Network Development Plan

Part 3 – Methodology Report

May 2026

Contents

1 Introduction

1.1 Who we are

We are SP Energy Networks. We own and operate the electricity distribution network in Central and Southern Scotland (our SP Distribution network), and in North Wales, Merseyside, Cheshire, and North Shropshire (our SP Manweb network). It is through these two networks of underground cables, overhead lines, and substations that we provide our 3.5 million customers with a safe, reliable, and efficient supply of electricity.

1.2 Document context and purpose

Sharing data is key to the efficiency of the energy system as we decarbonise to Net Zero. It enables customers and stakeholders to assess market opportunities and participate in flexibility markets, in turn promoting the efficiency and competitiveness of these markets. It enables network companies and key stakeholders to work together to promote efficient whole system planning and operation and spur innovation and new solutions benefitting all customers.

In this context, Ofgem introduced Standard Licence Condition 25B to require each DNO to publish a Network Development Plan (NDP), setting out a high-level scope of what was to be included and a Form of Statement was published in December 2021 for DNOs to follow.

The primary objective of the NDP is to provide information on available network capacity to accommodate demand and generation growth, and interventions the DNO plans, which will increase network capacity (such as reinforcement and flexibility use). The NDP is a medium-term outlook, and is designed to sit between Long Term Development Statements (LTDS) looking five-year ahead and long-term Distribution Future Energy Scenarios (DFES) forecasts.

Each DNO's NDP must cover three main components:

1. **Part 1: Development report** – detailed information on the interventions we plan that will increase capacity. This includes non-load interventions which are not done to provide capacity but will increase capacity nonetheless (e.g. asset management interventions such as replacing an end-of-life transformer with a larger equivalent)[1].
2. **Part 2: Network scenario headroom report** – the indicative demand and generation capacity available at each primary substation (down to and including the HV busbar). Forecasts are produced for every year for the first 10 years, and then for every five years after that out to 2050. These capacity forecasts must take account of known planned interventions which will increase capacity (i.e. those listed in Part 1).
3. **Part 3: Methodology statement** – a document explaining how we have produced Parts 1 and 2.

Parts 1 and 2 need to be produced for each DNO licence area, down to primary substation group (i.e. the NDP does not include network interventions and capacity headroom for the LV and HV networks).

[1] Non-load interventions that increase network capacity (included in the document) are assumed to be due to switchgear and transformer asset-risk driven replacements. Where this is done on a like-for-like basis, there will be no network capacity increase.

Therefore, to meet our NDP licence obligation we publish four NDP documents[2]:

1. A summary document to introduce our NDP, set out strategic context and summarise the contents.
2. A pdf report and supporting excel datasheet for SP Distribution, covering Parts 1 and 2.
3. A pdf report and supporting excel datasheet for SP Manweb, covering Parts 1 and 2.
4. A single document for Part 3, covering SP Manweb and SP Distribution together as the methodology is the same for each. This includes the consultation feedback we received. **This document.**

Figure 1 shows the document map for these four documents.

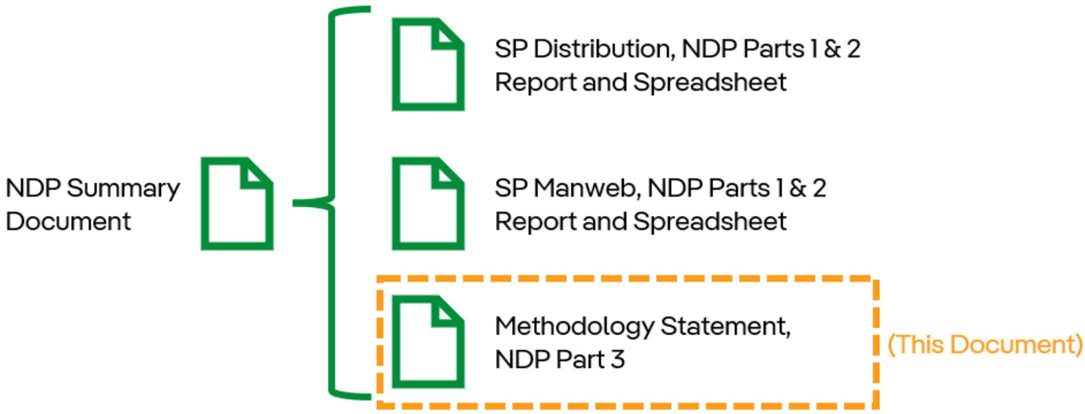


Figure 1: SP Energy Networks' NDP document map

In addition to financially approved interventions in RIIO-ED2 (April 2023 – March 2028), for this year's publication, we have also signposted indicative interventions that are being planned for the next price control period, i.e. RIIO-ED3 (April 2028 – March 2033) in NDP Parts 1 and 2.

These signposted RIIO-ED3 interventions remain subject to regulatory approval and are therefore provided for information only. We are preparing for the Draft Submission of our RIIO-ED3 plan to Ofgem in July 2026, followed by Final Submission in December 2026. Ofgem's Final Determination is expected December 2027.

We welcome stakeholder input and engagement throughout our RIIO-ED3 planning process.

1.3 Overarching process

The process below summarises how we produced NDP Parts 1 and 2 for SP Distribution and SP Manweb. For further details please refer to NDP Part 3 Methodology Statement.

- **Step 1, forecasting:** we develop our network to accommodate our customers' demand and generation requirements. Therefore, the first step of network planning is to understand what these are. We do this using the outcomes of our Distribution Future Energy Scenarios (DFES), which apply NESO's tRESP pathways directly and reflect stakeholder input, ensuring national, regional and local alignment.
- **Step 2, network impact assessments:** we undertake industry-leading assessments to understand where, when, and how much additional network capacity is needed to accommodate these forecast customer requirements.

[2] www.spenergynetworks.co.uk/NDP

- **Step 3, options assessment for load-driven investment:** to provide the capacity in the optimal way, we fairly and impartially assess different types and combinations of interventions (flexibility, energy efficiency, smart, innovation, and reinforcement), different delivery models (reactive, proactive), and how they could be coordinated with other interventions to reduce customer cost and disruption.
- **Step 4, flexibility tenders:** where our assessments show we need additional capacity, we tender for flexibility services to understand the availability and cost of using flexibility to provide it.

These four steps identify the RIIO-ED2 load interventions we will make that add network capacity – these are a key input to NDP Parts 1 and 2. Whilst these create the majority of the additional capacity we will deliver, the NDP requires that we include all interventions that increase capacity:

- **Step 5, NDP Part 1 – reporting of network interventions which add capacity:** we combine the load driven interventions identified in steps 1-4 with connections-driven, losses-driven, and non-load driven interventions which add capacity, to produce NDP Part 1.

After these five steps we know all the interventions we plan to make that will add capacity – this means Part 1 of the NDP is complete. To complete Part 2:

- **Step 6, NDP Part 2 – reporting network scenario headroom:** combining our existing network model, our scenario forecasts, and our known intervention plans to calculate the "post-intervention" headroom. Our NDP Part 2 Capacity Headroom spreadsheet data files provide an indication of headroom for each primary substation/substation group for each year through to 2050.

1.4 NDP Scope

This document is the NDP Parts 1 and 2 for SP Distribution. The scope of the Network Development report (Part 1) and Network Scenario Headroom report (Part 2) and are summarised below.

<table>
<tr><th>Documents</th><th>Network Development</th><th colspan="2">Network Scenario Headroom</th></tr>
<tr><td>Date range</td><td>Planned interventions for the next 10 years.</td><td colspan="2">Up to 2050.
Consideration to 2050 matches the DFES date range and so can reflect the uncertainty on long term network impacts.</td></tr>
<tr><td>Reporting granularity</td><td>Location, magnitude (MW) and timescales of interventions.</td><td colspan="2">Every year for the first ten years.
Every five years beyond that to the end of 2050.</td></tr>
<tr><td>Network coverage</td><td>All Primary substations (33/11 kV).</td><td colspan="2">All Primary substations (33/11 kV).
NOTE: In Scotland the 132/33 kV substations are considered as Grid Supply Points (GSPs), and are excluded from this document.</td></tr>
<tr><td>Forecast scenarios</td><td rowspan="4"></td><td colspan="2">Scenarios based on DFES for all years up to 2050.</td></tr>
<tr><td>Reported headroom</td><td>Demand</td><td>Generation</td></tr>
<tr><td>Network parameters underlying headroom calculations</td><td>Thermal loading</td><td>Thermal loading (including reverse power flows)
Fault level</td></tr>
<tr><td>Evaluation methodology</td><td colspan="2">Detailed analysis for the short-term where practical.
Simple tabular comparisons for the longer-term to 2050 (loading versus firm capacity).</td></tr>
</table>

2 Stakeholder engagement

Our stakeholder's views and feedback are vital in developing our methodology, we continue to be committed in ensuring that our publications and processes deliver the most value to our stakeholders and evolve with their needs. For this reason, we consult year round on our live Network Development Plan consultation survey; this can be found here. Alternately, you can continue to provide your feedback by email to systemdesignteam@spenergynetworks.co.uk. These will be monitored and fed into our next publication.

We would like to thank stakeholders for sharing their views with us on our Network Development Plan to date. Figure 2 shows the sectors that provided feedback on our NDP publication via online survey, e-mail response and other stakeholder events such as our DSO workshops.

