Company-specific and regional factors for RIIO-ED2

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Executive Summary

Regional or company-specific factors that are outside of the control of a distribution network operator (DNO) and affect costs need to be accounted for when setting allowances for ED2. This can either be done by including a variable that captures the effect in the modelling, or by applying a pre- or post-modelling adjustment. The need for cost adjustments therefore depends on the extent to which regional or company-specific factors are already captured within Ofgem's ED2 modelling, which will only become apparent over the coming months. Similarly, some factors may become more relevant during ED2 so that forecast data is needed in order to assess whether these are sufficiently captured in the modelling or need additional adjustments.

Based on the information available to date, we have assessed a number of potential regional or company-specific factors against Ofgem's proposed criteria. These criteria are as follows:

- **criterion 1—unique**: whether the factor is sufficiently unique and there is a material asymmetry between DNOs;
- **criterion 2—outside of management control**: whether the factor is outside of the control of an efficient company and DNOs have mitigated the effect where possible;
- **criterion 3—incremental**: whether the factor is additional to existing cost drivers and not already captured as part of the cost assessment;
- **criterion 4—material**: whether the factor is material (more than 0.5% of gross unnormalised TOTEX—for SSEH, this amounts to £1.25m for the year 2021).[1]

We find a number of regional and company-specific factors for SSEH and SSES that need accounting for and these are summarised in Table 1.

Table 1 Summary of factors and proposed treatment

Factor	Quantification p.a.	Proposed treatment
Islands - submarine cable (listed for SSEH only; includes CV7, CV26, CV30, CV31, HVP, C5 and C7)	**£36.90m**	Exclude from regressions and assessed separately
Islands – submarine cables team (SSEH)	**£1.50m**	Cost adjustment
Islands – specialist travel, deployed staff prior to storm, RIGs (SSEH)	**£7.52**	Cost adjustment
Sparsity (SSEH)	**£14.88m**	Cost adjustment
Regional wages (SSES and SSEH)	**7%** higher wages in Scotland and the South East compared to the rest of GB	Pre-regression adjustment of labour costs
Severe weather 1-in-20 (SSEH)	**£9.6m**	Upfront allowance or uncertainty mechanism

Note: All prices in 2020/21 terms. Submarine cables costs listed here only include costs for SSEH. Note that there may be additional submarine cable costs as part of an uncertainty mechanism.

[1] In this report 2021 refers to the year 2020/21. Total gross costs within the price control amounted to £250.9m according to the 2020/21 costs and volumes spreadsheet.

Source: Oxera and SSEN.

Submarine cables and serving islands

Serving islands off the GB mainland causes additional costs for SSEH. The most significant of these are submarine cables, which can lead to high asset replacement and fault costs, which the corresponding cost drivers in the TOTEX models do not sufficiently capture. We therefore propose that **submarine cable costs (and associated cost drivers) should be excluded from the regression** models. The need for, and efficiency of these costs should instead be examined on an engineering basis. This significantly affects SSEH, but also other DNOs (e.g. SSES's cable to the Isle of Wight). **SSEH's efficiency scores in the models without submarine cables improve by 4–6 percentage points**.[2]

Additionally, SSEH incurs a number of other costs in relation to its islands that other DNOs do not incur. These have been quantified by SSE and are summarised below.

Table 2 Cost impact of islands

Category	ED1 allowance (£m p.a.)	ED2 forecast (£m p.a.)
Submarine cables		**£36.90m** *
Submarine cables team		1.50
Specialist travel modes		
Island Flights, accommodation and ferries	0.16	0.43
Helicopters	0.10**	0.10
Deployed staff prior to forecast severe weather events	0.12	0.26
Remote Island Generation	5.05**	6.73***
Total excl. submarine	**5.42**	**7.52**

Note: 2020/21 prices. *Includes CV7, CV26, CV30, CV31, HVP, C5 and C7 only. Other areas (e.g. business support) would also be affected by submarine cables so this figure is likely to be an underestimate. Submarine cables costs listed here only cover SSEH. Note that there may be additional submarine cable costs as part of an uncertainty mechanism. ** Reduced claim as accepted by Ofgem. *** Note that the ED2 forecast for Remote Island Generation is equal to the average of forecast Remote Island Generation operation and maintenance costs in ED2 (2024-2028) from SSEH RIIO-ED2 Business Plan Data Template v.4.3 and average business as usual fuel costs for ED1 provided by SSEH, see Appendix A3. The estimate does not include fault related fuel costs.

Source: ED1: Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies - Business plan expenditure assessment', 28 November ; ED2 forecasts provided by SSE, apart from average business as usual fuel costs for ED1 provided by SSEN).

Sparsity/density/topography

Operating in particularly sparse or dense areas causes additional costs compared to an averagely sparse network. The former effect has been quantified in a bottom-up way as part of this report. This amounts to around **£15m p.a.** additional costs that SSEH will incur in ED2 due to its sparsity compared to an average network as summarised in the following table.

[2] This only excludes asset replacement and fault costs. Other costs related to submarine cables, such as SSEH' subsea cables team, were not considered as consistent data across the DNOs is not available.

Table 3 Cost impact of sparsity

Category	ED1 allowance (£m p.a.)	ED2 forecast (£m p.a.)
Remote depots		
Property costs	0.08*	0.25
Outposted staff	3.32	5.63
Longer driving times		
Unproductive time	-	1.07
Additional vehicle/fuel costs	0.25*	0.76
Private Mobile Radio (PMR) System	0.78*	1.07
Scanning telemetry	-	1.17
Load managed areas	-	0.56
North of Scotland resilience	1.05**	4.37
Total impact of sparsity	**5.48**	**14.88**

Note: 2020/21 prices.* Reduced claim as accepted by Ofgem. ** These costs were excluded from the regression modelling. The figure represents the average 2016-21. A missing figure means that no claim was made at ED1.

Source: ED1: Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies - Business plan expenditure assessment', 28 November; North of Scotland resilience from SSEH RIIO-ED2 Business Plan Data Template v.4.3. ED2: Unproductive time and depot costs quantified by Oxera in this paper using SSEN data; all other areas quantified by SSEN.

At the same time, SSEH benefits from not being dense (avoiding congestion, complicated streetworks, etc.). This has been taken into account in the U-shaped driving times calculation, which captures higher costs for dense and sparse areas. Other density factors for the London network may apply that have not been explicitly quantified here.

Regional wage differences

If regional wage differences are not already captured as part of a cost driver, they need to be accounted for through cost adjustments. Ofgem's ED1 approach used regional wages based on occupations and distinguished between three regions: London, the South East and the rest of GB. Updating Ofgem's ED1 index with the most recent data shows that wages in Scotland are very similar to those in the South East, although the underlying reasons for the wage developments in these two areas are likely to differ. The wage data available to date suggests that these areas could be grouped together.[3] This improves SSEN's position overall compared to Ofgem's ED1 approach.[4]

Environmental factors

As part of this report, we also examined the impact of severe weather and shrink-swell soil. While we have clearly shown that the SSEH and SSES networks are affected by these factors, there is currently insufficient evidence that they meet Ofgem's materiality threshold. These factors have therefore not been analysed further at this stage

[3] If wages develop differently in the future then alternative approaches would need to be considered (e.g. treating Scotland as a fourth region or treating all eleven regions separately).
[4] Note that we also looked at ONS ASHE data using a sectoral, rather than occupational, breakdown. While the differences between regions over time are less clear, using a sector based pre-modelling regional wage adjustment further improves the estimated efficiency gap to the UQ for both SSEH and SSES.

An exception is Severe Weather 1-in-20. SSEN has included c. £9.6m in its draft RIIO ED2 plan for Severe Weather 1-in-20 events. Discussions prior to final submission in December are expected within the sector and with Ofgem as to whether there will be an Uncertainty Mechanism for this rather than an upfront allowance.

1 Introduction

When setting allowances for the next price control period (ED2), Ofgem needs to take into account factors that are outside of the control of a distribution network operator (DNO) but determine the efficient cost level. This can be done by including specific cost drivers in the model that is being used to assess efficiency (e.g. a scale variable to account for the fact that larger DNOs typically incur higher costs). However, if a factor is not sufficiently captured in the cost drivers of a model, then additional adjustments are necessary in order to ensure comparability across DNOs.

As Ofgem has not yet published any detail on the cost models to be used for ED2, this report is based on ED1 models and provides an indication of *potential* factors that might need to be accounted for. Given that company-specific or regional factor adjustments are assessed relative to the models and methods used by Ofgem, the need for such adjustments will need to be reassessed as Ofgem's approach becomes clearer. Some factors may also become more relevant in ED2 so that forecast data needs to be available in order to assess whether these are sufficiently captured in the modelling.

Ofgem intends to use four criteria to assess whether a factor requires an additional adjustment:[5]

- **criterion 1—unique**: whether the factor is sufficiently unique and there is a material asymmetry between DNOs;
- **criterion 2—outside of management control**: whether the factor is outside of the control of an efficient company and DNOs have mitigated the effect where possible;
- **criterion 3—incremental**: whether the factor is additional to existing cost drivers and not already captured as part of the cost assessment;
- **criterion 4—material**: whether the factor is material (more than 0.5% of gross unnormalised TOTEX—for SSEH, this amounts to £1.25m for the year 2021).[6]

Based on these criteria, we find three main regional or company-specific factors that need accounting for.

- **Islands.** Serving islands off the GB mainland causes additional costs. The most significant of these are submarine cables, which can lead to high asset replacement and fault costs, which the corresponding cost drivers in the TOTEX models do not sufficiently capture. We therefore propose to exclude these costs (and associated cost drivers) from the regression models. The efficiency of these costs should instead be examined on an engineering basis. This significantly affects SSEH but also other DNOs (e.g. SSES's cable to the Isle of Wight). Additionally, SSEH incurs a number of other costs in relation to its islands (travel to islands, on-island generation) that other DNOs do not incur. Costs should be adjusted for these factors, which amount to around **£7.5m p.a.** for ED2.[7]

[5] Ofgem (2020), 'RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for consumers', 17 December, Table 1.
[6] In this report 2021 refers to the year 2020/21. Total gross costs within the price control amounted to £250.9m according to the 2020/21 costs and volumes spreadsheet.
[7] See Table 2 for detailed sources.

