

Table 19: Costs for automatic settlement of flexibility services

DSO5.5 Recruit specialist flexibility customer account managers

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
DSO5.5 Recruit specialist flexibility customer account managers	0.8	2.5	Dispatch stakeholder feedback survey and report (annual)	✓	✓	✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

As the volume of flexibility services we operate grows over 2023-28, we will increasingly require dedicated resources to establish and manage customer relationships with Flexibility Service Providers (FSPs). Given the relative immaturity of markets for flexibility services at the moment, it will be important to have the resourcing and capability to proactively engage with providers and support them to access and participate in markets for flexibility services (also detailed in deliverable DSO4.5).

We expect to signpost and tender for an increasing volume of flexibility services and will require additional resourcing to initiate and manage those processes. As our portfolio of active flexibility contracts grows we will also increasingly need to engage with the ESO to ensure effective utilisation of resources and maximise efficiency in the operation of transmission and distribution systems.

Our proposal

We are proposing to invest £0.4m to provide the customer account management capabilities for our flexibility services. Our proposed resourcing will grow over the course of the period in line with expected growth in Flexibility markets, from 0.5 FTE at the start of the price control period to 2.5 FTE by 2027/28. The holders of these roles will need to have strong commercial awareness and a customer-centric ethos to actively engage with a diverse range of FSPs such as asset operators and aggregators.

Choosing not to invest in customer account management for Flexibility Services would leave us without the resources needed to establish and grow our procurement of flexibility services and manage a growing pool of FSPs. This would likely lead to failure to procure our forecasted volume of Flexibility needs and therefore, force us to resort to traditional solutions to maintain our network. It may also result in non-optimal outcomes across the Transmission and Distribution systems if we are not able to liaise effectively with the ESO due to a shortfall in resources.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	**-**
People (£m)	0.1	0.1	0.2	0.2	0.2	**0.8**
						0.8

Table 20: Cost to recruit specialist flexibility customer account managers

Initiative 5.6 Project and change management to support the DSO transition

Deliverable/initiative	Investment		Measure (2023-28 target)	Ofgem DSO roles		
	£m	FTE		1	2	3
Initiative 5.6 Project and change management to support the DSO transition	2.6	6.5	N/A	✓	✓	✓
Related DSAP core areas and initiative(s)						
N/A						

Context and requirements

This DSO strategy contains a highly ambitious change programme – both for Northern Powergrid, our stakeholders and others in the energy system. We are significantly increasing our use of digitalisation, the use of flexibility, and our openness as an organisation. The work required is not just about what we are doing in terms of specific actions but also the supporting culture that will be required. A change management function is required both to lead the changes required and also to satisfy the stakeholder appetite to be kept aware of progress and outlook.

As we continue the transition to DSO, over the next five to seven years a significant amount of industry change will be progressed either through the ENA Open Networks programme or other industry forums. Therefore, a change management capability is required to quickly implement any market evolution.

The DSO strategy requires us to continue to develop the culture of the organisation to engage with the external stakeholders to explain what we are doing, support our regional stakeholders and deliver a flexibility first approach by exploiting the power of digitalisation and data. The culture of the organisation, in common with society, will need to put the net zero challenge on an even footing with the existing well-established service culture of keeping the lights on and connecting people to our network.

Our proposal

We are proposing to invest £2.6m to cover the costs of the people who will lead the central implementation of the DSO strategy, support reporting obligations and participate in industry forums driving change. These people will be focussed on both maximising operational effectiveness, delivering internal oversight of our programme delivery and external transparency.

In order to ensure that the DSO strategy is successfully delivered, we envisage a team to deliver:

- project management in order to engage the business in the delivery of our deliverables and the associated change management;
- stakeholder engagement and provision of external reports to address our commitments for transparency (e.g. publish annual report from external audit of investment decision making processes);
- deliver regulatory change to lead on the reporting requirements as part of delivering our DSO obligations; and
- participation in industry change such as the ENA Open Networks programme.

Choosing not to invest in a change management capability for the delivery and reporting of our DSO strategy would leave us without the resources needed to successfully implement the transformation. Not delivering on the commitments in this plan would risk the customer net savings in 2023-28 set out in this decarbonisation plan of £156m.

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
Systems (£m)	-	-	-	-	-	**-**
People (£m)	0.5	0.5	0.5	0.5	0.5	**2.6**
Table 21: Costs project and change management to support the DSO transition						**2.6**

Appendix 1 – Digitalisation strategy and action plan (DSAP) and DSO strategy mapping

Data and digitalisation activity forms a key component of our DSO strategy, and the DSO activities make up a significant proportion of our total investment in data and digitalisation. Figure 18 shows the linkages between the DSAP and the DSO strategy, while Figure 19 provides a reference list for the DSAP initiatives. Of the 29 DSO deliverables and initiatives, 15 are supported by investments in data and digitalisation.

DSAP initiatives	DSO strategy deliverables and initiatives															
	1.1	1.2	1.4	2.1	2.2	2.3	2.4	2.5	3.1	3.4	4.1	4.2	4.3	4.4	5.3	5.4
1.01	■	■	■													
1.02				■	■											
1.03										■						
1.04	■							■	■	■						
1.05	■			■	■											
1.06	■			■	■				■							
1.07									■							
1.08									■							
2.01				■	■	■	■				■					
2.02				■	■						■	■				
2.03	■											■	■			
2.04				■	■	■					■		■			
2.05				■	■	■					■					
2.06				■	■	■										
2.07				■	■	■										
2.08												■				
2.09														■		
2.10															■	■
8.13									■							
8.14									■							
9.01							■									
9.02							■									
9.03	■															
9.04	■						■									
9.05													■			
9.06											■					
9.09							■									
9.10							■									
9.11						■										

Figure 108: Mapping of DSAP initiatives to DSO strategy deliverables and initiatives

Note: DSO deliverables/initiatives which do not have a DSAP dependency are excluded from the above table. Similarly, DSAP initiatives not related to the DSO strategy are excluded.

Initiatives		2023-28 £m
1. Journey to Open Data: Understand, improve and expand our energy system data and promote data transparency through Open Data		
1.01	Data gap analysis - understanding what our stakeholders need and how and building the relevant data sources	0.0
1.02	Data quality understood and cleansed - deploy tooling to assess and manage the uplift of data quality	0.9
1.03	Implement data integration platform using standard data formats (i.e.CIM) and API driven to implement a hybrid solution of on premise and cloud capabilities to integrate data across our own landscape and provide access to data with ease from outside our organisation.	1.0
1.04	Build integrations between existing systems (e.g. APIs) where integration of data is required to provide Open Data services	4.4
1.05	Establish a central function to own and manage data governance - the central point of accountability that plays a coordinating role for all data requests and deliveries as well as setting the rules for data quality and availability (openness).	-
1.06	Asset data surfacing and integration - Connecting eAM Spatial data to the new integration platforms to surface asset data on the data platform for open sharing of this information.	0.7
1.07/1.08	Implement cloud data platform - Provision of a modern set of data capabilities, future-proofed and flexible enough to scale to demand.	1.3
2. Network management capability to enable Net zero: Upgrade and implement new IS systems to enhance network management and decision making in real-time to enable us to efficiently operate our distribution network in a decarbonisation era.		
2.01/2.02	Enhanced management solution for energy resources connected to our distribution network (DERMS for DSO)	4.8
2.03	Expand current DMS capability to Advanced DMS (A-DMS) capabilities within the Control Room to enable DSO roles to be fulfilled	7.1
2.04	Implement Forecasting and analytics capabilities for improved network operations efficiency and enable flexibility services	2.1
2.05	Design and implement Automation and AI tools for improved network operations efficiency and enable flexibility services	1.5
2.06/2.07	Implement IS tools to support the LV management centre	2.4
2.08	Build the capability to manage local microgrids	1.1
2.09	Build an ICCP link to improve connection to ESO	1.1
2.10	Expand technology capability for flexibility customer interaction (information provision and engagement platform / service management - settlement and reconciliation)	2.6
8. Enabling customers to self-serve: Implement self-serve, personalised services to meet customer demand and experience and reduce cost to serve. Give customers an insight and interaction portal.		
8.13/8.14	Deploy automation and self-service for all connections quotations (AutoDesign)	4.4
9. Advanced Analytics: Enable advanced analytics to improve the planning, design and operation of our distribution network.		
9.01/9.02	Implement Enhanced Condition Based Risk Management tools and techniques	1.3
9.03	Support wider DSO sensor deployment initiatives by providing enterprise class back end data handling capabilities and integrations	2.3
9.04	Update and enhance the current Oracle Asset data platform and EAM tools	2.7
9.05	Integrate and enhance network monitoring and advanced analytics tools within the Control Room	1.3
9.06	Define and implement the data governance and data platform(s) to enable the delivery of advanced analytics across the distribution network.	0.4
9.09	Define technical architecture for system operations and network planning (modelling/development of a digital twin)	2.2
9.10	Provide enhanced network modelling capabilities including probabilistic assessment	1.5
9.11	Implement cloud analytics platform and deliver scalable capacity to meet analytics workloads	2.8
Total		**49.8**