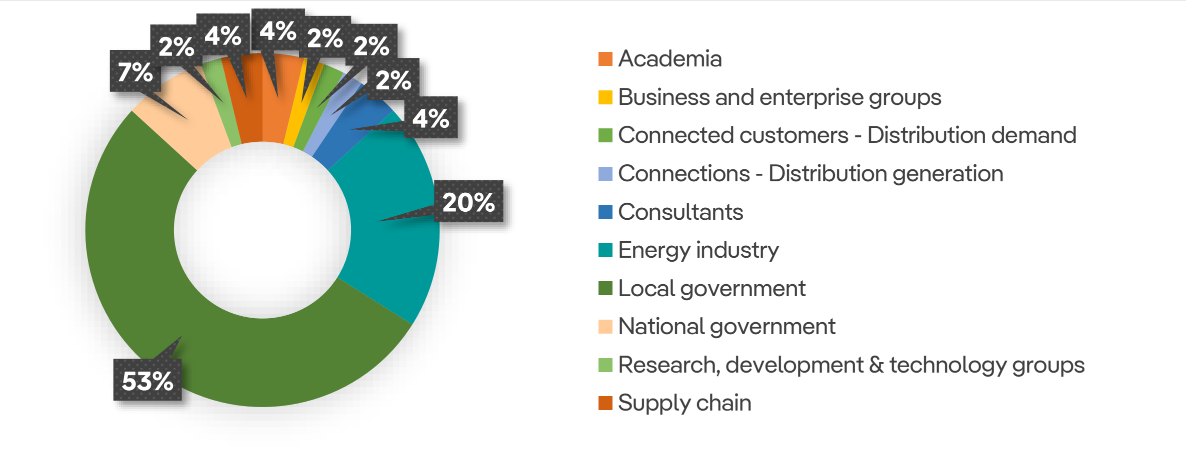


Figure 2: Stakeholder feedback by sector

Details on how to provide feedback was provided within our NDP summary document and shared with a wide range of stakeholders through email communications. These provided stakeholders with the links to our NDP website and online survey which asked our stakeholders to answer the below:

Part 1 - Development report:

1. How could/will our Network Capacity Headroom and Development report be used by your community/business?
2. Are there any ways we could improve the information contained within our Network Capacity Headroom and Development report?
3. Do you find the links to the Distribution Network Options Assessment (DNOA) Scheme pages useful?

Part 2 - Network capacity:

4. How could/will our Network Capacity Headroom data tables be used by your community/business?
5. Do you find the information contained within our Network Capacity Headroom data tables useful? If not, how could it be improved?
6. Do you find the presentation of headroom for the scenarios helpful? If not, how could they be improved?

Part 3 - Methodology statement:

7. Do you support the steps/process we have followed to produce our Network Development Plan (NDP)?

Other:

8. Do you make use of any other data sources we publish? LTDS, Heatmaps, ECR, DFES, Flexibility tenders, Other (tick all that apply)
9. Are there any other parameters you would like to see included within our NDP?
10. Are there any other comments or feedback you would like to make?

2.1.1 Summary of feedback

Overall stakeholders welcomed the publication of our Network Development Plan and saw the inclusion of Distribution Network Option Assessments (DNOA) as a positive addition. Stakeholders were generally pleased with the level of information provided on planned network interventions and within the capacity headroom forecasts.

Figure 3 provides an overview of the quantitative results from our online survey with non-confidential responses detailed in Appendix B:

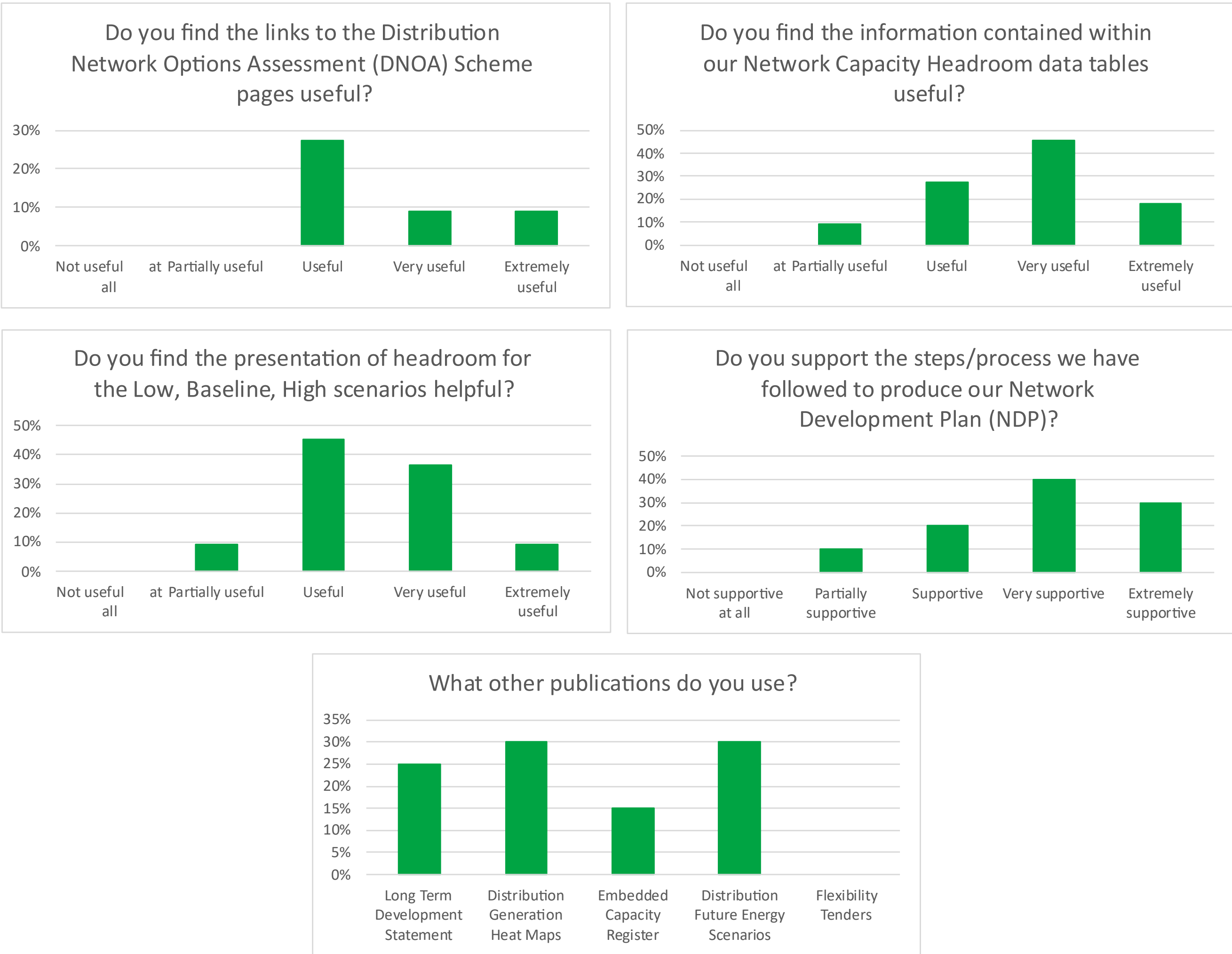


Figure 3: Stakeholder survey results

<u>Part 1 - Development report</u>

Stakeholders generally thought that the information on our planned network interventions would be useful for their organisations or communities to support decisions on decarbonisation, and also to understand opportunities for the provision of solutions and services. Some stakeholders also stated they plan to use the Network Development Plan report and findings to raise awareness of key challenges in decarbonisation within their regions.

The inclusion of DNOAs was unanimously supported by our stakeholders, with all responses agreeing the information contained was useful addition. Stakeholders highlighted that the information within the DNOAs was particularly useful to developers – both existing and prospective.

Stakeholders generally felt that inclusion of the Grid Supply Point navigation map was a positive addition and benefitted the report's useability. However, our Local Authority stakeholders highlighted that due to the scale of information provided in the report, they would benefit from further engagement through our Strategic Optimiser function to fully utilise the data provided. Several stakeholders highlighted that they would benefit from the data within the report being provided via a geospatial viewer, similar to Distributed Generation Heatmaps.

Part 2 - Network capacity

Over 90% of our stakeholders found the information in the network scenario headroom documents useful, very useful or extremely useful, and found presentation of Low, Baseline, High scenarios helpful to understand the range. They also thought that the information would play a useful role in their organisations and communities to help inform LCT deployment, policy/strategy development, project planning and assessment of opportunities. However, some were of the view that more certainty should be given on which of the Low, Baseline or High scenario is most likely.

Many of our Local Authorities stated that the information provided will allow them to refine the development Local Heat and Energy Efficiency Strategies (LHEES) and Local Authority Energy Plans (LAEP) plans through identification of areas that require less reinforcement. Stakeholders added that they plan to achieve this by using capacity data alongside other SP Energy Networks tools such as the Local Authority Network Insight Tool (LANIT). However, one stakeholder believed that some Low Carbon Technology deployment - such as journey and destination electric vehicle charging - would not be dictated by where network capacity was available but did acknowledge the importance of data in other areas.

Part 3 - Methodology statement

Stakeholders were generally very or extremely supportive about our process to produce our NDP. They highlighted the importance of continued stakeholder engagement, with one stakeholder stating that they believe there should be more focus on large industrial stakeholders in future.