- **Sparsity/density/topography.** Operating in particularly sparse or dense areas causes additional costs compared to an averagely sparse network. The former effect has been quantified in a bottom-up way as part of this report and using data provided by SSE. This amounts to around **£14.9m p.a.** additional costs that SSEH incurs in ED2 due to its sparsity.[8]
- **Regional wages.** If regional wage differences are not already captured as part of a cost driver, they need to be accounted for through cost adjustments. Ofgem's ED1 approach used regional wages based on occupations and distinguished between three regions: London, the South East, and the rest of GB. Updating Ofgem's ED1 index with the most recent data shows that wages in Scotland are very similar to those in the South East, so these areas could be grouped together.

Additional factors in relation to the weather and environmental conditions were examined, but we were unable to clearly show that these exceed Ofgem's materiality threshold. The exception are Severe Weather 1-in-20 events for which discussions with Ofgem are expected in order to determine how this should be treated.

The remainder of this report is structured as follows.

- Section 2 sets out the main cost drivers for the electricity distribution sector.
- Section 3 assesses potential company-specific and regional factor claims against Ofgem's criteria.
- Section 4 concludes.

[8] Driving times and additional depot costs calculated by Oxera; all other parts based on numbers provided by SSEN (see annex A3).

2 Main cost drivers for electricity distribution networks

Before discussing the possible regional factors claims in the ED sector, we first set out the key cost drivers in the industry. The extent to which these are captured or not in Ofgem's models will determine whether or not any cost adjustment claims for these regional factors will be required.

The main cost drivers for DNOs, which were identified in discussions with operational experts and from ED1 materials, are as follows:

- **scale and complexity of the network**—in ED1, this was captured through MEAV and customers as a composite scale driver in the top-down model, and MEAV, units distributed and length as drivers in the bottom-up regression model;
- **network condition/age**—this was not directly captured in the ED1 regression models, but it is related to the number of faults. The number of faults was used as a cost driver in the bottom-up regression;
- **serving islands**—in ED1, this was captured through some company-specific factors for SSEH;
- **sparsity/density and topography**—in ED1, this factor was captured through some company-specific factors for SSEH and LPN;
- **regional wages**—in ED1, this factor was captured using a regional wage index;
- **weather and environmental factors**—in ED1, this factor was captured through a small company-specific factor;
- **net zero (for ED2)**—this was not explicitly captured in ED1 models.

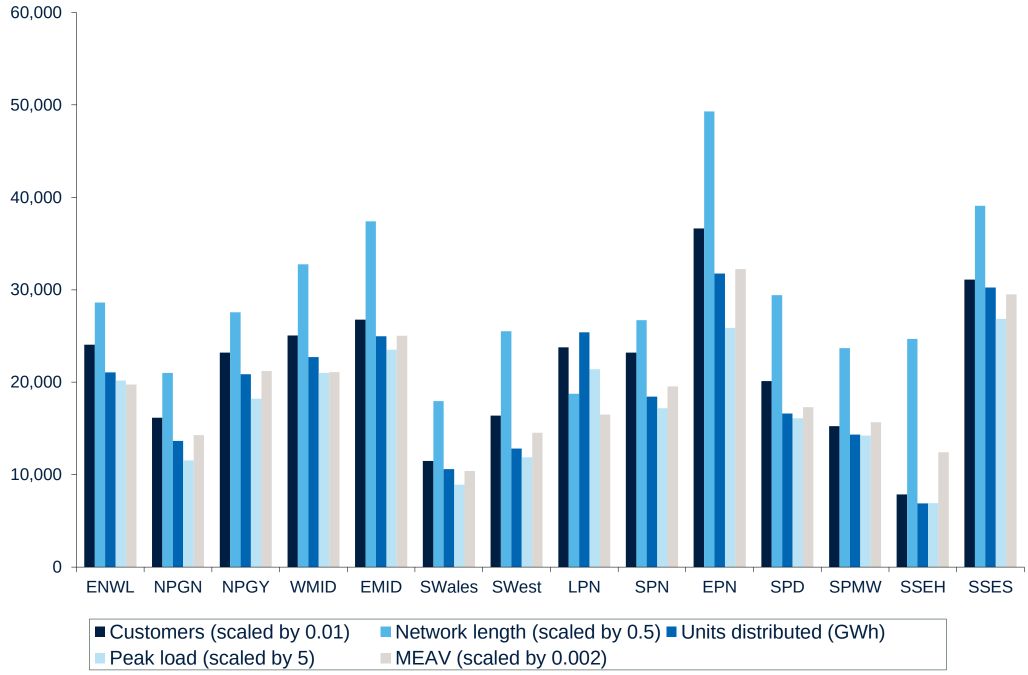
2.1 Scale and complexity of the network

The size of the network varies significantly across the different companies. For instance, EPN's network serves 4.7 times as many customers and has 4.6 times as many units distributed as that the smallest network (SSEH). EPN also has 2.7 times the network length of the smallest network (SWALES).

Modern equivalent asset value (MEAV) is calculated based on the different types of assets that make up a network and therefore somewhat takes into account network complexity. Peak load also captures a network's scale and may be better suited to capturing the strain on the network than total units distributed, as networks are built to be able to serve peak load.

These scale variables are shown in Figure 2.1. A larger network would be expected to lead to higher costs.

Figure 2.1 Scale of the different networks



Source: Oxera analysis based on 2019/20 costs and volumes data.

At ED1, Ofgem's TOTEX models consisted of one 'top-down' model purely based on scale drivers (MEAV and customer numbers), and a 'bottom-up' model that largely consisted of scale drivers (85% of the cost drivers consisted of units distributed, length and MEAV).

However, there are some more complex characteristics of an electricity distribution network that these measure are not well suited to picking up. For instance, submarine cables are a significant driver of costs for SSEH (c. 10% of the last five years), but contribute disproportionally less to measures such as the MEAV. These complex characteristics either need to be picked up by other cost drivers or removed from the main modelling and assessed separately due to their atypical nature.

In addition, the precise scale driver choice can have a significant impact on different networks. As evident from Figure 2.1, some networks rank disproportionally high/low on network length compared to customer numbers. This suggests that they are particularly sparse/dense compared to other networks that rank more evenly across the different scale variables. The scale driver chosen therefore also interacts with the sparsity/density issue covered below.

2.2 Network condition/age

Network condition drives costs as older, less reliable assets will need replacing sooner. There are also decisions about the network that were made in the past and are 'inherited' by current network owners. If this significantly differs across DNOs, materially affects costs and is not already captured in the modelling, then network age/condition should be captured as part of the benchmarking process. For instance, SSE is expecting peaks in asset replacement in the ED2 period due to the timing when certain assets were installed. Key examples are LV/HV/UG cables that were installed in the 1940s and 50s, and are now due for upgrades. At ED1, a number of cost drivers relating to the number of faults were used as part of the bottom-up regression. These may pick up the impact of network conditions to some extent. Alternative drivers could include metrics on asset age and condition. However, sufficiently reliable data is currently not available.

2.3 Serving islands

Providing electricity to an island is substantially more challenging than on the mainland. Islands need to be connected to the main grid via submarine cables or on-island generation needs to be installed. On-island generation is costly, both financially and in terms of CO_2 emissions, as this usually consists of diesel generators or other less environmentally friendly technologies. Additional costs are also incurred when travelling to the islands as workers and materials need to be transported over and overnight accommodation may also be required.

At ED1, Ofgem accepted SSEH's claim for these factors and partially accepted the quantified additional costs.

2.4 Sparsity/density/topography

There are increased costs associated with building and running an electricity distribution network in a densely populated area, as well as in a sparsely populated area, especially in combination with an area that is difficult to access (e.g. because of mountains).

- Labour costs are higher as a result of longer driving times leading to more unproductive time. To mitigate longer driving times, network operators in sparse regions need to set up additional depots and optimise their location.
- There are more specific arrangements needed in SSEH's remote areas, such as load managed areas, where a radio signal is used to control the electricity supply of particularly remote households.

At the same time, operating in a particularly dense environment also leads to increased costs due to congestion and a more costly process of carrying out works in a busy city (e.g. more costly streetwork permits, more costly work due to underground congestion of other utility networks, more costly design taking into account other utilities, etc.).

At ED1, Ofgem took these factors into account by adjusting costs prior to the modelling. The adjustments were based on (partially) accepted regional factor claims by SSEH and LPN.

2.5 Regional wages

Most of the work for DNOs needs to be carried out locally, therefore requiring local labour. If labour costs differ across the network areas, then this would increase the labour proportion of costs for some DNOs relative to others. At ED1, Ofgem normalised costs by applying local regional wage indices to the labour part of costs prior to the benchmarking regressions.

2.6 Weather and environmental factors

Environmental factors can also contribute to costs for DNOs that are exposed to more extreme conditions. For instance, the impact of cold weather, wind and proximity to the sea leads to assets corroding more quickly unless they are protected (e.g. by placing them in purpose-built buildings). Similarly, kit needs to be inspected more frequently and specialist equipment/vehicles may be needed (e.g. winches for snow drifts).

The type of ground (e.g. a particular type of soil) can also lead to work in one area being more expensive than in others. This is due to the need to install more specific assets as some soil types (particularly in the South of England) allow for more water seep through, corroding assets.

At RIIO-ED1, Ofgem granted SSEH an allowance of £0.12m p.a. for severe weather—specifically, the cost to deploy staff to islands prior to forecast storm events.[9] This would not pass Ofgem's latest materiality threshold.

2.7 Net zero

Achieving the UK's ambitious decarbonisation targets will lead to challenges for the DNOs. For instance, increasing electrification requires more network reinforcement as the network is pushed to peak points in the day and an increasing amount of decentralised generation needs to be connected directly to the distribution networks. Depending on how Ofgem undertakes its modelling (e.g. the use of historical versus forecast data), this may require additional consideration if there is a need for increased costs relative to past expenditure.

In addition, if there are regional differences arising from these decarbonisation developments that lead to differences in costs between the networks, then this needs to be accounted for in the modelling or through cost adjustments. At this stage, there is no ED2 forecast data available that would allow us to assess whether such regional differences exist and whether they can be directly captured in the cost models. However, this work will be undertaken in the future once ED2 forecasts from all DNOs are available.

[9] Ofgem (2014). 'RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment', 28 November, chapter 4, paras 4.20–4.37.

3 Regional and company-specific factors

Regional and company-specific cost adjustment claims will be required if there are factors resulting in material cost differences that are not already captured by the cost drivers used in the cost models or methods used by Ofgem.

As Ofgem has not yet published any detail on the cost models to be used for ED2, this report is based on ED1 models and provides an indication of potential factors that might need to be accounted for. Given that regional factor adjustments are assessed relative to the models and methods used by Ofgem, the need for such adjustments will require reassessment as Ofgem's approach becomes clearer.