Figure 119: DSAP initiatives supporting the DSO strategy

Note that this table excludes data and digitations strategy initiatives that do not directly link to the DSO strategy.

Appendix 2 - Costs

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
DSO1.1	2.4	2.5	2.5	0.5	0.5	**8.4**
DSO1.2	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO1.3	4.2	4.2	4.2	4.2	4.2	**21.1**
Initiative 1.4	0.0	0.0	0.1	0.1	0.1	**0.3**
DSO2.1	1.0	1.0	1.0	1.0	1.0	**4.9**
DSO2.2	0.4	0.4	0.4	0.4	0.4	**2.2**
DSO2.3	1.1	1.1	1.1	1.1	1.1	**5.4**
DSO2.4	1.5	1.5	1.5	1.5	1.5	**7.3**
DSO2.5	0.2	0.2	0.7	0.7	0.7	**2.5**
Initiative 2.6	0.1	0.1	0.1	0.1	0.1	**0.4**
Initiative 2.7	-	-	-	-	-	**0.0**
DSO3.1	1.3	1.3	1.3	1.3	1.3	**6.7**
DSO3.2	0.5	0.5	0.5	0.5	0.5	**2.4**
Initiative 3.3	0.0	0.0	0.0	0.0	0.0	**0.2**
Initiative 3.4	1.0	1.0	0.2	0.2	0.2	**2.6**
DSO4.1	1.7	1.7	0.1	0.1	0.1	**3.9**
DSO4.2	2.1	2.1	0.3	0.3	0.3	**5.2**
DSO4.3	1.9	1.9	0.2	0.2	0.2	**4.5**
DSO4.4	1.1	0.1	0.1	0.1	0.1	**1.5**
DSO4.5	0.7	0.7	0.7	0.7	0.7	**3.7**
Initiative 4.7	-	-	-	-	-	**-**
Initiative 4.8	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO5.1	0.1	0.1	0.2	0.2	0.2	**0.6**
DSO5.2	0.2	0.2	0.3	0.3	0.3	**1.2**
DSO5.3	0.1	0.1	0.7	0.7	0.7	**2.2**
DSO5.4	0.0	0.0	0.4	0.4	0.4	**1.2**
DSO5.5	0.0	0.0	0.2	0.2	0.2	**0.8**
Initiative 5.6	0.5	0.5	0.5	0.5	0.5	**2.6**
Total	**22.4**	**21.6**	**17.4**	**15.5**	**15.5**	**92.4**
Excluded from totex – directly remunerated services:						
DSO4.6	0.7	0.7	0.7	0.7	0.7	**3.5**

Figure 20: 2023-28 costs (£m) – total

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
DSO1.1	2.2	2.2	2.2	0.3	0.3	**7.3**
DSO1.2	-	-	-	-	-	**-**
DSO1.3	-	-	-	-	-	**-**
Initiative 1.4	-	-	-	-	-	**-**
DSO2.1	0.9	0.9	0.9	0.9	0.9	**4.7**
DSO2.2	0.4	0.4	0.4	0.4	0.4	**2.0**
DSO2.3	0.9	0.9	0.9	0.9	0.9	**4.6**
DSO2.4	1.3	1.3	1.3	1.3	1.3	**6.5**
DSO2.5	-	-	0.4	0.4	0.4	**1.1**
Initiative 2.6	-	-	-	-	-	**-**
Initiative 2.7	-	-	-	-	-	**-**
DSO3.1	1.2	1.2	1.2	1.2	1.2	**5.9**
DSO3.2	-	-	-	-	-	**-**
Initiative 3.3	-	-	-	-	-	**-**
Initiative 3.4	1.0	1.0	0.1	0.1	0.1	**2.2**
DSO4.1	1.6	1.6	-	-	-	**3.1**
DSO4.2	1.9	1.9	0.2	0.2	0.2	**4.4**
DSO4.3	1.8	1.8	0.2	0.2	0.2	**4.1**
DSO4.4	1.1	-	-	-	-	**1.1**
DSO4.5	-	-	-	-	-	**-**
Initiative 4.7	-	-	-	-	-	**-**
Initiative 4.8	0.04	0.04	0.04	0.04	0.04	**0.2**
DSO5.1	-	-	-	-	-	**-**
DSO5.2	-	-	-	-	-	**-**
DSO5.3	-	-	0.6	0.6	0.6	**1.8**
DSO5.4	-	-	0.3	0.3	0.3	**0.8**
DSO5.5	-	-	-	-	-	**-**
Initiative 5.6	-	-	-	-	-	**-**
Total	**14.3**	**13.3**	**8.7**	**6.8**	**6.8**	**49.8**
Excluded from totex – directly remunerated services:						
DSO4.6	0.5	0.5	0.5	0.5	0.5	**2.5**

Figure 21: 2023-28 costs (£m) – systems (data and digitalisation)

	2023/24	2024/25	2025/26	2026/27	2027/28	Total
DSO1.1	0.2	0.2	0.2	0.2	0.2	**1.1**
DSO1.2	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO1.3	-	-	-	-	-	**-**
Initiative 1.4	0.0	0.0	0.1	0.1	0.1	**0.3**
DSO2.1	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO2.2	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO2.3	0.0	0.0	0.0	0.0	0.0	**0.2**
DSO2.4	0.2	0.2	0.2	0.2	0.2	**0.8**
DSO2.5	0.2	0.2	0.2	0.2	0.2	**0.8**
Initiative 2.6	0.1	0.1	0.1	0.1	0.1	**0.4**
Initiative 2.7	-	-	-	-	-	**-**
DSO3.1	0.2	0.2	0.2	0.2	0.2	**0.8**
DSO3.2	0.5	0.5	0.5	0.5	0.5	**2.4**
Initiative 3.3	0.0	0.0	0.0	0.0	0.0	**0.2**
Initiative 3.4	0.1	0.1	0.1	0.1	0.1	**0.4**
DSO4.1	0.2	0.2	0.2	0.2	0.2	**0.8**
DSO4.2	0.2	0.2	0.2	0.2	0.2	**0.8**
DSO4.3	0.1	0.1	0.1	0.1	0.1	**0.4**
DSO4.4	-	-	-	-	-	**-**
DSO4.5	0.7	0.7	0.7	0.7	0.7	**3.7**
Initiative 4.7	-	-	-	-	-	**-**
Initiative 4.8	-	-	-	-	-	**-**
DSO5.1	0.1	0.1	0.2	0.2	0.2	**0.6**
DSO5.2	0.2	0.2	0.3	0.3	0.3	**1.2**
DSO5.3	0.1	0.1	0.1	0.1	0.1	**0.4**
DSO5.4	0.0	0.0	0.1	0.1	0.1	**0.4**
DSO5.5	0.1	0.1	0.2	0.2	0.2	**0.8**
Initiative 5.6	0.5	0.5	0.5	0.5	0.5	**2.6**
Total	**3.8**	**4.1**	**4.5**	**4.5**	**4.5**	**21.3**
Excluded from totex – directly remunerated services:						
DSO4.6	0.2	0.2	0.2	0.2	0.2	**0.2**