Other

Over 80% of stakeholders who responded to the online survey stated that they make use of at least one of our Long Term Development Statement, Distributed Generation Heatmaps, DFES scenarios, Embedded Capacity Register, or Flexibility Tenders. Of these responses, the majority of stakeholders were using the information provided within our DFES or Distributed Generation Heatmaps. It was also stated that the information provided within the Network Development Plan provided a useful picture of the network when used alongside these other documents, in particular the Long Term Development Statement.

Incorporating stakeholder feedback

Since the publication of our draft NDP, we have applied a number of updates to our NDP publication to reflect what our stakeholders have told us. The table below summarises the feedback we received and explains the resulting action we have taken.

Stakeholder feedback	Action we have taken
It would be useful to have geographical information on boundaries for network supply areas.	As a result, we published GIS shape files containing our network primary supply areas alongside our final report. As part of our 2024 Network Development Plan process, we have updated these shape files, which are now provided in higher resolution and can be found on our NDP website. We are committed in continuing to refresh these network shape files for each Network Development Plan publication.
There is a lot of information in the publication, it would be useful to have a summary.	In addition to our summary report, we have recently lunched our NDP landing page on our Open Data Platform. We continue to incorporate stakeholder feedback to ensure the landing page functionality best meets our stakeholders needs. The map based approach, and summary graphs means the key information from our NDP can be obtain at regional granularity with a couple of clicks.
It would be useful to provide the information within the Network Development Plan within a geographic viewer. Being able to map a postcode or co-ordinate point to a substation would be beneficial.	We agree, it is important that we provide our result in formats that suit our stakeholder's needs. This is why - in addition to our NDP document suite and GIS shape files - we have developed our Network Development Plan landing page on our Open Data Platform. Much like our Distributed Generation Heatmaps or Distribution Future Energy Scenarios, this page provides an overview of the data in geospatial format and will allow stakeholders to locate substations of interest. The Network Development Plan landing page can be found: here
It would be useful to state which of the scenarios is most likely.	Our DFES and NDP investment scenarios purposely cover a range of potential futures to capture and plan against uncertainty. This process is outlined in Section 2.2 of our NDP Methodology Statement. We proactively plan against the HT scenario which is aligned with the national framework in tRESP. If uptake is higher than baseline we scale our investment through RIIO-ED2 re-openers and uncertainty mechanisms. This approach ensures we have a robust investment plan which can adapt to our customers' needs across the range of credible Net Zero scenarios, and it protects customer by making sure we have sufficient investment to enable Net Zero, but no excess allowances. We, therefore, do not believe it is appropriate to comment on the most likely scenario.
It would be beneficial to have a longer period to provide feedback as it is important to continually consider stakeholder views.	We are committed to ensuring our Network Development Plan publications continue to develop our stakeholders' needs and appreciate you may want to provide feedback beyond our consultation period. For this reason keep our online consultation survey live alongside our final publication. This will provide stakeholders with the opportunity to provide feedback of our Network Development Plan on a continuous basis until our next publication.

More granular data would help with local deployment of EVs and heat pumps.	During the RIIO-ED2 period, we are installing 14,102 LV network monitors to improve network visibility. As more data becomes available we will endeavour to include this in future updates. We have also passed this feedback for consideration within relevant industry working groups.
As Local Authority plans develop, it is important the feed into the DFES and NDP forecasts.	Alongside our Strategic Optimiser team we have also developed the "Register of Strategic Projects' which will allow stakeholders to feedback planned projects into our DFES scenarios, as well as our investment and intervention plans. This aims to achieve a targeted approach for local decarbonisation and will be reflected in our DFES and NDP annual updates.
Uncertainty around the impact of non-load interventions on network capacity	We have updated Section 1.2 of the Development and Capacity report to clarify the impact of non-load interventions such as asset modernisation.
More focus should be given to obtaining feedback from industrial stakeholders in future consultation periods.	Through our Net Zero Industrial Pathways (NZIP) innovation project, we have developed a repeatable and standardise process for engaging directly with industrial stakeholder in order to understand their future decarbonisation pathways. Initial stages of NZIP have directly fed into DFES and NDP to ensure our forecasts reflect this local need. We will continue to gather further industrial decarbonisation evidence as we move into stage 2 of NZIP.
It would be useful to translate what XMW in flexibility really means	We have updated our Methodology Statement to include links to our DSO Decision Making Framework. This publication provides detail and transparency on the process we follow to impartially select optimal solutions and how we decide when and where to rely on flexibility services instead of other network interventions.
Incorporation of transmission capacity will provide a holistic overview and would be very useful for regional energy planning.	Capacity headroom data on the transmission network is out of scope of the NDP, however we will pass this feedback for consideration within relevant industry working groups.

3 Forecasting our customers' needs

We develop our network to accommodate our customers' demand and generation requirements. The first step in network development planning is therefore to understand how customers are expected to use the network in the future. This is achieved through SP Energy Networks' Distribution Future Energy Scenarios (DFES), which provide a consistent, long-term forecast of future electricity demand, generation and storage across our distribution networks.

The Network Development Plan (NDP) does not create or adjust forecasts. Instead, it uses DFES outputs (drawn directly from NESO tRESP) as the single forecasting evidence base for assessing future network impacts and identifying capacity requirements.

3.1 DFES forecasts

The Distribution Future Energy Scenarios (DFES) provide the long-term forecast of customer demand, generation and storage that underpins the Network Development Plan. DFES does not represent a single prediction of the future; instead, it provides a structured, scenario-based view of how electricity use may evolve under credible pathways to Net Zero.

DFES is derived directly from the NESO's tRESP, ensuring that forecasts used for distribution network planning are aligned with national strategy, regional priorities and Clean Power 2030 by construction. The DFES process combines national pathways with local insight and spatial analysis to produce forecasts at a level of granularity suitable for network impact assessment.

The DFES process can be summarised as the following steps:

DFES Step 1: establishing the baseline network position

DFES establishes a robust baseline against which future change is assessed. This includes:

- current measured demand and generation,
- existing network configuration and asset data,
- confirmed connections and accepted connection offers,
- historic trends in demand and technology uptake.

This baseline ensures that future forecasts are anchored to the observed operation of the network and provides the reference point for assessing incremental change over time.

DFES Step 2: strategic pathway definition The starting point for DFES is the set of strategic pathways defined by NESO through tRESP. These pathways describe credible trajectories for the transition to Net Zero, setting out the expected scale and timing of low-carbon technology deployment across Great Britain.

tRESP pathways provide technology volumes for key drivers of distribution network demand and generation, including electric vehicles, low-carbon heating, renewable generation and electricity storage. Pathways are defined at Grid Supply Point (GSP) group level and reflect national and devolved government policy, including Net Zero targets and Clean Power 2030.

DFES adopts these pathways directly and does not create alternative futures or locally optimised scenarios. This ensures consistency between national system planning and distribution-level forecasting.

DFES Step 3: spatial translation of pathways

While tRESP pathways are defined at GSP group level, distribution network planning requires a more granular spatial view. DFES therefore translates pathway outputs into a detailed geographic distribution across SPEN' licence areas.

This spatial translation reflects:

- housing stock characteristics and land use,
- socio-economic factors,
- Local Authority plans, including Local Heat and Energy Efficiency Strategies (LHEES) and Local Area Energy Plans (LAEPs),
- known strategic developments and industrial growth signals,
- insights from engagement with Local Authorities, developers and industrial stakeholders,
- early visibility of projects captured through the Register of Strategic Projects.

The result is a spatially resolved forecast at GSP, primary substation and Local Authority level, suitable for network impact assessment.

DFES Step 4: application of tRESP CPAs

To translate technology uptake into network-relevant impacts, DFES applies NESO's Consistent Planning Assumptions (CPAs). CPAs provide a standardised methodology for converting volumes of low-carbon technologies into demand and generation profiles suitable for network analysis.

CPAs define assumptions for:

- electric vehicle charging behaviour and diversity,
- residential low-carbon heating demand profiles,
- changes in underlying domestic demand due to energy efficiency improvements.

By using CPAs, DFES ensures that expected levels of flexibility and behavioural change are embedded within demand profiles, rather than treated as separate sensitivities. This provides a consistent and transparent basis for assessing peak demand and other network parameters.

DFES Step 5: production of scenario outputs

DFES produces a suite of forecast outputs for each scenario, covering key demand, generation and storage metrics. These outputs are produced for each year out to 2050 and provide the inputs required for network modelling and planning.

Outputs include both total demand and generation volumes and their contribution at times of peak demand, ensuring that forecasts are directly applicable to network capacity assessment.

DFES Step 6: stakeholder testing and validation

D Stakeholder engagement is embedded within the DFES process. validate spatial distribution assumptions, Adjustments are made where feedback is supported by evidence, ensuring that DFES remains regionally reflective while staying aligned with national tRESP pathways.

DFES Step 7: publication and governance

DFES outputs are published annually alongside supporting documentation, data tables and maps. This includes transparency on assumptions, methodology and how stakeholder feedback has been considered. DFES governance ensures that forecasts are updated regularly to reflect changes in policy, technology, customer behaviour and stakeholder plans, providing a stable but adaptable evidence base for network planning.

For more details on UK, Scottish, and Welsh Net Zero targets and the DFES forecasting methodology, scenario assumptions, stakeholder feedback, data workbooks and maps, please see our DFES suite of documents available on our DFES website[3].

3.2 Enhanced spatial forecasting and innovation

While DFES provides a strategic, scenario-based view of future demand and generation, additional spatial insight is required to identify where network impacts will materialise at a local level.