3.1 Islands

3.1.1 Need for adjustment

This section assesses the need to take into account the additional costs that arise from DNOs serving islands. These costs should be accounted for in the benchmarking process in order to increase comparability across DNOs. The main focus here is on submarine cables, which are a significant cost factor for SSEH, although some other DNOs also operate submarine cables e.g. SSES's connection to the Isle of Wight). However, there are other types of company-specific spend that arise for SSEH as a result of the large number of islands in its region. This includes remote island generation, the Shetland licence, and costs for transportation to the islands.

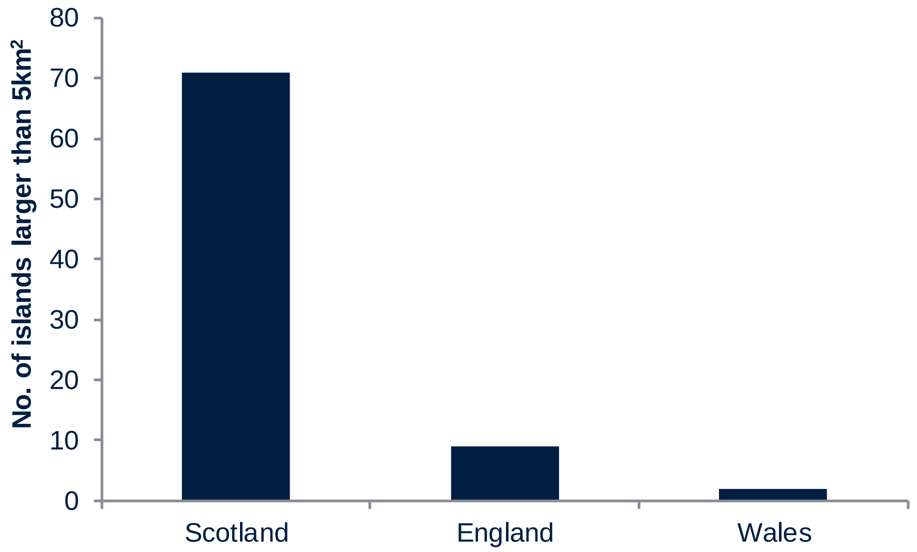
The remainder of this section assesses the need for cost adjustment according to the criteria set out in the introduction.

Criterion 1—unique

87% of the islands in Great Britain that are larger than 5km^2 are located in Scotland.[10] This puts SSEH in a unique position compared to other DNOs as many of these islands need to be supplied with electricity and staff need to travel to the islands to carry out work.

[10] We use the number of islands greater than 5km^2 in GB as a proxy for the number of inhabited islands in GB. This gives an estimate of the number of islands in GB that have an energy requirement and therefore lead to cost increases for network companies. Source: https://www.ordnancesurvey.co.uk/newsroom/blog/britains-largest-islands (last accessed 27 May 2021).

Figure 3.1 Number of islands greater than 5km² in GB



Source: Oxera, based on Ordnance survey, 'Britain's largest islands', available at: https://www.ordnancesurvey.co.uk/newsroom/blog/britains-largest-islands (last accessed 27 May 2021).

SSEH's network area covers Scotland, including its island communities as shown in Figure 3.2. This requires specific arrangements that are unique to SSEH.

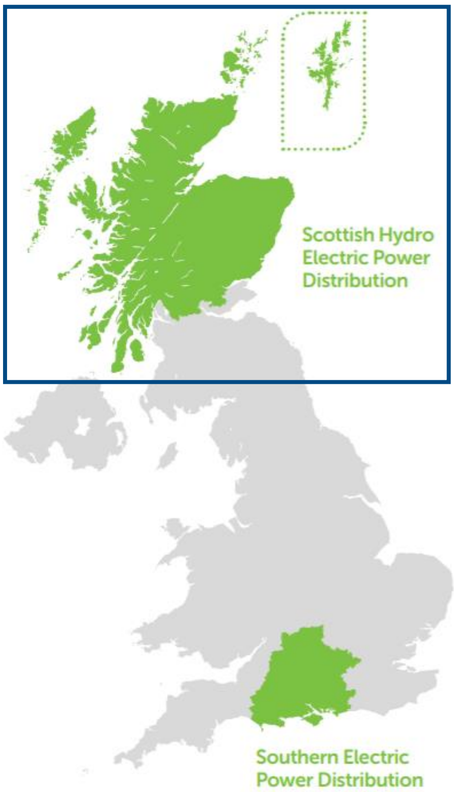
- **Submarine cables.** SSEH connects its 59 island communities on the north and west coasts of Scotland to the mainland electricity grid using 111 submarine cables totalling 454km.[11] SSEH's submarine cable portfolio forms an extensive network, connecting various islands to one another and to the mainland of Scotland. For example, submarine cables connect the island of Barra to Uist, Uist to the Island of Skye, and the Island of Skye to the mainland.[12] Maintaining and operating submarine cables leads to additional costs for SSEH, especially when faults occur or assets need replacing.
- **Remote Island Generation.** SSEH operates seven remote island generation (RIG) sites,[13] used as an essential alternative supply if the connections between the mainland and the islands were to fail. Only three DNOs use RIG, and SSEH accounted for 77% of total combined RIG expenditure from 2011 to 2019.[14] The expenditure is associated with inspection, maintenance, repair and replacement of the diesel generators and buildings.
- **Transport and accommodation.** SSEH staff must frequently use ferry and air travel, including helicopter flights, to service islands, and landing craft vessels are often required to transfer specialist equipment to the islands. Overnight accommodation is often required for routine and fault related work on islands due to limited daily ferry and flight services.

[11] SSEN (2021), 'North of Scotland Strategy paper'.
[12] SSEN (N.D.), 'Sub-Elec-Cables-Networks-Locations-merged.pdf'.
[13] Battery Point, Stornoway; Arnish, Stornoway; Loch Carnan, South Uist; Barra Power Station, Barra; Tiree Power Station, Tiree; Bowmore, Islay; Kirkwall, Orkney.
[14] Oxera analysis based on 2019/20 Cost and Volume tables.

- **Staff required in remote locations prior to storm events.** During severe weather events, it is common for ferry services to be cancelled, causeways to be closed to traffic and aircrafts to be grounded. This requires SSEH to transfer additional staff to islands prior to forecast storm events to ensure that there are sufficient resources to deal with potential faults.[15]

- **The Shetland Isles.** SSEH operates the only islanded network in Great Britain, the Shetland Isles. There is no direct connection between the Shetland Isles and Great Britain, and power is supplied with on-island diesel generation at Lerwick Power Station. Submarine cables are used to connect the outlying islands to the mainland of the Shetlands Isles. As part of the current resilience contracts for the island, SSE also contract with Sullom Voe Power Station to provide additional support as required throughout the year. Costs specifically relating to the Shetland Isles have not been captured within this report.[16]

Figure 3.2 Area covered by SSEN



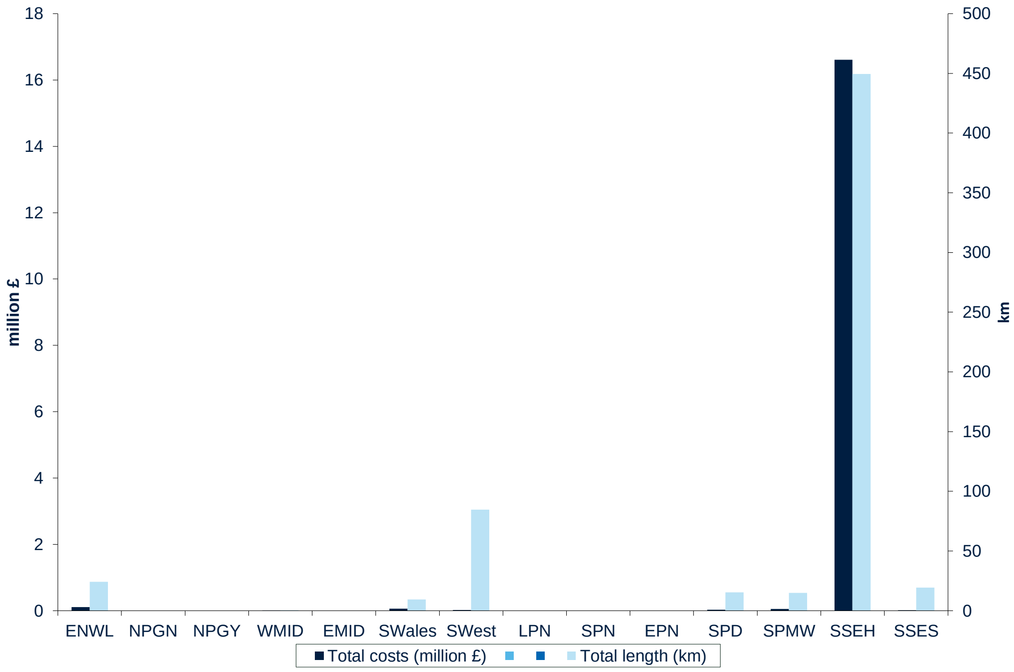
Source: Scottish and Southern Electricity Networks (2015/16), 'Distribution Business Plan Commitment Report', p. 5.

The factors listed above should be accounted for in the benchmarking process in order to increase comparability across DNOs. As stated, the main focus of this section is submarine cables, which are a significant cost factor for SSEH and, to a lesser extent, some other DNOs.[17] Other factors that are specific to SSEH are listed below.

[15] SSEN (2013), 'Scottish Hydro Electric Power Distribution RIIO-ED1 Business Plan Regional Factors Supporting Paper', 1 July.
[16] SSEN (2021), 'North of Scotland Strategy paper'.
[17] See Figure 3.3.

SSEH's submarine cable portfolio accounts for around 73% of the UK's submarine cable assets.[18] The submarine cable lengths for the different DNOs are represented in the figure below. The proportion of submarine cables accounted for by SSEH is likely to be even higher when excluding submarine cable assets that do not cross open water.

Figure 3.3 Length and cost of submarine cables (avg. 2016–21)



Source: Oxera analysis based on 2020/21 costs and volumes data.

Note: The cost figure includes asset replacement and fault costs for submarine cables as displayed in the CV7 and CV26 tables. In addition, there are likely to be other costs, such as overhead costs, that have not been considered here as they are not separated out in the costs and volumes tables. Tables CV7 and CV26 tables include data for all relevant DNOs and for the entire 2011-2021 period, thus ensuring both external and internal consistency. The data in the M11 tables was not used as it was only compiled by SSEN and it only went back to 2016.