Figure 22: 2023-28 costs (£m) – people (workforce)

Appendix 3 – Metrics

In this appendix, we describe the metrics that we are proposing for each of our five DSO strategy outcome areas. This is a Northern Powergrid proposal that has been influenced by the prior engagement with the Ofgem and DNO working group that generated some of these metrics. At the time of completing this plan we continue to work with Ofgem and the DNOs on developing a common approach to assessment and the metrics that would form part of that assessment. This work is expected to continue into 2022.

We have created a DSO monitoring framework which includes three types of metrics. In line with Ofgem's requirements we propose:

- those which should be associated with a financial output delivery incentive (ODI-F) – 11 sub-metrics;
- those associated with a reputational output delivery incentive (ODI-R) – 7 sub-metrics; and
- as our own additional category, a range of measures which we intend to report on annually to stakeholders – 9 sub-metrics. (Note that this category of metric does not appear in the main business plan proposition table.)

The metrics we have included in our ODI-F are those which are within our direct control which include:

- a new activity with insufficient historical data for us to accurately forecast an appropriate measure of success;
- stakeholder insights or feedback on the delivery of our DSO strategy; or
- collaboration across DNOs/ESO such that when or how it is delivered is not directly within our control.

Metrics are summarised below by DSO outcome area and then by type.

Outcome DSO1 – Significantly expand network and market data capture to establish a vital building block for the smarter and more active energy system

Deliverable	Metric ID	Metric type	Measure	Description	End of 2015-23 Forecast	End of 2023-28 Target
DSO1.3 Targeted low voltage (LV) monitoring	DSO.A	ODI-F	Low Voltage (LV) monitoring	Percentage of ground mounted substation network directly monitored	10%	50%
	DSO.B	ODI-R	LV load monitors installed	Number of LV load monitors installed	2,700	12,700

Enhancing visibility of the LV network is a major part of our DSO strategy. By installing additional monitoring and combining this with other data sources to understand the increased demand on our local network, this will enable us to manage the interventions we need to make – be that flexibility or network reinforcement. We will measure the roll-out of this additional network of sensors, which is the foundation of a significant step change in the visibility of the behaviour of our LV network.

We have prioritised metrics that provide a measure of customer outcomes. It is logical that there are fewer metrics in DSO1 since the deliverables in this section tend to be preparatory steps or inputs to outcomes that follow in DSO3-5.

Outcome DSO2 – Transform our analytical capabilities to enable data-driven decision-making in planning and operational timescales

Deliverables	Metric ID	Metric type	Measure	Description	End of 2015-23 Forecast	End of 2023-28 Target
DSO2.3 Improved planning and operational forecasting	DSO.C	ODI-R	Standardised DFES inputs	The development of a Code of Practice between DNOs for the DFES to detail industry best practice and standardisation	-	2023/24
	DSO.D	ODI-R	Accurate forecasting of network needs (reconciliation of outturn vs. forecast)	An annual report detailing the reconciliation of outturn vs. forecasted volumes and general reasoning, e.g. capacity that relates to peak demands, and general comments about what the trends are and why	DFES	Detailed in an annual report
DSO2.5 Improved format and consistency of information we share with stakeholders	DSO.E	ODI-R	Historical operational and outage planning data ESO/DSO	Historical operational and outage planning data to be shared with stakeholders (e.g. monthly)	-	>90% shared
	DSO.G	Annual report to stakeholders	Planning and operational network forecasting stakeholder feedback survey and report	Planning and operational network forecasting stakeholder feedback survey and report	-	Detailed in an annual report

DSO2 carries more customer value as it focuses on how we use the data we have captured to transform our analytical capabilities to provide customer insights. We have proposed a quantifiable metric in this outcome on sharing historical operational and outage planning data between the ESO and DSO. This metric consists of a count of DER utilisation and outage planning data exchange and continues to develop whole system thinking. We have set the value at 90 per cent which we consider a reasonable standard to design, implement and refine this data exchange process with the ESO over the period.

Outcome DSO3 – Enable open energy system data sharing and joint planning with stakeholders

Deliverables	Metric ID	Metric type	Measure	Description	End of 2015-23 Forecast	End of 2023-28 Target
DSO3.1 Open Insights data portal	DSO.H	ODI-F	Availability of energy system data products	Through a data catalogue, APIs and a dedicated portal we will increase our data and service availability to our customers and stakeholders	-	+70%
	DSO.I	ODI-F	New network asset data self-service	Enhanced open data through implementing a set of free analytical tools to help processing data and enhanced self-service such as: dynamic heat maps and Autodesign	-	2026/27
	DSO.J	ODI-R	Network asset data stakeholder feedback survey and report	Network asset data stakeholder feedback survey and report	-	Detailed in an annual report

DSO3.2 Recruit Local Area Energy Plan (LAEP) advisors	DSO.K	Annual report to stakeholders	Number of LAEP engagements reported	Number of LAEP engagements reported	-	Detailed in an annual report

- DSO3 deliverables are focused on delivering direct value for the customer by customer engagement and the development of a new network asset data self-service capability. We propose measuring effective delivery via qualitative metrics that provide a continuous feedback loop. In particular, we put a key focus on improving our data availability through sharing increased data sets.

Outcome DSO4 – Enhance processes and systems for network operations to enable a step change in our capability to operate and optimise a system with increasing customer and network flexibility

10. Deliverables *11.*	Metric ID *12.*	Metric type *13.*	Measure	Description	End of 2015-23 Forecast	End of 2023-28 Target
DSO4.1 Flexibility services processes and dispatch system	DSO.L	ODI-F	Error corrections issued for dispatch	The count of error corrections related to dispatch instructions and/or information which results in incorrect delivery that are incorrectly issued to market participants	0	<10%
	DSO.M	ODI-F	Late issuance of dispatch data	The count of late issuance of dispatch data	0	<10%
DSO4.2 Enhanced enterprise Active Network Management (ANM)	DSO.N	Annual report to stakeholders	ANM flexibility volume	ANM flexibility volume connected to our network		Detailed in an annual report
	DSO.O	Annual report to stakeholders	Number of ANM connections	The number of connections with ANM agreements		Detailed in an annual report
DSO4.4 Architecture and processes for effective deployment of flexibility services across transmission and distribution networks	DSO.P	ODI-F	Operational data exchange ESO-DSO	The "up time" for exchanging real-time operational data with 90% reliability	-	>90%
	DSO.Q	ODI-F	Constrained data exchange ESO-DSO	System "up time" for the exchange of network constraint data via the new ICCP link in the Common Information Model (CIM) format (daily)	-	>90%
	DSO.R	ODI-R	Common flexibility dispatch principles	A DSO decision-making framework, commonly aligned across DSOs for when DER are instructed to dispatch in real-time	-	2025/26

DSO4 includes deliverables that establish our capability to deliver flexibility and therefore directly impact the value provided to the customer. We propose four quantifiable metrics:

- Error corrections issued for dispatch – measuring our performance to the flexibility provider when delivering dispatch instructions. This metric holds us to account on the accuracy of our dispatch instructions. We have proposed the target of 10 per cent or fewer error corrections as we consider it a reasonable performance standard for processes that are still being developed and are not yet commonplace.