To support this, SP Energy Networks has developed enhanced spatial forecasting tools, including EV-Up and Heat-Up, which distribute DFES uptake assumptions across individual network areas using spatial, demographic and socio-economic data.

These capabilities are now being brought together through FutureUp, SP Energy Networks' next-generation spatial forecasting programme. FutureUp provides high-resolution, location-specific insight for network planners and Local Authority partners, enabling more informed planning decisions and earlier identification of potential network constraints.

These tools do not replace DFES; they support the spatial application of DFES forecasts within network impact assessments.

3.3 Use of DFES within the Network Development Plan

DFES forecasts are used consistently across both parts of the NDP:

- **NDP Part 1 (Network Development report)** uses DFES outputs to identify where future capacity constraints may arise and to inform the need for network interventions.
- **NDP Part 2 (Network Scenario Headroom report)** combines DFES forecasts with the existing network model and planned interventions to calculate post-intervention headroom at each primary substation.

Using a single, consistent set of DFES forecasts ensures transparency and alignment between intervention planning and headroom reporting and that proactive investment remains driven by the NESO tRESP outputs..

[3] Our DFES is available at: https://www.spenergynetworks.co.uk/pages/distribution_future_energy_scenarios.aspx

4 Network impact assessments

Our forecasts show that customer demand and generation levels are increasing significantly. This section explains how we assessed the ability of the existing network to accommodate these changes, and how we identified where, when, and how much additional network capacity we need to provide. We use this information to identify the interventions we need to make (Section 5), including the tendering for flexibility (Section 6).

4.1 Our ENZ Model

The level of activity on our distribution networks is a step change from decades of steady, predictable, incremental change. We need to do more than just increase network capacity – to enable us to fully understand the network impact of our future energy scenarios and intervention requirements at an individual asset level we have needed to significantly develop our modelling capability.

Therefore over RIIO-ED1, through our award-winning Network Constraints Early Warning System (NCEWS) innovation project, we have built a full connectivity model of all 48,000km of our LV network. We have combined it with our existing HV and EHV network connectivity models, so we now have a complete model of our entire network, from customers' cut outs up to the transmission network. We call this our ENZ Model.

The ENZ Model allows for complex modelling and is a significant advancement on vectorised geographic information systems (GIS). It has been designed to operate with large data sets and provides access to full asset data including conductor types, ratings etc. It enables us to trace the network and aggregate demand, including the effects of demand diversity at any point in the network. These developments are part of our efforts to enable better monitoring, control, design, and operation of the network.

4.2 Using our ENZ Model to develop intervention plans

We used our ENZ Model to develop our load intervention plan. Using outputs from our DFES and enhanced forecasting tools (Section 3.2, the ENZ Platform ran a comprehensive programme of power flow analysis for every half hour for every forecast scenario – 175,000 iterations per network asset. This systematically identified the location, magnitude, and timing of every network constraint in RIIO-ED2 (Figure 4).

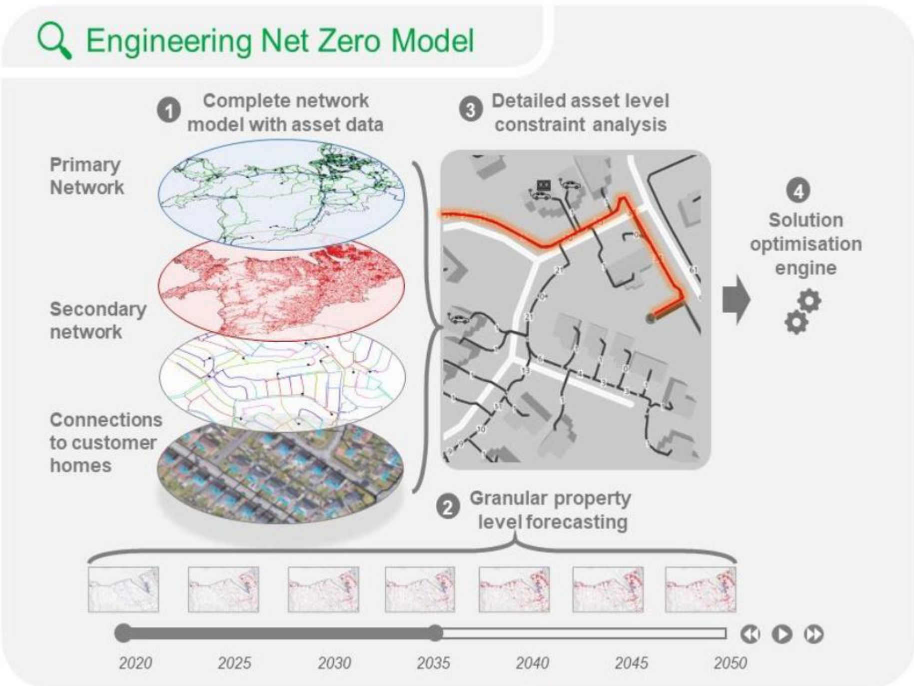


Figure 4: ENZ Model

The process in detail was as follows:

- **Step 1: assessing present maximum loading for each asset.** At primary substation (EHV/HV) and above, the historical network SCADA network data was fully available. At lower voltages, the present loading was assessed using the full connectivity data including the number, type, and size of customers supplied by each asset. This assessment made use of utilisation data where this was available, for example using Maximum Demand Indication (MDI) data.
- **Step 2: assessing the forecast change in loading for every asset.** The ENZ Model used the low, baseline and high scenario forecasts, including the individual property level data from EV-Up and Heat-Up across the entire network. The modelling combines the forecast information with detailed network data on each of the assets (e.g. their electrical characteristics, ratings etc.) to calculate the change in asset loading.
- **Step 3: identifying and characterising forecast capacity constraints.** The ENZ Model established what the resulting loading would be for each scenario and identified where individual assets would be operating outside network limits. This is where network constraints would occur if we do not deliver additional capacity. In many cases to understand these constraints better we modelled constraints for every half hour period, at individual asset level, for both normal and fault conditions, in each year up to and beyond 2030. After this process we know the timing, location, type (e.g. thermal, voltage), and magnitude of every forecast constraint in RIIO-ED2.
- **Step 4:** The ENZ Platform also contains a linear optimiser, enabling us to impartially assess optimal solutions.

To put this level of analysis into context, each iteration of the model required around 20 hours of processing time using high-powered cloud-based Microsoft Azure virtual servers. It processed over 150k circuits and 70k transformers in each scenario. Traditional manual modelling would not have been capable on this level of analysis. The model can be viewed geographically to see which customer properties are likely to have EV and heat pumps and which assets will overload as a result.

How we use the modelling outputs

We assessed the range of low, baseline, and high scenarios to systematically identify where, when, and how much additional capacity is needed to accommodate customer needs. This fed into flexibility tender requirements and outlined the minimum requirements that conventional / smart solutions would need to be capable of managing. This information is a key input for the flexibility tendering and solution options assessments stages (Sections 6 and 5 respectively).

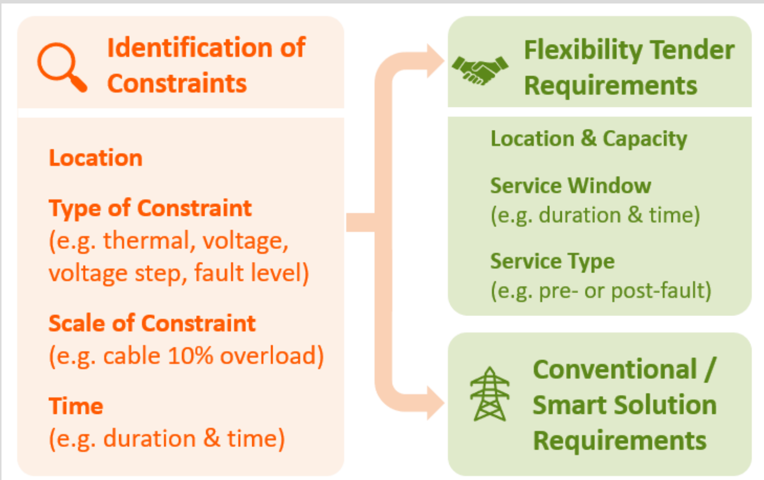


Figure 5: Outputs of the network impact assessments

If we have a single baseline forecast scenario, why model the other forecast scenarios?

Modelling the low to high scenario range in addition to the Baseline scenario helps us in the following ways:

- Seeing the results from the range of scenarios helps us identify sensitivities. These may then need to be investigated further or managed through the RIIO mechanism.
- Some areas of the network will be constrained in all scenarios. This helps prioritise interventions – constraints that appear in all scenarios are usually those that are closest to manifesting.
- The highest impact scenario represents our upper case. This helps us understand what we need to be prepared to potentially deliver.

What are the different types of network constraint and when do we intervene?

There are three main types of network constraint. These are:

1. **Thermal constraints** – where network current would exceed equipment thermal ratings. Thermal constraints can affect any type of asset at any voltage level. High loadings on certain assets may simply reduce their life, however significant overloading introduces safety risk. For example, an overhead line conductor will sag more if it is overloaded – this may risk the statutory minimum safety clearance distances outlined in the Electricity Safety, Quality and Continuity Regulations (ESQCR).

   The thermal loading on each asset is considered against its capability under normal and fault/outage conditions. Equipment thermal ratings are considered to vary seasonally with temperature throughout the year. Cyclic thermal ratings of assets are used when assessing the network under fault/outage conditions. The cumulative time exposure to overloads, and whether equipment has sufficient cool back periods are considered. We prioritise interventions when the network assets are at risk of exceeding 100% of their thermal rating.