The picture is even more extreme when considering the cost impact due to the lumpy nature of the associated expenditure. The submarine cables costs considered here are only for asset replacement and faults. Other cost areas are likely to be affected (for instance overhead costs). While SSEN provided this breakdown, it is not available to us on a consistent basis for all DNOs (as these other costs are not split out in the costs and volumes files). We therefore only consider asset replacement and faults here and note that this likely underestimates the total cost of submarine cables.

SSEH's total submarine cable costs (faults and asset replacement) were over £99m over 2016–21.[19] During this time period no other DNO incurred costs associated with submarine cables over £0.7m. SSEH's submarine cable costs were therefore more than 100 times higher than those of any other DNO. Nevertheless, any DNO that operates subsea cables may incur costs (e.g. faults, asset replacement) that are lumpy in nature. For instance, while SSES's submarine cable costs to the Isle of Wight have been very low since 2016, it

[18] Oxera analysis based on costs and volumes data.
[19] All prices in this report are in 2020/21 terms.

incurred costs of over £8m p.a. during some years of DPCR5. Costs for submarine cables are likely to remain high but uncertain over ED2.[20]

Overall, SSEH's position is clearly unique among the networks.

Criterion 2—outside of management control, with efforts being made to mitigate the impact

Supplying power to the remote island communities within SSEN's network is required as a condition of SSEH's licence.[21] The installation, inspection, protection, maintenance, repair and decommissioning of SSEH's submarine cables portfolio leads to a number of unavoidable costs. Similarly, workers need to travel to the islands in order to carry out activities locally.

Instead of connecting communities to the main grid, on-island generation can also be used. SSEH's Remote Island Generation (RIG) was established before the use of submarine cables and was the main source of electricity supply to some of the island communities. As the network has developed, the RIGs have been used as an essential alternative supply if the long radial connections between the mainland and the island were to fail. This current arrangement ensures that SSEH meets its licence obligations for these remote communities. The RIGs deliver a cost-effective solution to network security for these island communities as opposed to significant network investment to install additional infrastructure to these remote communities.[22]

In addition to its licence condition, all submarine cables must be consented through Marine Scotland and SSEH require a specific Marine Licence to undertake any submarine cable works. As a result, SSEH must engage with Marine Scotland and ensure that all necessary compliance, approval and consent is in place prior to commencing any project.[23]

Criterion 3—incremental

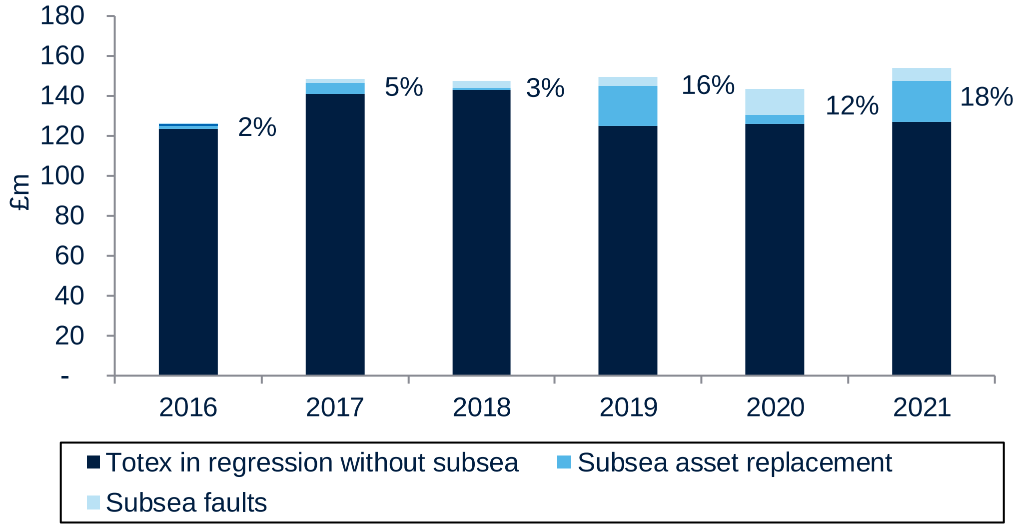
This criterion assesses whether the special factor (submarine cables) is not already captured by existing cost drivers, i.e. that it is incremental. This depends on the precise models and cost drivers Ofgem uses in RIIO-ED2, which have not yet been determined. The following analysis therefore considers whether submarine cable spend is captured in the ED1 models and cost drivers. The assessment would need to be updated once Ofgem has published its cost models for ED2.

Top-down regression model

The ED1 TOTEX top-down regression model uses a cost driver comprising MEAV and customers. There are no customers directly associated with subsea cable spend, so this cost driver does not capture submarine cables. MEAV does include submarine cables. The following two figures show the proportion of costs and cost driver proportions that are due to submarine cables.

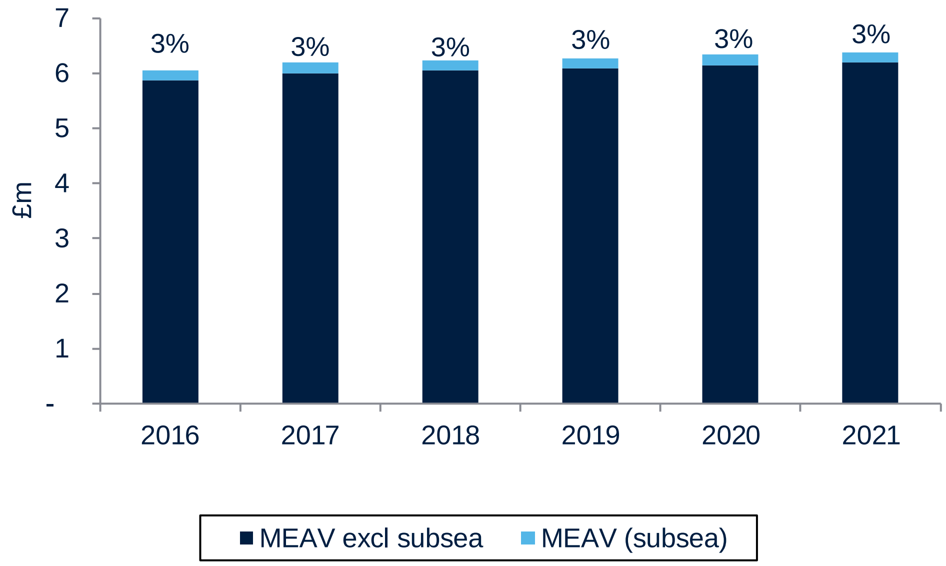
[20] SSEN (2021), 'Managing uncertainty in RIIO-ED2', 02 June.
[21] SSEN (2021), 'North of Scotland Strategy paper'.
[22] SSEN (2021), 'North of Scotland Strategy paper'.
[23] Ibid.

Figure 3.4 TOTEX used in the regressions and % attributable to submarine cables for SSEH



Source: Oxera analysis based on 2020/21 costs and volumes data. Subsea cost data based on tables CV7 and CV26.

Figure 3.5 MEAV and % of MEAV from submarine cables for SSEH



Source: Oxera analysis based on 2020/21 costs and volumes data.

The proportion of MEAV attributable to submarine cables is relatively small (c. 3%) compared to the costs in recent years (around 15% in the last two years and c. 9% on average over the past six years). Costs are expected to remain high (but lumpy) over the ED2 period. There are two reasons for the discrepancies between costs and cost drivers in the TOTEX top-down model.

- First, submarine cables are a relatively small part of the asset base and do not carry very much weighting in the overall MEAV. In contrast, the costs associated with submarine cables can sometimes account for a large proportion of overall costs.
- Additionally, MEAV does not vary much over time because submarine cables are not necessarily being added as new assets. Nevertheless, costs

associated with submarine cables are lumpy and can occur at any time (e.g. if there is a submarine cable fault).

As such, only a marginal element of submarine cables can be accounted for by Ofgem's model. The element of submarine cables that is being accounted for in Ofgem's model can be thought of as the 'implicit allowance', i.e. how much higher the model predicts costs to be when submarine cables are present compared to when they are not. For SSEH, the top-down model gives an implicit allowance of £37.5m compared to actual costs amounting to £99.6m[24] over the entire 2016–21 period.[25] This demonstrates that the model insufficiently takes account of SSEH's subsea cable costs. The shortfall is more extreme for the bottom-up model (see below).

Bottom-up regression model

There are a number of costs and cost drivers associated with submarine cables. These are summarised in Table 3.1, showing the percentage attributable to submarine cables for the cost area and the corresponding driver as identified by Ofgem.[26]

Table 3.1 Cost and cost drivers in Ofgem's bottom-up TOTEX model that are affected by submarine cables

Costs by activity area Average percentage of cost attributable to submarine for SSEH 2016–21 (range)	Cost driver Average percentage of cost driver attributable to submarine cables for SSEH 2016–21 (range)
Diversions, operational IT&T (non-quantifiable)	Total length 0.92% (range: 0.91–0.95%)
Asset replacement 31% (range: 4–66%)	MEAV 3.07% (range: 2.98–3.21%)
Faults 37% (range: 3–70%)	Total faults 0.05% (range: 0.00–0.08%)
Total costs 9% (range: 2–18%)	Total cost driver (bottom-up csv)* 2.14% (range: 1.93–2.35%)

Note: * Calculated as the average of submarine cables' share of each cost driver, weighted by the share of costs associated with each cost driver, for SSEH, considering only cost items included in the calculation of the bottom-up csv.

Source: Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies - Business plan expenditure assessment', 28 November, Table A5.1; Oxera analysis of costs and volumes data.

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[24] This figure includes asset replacement and trouble call costs as displayed in the CV7 and CV26 tables. In addition, there are likely to be other costs, such as overhead costs, that have not been considered here as they are not separated out in the costs and volumes tables. Tables CV7 and CV26 include data for all relevant DNOs and for the entire 2011-2020 period, thus granting both external and internal consistency. The data in the M11 tables was not used as it was only compiled by SSEN and it only went back to 2016.
[25] This is calculated by running the cost model on (i) costs including submarine using the cost driver including submarine, and (ii) costs including submarine using the cost driver excluding submarine. The difference between these two cost predictions gives the implicit allowance. This is similar to the implicit allowance used by Ofwat—see Ofwat (2019), 'PR19 final determinations – Securing cost efficiency technical appendix', December, p. 38.
[26] In order to use consistent data across all DNOs, we have not used the information in table M11 of the cost and volumes tables but instead used the costs that are split out within the asset replacement and faults tabs contained within the costs and volumes files.