- Late issuance of dispatch data - measuring the amount of late issuance of dispatch data to the flexibility provider. As before, we consider 90 per cent success rate for a new process is reasonable.

- Operational data exchange ESO-DSO – measuring the system 'up time' for exchanging real-time operational data. We have opted for a 90 per cent reliability on this service as we consider it an appropriate standard for a process that is not yet developed and is important but not business critical for either party.

- Constrained data exchange ESO-DSO – measuring the system "up time" for the sharing of constraint data between the ESO and DSO via the ICCP link. Consistent with the other metrics, this is a form of 'up time' measurement where we also consider 90 per cent to be appropriate.

Outcome DSO5 – Enable significant uptake of customer flexibility and facilitate development of new markets for customers providing services to networks

Deliverables	Metric ID	Metric type	Measure	Description	End of 2015-23 Forecast	End of 2023-28 Target
DSO5.1 Collaborate with the wider energy industry to facilitate non-DSO services and network access rights	DSO.S	Annual report to stakeholders	Network access amendments	Count of amendments made to customer connections arrangements following the review of network access arrangements	-	Detailed in an annual report
	DSO.T	Annual report to stakeholders	Re-adjustment of existing connection agreement	Count of re-adjustments to existing connections agreements following the review of network access arrangements	-	Detailed in an annual report
DSO5.2 Improved development and procurement of flexibility services	DSO.U	ODI-F	Number of EHV substation areas in flexibility market evaluations	A report detailing the cumulative volume of EHV substations in flexibility evaluation exercises involving our stakeholders	25 (end of period)	80 (end of period)
	DSO.V	ODI-R	Common registration processes	The development of industry wide prequalification processes between DNOs to ensure standardisation	-	2024/25
DSO5.3 Develop a flexibility information provision and engagement platform	DSO.W	ODI-F	Flexibility provider registration acceptance time <30 days	Time taken for a response to be provided to new customers who apply to become a flexibility provider	-	>95%
	DSO.X	ODI-F	Procurement events response time <3 months	Time taken for a response to be provided to customers who participate in our flexibility tenders	-	>95%
	DSO.Y	ODI-F	Local flexibility stakeholder engagements	The total number of stakeholder engagements to promote flexibility	-	120
	DSO.Z	Annual report to stakeholders	Efficient dispatch of flexibility audit	The assessment of how the DSO ensures it facilitates efficient dispatch of flexibility services by providing evidence of the necessary processes, procedures and systems	-	Detailed in an annual report
	DSO.AA	Annual report to stakeholders	Procurement stakeholder feedback survey and report	Stakeholder survey and report	-	Detailed in an annual report
DSO5.5 Recruit specialist flexibility customer account managers	DSO.BB	Annual report to stakeholders	Dispatch stakeholder feedback survey and report	Stakeholder survey and report	-	Detailed in an annual report

DSO5 includes deliverables that directly impact the value provided to the customer for which we have identified three quantifiable metrics:

- EHV substation areas in flexibility market evaluation – this metric measures the cumulative volume of EHV substations in flexibility evaluation exercises involving our stakeholders – either a market tender or a decision not to tender with transparent explanation. It includes sites in our plan for potential reinforcement deferral in the 2023-28 period and market stimulation ahead of the 2028-33 period;

- Flexibility provider registration acceptance time – once a customer requests interest to register as a possible flexibility provider we have set a maximum expectation on the time taken to respond formally with a decision as 45 days in 2023, reducing to 30 days by the 2028.

- Procurement events response time – as for the registration process, are also proposing a maximum time for decisions on tenders from the point at which the formal tender is launched to all bidder(s) being notified with the suggested committed time being less than three months by 2028.

Summary: ODI-financial sub-metrics

Deliverable	Metric ID	Measure	Description	2015-23 Forecast Outturn	2023-28 Target
DSO1.3	DSO.A ***14.***	Low Voltage (LV) monitoring	Percentage of ground mounted substation network directly monitored	10%	50%
DSO3.1	DSO.H	Availability of energy system data products	Through a data catalogue, APIs and a dedicated portal we will increase our data and service availability to our customers and stakeholders	-	+70%
DSO3.1	DSO.I	New network asset data self-service	Enhanced open data through implementing a set of free analytical tools to help processing data and enhanced self-service such as: dynamic heat maps and Autodesign	-	2026
DSO4.1	DSO.L	Error corrections issued for dispatch	Count of error corrections related to dispatch instructions and/or information which results in incorrect delivery that are incorrectly issued to market participants	-	<10%
DSO4.1	DSO.M	Late issuance of dispatch data	Count of late issuance of dispatch data	-	<10%
DSO4.4	DSO.P	Operational data exchange ESO-DSO	The “up time” for exchanging real-time operational data with 90% reliability	-	>90%
DSO4.4	DSO.Q	Constrained data exchange ESO-DSO	System “up time” for the exchange of network constraint data via the new ICCP link in the Common Information Model (CIM) format (daily)	-	>90%
DSO5.2	DSO.U	EHV substation areas in flexibility market evaluation	A report detailing the cumulative volume of EHV substations in flexibility evaluation exercises involving our stakeholders	25 (end of period)	80 (end of period)
DSO5.3	DSO.W	Flexibility provider registration acceptance time <30 days	Time taken for a response to be provided to new customers who apply to become a flexibility provider		>95%
DSO5.3	DSO.X	Procurement events response time <3 months	Time taken for a response to be provided to customers who participate in our flexibility tenders	-	>95%
DSO5.3	DSO.Y	Local flexibility stakeholder engagements	The total number of stakeholder engagements to promote flexibility	-	120

Summary: ODI-reputational sub-metrics

Deliverable	Metric ID	Measure	Description
DSO1.3	DSO.B	LV load monitors installed	Number of LV load monitors installed
DSO2.3	DSO.C	Standardised DFES inputs	The development of a Code of Practice between DNOs for the DFES to detail industry best practice and standardisation
DSO2.3	DSO.D	Accurate forecasting of network needs (reconciliation of outturn vs forecast)	An annual report detailing the reconciliation of outturn vs forecasted volumes and general reasoning, e.g. capacity that relates to peak demands, and general comments about what the trends are and why
DSO2.5	DSO.E	Historical operational and outage planning data ESO/DSO	Historical operational and outage planning data to be shared with stakeholders (e.g. monthly)
DSO3.1	DSO.J	Network asset data stakeholder feedback survey and report	Network asset data stakeholder feedback survey and report
DSO4.4	DSO.R	Common flexibility dispatch principles	A DSO decision-making framework, commonly aligned across DSOs for when DER are instructed to dispatch in real-time
DSO5.2	DSO.V	Common registration processes	The development of industry wide prequalification processes between DNOs to ensure standardisation