2. **Voltage constraints** – where network voltage would be in breach of statutory limits. Network voltages can be too low (usually caused by excess demand), too high (usually caused by excess generation), or change too quickly (instantaneous change in voltage due to planned/unplanned outages). Voltage excursions can cause damage to customer equipment and network assets, and introduce safety risks.

   We have a duty to maintain voltages within the statutory limits at each voltage level. We prioritise interventions when the network is at risk of breaching these limits.

3. **Fault current constraints** – where the network fault current would exceed the fault current rating of switchgear. If this happened, it would represent a serious safety risk as the network could not be safely isolated in the event of a fault. Fault current constraints can affect equipment at any voltage level.

   Circuit breakers may be called upon to disconnect faulting equipment from the network; or energise onto faulty or earthed equipment. Different types of fault (including 3-phase and single-phase faults) are assessed under make and break fault duties. Where substations are approaching switchgear capability or operationally managed, detailed assessments of the maximum fault flows through each individual breaker are undertaken. Substation infrastructure such as busbars, supporting structures, flexible connections, current transformers, and terminations must be capable of withstanding the mechanical forces associated with the passage of high magnitude fault current i.e. through-current withstand duty. Where switchgear is in excess of 95% of equipment or design rating we consider the substation to be constrained.

These constraints can occur together or independently. These network constraints are a result of there being insufficient network capacity to accommodate customer power flows and demand/generation growth.

5 Options assessment for load-driven investment

Forecasting → Network Assessments → **Options Assessments** → Flexibility Tenders → Intervention Plan (NDP Part 1) → Capacity Headroom (NDP Part 2)

By this point we know where, when, and how much additional capacity our customers need (Section 4). For each constraint identified, we impartially assess a long list of solutions against defined criteria to identify the optimal solution (or combination of solutions). Where flexibility services are a technically viable solution (either as part of the solution or the whole solution), we calculate the ceiling price and proceed to a flexibility tender to confirm their cost and availability. Where flexibility services are not a technically viable solution we go straight to an intervention decision.

5.1 Intervention options

For each forecast capacity need in RIIO-ED2, we assess a range of flexible, innovative, and conventional solutions. Table 1 shows the six main categories of interventions to add capacity. They are not mutually exclusive, so can be combined to provide capacity.

Table 1: Network intervention categories

Intervention type	Advantages and disadvantages
Flexibility services Where customers agree to actively manage their demand/generation to help avoid constraints.	✓ Can help defer or avoid reinforcements ✓ Encourages competition and the democratisation of the energy system × Not always available as an option × Doesn't help fault level (switchgear) constraints
Energy efficiency Where customers have agreed to passive measures to manage their demand to help avoid constraints.	✓ Directly benefits the customer through lower bills ✓ Helps reduce whole system peak, network losses, and the need for generation capacity × Cost effectiveness (MW reduction per £) is lower than other solutions × Doesn't help fault level (switchgear) constraints
Smart network interventions Where we look to get more out of existing network capacity.	✓ Often lower-cost than network reinforcement ✓ Can have secondary benefits, such as enhancing the effectiveness of other interventions × Can increase network complexity × Typically lower capacity release than network reinforcement
Network reconfiguration Where we temporarily or permanently adjust the topography of the network to match existing network capacity with customer power flows.	✓ A low-cost intervention ✓ Quick to implement × Limited to where there is a low coincidence of customer usage between neighbouring sections of network
Enhanced asset ratings Where we seek to increase the thermal capacity of individual existing network assets without having to replace them.	✓ Typically a low-cost intervention ✓ Quick to implement × Capacity uplift might only be for short periods × Can increase asset deterioration × Doesn't help switchgear constraints
Network reinforcement Where we permanently increase network capacity by replacing existing assets or adding more assets – for example, a new substation.	✓ Allows significant customer demand and generation growth by providing substantial additional capacity ✓ Enables customer participation in wider market opportunities by providing unconstrained access on an enduring basis ✓ Can improve asset health and reliability × Can take a long time to deliver, especially if planning permission is needed × Potentially higher environmental impact than other interventions

Included in the above are new solutions we've developed through RIIO-ED1 innovation projects which have been incorporated as business as usual solutions in RIIO-ED2 – please see the case study below for one such example. Building on RIIO-ED1 innovation has saved our customers over £80m across our whole business plan.

Case study: innovative approaches to managing fault level

In RIIO-ED1, we partnered with Outram Research Ltd to develop the world's first real-time fault level monitor. For the first time for any DNO, this gives an accurate real-time understanding of network fault level. We combined this innovation with a network management scheme – another first for any DNO. Together, these capabilities allow us to safely connect more generation without triggering fault level reinforcements.

This is good for our generation customers, who can connect more quickly and at lower cost. It's also beneficial for our wider customer base, who pay a portion of interventions to manage fault level.

Due to these advantages, we have included this system in our plans to manage 38 fault level constrained sites over RIIO-ED2.

5.2 Options assessments

Having identified where, when, and how much additional capacity we need across our network in RIIO-ED2 (Section 4) and established the long-list of potential solutions (Section 5.1) including the applicability of flexibility (Section 6), we need to identify the optimal combination and sequence of solutions for every constraint.

5.2.1 The information we need to assess solutions

To assess solutions we need to understand their costs and capabilities. For most solutions we do this by maintaining close links with manufacturers and industry, delivering innovation projects, monitoring other DNOs' innovation projects, and using our experience. To understand the costs and capabilities of flexibility services, we tendered for every forecast constraint that our load related plan is seeking investment to address (Section 6).

5.2.2 Our solution assessment criteria

When we assess interventions, we consider potential solutions against a number of factors:

Technical

- **Customer needs**
  Can it provide the required capacity
- **Technical requirements**
  Technically feasible and doesn't introduce other issues

Cost

- **Whole life cost**
  Cost benefit considering Capex and Opex
- **Environmental impact**
  Losses, noise, visual impact, and carbon impact

Other

- **Timing/delivery**
  Can the solution be delivered in time
- **Whole system**
  Transmission/distribution and cross vector interactions

1. Does the solution provide the required volume of capacity in the right location? If a solution can't provide sufficient capacity by itself, we will consider whether it can in combination with another solution.
2. Is the solution technically acceptable? Does it comply with technical standards and statutory limits? For example, a solution may provide sufficient capacity, but it would not be an acceptable solution if it causes voltage levels to exceed statutory limits or material risks to supply reliability.
3. What is the whole life cost of the solution? Here we consider both the upfront capital cost (capex) and the ongoing operational cost (opex). The Common Evaluation Methodology Tool can also consider optionality value.
4. What is the solution's environmental impact? Here we consider the solution's impact on network losses, noise, visual impact, and carbon footprint.

5. Is the solution deliverable in the timescales required by customers? For example, a lengthy planning permission process may mean a particular solution cannot be delivered in the timescales required, or may need to be combined with a shorter-term interim solution.
6. Whole systems considerations? Here we consider whether solutions are coordinated from a whole energy system perspective, or whether we need to engage with other stakeholders, for example adjacent DNOs and/or the transmission network operator connected to our distribution network.

5.2.3 Assessment approaches at EHV and above

When assessing what solutions to use for each constraint, there are numerous variables to consider. For example, how our customers' capacity needs vary over time, how much capacity each solution adds, the lifetime of each solution, and the different capital (capex) and operational (opex) costs for each solution. This means there are a number of different combinations and sequences of solutions for each of the forecast RIIO-ED2 constraints, and we need to identify the individual optimal intervention approach for each.

We use detailed design studies, technical assessments, and CBAs for each scheme intervention at EHV and 132kV. These tools are excellent at analysing assessment criteria 1, 3, and 4 from the list above, but don't have the ability to assess other criteria such as deliverability. This means we use these tools to support the assessment criteria, rather than instead of them.

For each solution, we also consider how the potential requirements for the solution change across the low to high scenario range. This considers how robust the investment is across the range of credible Net Zero pathways, and identifies where the scope, magnitude, or timing of the investment is sensitive to the range of future pathways. Figure 6 shows an example of this: our plan is developed to deliver the baseline scenario (top row), meaning our plan contains a 7.5MVAr STATCOM (static synchronous compensator) delivered by 2028. However, understanding how the solution varies across the main Net Zero decarbonisation pathways is helpful as the Figure 6 analysis shows us that:

1. a STATCOM is the right solution for every pathway, so we can be confident installing a STATCOM is a robust choice across different decarbonisation pathways.
2. the size of the STATCOM (7.5MVAr or 10MVAr) and the timing of when it's needed (2027-2029) is sensitive to the different decarbonisation pathways, so in the early years of RIIO-ED2 we need to monitor the situation and, if customer growth is higher than our baseline scenario, be prepared to install a larger STATCOM sooner than in our baseline plan. The additional funding needed for the larger STATCOM would need to be recovered through an uncertainty mechanism.

	RIIO-ED1				RIIO-ED2					RIIO-ED3				
Solution Requirements	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Baseline									S1					
Consumer Transformation								S2						
Leading the Way									S1					
Balanced Net Zero Pathway									S1					
Headwinds										S1				
Widespread Engagement								S2						
Widespread Innovation								S2						
Tailwinds									S1					

S1 – Install +/-7.5MVAr STATCOM at Stranraer
S2 – Install +/-10MVAr STATCOM at Stranraer

Figure 6: Example of solution sensitivity to future pathways assessments

Using this approach, we have built up a bespoke and robust set of interventions for every scheme at EHV and above. For each scheme, we have summarised the investment into ex ante baseline funding, and uncertain funding associated with the higher uptakes.