Again, there is a significant discrepancy between the cost and the cost driver that is attributable to submarine cables. In particular, the costs are very volatile and, in some years, extremely high, whereas the cost driver that is attributable to subsea cables is consistently very small.[27] There may also be other areas where submarine cables increase costs but where this element is not split out (e.g. certain indirect costs). These should ideally be identified and removed accordingly. On average across the period 2016–21, subsea costs that could be split out from the data provided account for 9% of TOTEX whereas the cost driver attributable to subsea is around 3% or less. In the last two years, the mismatch was more extreme with submarine costs accounting for 15% of TOTEX but still 3% at most of the cost driver.

As such, only a marginal element of submarine cables can be accounted for by Ofgem's model.

The 'implicit allowance' in the bottom-up model amounts to £13.5m over the period 2016–21 compared to actual costs of £99.6m.[28] Averaging the implicit allowance from the top-down and bottom-up regression models would imply an implicit allowance of £25.5m. Clearly, the cost driver fails to adequately account for submarine cables.

Island-related costs other than submarine cables

The other costs quantified in relation to islands are transport to the islands, the costs of sending staff to an island prior to a forecast storm, and RIG. Conceptually, there is no cost driver that would capture these costs. Given SSEH's unique position in terms of the number of islands (see also Figure 3.1) these costs can be seen as incremental compared to an average DNO.

Criterion 4—material

SSEH's total submarine cable costs (faults, asset replacement and inspections) were over £99m over the period 2016–21 (on average £16.6m p.a.). In the last three years, submarine cable costs increased significantly, amounting to £29.3m in 2019, £21.4m in 2020 and £32.7m in 2021, clearly exceeding the materiality threshold of around £1m p.a. These costs are expected to remain high and lumpy in ED2.

In addition to submarine cables, there are a number of further cost items relating to islands as set out above.

These costs were already accounted for at ED1 through a regional cost adjustment, and SSEN has updated the corresponding cost estimates.[29] The overall impact of serving islands is summarised in the following table. Further detail, including on the rationale behind changes from ED1 to ED2 is provided in Appendix A3.

[27] The first row of Table 3.1 shows that there are some cost areas (diversions, operational IT&T) that do not directly relate to submarine cables, yet the corresponding cost driver includes a (very small) submarine cables part. However, the impact of this very slight overestimate of the diversions and operational IT&T cost driver is likely to be immaterial given how small the submarine part of network length is.
[28] See explanation in footnote 25.
[29] Data provided by SSE.

Table 3.2 Cost impact of islands

Category	ED1 allowance (£m p.a.)	ED2 forecast (£m p.a.)
Submarine cables		**£36.90m** *
Submarine cables team		1.50
Specialist travel modes		
Island Flights, accommodation and ferries	0.16	0.43
Helicopters	0.10**	0.10
Deployed staff prior to forecast severe weather events	0.12	0.26
Remote Island Generation	5.05**	6.73***
Total excl. submarine	**5.42**	**7.52**

Note: 2020/21 prices. *Includes CV7, CV26, CV30, CV31, HVP, C5 and C7 only. Other areas (e.g. business support) would also be affected by submarine cables so this figure is likely to be an underestimate. Submarine cables costs listed here only cover SSEH. Note that there may be additional submarine cable costs as part of an uncertainty mechanism. ** Reduced claim as accepted by Ofgem. *** Note that the ED2 forecast for Remote Island Generation is equal to the average of forecast Remote Island Generation operation and maintenance costs in ED2 (2024-2028) from SSEH RIIO-ED2 Business Plan Data Template v.4.3 and average business as usual fuel costs for ED1 provided by SSEH, see Appendix A3. The estimate does not include fault related fuel costs.

Source: ED1: Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies - Business plan expenditure assessment', 28 November ; ED2 forecasts provided by SSE, apart from average business as usual fuel costs for ED1 provided by SSEN).

These costs are clearly material, and at c.18% of TOTEX easily pass the threshold of 0.5% of TOTEX. Even without subsea cables, the materiality threshold of around £1.25m p.a. is exceeded by a factor of six.

3.1.2 Proposed adjustment

As costs related to submarine cables are unique, not well captured by cost drivers and lumpy in nature, we recommend that they should be excluded from the TOTEX regression benchmarking—this means, excluding submarine cables from both, the cost and cost driver side of the regression equation. The impact of this change would be most material to SSEH, but it would also affect other DNOs with submarine cable costs (e.g. SSES's cable to the Isle of Wight). The other factors mentioned above (i.e. specialist travel modes and remote island generation) were already captured at ED1 and should continue to be treated as a company-specific factor.

The revised results of the TOTEX regressions (i.e. excluding subsea costs and the associated element of the cost driver) are summarised in Table 3.3.[30]

[30] Note that this is based on ED1 data. We have therefore applied other regional adjustments as in ED1 and not applied the ED2 figures from Table 3.2. As mentioned above, the submarine exclusion only covers asset replacement and faults. Other costs may need to be excluded.

Table 3.3 Efficiency scores with and without submarine cables

DNO	Top-down incl. submarine	Top-down excl. submarine	Bottom-up incl. submarine	Bottom-up excl. submarine
SSEH	0.97 (+5.3%)	0.94 (+1.7%)	0.92 (-0.4%)	0.86 (-6.8%)
SSES	0.97 (+5.3%)	0.98 (+5.8%)	0.93 (0.6%)	0.93 (0.0%)
UQ	0.92	0.92	0.92	0.93

Note: 2016–21 average efficiency score (and % deviation from upper quartile).

Source: Oxera analysis based on 2019/21 costs and volumes data.

Although we recommend that the costs relating to submarine cables be excluded from the regression modelling, it is still necessary to assess the efficiency of this excluded expenditure. Because no other DNO incurs even remotely similar costs to SSEH, it is not possible to benchmark submarine cable costs on a top-down basis. Instead, this assessment has to be done on a bottom-up/engineering basis based on need and cost. Given the uncertain nature of submarine cables costs SSEN is proposing that some of these costs should be treated as an uncertainty mechanism.[31]

3.2 Sparsity/density/topography

3.2.1 Need for adjustment

Criterion 1—unique

SSEH operates a distribution network that covers 25% of Great Britain's (GB) landmass, with just 2.6% of the GB customer base.[32] SSEH's licence area covers the most sparsely populated geographic area with the most challenging topography in the UK.

We have constructed several sparsity measures to examine the differences across DNOs. These show the extreme sparseness of SSEH's network area.

- **Customer density.** A simple measure of sparsity and density is customer density. This is defined as the number of customers a DNO serves divided by DNO network area. A smaller value indicates a sparser network.
- **Customers by network length.** In a larger and sparser network area where customers are more widely dispersed, more kilometres of network are likely to be needed to reach a fixed number of customers compared to other DNO areas. A smaller value indicates a sparser network area.
- **Ofgem's RIIO-GD1 sparsity measure.** We have calculated and applied the sparsity measure used by Ofgem at RIIO-GD1 for the electricity distribution sector. The sparsity measure involves identifying sparse districts as districts with population density lower than the total industry population density, and applying weightings to construct an index for each DNO. A higher value indicates a sparser network. While the less sparse networks on this index are also likely to be those that are denser, the measure was intended as a sparsity measure and does not necessarily reflect density to the same extent.
- **Ofwat's PR19 sparsity measure.** Ofwat calculated multiple company specific sparsity indicators at PR19. The measure shown in Figure 3.6 is the weighted average of Local Authority District (LAD) population density per

[31] SSEN (2021), 'Managing uncertainty in RIIO-ED2', 02 June.
[32] Oxera analysis based on Ofgem data.

company, using weights equal to the LAD population divided by the total population served by the DNO. A smaller value indicates a sparser network.

A detailed description of the sparsity measures used by Ofwat ay PR19 and Ofgem at RIIO-GD1 is included in Box 3.1.

Box 3.1 Ofgem and Ofwat sparsity measures

Ofgem RIIO-GD1

Ofgem identified district population sizes and surface areas for each district served by each GDN, excluding any districts with no gas coverage, and calculated population density for each UK district and for the industry as a whole.

Ofgem classified all districts with a population density less than industry population density as sparse.

For each GDNs' district classified as sparse:

Ofgem computed an un-weighted, un-normalised sparsity index as district population density divided by industry population density.

The un-weighted indices were normalised by converting the indices into deviations from 1 and then were weighted by district population divided by total population served by the GDN for that district.

Ofgem calculated each GDN's sparsity index by summing up all the normalised, weighted district indices for each district it serves and standardised the indices using the formula [1+(company-specific index value – median value for all GDNs)].

Ofwat PR19

Ofwat used local authority districts (LADs) population density to construct multiple company specific population density indicators.

Weighted average density indices

Using weights equal to the LAD population divided by the total population served by the water company, Ofwat calculated three weighted average density indices:

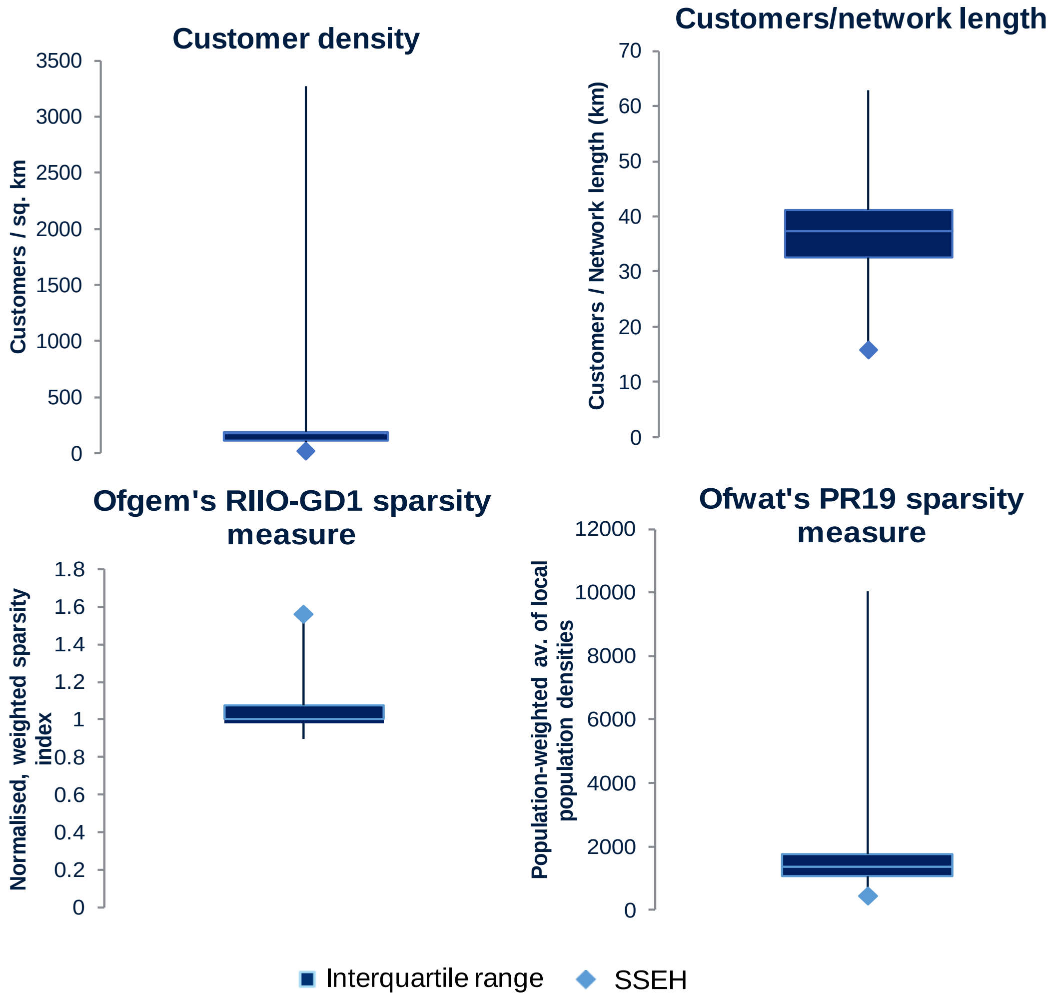
- weighted average of LAD population density;
- weighted average of the natural logarithm of LAD population density;
- weighted average of the square of the natural logarithm of LAD population density.

High density/high sparsity measures

Ofwat calculated the proportion of population within a water company's area, that resides in highly dense or highly sparse areas defined by six thresholds based on 'kink points' in the distribution of population density over LADs.

Source: Ofgem (2012), ' RIIO-GD1: Initial Proposals – Step-by-step guide for the cost efficiency assessment methodology', 3 August, p. 28. Ofwat (N.D.), 'Final determinations models – weighted average density index – forecast'.

Figure 3.6 Sparsity measures



Note: The blue boxes represent the interquartile range, which is the difference between the 75th percentile and the 25th percentile values of the DNOs. The light blue line inside the boxes represents the median value of the DNOs. The vertical black lines that cross each box represent the span from the maximum to the minimum values of the DNOs. A higher value of Ofgem's RIIO-GD1 sparsity measure indicates a sparser network.

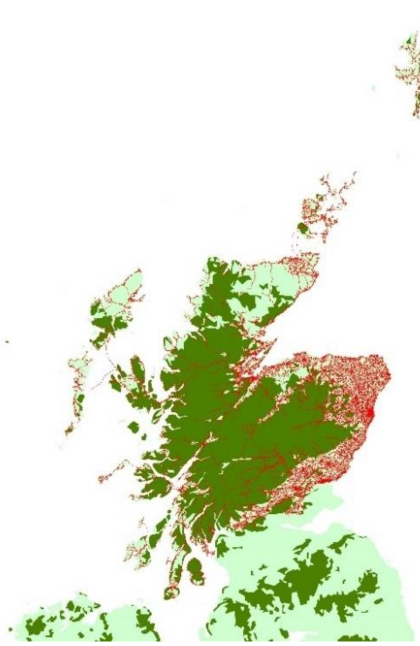
Source: Oxera analysis based on ONS 2018-based subnational population projections for England, National Records of Scotland 2018-based principal population projections by council area for Scotland and StatsWales 2018-based population projections by local authority for Wales.[33]

It is clear that SSEH is the sparsest DNO compared to all other DNOs, regardless of the sparsity measure used, including the sparsity measures used by Ofgem in RIIO-GD1 and RIIO-GD2 and Ofwat in PR19. There are increased costs associated with operating in sparsely populated areas,[34] especially when

[33] ONS (2020), 'Dataset: Population projections for local authorities: Table 2', 24 March, available at: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/localauthoritiesinenglandtable2 (last accessed 27 May 2021). National Records of Scotland (N.D.), '2018-based principal population projections for 2018-2043, by sex, council area and single year of age', available at: https://www.nrscotland.gov.uk/statistics-and-data/statistics/statistics-by-theme/population/population-projections/sub-national-population-projections/2018-based/detailed-datasets (last accessed 27 May 2021).
StatsWales (2020), '2018-based local authority population projections for Wales, 2018 to 2043', August, available at: https://statswales.gov.wales/Catalogue/Population-and-Migration/Population/Projections/Local-Authority/2018-based/populationprojections-by-localauthority-year (last accessed 27 May 2021).
[34] We also note that operating in particularly dense areas is more costly than operating an averagely dense network due to congestion, more challenging streetworks, etc. This impact has not been quantified as part of this paper as it is specific to the London network.

this involves difficult topography. For example, the rocky, mountainous topography of the Scottish Highlands extends the time it takes to build and access network assets and extends travel times due to the constraints the topography places on the road network. Figure 3.7 shows mountainous areas, as well as the location of SSEH's assets (in red). **SSEH's region is particularly mountainous**.

Figure 3.7 Mountains in the UK and SSEH's asset location



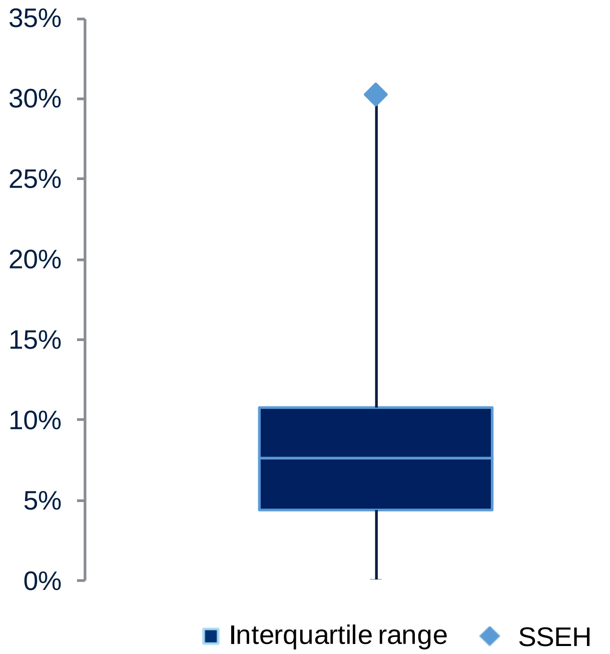
Note: Mountainous areas (as defined by EEA: https://www.eea.europa.eu/data-and-maps/data/european-mountain-areas, last accessed 27 May 2021).

Source: Oxera, using MapInfo and based on SSEN's asset data.

Figure 3.8 shows the extreme topography of SSEH's network compared to all other DNOs. Mountain soil is generally characterised by shallow depth.[35] Therefore, using data from the British Geological Survey,[36] we use the proportion of shallow soil within a DNO's network area as a proxy for mountainous terrain.

[35] Food and Agriculture Organisation of the United Nations (2015), 'Understanding Mountain Soils – A contribution from mountain areas to the International Year of Soils 2015', Rome.
[36] British Geological Survey (N.D.), 'Soil Parent Material Model', available at: https://www2.bgs.ac.uk/products/onshore/soilPMM.html (last accessed 27 May 2021).

Figure 3.8 **Proportion of DNO network area characterised by mountain terrain**



Note: The blue box represents the interquartile range, which is the difference between the 75th percentile and the 25th percentile values of the DNOs. The light blue line inside the boxes represents the median value of the DNOs. The vertical black lines that cross each box represent the span from the maximum to the minimum values of the DNOs. A high value indicates a high proportion of mountain terrain.

Source: Oxera analysis based on data from the British Geological Survey.

It is clear that SSEH is unique topographically. The above measure suggests that at least 30% of SSEH's network area is characterised by mountain terrain. This is in contrast to the median value of 8%.

Criterion 2—outside of management control, with efforts being made to mitigate the impact

Clearly, sparsity/topography is an external factor outside of management control that affects the operation and maintenance of the network and the asset base. Additional services and expenditure are required to ensure that the remote customers receive the same level of service as others living in urban environments.

Both planned capital investment and day-to-day operations of the network aim to mitigate the impacts of sparsity/topography on costs. Two examples of this are discussed below.

- **Use of Skedulo.** SSE use Skedulo, a mobile workforce management and scheduling tool to improve efficiency of daily operations.[37] Skedulo helps to ensure optimal assignment of workers to jobs based on real time location data, reducing unproductive time spent travelling.
- **Remote depots.** SSEH operates and maintains 30 depots and properties across its area. This includes four main depots and the rest of varying degrees of remoteness, all equipped with a full range of equipment to ensure all necessary activities can be undertaken in remote areas. This not

[37] See the Skedulo website, available at: https://www.skedulo.com/ (last accessed 27 May 2021).

only allows SSEH to deliver a consistent quality of service for all customers across its network—it reduces the remoteness of customers from staff reducing unproductive travel time.[38]

Criterion 3—incremental

In RIIO-ED1, Ofgem accounted for the effects of sparsity and density with pre-modelling adjustments to costs based on (partially) accepted regional factor claims by SSEH and LPN.[39] As such, if the same cost drivers as used in ED1 are used in ED2, then sparsity would again need to be accounted for.

We examined whether it is also possible to show the incremental impact of sparsity by including such a variable in the regression model (instead of using pre- or post-modelling adjustments). However, based on ED1 data that is currently available, we did not find a statistically significant relationship. We note that this is similar to the outcome in gas distribution where sparsity was accepted by Ofgem as a regional factor for Emergency and Repair costs on the basis of bottom-up evidence while top-down evidence did not demonstrate a statistically significant impact. This could be investigated again once forecast ED2 data becomes available. However, based on the data currently available, an update of the ED1 approach with pre-regression adjustments would need to be used.

Criterion 4—material

As a result of the extreme sparsity/topography and remoteness of operations, there is a higher cost associated with operating and maintaining SSEH's network compared to an averagely sparse DNO. This is due to the following factors.