Summary: reported annually to stakeholders sub-metrics

Deliverable	Metric ID	Measure	Description
DSO2.5	DSO.G	Planning and operational network forecasting stakeholder feedback survey and report	Planning and operational network forecasting stakeholder feedback survey and report
DSO3.2	DSO.K	Number of LAEP engagements reported	Number of LAEP engagements reported
DSO4.2	DSO.N	ANM flexibility volume	The capacity of ANM connected to our network
DSO4.2	DSO.O	Number of ANM connections	The number of connections with ANM agreements
DSO5.1	DSO.S	Network access amendments	Count of amendments made to customer connections arrangements following the review of network access arrangements
DSO5.1	DSO.T	Re-adjustment of existing connection agreement	Count of re-adjustments to existing connections agreements following the review of network access arrangements
DSO5.3	DSO.Z	Efficient dispatch of flexibility audit	The assessment of how the DSO ensures it facilitates efficient dispatch of flexibility services by providing evidence of the necessary processes, procedures and systems
DSO5.3	DSO.AA	Procurement stakeholder feedback survey and report	Stakeholder survey and report
DSO5.5	DSO.BB	Dispatch stakeholder feedback survey and report	Stakeholder survey and report

Appendix 4 – Ofgem requirements

Below we have mapped our deliverables and initiatives against Ofgem's baseline requirements. It is through these DSO deliverables and initiatives that we will deliver the standard of service outlined in the activities and baseline expectations, and fulfil the DSO roles envisioned by Ofgem for RIIO-ED2. The performance measures set out in appendix C will enable evaluation of our progress in delivering our DSO strategy and meeting (or exceeding) specific baseline expectations.

We have marked a small number of deliverables/initiatives as exceeding baseline; however this is not based on requiring additional funding over and above the investment required to deliver baseline expectations for these items. Additional benefits in excess of baseline are a result of cost optimisation across the plan.

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
Role 1: Planning and network development	Activity 1.1: Plan efficiently in the context of uncertainty, taking account of whole system outcomes, and promote planning data availability	1.1.1: DNOs to define and develop enhanced forecasting, simulation and network modelling capabilities, with processes in place to drive continual improvement to meet network and user needs. We expect increased monitoring equipment to be rolled out across their network where it has demonstrable net value for network planning. We expect demonstrable value to include a rigorous presentation and analysis of needs and use of data for networks and non-networks parties, well established functional and technical specifications, and cost-effectiveness analysis. DNOs should also explore all reasonable options to use data from third parties, including harnessing smart meter data subject to data sharing agreements, to improve their simulated forecasting.	DSO1.1 (B); DSO1.3 (B); DSO2.1 (B); DSO2.2 (B); DSO2.3 (B); Initiative2.7 (E); DSO3.2 (B)
		1.1.2: We expect DNOs to submit a network visibility strategy and this should cover the use of all sources of network data including direct measurement from monitoring roll-out, smart meter data, data analysis and modelling, and any other third party data sources. The strategy should explain how network monitoring for planning purposes will inform planning decisions, including the use of flexibility; clear justifications for where and when monitoring is rolled-out, including explanations of any targeting for equipment deployment; and the specifications of equipment, including detail on the data captured, frequency of polling, and the mode of communicating data. Note, companies may wish to combine this strategy with network monitoring and visibility for network operations under role 2.	Refer to separate Network Visibility Strategy Annex
		1.1.3: DNOs to have in place standard and effective processes for sharing network planning information with other network licensees, including the ESO, network users and other interested parties, for example to enable innovation and support the development of local government plans for decarbonisation. As part of this, we expect DNOs to liaise with their network users to collate and share data, to publish comprehensive and comparable heat maps that provide network users high value information about where to connect, and to inform their operations. These geographic information system datasets should be available for download or for access independently of DNO websites (for example, via Web	DSO2.5 (B); DSO3.1 (B); DSO3.2 (B); Initiative3.4 (B)

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
		Map Service server connections). Ofgem-led reforms to the LTDS will seek to licence minimum standards against these improvements.	
		1.1.4: DNOs to have in place transparent and robust processes for identifying and assessing options to resolve network needs, using competition where efficient. This should include demonstrable cross-sector engagement, optioneering, and planning with sectors or vectors other than their own. DNOs should consider flexibility and promoting energy efficiency in addition to innovative use of existing network assets and traditional reinforcement. The process of identifying options should include engaging with other network licence holders and current and prospective network users. Options must be fairly compared against one another, with flexibility used where it is economic and efficient compared to investing in traditional reinforcement or technological solutions. We expect a consistent approach for valuing flexibility, taking into account the option value it provides in the context of uncertainty. DNOs must ensure transparency in their approach to allow scrutiny of decision-making.	Initiative2.6 (B); Initiative2.7 (E – *note assumed to be funded through NIA*); Initiative3.3 (B)
Role 2: Network operations	Activity 2.1: Promote operational network visibility and data availability	2.1.1: DNOs to improve network visibility and identification and sharing of operability constraints, including publishing this data to help avoid conflicting actions being taken by other network and system operators. DNOs must take reasonable steps to access and subsequently share, including by publishing, data and operability constraint information in a timely manner.	DSO1.1 (B); DSO2.3 (B); DSO2.5 (B); DSO3.1 (B); Initiative3.4 (B)
		2.1.2: We expect DNOs to submit a network visibility strategy and this should cover the use of all sources of network data including direct measurement from monitoring roll-out, smart meter data, data analysis and modelling, and any other third party data sources. The strategy should explain how network monitoring for operational purposes will inform operational decisions, including enabling the management and delivery of flexibility services; clear justifications for where and when monitoring is rolled-out, including explanations of any targeting for equipment deployment; and the specifications of equipment, including detail on the data captured, frequency of polling, and the mode of communicating data. Note, companies may wish to combine this strategy with network monitoring and visibility for network planning under role 1.	Refer to separate Network Visibility Strategy Annex
		2.1.3: DNOs to provide the ESO with information across timescales about the DER it is planning to instruct to dispatch. Data should include contracted parties, availability and information on scheduled and unscheduled utilisation. Sharing this information in a timely manner should enable the ESO to identify which DER are available for its own needs and improve the ability of DER to stack value across markets.	Initiative3.4 (B); DSO4.1 (B)
		2.1.4: DNOs to gather sufficient information on DER characteristics and parameters to provide information and inform decisions to secure against events that could lead to disconnection of DER.	Initiative4.8 (B)
		2.1.5: DNOs to make available operational data that supports network users and other relevant stakeholders to make better decisions about how to use the network. Data	DSO2.5 (B); DSO3.1 (B); Initiative3.4 (B)