6 Flexibility tenders

We tender for flexibility tenders as standard for all viable[4] network constraints. This is to confirm their availability and cost of flexibility. DSO Decision Making Framework[5] provides detail and transparency on the process we follow to impartially select optimal solutions and how we decide when and where to rely on flexibility services instead of other network interventions.

6.1 Flexibility tenders

We tender for flexibility for all viable network constraints. When we tender for flexibility we state the location, service product (see Table 2), service window and time (e.g. 4-6pm weeknights between October and March), required magnitude (MW/MVArs), and any other necessary technical parameters (e.g. response time). In some cases we will also send ceiling price information.

Table 2: Flexibility products

Flexibility Product	Product Description
Scheduled Utilisation (SU)	In this product, the time that flexibility is delivered has been pre-agreed in advance with the provider. This product will primarily benefit flexibility service providers that cannot respond in real-time or near to real-time. This service is used to manage seasonal peak demands and defer network reinforcement.
Operational Utilisation (OU)	This product allows for the use case where the amount of flexibility delivered is agreed nearer to real time. This can be utilised to facilitate a change in demand profile from flexibility service providers based on network conditions close to real-time. The assets will be dispatched for the required level of service that is required based upon actual network measurement data thus managing the cost. We utilise this product in order to restore network supplies following an unplanned outage/fault where the regulatory funding does not allow for availability payments e.g. customer interruptions (CI).
Operational Utilisation + Scheduled Availability (OUSA)	This product procures, ahead of time, the ability of a flexibility service provider to deliver an agreed change following a network abnormality. The availability will be defined at the point of procurement and cannot be modified once the contract has been agreed. The assets will be dispatched for the required level of service that is required based upon actual network measurement data, meaning that the DNO/ESO is only paying utilisation payments based upon the actual needs of the network. An example use case for this product is when a DNO is planning for sufficiency of flexible services contracts based upon long range forecasting of network constraints.
Operational Utilisation + Variable Availability (OUVA)	This product allows for DNOs to procure a level of contracted capacity, but then refine the requirements in terms of availability closer to the event. The assets will be dispatched for the required level of service that is required based upon actual network measurement data, meaning that the DNO is only paying utilisation payments based upon the actual needs of the network. An example use case for this product is when a DNO is planning for sufficiency of flexible services contracts based upon short-medium range forecasting of network constraints.

Once we receive tender responses, the bids are assessed in detail to check they were in the right area of network and could technically manage the constraint. We assess any risks associated with using the flexibility and considered the most cost-efficient mix of tender responses (if responses were greater than requested capacity). Technically competent bids feed into our options assessments (step 4 / Section 5) where they are assessed alongside all other options. We publish the results of our tenders, which includes prices bid and reasons for acceptance/rejection. Where we receive no acceptable bids, we may retender for the same constraint in a future tender round. Please see Appendix A for some examples of where we use flexibility on our EHV and 132kV network.

The capacity headroom data presented in this report incorporates flexibility services where contracts have been awarded.

[4] For example, flexibility can't resolve fault level constraints so we won't tender for flexibility for those types of constraints.
[5] Our Decision Making Framework is available here: DSO Decision Making Framework - SP Energy Networks

7 NDP Part 1 – reporting Network Developments

Forecasting → Network Assessments → Options Assessments → Flexibility Tenders → **Intervention Plan (NDP Part 1)** → Capacity Headroom (NDP Part 2)

The preceding sections detail how we have applied our forecasts, through network assessments, options assessments, and detailed design to establish our load driven interventions that we plan to undertake to add network capacity.

Whilst these are a key input to NDP Parts 1 and 2 and form the majority of the additional capacity we will deliver, the NDP requires that we include all interventions that increase capacity. This means we have also included in our NDP Part 1 losses-driven, and asset management-driven interventions which increase network capacity even though this isn't the primary reason for the intervention. Our NDP Part 1 provides a detailed breakdown of our 10-year intervention plans, arranged by GSP and disaggregated by intervention driver. The intervention activities included are detailed in Table 3.

Table 3: Types of intervention which add capacity and are included in NDP

Activity	Inclusion within NDP
Load related network interventions	**Included – to achieve our Baseline forecast** The NDP Parts 1 & 2 include all planned load driven interventions to facilitate our Baseline plan for the next 10 years. This includes flexibility services, smart and innovation solutions, and reinforcement schemes. These may be driven by thermal, voltage or fault level constraints. These constraints can occur together or independently. In all cases, these network constraints are a result of there being insufficient network capacity to accommodate customer power flows. Headroom at a primary may also be limited by a constraint on the upstream (higher voltage) network. Where this is the case, our NDP Part 1 tables indicate the presence of upstream constraints. We have not included the load-driven interventions needed to enable a higher than baseline scenario (a summary of load-driven interventions for the high scenario is on page 41 of our RIIO-ED2 Business Plan).
Asset modernisation	**Included – where these affect network capacity** The NDP Parts 1 & 2 includes planned asset modernisation activities where these affect network capacity. For example, we list where a condition driven asset replacement increases the rating of the transformer or switchgear being replaced. We have not listed asset modernisation interventions which do not affect capacity. Therefore the schemes listed in the first five years of the NDP may differ slightly from those listed in the LTDS. This is typically true of OHL modernisation/refurbishment activities.
Losses driven modernisation	**Included – where these affect network capacity** The NDP Parts 1 & 2 include planned losses driven modernisation activities where these affect network capacity. For example, where we replace primary or grid transformers, because of the high losses they incur, with new EcoDesign Tier 2 transformers which are of a larger capacity.

8 NDP Part 2 – reporting Scenario Headroom

Part 2 of our NDP forecasts post-intervention headroom across all network groups out to 2050. We've calculated this post-intervention headroom by combining our existing network model, our scenario forecasts, and our known intervention plans.

Our NDP Capacity Headroom spreadsheet data files provide this information for each primary (and grid in SPM) substation/substation group for each year for ten years and every 5 years through to 2050 thereafter. Given the forecast uncertainty in future pathways to achieve Net Zero, we have done this for each of the Holistic Transition (HT), Hydrogen Evolution (HE), and Electric Engagement (EE) scenarios. We provide our headroom calculation for demand and generation separately as the constraints limiting each can be different.

The following sub-sections detail how we have calculated the demand headroom and generation headroom.

8.1 Demand headroom

Demand headroom is calculated as the firm capacity of the substation, plus any capacity added due to planned interventions or flexibility services, minus the forecast level of demand. A positive number indicates spare capacity and a negative number indicates a forecast constraint. Some points:

- The firm capacity is the maximum load the substation (or substation group) can support whilst keeping the network operating safely within limits. For primary substations this is generally the capacity available during single circuit outage conditions.
- When calculating the firm capacity, we consider the season of most onerous demand (typically winter). This is because the ratings of some equipment differ seasonally.
- For multi-transformer substations, the firm capacity considers only the capacity that can be available through automatic processes (e.g. parallel operation of the transformers or automatic changeover schemes).
- For single-transformer substations, the firm capacity values include the capacity that will be available through both automatic and manual switching processes, provided these can be carried out within the time constraints specified in Engineering Recommendation P2.
- The firm capacity of solidly interconnected network groups in SP Manweb must be calculated from network analysis due to the more complex interconnected nature of the system.

8.2 Generation headroom

To calculate the generation headroom, we compared the forecast level of generation against the generation hosting capacity of the substation. The generation hosting capacity considers the reverse power flow capability[6] of the substation/group, and the fault level capability of the equipment[7].

We assess fault level capability through short circuit studies:

- The fault levels are calculated under the most onerous network conditions to yield the maximum anticipated fault currents. The most onerous network condition is considered to be when the following conditions occur concurrently:
    - all generating apparatus is in service;

[6] Reverse power flows occurs when generation exceeds local demand. Reverse power flow can cause problems for older transformers, which were not designed to accommodate as much power flow in this direction (tap changers are usually the limitation). Increasing generation in recent years has created widespread areas which experience reverse power flow.

[7] When there is a network fault, the local network experiences a 'fault current'; these are orders of magnitude higher than normal network current. Generators are a source of fault current, so the increasing levels of DG needed for Net Zero will increase prospective network fault current. Switchgear are the assets which are designed to safely isolate network faults, and so are sized to cope with a certain level of fault current. We need to check that generation growth wouldn't increase the network fault current above the rating of the switchgear.

- all transformers are set to nominal tap position;
- the system is intact (N); and
- fault level contributions are included from all independent generators.

- Fault contributions from synchronous generators and converter connected generators are treated differently. Typical fault current contributions from synchronous generators and converter connected generators are used to determine the available fault level headroom when considering forecast generation.

8.3 Capacity Headroom results

The full suite of capacity headroom results for SP Distribution primary substations (33/11 kV), and SP Manweb grid substation groups (132/33kV) and primary substations/substation groups (33/11 kV), are provided as part of our NDP.