- **Longer driving times.** Due to the sparse and difficult to access network, SSEH's workers spend more time driving compared to staff of an average network. This leads to unproductive time, as well as additional fuel and vehicle costs. The quantification of additional costs due to longer driving times is set out below. The cost of longer driving times (and therefore more unproductive time and additional vehicle and fuel costs) for ED2 is estimated to amount to £1.83m p.a.[40]
- **Remote depots and out-posted staff.** SSEH must maintain additional properties and retain out-posted staff to service remote areas. Additional depots compared to an averagely sparse network are estimated to lead to an additional cost of £0.23m p.a. in ED2, and additional staff costs are estimated to be £5.63m p.a. (see quantification in this section).
- **Private Mobile Radio network.** Maintaining and operating a Private Mobile Radio (PMR) network is necessary as remote areas of SSEH's network are not covered by telecoms companies, and also allows staff to communicate during disruptions to the telecoms network where there is one. The cost to maintain and operate the PMR network is estimated to be £1.07m p.a. for ED2. SSEH must also use specialist scanning telemetry in its remote areas, at a forecast cost of £1.17m p.a. for ED2.[41]

[38] SSEN (2013), 'Scottish Hydro Electric Power Distribution RIIO-ED1 Business Plan Regional Factors Supporting Paper', 1 July.
[39] Ofgem (2014). 'RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment', 28 November, chapter 4, paras 4.20–4.37.
[40] Consisting of £0.76m fuel/vehicle costs as calculated by SSE and £1.07m due to longer driving times calculated below.
[41] Figure provided by SSEN.

- **Load managed areas.** In particularly remote areas, SSEH needs to use radio signals to manage electricity supply in order to manage load on the system. This allows SSEH to stagger demand requirements and ensure network capacity is not breached, thus minimising risk of failure and maintaining network integrity. SSEH is the DNO that is most affected by load managed areas within its network, and currently, load management is applicable to 90,000 customers, equal to 10% of the customer base.[42] In the future, load managed areas will be managed by smart meters and forecast costs for load management during ED2 are £0.56m p.a.[43]

- **North of Scotland resilience.** Ensuring a certain standard of reliability is particularly costly in very remote areas. These resilience schemes will focus on delivering significant improvements in the Interruptions experience of the worst served customers. These schemes will be undertaken in the following four areas: Western Isles - Barra, Argyll and Bute - Islay, Argyll and Bute – Mull, and Orkney – Sanday.[44] SSEN estimates this cost to be £4.37m p.a. for ED2.[45]

Longer driving times

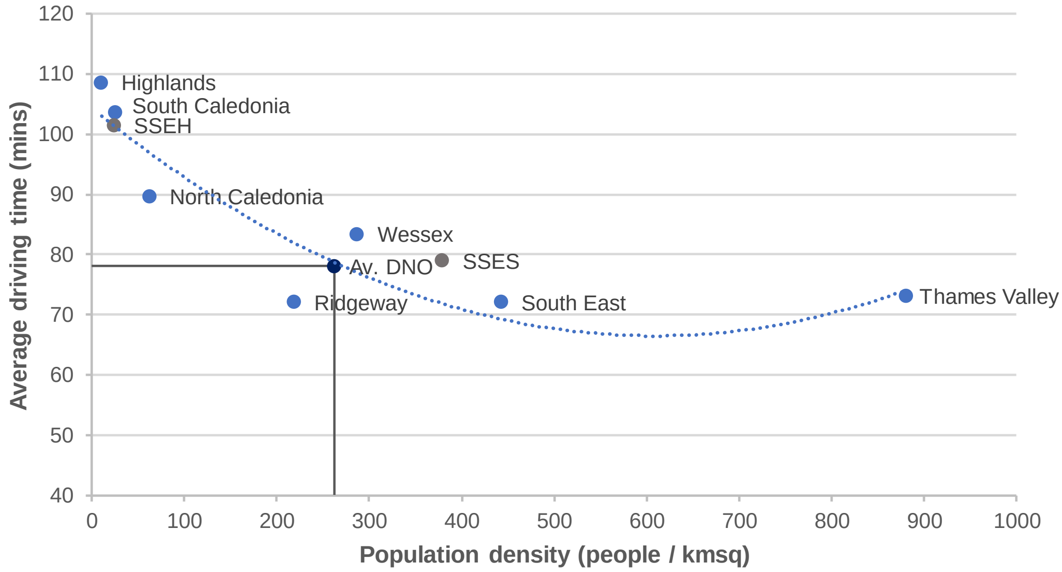
Oxera has estimated the impact of longer driving times on SSEH's costs and SSEH's additional depot costs in order to service remote areas (whereas the other factors have been quantified by SSEN).

The cost impact of longer driving times is calculated using data obtained from SSEN's mobile workforce management and scheduling tool (Skedulo), which is used to ensure optimal assignment of workers to jobs based on real-time location of staff. Skedulo allows SSEN to record the duration of a job and the time spent driving to a job within the seven regions of its two networks: Highlands and Islands, South Caledonia and North Caledonia within SSEH; and Thames Valley, Wessex, Ridgeway and South East within SSES.

Based on this data, we calculated the average driving time per job for the different regions, which was then mapped to the population density of each region. Figure 3.9 shows that this results in a U-shaped relationship between sparsity and driving times; driving times are longer in very sparse and dense areas and are shorter in averagely sparse areas. This explicitly acknowledges that denser areas are exposed to higher costs compared to an average network.

[42] Figure provided by SSEN.
[43] Figure provided by SSEN.
[44] Ofgem (2021), 'RIIO-ED2 Business Plan Data Template – Glossary', 31 March , p. 148.
[45] Figure provided by SSEN.

Figure 3.9 Average driving time plotted against population density for SSEH and SSES and the seven regions within SSEN's networks



Source: Oxera analysis based on SSEN data from Skedulo and ONS 2011 population data.

Using the relationship between population density and driving times gives an average driving time of 78 minutes per job in an averagely sparse network, defined as a network with population density equal to the population density of Great Britain. This is in contrast to, on average, 102 minutes of driving per job in SSEH's area. On average, driving times in SSEH's area are therefore 30% longer than an averagely sparse network. This extends the working hours of SSEH's staff and contractors, and results in a significant amount of unproductive time spent travelling. The scheduling tool is specifically designed to optimise driving times so it is reasonable to assume that the resulting driving times in SSEN's area are therefore efficient.

The impact on costs is calculated as:

- the forecast labour and contractor costs for the above cost categories;[46]
- multiplied by the average proportion of time spent driving of the total duration of a job[47];
- multiplied by the percentage of additional driving time in SSEH's network compared to an average network (30%).

The annual cost impact is presented in Table 3.4 below. This has been calculated for each year of ED2 using forecast data, with the headline figure presented being the average p.a. amount.

[46] We use forecast labour and contractor costs for ED2 (2024–28). The costs are given in SSEH's SSEH RIIO-ED2 Business Plan Data Template v.4.3

[47] This varies by job and ranges from 6% (asset replacement) to 10% (faults).

Table 3.4 Forecast impact on labour costs as a result of travel times due to sparsity in ED2 (£m)

Cost category	2024	2025	2026	2027	2028	Average p.a.
Connections inside price control—C2	0.36	0.38	0.37	0.38	0.37	0.37
Faults—CV26	0.13	0.08	0.10	0.09	0.09	0.10
Inspections—CV30	0.29	0.28	0.29	0.27	0.26	0.28
Repairs and maintenance—CV31	0.08	0.08	0.08	0.08	0.07	0.08
Tree cutting—CV29	0.05	0.05	0.05	0.05	0.05	0.05
Asset replacement—CV7	0.21	0.21	0.21	0.17	0.17	0.19
Total	1.13	1.08	1.11	1.02	1.02	1.07

Note: 2020/21 prices.

Source: Oxera analysis based on SSEN data from Skedulo and draft business plan tables

Remote depots and out-posted staff

As a result of the extreme sparsity and remoteness of SSEH's network area and its customer base, SSEH requires additional depots, and its staff requirement is higher than for an average DNO. SSEH must employ additional staff in order to deliver a consistent quality of service for all customers regardless of location.

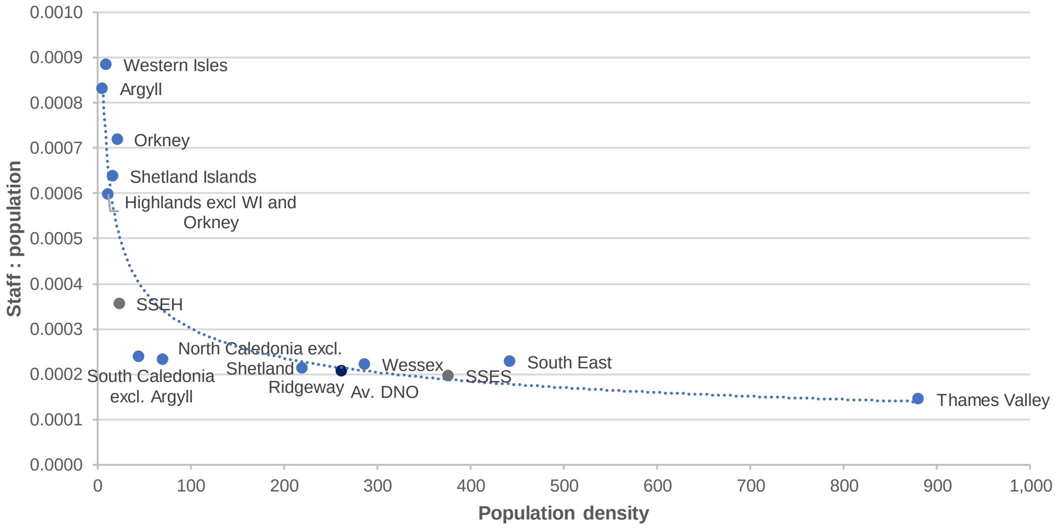
SSEH operates 30 depots, whereas SSES only has 20 depots. In terms of area, SSES is roughly similar to an average DNO.[48] SSEH needs additional depots due to sparsity, SSEN calculates this to be the additional 10 depots that SSEH operates in across its network area.[49] Multiplying this by the annual rental cost of £25,000 (provided by SSE), this leads to additional costs of £250,000 p.a. incurred by SSEH due to its sparsity.[50]

More granular data is available to calculate the number of additional staff for SSEH. Using data on depot staff within regions of SSEH' and SSES's networks, we quantify the additional staff requirement of SSEH when compared to an average network using two metrics: the ratio of staff to population, and the ratio of staff to line length. Ideally we would use MEAV as the relevant scaling variable because it is the main driver in the cost models and this approach would therefore ensure that the incremental impact is captured. However, MEAV data at this granular level is currently not available. SSEN may be able to extract this data in the future, which would allow us to refine the calculation.