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
		should be readily available in agreed and common data formats. This could include, but is not limited to: – working network configuration data – losses recorded at substation level – outages both planned and unplanned – as recorded historic Feeder MW/MVA Utilisation and calculated headroom/footroom – utilisation and curtailment of areas under the control of capacity management systems such as Active Network Management systems.	
	Activity 2.2: Facilitate efficient dispatch of distribution flexibility services	2.2.1: DNOs to have and regularly review a decision-making framework for when DER are instructed to dispatch in real-time. The decision-making process, including alternatives considered, should be transparent. This should promote coordination across services (including curtailment as part of non-firm connection agreements and ESO flexibility services), maximise liquidity, avoid market fragmentation and ensure dispatch results in the best outcome for the whole system; this includes service provision to the ESO and other distribution networks. As part of this decision-making framework, there must be rules in place for coordinating dispatch instructions for DSO and ESO flexibility services. This could be through primacy rules or more comprehensive optimisation processes that better enable stacking of revenues for DER. The rules should be transparent, objective, and promote whole system efficiencies.	Initiative3.3 (B); DSO4.1 (B); DSO4.2 (B); DSO4.4 (B)
		2.2.2: DNOs shall facilitate secondary trading of distribution flexibility services and curtailment obligations. In this context, facilitating means providing the relevant operational data, ensuring the DNO has processes in place to collect the relevant data about the trade, and making the operational parameters clear (and justified in the context of network reliability and efficiency).	Initiative3.4 (B); DSO5.1 (B)
		2.2.3: DNOs to introduce clear processes for the design, development, and communication of the decision-making framework. These should include transparent and participatory processes for stakeholder input.	Initiative2.6 (B); Initiative3.3 (B); DSO5.3 (B)
		2.2.4: DNOs to develop efficient, scalable dispatch instruction infrastructure and avoid proprietary systems. We expect clear definitions of different types of dispatch instruction for distribution flexibility services and transparent rules about when and in which markets they should be used. Circumstances for different dispatch instructions should be well-justified. Definitions of these circumstances should be developed with input and cooperation from network users. The application of hard dispatch controls shall be for the improved reliance on market-based mechanisms, not to the detriment of their development. Capabilities in network operations, for example in dispatch instructions and associated system architectures shall not be hard coded to the DNO. These must be developed so that they can be cost effectively assigned to another party in future if this is needed.	DSO4.1 (B); DSO4.3 (E); DSO4.4 (B); Initiative4.7 (B)
Role 3: Market development	Activity 3.1: Provide accurate, user-friendly and	3.3.1: DNOs collate and publish as much relevant data and information as reasonable that will help market participants identify and value opportunities to provide network services to DNOs and take market actions that	DSO2.5 (B); DSO3.1 (B); Initiative3.4 (B); DSO5.3 (B)

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
	comprehensive market information	support efficient whole system outcomes. Relevant data and information include planning and operational data (such as that set out in Activity 1.1 and 2.1). This should be provided with sufficient lead times to enable wider participation in distribution flexibility services markets. It also includes information on historic and future distribution flexibility services market actions. This should include tender results, prices bid and paid, the carbon content of aggregated units, how often DER is dispatched (and volumes) and other actions taken by the DNO (with anonymisation as required), including curtailment as part of non-firm connection agreements. The information should include all requirements set out in licence conditions to support DER to identify revenue opportunities. This increases the accessibility of tendering for distribution flexibility services for flexibility providers (while also taking account of DNOs flexibility needs).	
		3.1.2: DNOs should, with stakeholder input, develop robust strategies for how they will collate and publish more helpful information, wherever possible consistently and in coordination with other network licence holders, and communicate this clearly.	DSO1.2 (B); DSO3.1 (B)
		3.1.3: DNOs should regularly and actively engage with market participants to understand what data and information is helpful to support market development. While there will be minimum legal requirements set out in licences, we expect DNOs to use their stakeholder engagement to consider the most effective format and frequency of publishing that data to ensure it is user-friendly. The information must be easily accessible and navigable. We expect this includes publishing data in machine-readable formats.	DSO1.2 (B); Initiative1.4 (B); DSO3.1 (B); Initiative3.4 (B)
		3.1.4: DNOs should, where reasonable, tailor both their information provision and engagement approaches to reflect different needs of potential market participants, including groups in vulnerable situations. In many instances, collaboration across DNOs in engagement is expected to reduce duplication, make it easier for stakeholders to engage and avoid stakeholder fatigue.	DSO1.2 (B)
		3.1.5: DNOs should seek to ensure the information they publish is as accurate and unbiased as reasonable (i.e. correct at time of publication, as close as possible to the actual value and not skewed in any direction).	Initiative3.4 (B)
	Activity 3.2: Embed simple, fair and transparent rules and processes for procuring distribution flexibility services	3.2.1: DNOs to have clear processes in place for developing and amending distribution flexibility services products, contracts, and qualification criteria, that are, wherever possible, standardised. The processes should be transparent and participatory, involving other DNOs, the ESO, and current and potential distribution flexibility service providers. DNOs should also coordinate and engage with third party platform providers, who can offer system value by providing new routes to market and driving whole system outcomes. DNOs should not prevent the emergence of this sector and should enable third party platforms to 'plug-in' to DNOs' flexibility procurement processes. Products and contracts should be adaptive to reflect prevailing system needs, type, and availability of flexible resources. The objective of these processes is to enable as wide participation in distribution flexibility	Initiative1.4 (B); Initiative3.3 (B); DSO5.2 (B)

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
		services markets as possible.	
		3.2.2: DNOs should identify the optimum combination of longer and shorter term lengths of markets and contract lengths reflecting the network need. Needs should be neutrally defined, to allow for a range of flexibility providers to participate. This will help improve market liquidity and the opportunities for innovation and dynamic competition. Individual decisions and frameworks for deciding market timeframes and contract lengths should be transparent, informed by stakeholders and justified as being the most economic and efficient solution. Notwithstanding, deviations from the standard should be justified with clear governance processes for managing change that should be clearly communicated. DNOs should have clear, comprehensive and transparent mechanisms and associated commercial structures for coordinating distribution flexibility services and ESO flexibility services procurement. DNOs shall not act as the commercial route for DER accessing ESO flexibility services. Transparent (and possibly tripartite) commercial agreements may be required to reflect the potential effects of DER dispatch on distribution system operability and the role of DNOs in setting dispatch parameters (as set out in Activity 2.1 and 2.2). These agreements should remove exclusivity clauses as far as possible, including with regard to non-firm connections. Coordination on dispatch parameters should enable a closer to real-time understanding of what DER needs to be armed and available for a particular service, and what can be available to provide other services. DNOs should consider arrangements to support DERs to provide services that meet both DNO and ESO needs.	Initiative1.4 (B); DSO3.1 (B); DSO5.2 (B); DSO5.3 (B)
		3.2.3: DNOs should make available the necessary data to enable secondary trading, for example capacity and other peer-to-peer trading. Enabling includes defining, communicating and justifying the parameters in which these trades can take place for operability purposes.	DSO5.1 (B); DSO5.3 (B)
		3.2.4: Market support services, such as pre-qualification, credit-checking and settlement must enable simple and cost-efficient participation in markets. DNOs should enable, and never prevent, the opportunity for third parties to provide these services where they could do so more efficiently.	DSO5.4 (B); DSO5.5 (B)
		3.2.5: DNOs to introduce other proportionate measures, developed with robust stakeholder engagement, to identify and address actual and perceived conflicts between its market development and network ownership roles or other business interests. The introduction of such measures should enable DNOs to efficiently plan, develop and use their network, taking into account and using flexible alternatives to network reinforcement where efficient for the system, in a visibly neutral way. At a minimum, this should include demonstrable executive-level accountability and board-level visibility of key DSO decisions across the planning, operation and market facilitation functions. This should also include clear and separate decision-making frameworks, supported by independent oversight, such as external auditing, to	DSO governance section; Initiative2.6 (B); Initiative 3.3 (B); DSO5.5 (B)

Role	Activities	Baseline expectations	Northern Powergrid deliverable/initiative (B = meets baseline; E = exceeds baseline)
		promote transparency and enable scrutiny. Additionally, to support the justification of DNOs' proposals as proportionate, we expect DNOs to set out conflict mitigation options that were considered but not proposed, including legal separation if this is not part of the DNO's suite of proposals. As part of their justification, DNOs should include the available supporting information on the likely costs, timings and implications of these alternative options or a narration of initial views.	