In reviewing the capacity headroom results, it is worth noting:

- Headroom results do not take account of the additional capacity provided through the rollout of Constraint Management Zones (CMZs) or other flexible connection arrangements such as local constraint schemes.
- Generation headroom at a substation/group may be limited by upstream constraints beyond our network boundary. These upstream constraints are flagged in column E within the Part 2 spreadsheets, but are not reflected within the capacity headroom values. Any new generation connections where there are upstream constraints beyond our network boundary will be subject to detailed network assessments to determine the actual generation capacity headroom.
- The SP Manweb distribution network is configured as a mesh network with interconnection at all voltage levels.[8] Headroom results provide the calculated headroom of the substation/substation group. The actual headroom at a particular location within interconnected networks is subject to further assessments, as the changing distribution of demand and generation across the mesh may alter available headroom.
- Demand and generation forecasts are subject to factors which can change over time and influence pre-determined plans.
- The timing and type of network interventions may vary, depending on the rate of change in stakeholder requirements influenced by regional and national policies, and requirements for emerging new connections.
- We have taken all reasonable endeavors to ensure the accuracy of the results using information available at the time of publishing. We are not responsible for any loss that may be attributed to the use of the information presented in this report and the capacity headroom results.

[8] A meshed (a.k.a. interconnected) network means power can flow through multiple routes to the point of use. By comparison, most distribution networks in Great Britain have a radial design, where power typically has only one possible path. Meshed networks give exceptionally high reliability but, once capacity is saturated, are typically more expensive to reinforce.

9 Glossary

Constraint Management Zone (CMZ) – CMZs are areas of network we have an automated control system to coordinate and dispatch different operational solutions.

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

Decarbonisation – the process to reduce the amount of carbon dioxide (CO2) and other greenhouse gas emissions by introducing new low carbon alternatives and technologies. Much of the UK's decarbonisation strategy is based on switching carbon energy vectors (e.g. petrol/diesel for transport, and natural gas and oil for heating) to electricity and powering them with renewable generation.

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

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

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

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

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

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

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

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

GW – equal to 1,000 MW.

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

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

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

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

MW – megawatt is a unit of power (not energy). It can describe both the amount of power that a demand user is consuming (e.g. "this town's peak demand has increased by 3MW due to an increase in EVs and heat pumps"), and the amount of power that a generator is producing (e.g. "3MW of solar PV generation has been installed in this area").

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

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

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

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

iii. The Welsh Government has introduced The Environment (Wales) Act 2016 (Amendment of 2050 Emissions Target) Regulations 2021. This introduces a legally binding target for Wales to have net zero greenhouse gas emissions by 2050. The legislation is available at: https://www.legislation.gov.uk/anaw/2016/3/contents

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

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

Primary substation – see 'Substation'.

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

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

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

SP Distribution (SPD) – the Distribution network Operator for Central and Southern Scotland, that owns the distribution network at 33kV, 11kV and LV up to customers' meters.

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

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

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

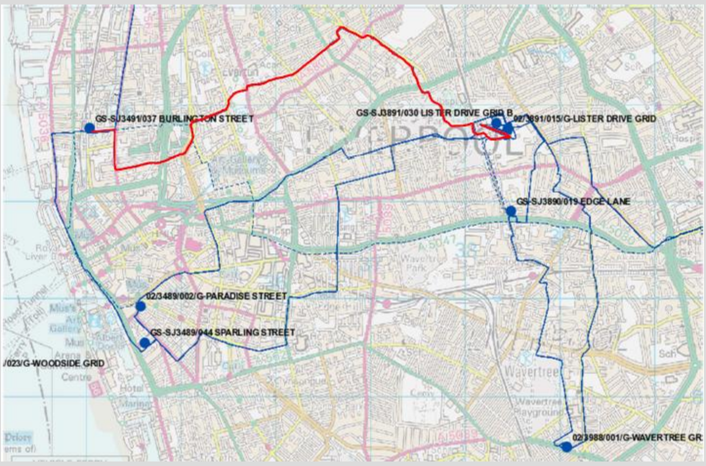
Appendix A – Example flexibility use cases

This appendix provides three example use cases where we have included flexibility within our plans to manage network constraints at 33kV and 132kV voltage levels. Where flexibility services are not yet available and we have had to assume the use of network reinforcement, we will retender for flexibility before the reinforcement starts to ensure we are using the most efficient intervention. We have not included use cases of flexibility on the HV and LV network as these are beyond the scope of the NDP.

Use Case 1: Using flexibility to defer major reinforcements

We will use flexibility to defer major reinforcements. For example, in the Carrington–Fiddlers Ferry group we will defer £10.5m of 132kV circuit upgrades, and at Redhouse we are able to defer replacing a 132/33kV transmission transformer, saving our customers £2.8m in exit charges. At Lister Drive in Liverpool, we will combine flexibility with network monitoring and automation to defer replacing 10km of the 132kV cable that runs into the centre of Liverpool (Lister Drive); as well as deferring £9m, this avoids significant disruption for residents.

Case study: Lister Drive 132kV, Liverpool



Background The Lister Drive 132kV network group provides supplies to 163,700 customers including Liverpool city centre as well as the shipping docks and industries along the Mersey River.

Conventional solution is to reinforce by overlaying with a new 10km 132kV circuit in central Liverpool.

Proposed solution is to manage the constraint through RIIO-ED2 by contracting with 8MW of flexibility capacity in combination with thermal monitoring and network automation.

The automation secures the network and maintains assets within safe limits if there are shortfalls in flexibility. The flexibility reduces the hours at risk that could trigger the automated load transfer.

Use Case 2: Using flexibility to manage uncertainty

We intend to use flexibility to manage 38 demand groups in RIIO-ED2 where the forecast loading is approaching limits and flexibility can reduce the risk of network constraints – particularly under higher uptake scenarios. These are the network areas where demand forecasts are high with marginal exceedances over the network firm capacity. The network constraints in these areas depend on the forecast demand/generation being fully realised. Capacity exceedances are minimal and predicted to occur for a few hours in a year. Flexibility services can manage these high loadings through the RIIO-ED2 period, deferring potential investments associated with high uptake scenarios from RIIO-ED2 into RIIO-ED3.

Use Case 3: Using flexibility to reduce the number of hours the network is at risk of constraint

We will use flexibility to help manage the network at sites with high utilisation, where this is in customers' best interests. For example, flexibility solutions may be able to manage constraints for a few years, but within the RIIO-ED2 period the increasing hours the network is at risk of constraint, and growing magnitude of the constraint, are such that an alternative intervention is required. In these scenarios we have carefully considered the timing of the intervention and the bids received to-date to optimally intervene.

Similarly, where flexibility has been sought but the bids received are not able to fully manage the constraint, we have considered whether the level received may help reduce the hours the network is at risk of constraint. This can help us manage the network while we deliver reinforcements.

We will continue to tender in these locations as we prepare to intervene during RIIO-ED2.

Appendix B – Stakeholder responses

Standard Licence Condition 25B introduces a requirement for DNOs to publish the non-confidential responses received to the NDP consultation. This Appendix contains the ones we received online or via e-mail marked as non-confidential.

The non-confidential responses below are from:

- Threepwood Consulting – TC
- Growing Mid Wales – GMW
- Net Zero Energy Systems – NZES
- Glasgow City Region - GCR

Part 1 - Development report:

1. How could/will our Network Scenario Headroom and Development report be used by your community/ business?

TC	We use the reports and data to help potential customers with optioneering for their demand/generation. We also use the data to inform modelling for innovation projects and analysis reports.
GMW	Growing Mid Wales works closely with Powys County Council, Ceredigion County Council and a range of public and private organisations across Mid Wales. We will use the report, alongside the Mid Wales Energy Strategy and Local Area Energy Plans, to understand where the key constraints / opportunities are on the electricity network. We note that Aberystwyth is named as a Constraint Management Zone so it would be useful to better understand how flexibility solutions could be unlocked there and other locations. We will also use the report to raise awareness within the region of the key challenges (e.g. long term capacity requirements which will require transmission infrastructure to be built). We will continue to work with SPEN and NGED to develop smart local energy systems fit for purpose as the Mid Wales area continues the move to net zero and we look forward to investigating options for flexible connection solutions for local businesses and households in Powys and Ceredigion.
NZES	The introduction to the NDP states that sharing data is key to the efficiency of the energy system as we decarbonise to Net Zero. The need for collaboration between key stakeholders to ensure the successful delivery of a GB net zero energy system on time, on benefits and at lowest cost to consumers cannot be overstated. This is anticipated to be an iterative and evolving process. Intelligence which is presently being gathered by the NEWID project from key industrial stakeholders in North Wales is intended will help inform SP Manweb's future system infrastructure requirements forecasts and utility submissions to Ofgem. In turn, it is hoped that collating and aggregating future industrial requirements in the North Wales region will help avoid implementing a piecemeal approach to net zero infrastructure development which would almost certainly be sub-optimal in terms of cost and effort as well as the developed infrastructure arrangements.
GCR	The eight Glasgow City Region local authorities are currently collaborating on the GCR EVCI expansion. This will include the installation of circa 3500-4000 new EV chargepoints across the Glasgow City Region over the next 3-5 years. Whilst an early indicative location plan has been prepared the Network Development Report will assist with the next stage in site assessment to determine the most suitable locations particularly for residential charge points. For the journey and destination charge points there may be less opportunity for movement in these cases, recognition of these chargepoints in the NDR would very much support our net zero ambitions to develop the EV network

2. Are there any ways we could improve the information contained within our Network Scenario Headroom and Development report?