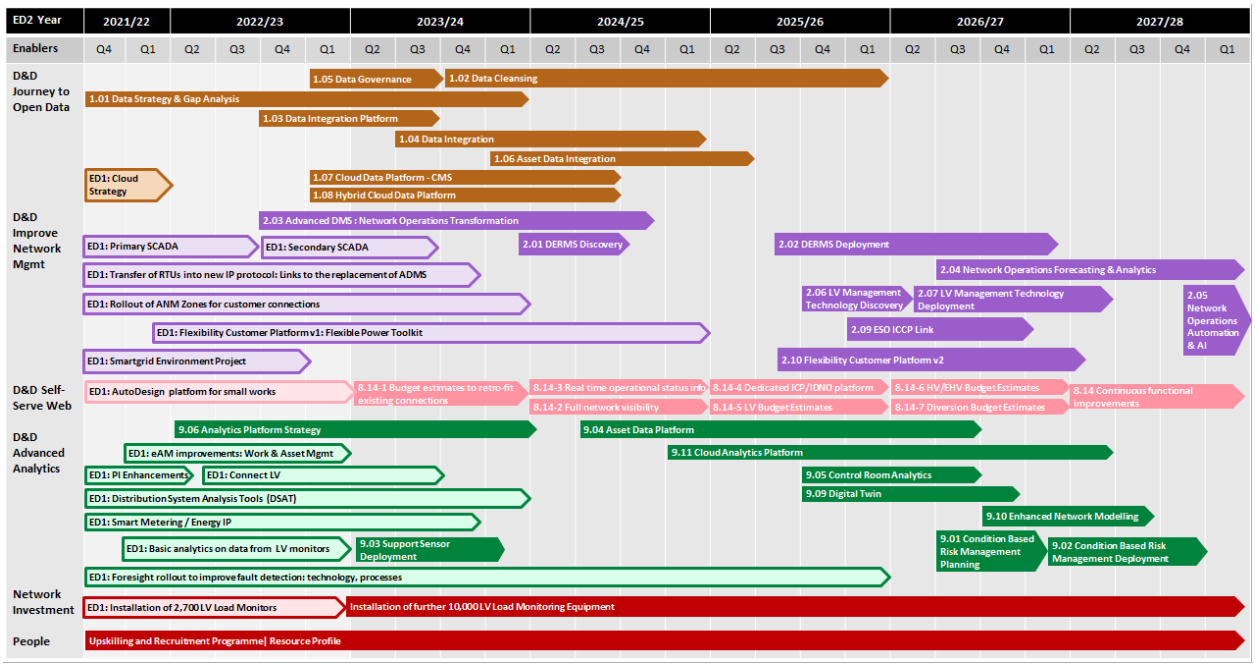
Note that three DSO deliverables/initiatives have not been mapped to Ofgem's baseline expectations, as they do not align directly. They are: DSO2.4, DSO4.5 and Initiative 5.6.

Appendix 5 – DSO strategy delivery plan

A high-level, “plan on a page” view of our DSO strategy implementation plan is shown below. This shows plans around the three key practical areas of delivery for the strategy – data and digitalisation (D&D), LV monitoring rollout, and people and skills. This supports the delivery planning section included in the strategy above.

As approximately 47% of all data and digitalisation investment will contribute to enabling DSO capabilities, we show below the detailed D&D initiatives which are required to successfully deliver the DSO strategy, including ongoing activities taking place today which will continue into the next price control period and are prerequisites for delivering the DSO strategy in 2023-28. The mapping of these activities across the D&D and DSO strategies is included at Appendix A above, with further detail on D&D initiatives in the DSAP, additionally, we present a more detailed view of the benefits that will be delivered by D&D investment and how this supports DSO in the justification annex.

As shown in the chart below, four of the ten focus areas in the DSAP are directly linked to the DSO strategy.



Glossary

Acronym/Term	Definition	Description
ADMS	Advanced Distribution Management System	Suite covering network control systems
AI	Artificial Intelligence	Artificial intelligence makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tests
ANM	Active network management	A control system that manages generation and load in real-time to keep the system within parameters
API	Application Programming Interface	An interface that defines interactions between multiple software applications
APRS	Automated Power Restoration System	Technology that improves network performance by identifying the location of faults on the HV network and restores power supplies by automatically switching to alternative connections
AutoDesign	N/A	Self-service online budgeting tool
AVC	Automatic Voltage Control	A system that maintains the voltage profile of a power system in an acceptable range and minimises the operational cost by coordinating the regulation of controllable components
BAU	Business as usual	N/A
BEET	Boston Spa Energy Efficiency Trial	A Northern Powergrid innovation project that seeks to develop a system that will use half-hourly averaged voltage measurements from smart meters in order to calculate an optimum 11kV target voltage that can be dynamically applied at three primary substations in the trial area
BEIS	The Department of Business, Energy and Industrial Strategy	N/A
BSUOS	Balancing Services Use of System charge	Charges levied to users of the national electricity transmission system by National Grid that aim to recover the costs of the day-to-day operation of the electricity transmission system
CA	Combined Authority	A legal body set up using national legislation that enables a group of two or more

		councils to collaborate and take collective decisions
CBA	Cost Benefit Analysis	N/A
CIM	Common Information Model	An open standard that defines how managed elements in an IT environment are represented as a common set of objects and relationships between them
CLASS	Customer Load Active System Services	Distribution network voltage control and network management services (developed through ENWL's innovation project) that could be provided to the ESO in its role as system operator (and residual balancer).
Connect/LV	N/A	A tool that allows the design and assessment of LV networks
CRM	Customer Relationship Management system	A system for managing all a company's relationships and interactions with customers and potential customers
CVP	Consumer Value Proposition	Companies may bid for a CVP reward on the quality aspects of their plan by demonstrating the additional value the plan will generate for existing and future consumers; and consumers in vulnerable situations.
CVR	Conservation Voltage Reduction	Optimising voltages to reduce customer energy consumption
DCUSA	Distribution Connection and Use of System Agreement	The DCUSA provides a single centralised document which relates to the connection to and use of the electricity distribution networks. It includes the charging methodologies for connection to, and use of, the electricity distribution networks
DEBUT	N/A	LV distribution network planning and design tool
DER	Distributed Energy Resource	Flexible generation or demand connected to the distribution system
DERMS	Distribution Energy Resource Management System	Enables optimised and proactive network management
DFES	Distribution Future Energy Scenarios	Outline a range of credible futures for the customer energy uses that will require servicing by the electricity distribution network

DG	Distributed Generation	Any generation which is connected directly to the local distribution network, as opposed to the transmission network, as well as combined heat and power schemes of any scale. The electricity generated by such schemes is typically used in the local system rather than being transported across the UK
Digital Twin	N/A	A static strategic planning model of a system, with input of long-term condition data from the physical twin via corporate systems; feedback into the physical twin via the capital investment process
DINIS	N/A	Power systems analysis software
DMS	Distribution Management Systems	Suite covering network control systems
DNO	Distribution Network Operator	A DNO is a company which operates the electricity distribution network which includes all parts of the network from 132kV down to 230V in England and Wales. In Scotland 132kV is considered to be a part of transmission rather than distribution so their operation is not included in the DNOs' activities
DNOA	Distribution level Network Options Assessment	A process for assessing options for reinforcing the distribution network to meet the requirements set out in DFES
DPS	Dynamic Purchasing System	A procedure available for contracts for works, services and goods commonly available on the market
DSAP	Digitalisation Strategy and Action Plan	The digitalisation strategy that sets out Northern Powergrid's strategic approach and plan to digitalise its products and services
DSAT	Distribution System Analysis Tool	A Powerfactory tool replacing DINIS and IPSA systems allowing better data sources integration, user friendly interface and more
DSO	Distribution System Operation	The monitoring, control and active management of the power flows on the distribution system to maintain a safe, secure and reliable electricity supply
eAM Spatial	N/A	Software with spatial network and asset data
ECR	Embedded Capacity Register	A register that provides information and visibility on connected resources and