TC	A statement is made in the report. This includes non-load interventions which are not done to provide capacity but will increase capacity nonetheless. This is understood, but Part 1 then includes sites with equipment 'modernisation' and the indication that these 'could increase capacity'. A suggestion is to clarify the likelihood of capacity increase e.g. highly likely to increase by maximum of 10%, or unlikely to make significant change to capacity. Otherwise I found the reports very easy to read, find relevant information and understand.
GMW	Mid Wales covers two DNO areas - is there any way for the relevant information from SPEN and NGED's reports to be compiled to make it easier to digest? It would be useful to translate what XX MW in flexibility really means for a lay person to understand.
NZES	There is an enormous amount of useful information presented in the Network Capacity Headroom and Development report which along with the Open Portal data available online. However, the intended report audience is not entirely clear and isn't explicitly stated in the introduction. Assuming that regional industrial sites are part of the intended stakeholder audience group, if there were ways that the scope and presentation of the information in the report could be improved upon then it might be worthwhile considering the following: 1: The report is written very much from the perspective of an electrical engineering and distribution system operator's perspective. Although the GSP map on page 22 allows the reader to navigate directly to the detail for each GSP, the GSP coverage areas are only shown in each individual sub-section. The information could be made more accessible by making it easier for stakeholders to determine which GSP provides their electricity supply. Within the document this could involve adding shading for each GSP area within the main figure in the report. Having some means (e.g. a post code or grid coordinate lookup as part of the SPEN website infrastructure?) which readily advises GSP supply information for individual site operators could also be useful. 2: As noted in Section 2.2, transmission network capacity constraints are not insignificant and can significantly impact on the capacity which can be made available on the distribution network (even when applying SMART grid techniques). While addressing transmission network constraints is clearly outside of the scope of SPEN's remit having an element of interface in the NPD document which provides a high level summary of the present transmission system contraints relative and relevant to SPEN's SPD Distribution and SP Manweb areas of operation along with up to date information on the proposed mitigating actions and timescales could be useful additional information to include.
GCR	It may be useful if this could be interrogated via a geospatial/mapping tool.

3. Do you find the links to the Distribution Network Options Assessment (DNOA) Scheme pages useful? If not, are there any ways we could improve the information contained within these pages?

TC	5
GMW	N/A
NZES	4, Some suggestions were also provided above under the response to #2. Links to the DNOA scheme pages have been scored as 4 rather than 5 out of 5 based upon the potential improvements suggested as per above under the response to #2 (e.g. making it easier for stakeholders, particularly project developers to identify the GSP / Primary substation which supplies their geographical area of interest). However, that does not detract from the fact that the information which has already been published is potentially extremely useful to both existing site operators and also new industrial site developers.
GCR	3

Part 2 - Network capacity:

4. How could/will our Network Scenario Headroom data tables be used by your community/business?

TC	Used for optioneering for connection of generation and/or demand to the network
GMW	As previously stated, we will continue to work with SPEN and NGED to develop smart local energy systems fit for purpose as the Mid Wales area continues the move to net zero and we look forward to investigating options for flexible connection solutions for local businesses and households in Powys and Ceredigion. I believe this information, alongside the LAEPs, could be used to understand where SLES would be most suitable however we would need support from the DNOs to properly interpret this data.
NZES	The Network Scenario Headroom data tables provide extremely useful data on anticipated demand and generation headroom at each Primary Substation. This should be sufficiently accessible to existing site operators (who will know the Primary substation they source their electricity supply from). But is potentially less accessible to developers who are looking to establish industrial operations in the region.
GCR	This level of detailed information could be used by both local authorities and Charge Point Operators when designing the expansion of EV Charging Infrastructure across Glasgow City Region. The current proposal is to install circa 3500 EV chargepoints over the next 3-5 years

5. Do you find the information contained within our Network Scenario Headroom data tables useful? If not, how could it be improved?

TC	5
GMW	4
NZES	4, Are there any plans to introduce a more interactive / graphic type interface to access this information?
GCR	5

6. Do you find the presentation of headroom for the Low, Baseline, High scenarios helpful? If not, how could they be improved?

TC	4, a minor improvement would be to present a the low and high on one sheet e.g. a column for low next to a column for high. This speeds up analysing the spread of capacity for low and high scenarios.
GMW	5
NZES	3, Little information appears provided which would help anyone reviewing the Network Scenario Headroom data to determine which of the minimum, maximum or baseline scenarios might be more likely to apply (and why). In which case, the usefulness of including three sets of information is potentially more limited than might otherwise be the case.
GCR	4

Part 3 - Methodology statement

7. Do you support the steps/process we have followed to produce our Network Development Plan (NDP)? If not, how could the steps/process be improved?

TC	5
GMW	N/A

NZES	4, Gathering a wide range of input across different sectors is really important to get a broad cross section of information. However, the stakeholder group which is least represented in the NDP 2022 consultation are industrial stakeholders which represents a large concentration of energy and electricity demand within a relatively small number of key stakeholders. Initial SP Manweb engagement with key industrial stakeholders in North-East Wales as part of the NEWID project scope in 2024 should help address that potential gap going forwards. A small number of more significant energy end users do not lend themselves to the same modelling methodology as heat pump and EV forecasts. Which is why the NEWID project is undertaking a 1-2-1 interview approach to gather data from around 30 key industrial site stakeholders and proposed site developers. However, once that intelligence has been gathered, the network impacts assessment process would be expected to be applied in the same way. In terms of assessing the potential for load-driven investment, with the use of standard equipment providing step changes in capacity, the future NDP methodology process should consider the opportunity to use industry led infrastructure capacity development to provide additional capacity for other more disperse and aggregated demand applications – such as heat pumps and EVs – at a relatively low incremental cost. Initial SP Manweb engagement with key industrial stakeholders in North-East Wales as part of the NEWID project scope in 2024 should help address that potential gap going forwards. So if the work which SP Manweb is already carrying out were built into the stated Methodology for next year's survey (and also replicated across the SPD Distribution operating region), then a higher score would be given.
GCR	3

Other

8. Do you make use of any other data sources we publish? LTDS, heatmaps, ECR, DFES, etc. (tick all that apply)

TC	Long Term Development Statement, Distributed Generation Heatmaps, Embedded Capacity Register, Distribution Future Energy Scenarios
GMW	Distribution Future Energy Scenarios
NZES	Long Term Development Statement, Distributed Generation Heatmaps, Embedded Capacity Register, Distribution Future Energy Scenarios
GCR	None of these documents have been used by yet but are likely to be used going forward.

9. Are there any other parameters you would like to see included within our NDP?

TC	By using the LTDS and NDP a very useful picture of the capacity on the network can be attained. The only improvement I can suggest is probably for Ofgem to consider consolidating the information i.e. combine LTDS tables and NDP tables e.g. combine Appendix 6 LTDS with the NDP Part 2 headroom tables.
GMW	N/A
NZES	The information presented in Parts 1 and 2 is very much focused on SPEN's substation capacity (SP Manweb information only reviewed) with little information also provided on the associated distribution system circuits which collectively help provide power transfer capacity across each geographical region. Are there any plans to present more information on the distribution circuit aspect of SPEN's network and any (e.g. thermal) constraints that might need circuit reinforcement to resolve and/or introduce additional capacity? Also, as detailed previously some information on the interface(s) between transmission and distribution and any constraints on the SPEN distribution system which would require that external (transmission) issues be addressed to fully resolve could also be useful information to include.

GCR	N/A

10. Are there any other comments or feedback you would like to make?

TC	The map diagrams for each group are useful.
GMW	The reason I marked some of these questions as 4 is because Growing Mid Wales and the Local Authorities within Mid Wales have limited resource which makes it difficult to engage with all of the information published by the DNOs. Both GMW and the Local Authorities need the DNO to hand hold us through the information that is available to help us digest it and understand how we can use it effectively within our day to day working. Having a singular contact within the DNO was invaluable through the Local Area Energy Plan process and will be essential moving forward to unlock decarbonisation in the region.
NZES	As per the outline decarbonisation philosophy presented by Net Zero Energy Systems at the Deeside Decarbonisation Forum last summer ahead of submission of the NEWID project application into the LIDP competition (which is now in the process of being delivered), it arguably makes logical sense when considering a strategy to deliver regional decarbonisation to initially focus on the requirements of the (relatively small number of) largest, most significant industrial energy users within a region. And having established one or more anchor decarbonisation projects, to then progressively look to subsequently determine how to optimally decarbonise the larger number of much smaller and more diffuse industrial sites: With other similarly small, dispersed energy demand requirements (e.g. domestic and transport demand) also considered at the same time. Such a strategy would appear to largely be in line with the UK government's decarbonisation strategy having started by focusing on six main industrial clusters, although a full decarbonisation strategy which would deliver net zero across the UK by 2050 has not yet been articulated in detail. Energy infrastructure can either facilitate or constrain the ability to implement decarbonisation projects. Regional energy utilities therefore can potentially play a key role to play in supporting the development of credible plans which help facilitate the delivery of the UK's net zero objective. Which is why it is so exciting to have SP Manweb along with Wales & West Utilities as partners in this first phase NEWID project collaborating and working together with local industry to take the first steps in defining a credible regional industrial decarbonisation plan for the North-East Wales region in line with the Local Industrial Decarbonisation Plan competition objective. However, the work being undertaken in 2024 is only the start of what needs to be a longer term strategic initiative if the region is to progress this objective all the way to a successful conclusion.
N/A	If useful the Glasgow City Region Programme Management Office would welcome a conversation with the service delivery team to discuss current proposals and how the EV charging network could be better designed with capacity and network planning issues core to the designing of EV chargepoint locations.

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