		network services
EDTF	Energy Data Task Force	A taskforce commissioned by the UK Government, Ofgem and Innovate UK to develop an integrated data and digital strategy that helps unlock the opportunities of a modern, decarbonised and decentralised energy system for the benefit of consumers
EHV	Extra high voltage	EHV refers to voltages equal to or greater than 33kV and less than 132kV
EJP	Engineering Justification Paper	A paper used to justify load-related and non-load related investments that are aimed at reinforcing the network, improving assets health or network performance
ENA	Energy Networks Association	A trade association that represents the transmission and distribution network operators for gas and electricity in the UK and Ireland.
Energy IP	N/A	Smart meter portal. Requests/receives and provides working storage for data from SMETS2 Smart Meters via the Data Communication Company (DCC)
ESO	Electricity System Operator	The entity responsible for operating the GB electricity transmission system and for entering into contracts with those who want to connect to and/or use the electricity transmission system. National Grid is the GB electricity transmission system operator
EV	Electric vehicle	N/A
FES	Future Energy Scenarios	A range of different, credible ways to decarbonise our energy system as we strive towards the 2050 target
Flexible Power	N/A	A joint initiative from DNOs which provides a single point of information and toolkit to operate customer flexibility services
Foresight	N/A	Northern Powergrid's NIA funded innovation project that monitors pre-fault behaviour of LV networks, aiming to improve fault detection capability
FSP	Flexibility Services Provider	Flexible responses, typically distributed generation, storage or demand response, are connected to the electricity network, and are flexible in how they operate and impact the

		network
FTE	Full Time Equivalents	N/A
GB	Great Britain	N/A
GIS	Global Information System	A system that is able to hold spatial and geographic data
GM substation	Ground Mounted substation	N/A
GSP	Grid Supply Point	Substation to transform voltage from 400kV or 275kV to lower voltages
HV	High Voltage	HV refers to voltages greater than 1kV and less than 33kV
ICCP	Inter-Control Centre Protocol	A standard protocol which allows real time data exchange between utility control centres
ICCP Gateway Device	Inter-Control Centre Protocol Gateway Device	A software and/or hardware solution that connects to multiple data sources
IDNO	Independent distribution network operator	Any electricity distribution company whose licence was granted after 1 October 2001 is defined as an IDNO. IDNOs do not have distribution services areas. They own and operate electricity distribution networks which are predominantly extensions to the incumbent networks (e.g. to serve new housing developments).
iHost	N/A	Receives and stores data from network monitors
IPSA	Interactive Power System Analysis	Power systems analysis software
IS	Information Systems	An integrated set of components for collecting, storing, and processing data and for providing information and digital products
IT	Information Technology	The use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data
kW	Kilo watt	N/A
kWh	Kilo watt hour	N/A

LA	Local Authorities	An organization that is officially responsible for all the public services and facilities in a particular area
LAEP	Local Area Energy Plans	The product of a process involving a range of stakeholders, including gas and electricity network operators, agreeing on the optimal long-term energy solution for an area
LCT	Low Carbon Technologies	Technologies that emit low levels of CO2 emissions, or no net CO2 emissions
LEP	Local Enterprise Partnerships	Voluntary partnerships between local authorities and businesses to help determine local economic priorities and lead economic growth and job creation within the local area
LFDD	Low Frequency Demand Disconnection	The mechanism that automatically disconnects demand should the frequency levels hit certain trigger levels
LTDS	Long term development statement	A document produced annually that provides information on the operation and development of the distribution system
LV	Low Voltage	LV refers to voltages less than 1000V
Machine learning	N/A	Machine learning is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention
MDI	Maximum Demand Indicator	A low fidelity monitor of the maximum demand on a distribution transformer
MVA	Mega volt-ampere	N/A
MW	Mega watt	N/A
MWh	Mega watt hour	N/A
NDP	Network Development Plan	A NDP defines network plans over a five to 10 year window, including the use of flexibility services, as well as defining the expected uptake of LCTs
NG	National Grid	The company that develops, operates and maintains the transmission system

NGN	Northern Gas Networks	One of the companies that owns and manages the gas distribution network
NG Week 42	N/A	Annual provision of data to Network Operators by National Grid
NMS	Network Management System	A network management system that details and controls the HV/EHV and 132kV network
NOA	Network Options Assessment	A process for assessing options for reinforcing the National Electricity Transmission System to meet the requirements of the ESO
NPV	Net present value	The present value of a sum of money occurring at different times.
ODI	Output Delivery Incentive	A mechanism that will incentivise service level improvements by setting target service levels, rewards and penalties
ODI-F	Output Delivery Incentive – Financial	Financial ODI
ODI-R	Output Delivery Incentive – Reputational	Reputational ODI
ONP	Open Networks Project	A major Energy Networks Association initiative that is transforming the way our electricity networks are supporting delivery of a smart flexible energy system
OT	Operational Technology	The hardware and software dedicated to detecting or causing changes in physical processes through direct monitoring and/or control of physical devices. This includes all processes in a loop between sensing and output of operational actions including communication, storage of received data, holding working copies of network data and real time/ near real time processing of data prior to application back to system operation
PI Coresight	N/A	System for storage of half-hourly metered and SCADA data
Piclo	N/A	An online independent marketplace for trading energy flexibility services
PM substation	Pole Mounted substation	N/A
Powerfactory	N/A	Power systems analysis software
PowerOn	N/A	Software used to manage the status of the electricity distribution network, including safety documents and

Fusion		identification/mitigation of faults.
PPA	Power purchase agreements	An electricity supply agreement between two parties, usually between a power producer and a customer
RIIO	Revenue = Incentives + Innovation + Outputs	A performance-based regulatory model created by the UK's Office of Gas and Electricity Markets (Ofgem)
QPID	Quotation and Project Information Database	Software used to manage network connection jobs
RAG	Red, amber, green	N/A
RTU	Remote Terminal Unit	A unit that monitors the field digital and analogue parameters and transmits data to a SCADA master station
Safedig	N/A	3rd party facing system with view of geographic records
SCADA	Supervisory Control and Data Acquisition	A control system architecture comprising of hardware, software and data communications that allows the control and monitoring of assets
SCR	Significant Code Review	The Ofgem Access and Forward-looking Charges SCR aims to ensure that electricity networks are used efficiently and flexibly, reflecting users' needs and allowing consumers to benefit from new technologies and services while avoiding unnecessary costs on energy bills
SGT	Super Grid Transformer	A transformer to transform voltage from 400kV or 275kV to lower voltages
SME	Small and medium enterprises	N/A
STEM	Science, technology, engineering and mathematics	N/A
SP	Supply Point	Major substation which transforms 132kV to EHV or HV voltages
THD	Total Harmonic Distortion	The measurement of the harmonic distortion present in a signal and is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency

TO	Transmission Owners	TOs own and maintain the transmission networks. There are three licensed TOs in Britain, and each is responsible for a regional transmission services area
VPP	Virtual Power Plant	A virtual power plant is a cloud-based distributed power plant that aggregates the capacities of distributed energy resources for the purposes of enhancing power generation, as well as trading or selling power on the electricity market
WG	Working Group	A committee or group appointed to look into and report on a particular area

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