Figure 3.10 shows the relationship between the ratio of staff to population and population density. SSEH has a significantly higher staff to population ratio when compared to an average DNO, defined above. This is particularly prevalent in the Highland and Island areas, since there is a distinct lack of economies of scale on islands and in rural areas.

[48] SSES' network area is 16,871km^2 compared to 16,353 km^2 for an average DNO.
[49] This assumes that SSEH's number of depots is efficient. This is likely to be the case given that SSEH still has longer driving times (see analysis above).
[50] SSEH's depot costs are externally audited annually. In addition, as we estimate SSEH to be efficient overall, we assume that its costs per depot are also efficient. .

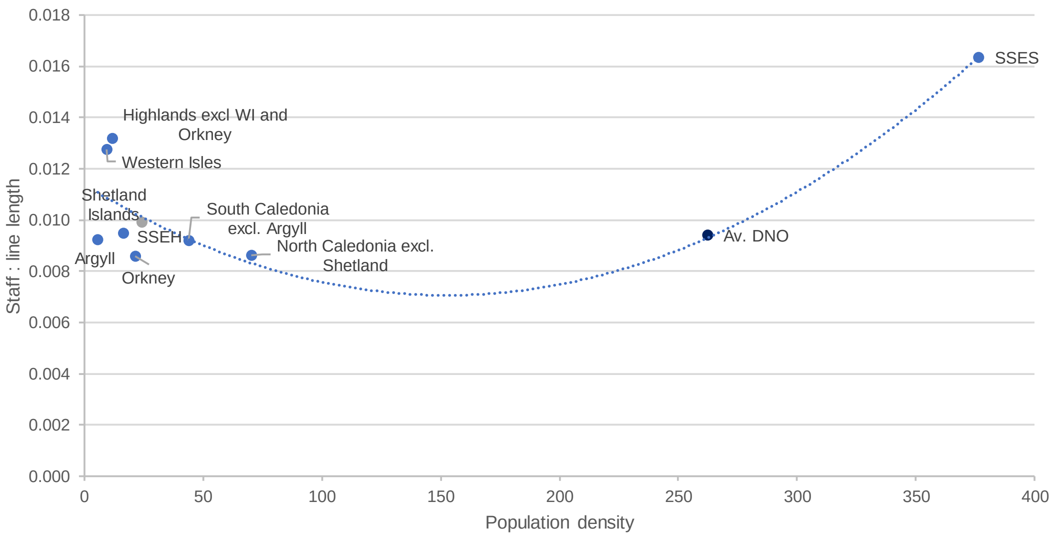
Figure 3.10 Ratio of staff to population plotted against population density



Source: Oxera analysis based on SSEN depot staff data and ONS 2011 population data.

Figure 3.11 shows the relationship between the ratio of staff to line length and population density.[51] Despite the fact that line length in SSEH's network area is high due to the vast area of the network, SSEH has a higher staff to line length ratio when compared to an average DNO. SSEH requires more staff to service its network due to remoteness of network assets.

Figure 3.11 Ratio of staff to line length plotted against population density



Source: Oxera analysis based on SSEN depot staff and line length (km) data, and ONS 2011 population data.

Table 3.5 summarises SSEH's additional staff requirement suggested by the above two metrics.

[51] Granular line length data for SSES was not available.

Table 3.5 Additional staff requirement compared to an average DNO

	SSEH	Av. DNO	% additional staff requirement
Staff : Population	0.00036	0.00021	72
Staff : Line length	0.0099	0.0094	5
Weighting	0.5	0.5	39

Note: The calculation can be refined if granular MEAV data becomes available.

Sources: Oxera analysis based on SSEN's data.

The large disparity in the two metrics is likely explained by SSEH's high line length due to the large network area, and SSEH's very small customer base. Equally, weighting both metrics suggests that SSEH requires 39% more staff than an average DNO.

Using SSEH's actual depot staff number of 490[52], this suggests that SSEH employs an additional 136 staff due to its sparsity. Multiplying this figure by an average depot staff salary of £41,394 (provided by SSEN) suggests that SSEH is exposed to additional staff costs of £5.63m.[53]

The regional or company-specific factors of fuel/vehicle costs, PMR, scanning telemetry, load managed areas and North of Scotland resilience are based on figures provided by SSEN. North of Scotland resilience costs have been extracted from the costs and volumes file.

The estimated impact of the different cost factors that are incurred as a result of sparsity is listed in the table below.

Table 3.6 Cost impact of sparsity

Category	ED1 allowance (£m p.a.)	ED2 forecast (£m p.a.)
Remote depots		
Property costs	0.08*	0.25
Outposted staff	3.32	5.63
Longer driving times		
Unproductive time	-	1.07
Additional vehicle/fuel costs	0.25*	0.76
Private Mobile Radio (PMR) System	0.78*	1.07
Scanning telemetry	-	1.17
Load managed areas	-	0.56
North of Scotland resilience	1.05**	4.37
Total impact of sparsity	**5.48**	**14.88**

Note: 2020/21 prices.* Reduced claim as accepted by Ofgem. ** No explicit claim was made at ED1 but these costs were not included in the regression modelling. The figure represents the average 2016-21. A missing figure means that no claim was made at ED1.

Source: ED1: Ofgem (2014), 'RIIO-ED1: Final determinations for the slowtrack electricity distribution companies - Business plan expenditure assessment', 28 November; North of Scotland resilience from SSEH RIIO-ED2 Business Plan Data Template v.4.3. ED2:

[52] Provided by SSEN.

[53] The salary figure is assumed to be efficient. According to SSEN, some external benchmarking/market testing is carried out. In addition, as we estimate SSEH to be efficient overall, we assume that its salary costs are also efficient.

Unproductive time and depot costs quantified by Oxera in this paper using SSEN data; all other areas quantified by SSE.

The overall cost impact of these factors for ED2 is estimated to be £16.79m. This represents around 6% of SSEH's TOTEX and thus clearly passes Ofgem's materiality threshold.

3.2.2 Proposed adjustment

There continues to be a need for company-specific factors relating to sparsity. We have quantified these using either our own analysis (additional depots and driving times) or SSEN's cost figures directly (see annex A3). These sparsity factors need to be taken into account in the cost assessment framework, either by using specific cost drivers or through cost adjustments. Based on ED1 data we have not found a sparsity variable that directly captures these effects in the modelling. Ofgem might therefore choose to apply the same approach as in ED1 by applying cost adjustments to account for SSEH's sparsity. We will examine this issue further when forecast data becomes available. We would recommend that the same approach as in ED1 is adopted for ED2, namely applying cost adjustments to account for SSEH's sparsity.

3.3 Regional wages

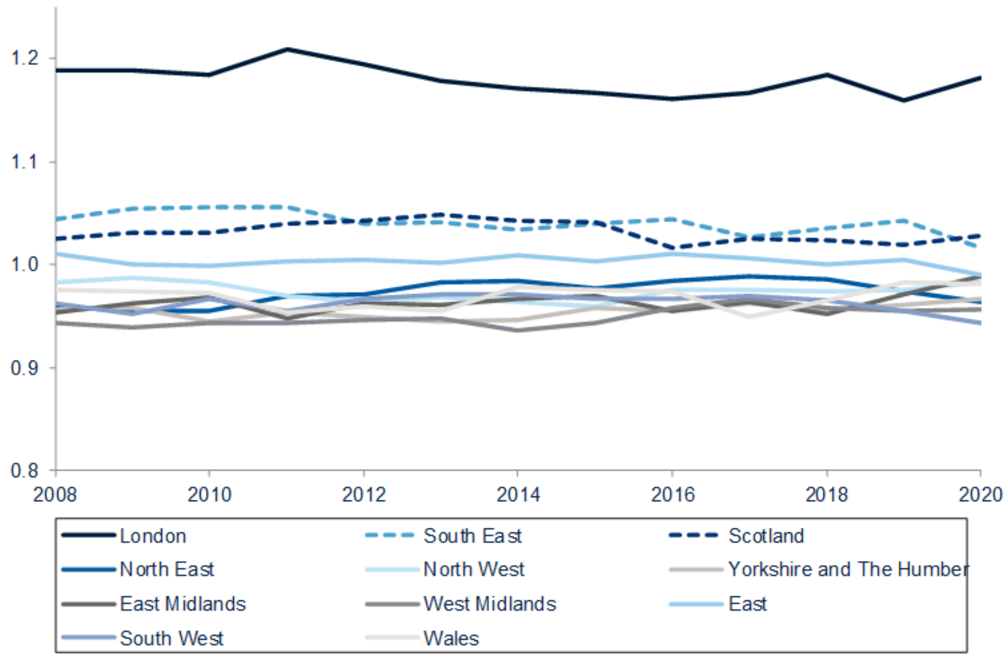
3.3.1 Need for adjustment

Criterion 1—unique

At ED1, Ofgem made regional labour adjustments for three regions: London, the South East, and the rest of Great Britain. The adjustments were based on a weighted average of regional occupational wage data. Ofgem used occupational weights to construct what it considered to be an average DNO worker. The adjustment was applied to all labour costs apart from business support costs as Ofgem assumed the corresponding staff could be relocated to the most cost-effective location.

The updated indices of Ofgem's ED1 approach are shown in Figure 3.12.

Figure 3.12 Updated regional wage indices based on occupation



Note: Based on occupational weights as in ED1.

Source: Oxera analysis based on Ofgem's ED1 model and ASHE data.

The data clearly shows London to be above all other regions throughout the entire time period (the index is roughly 20% higher than the average index for the rest of GB). Wages in the South East (light blue dashed line) still appear to be consistently higher than in almost all other areas. However, the wage level in Scotland (dark blue dashed line) is also very close to the South East. Both of the indices are around 7% higher than the average of the rest of GB. **Based on this data, it would seem arbitrary to group the regions in the same way Ofgem did at ED1 as this approach would not sufficiently capture the relatively high labour cost in Scotland**.

Alternatively, Ofgem could amend the three-region approach by reassigning Scotland to the same category as the South East.[54] We note that the underlying economic drivers for high wages in Scotland are likely to be very different to those in the South East. According to SSEN, wages in Scotland are driven by a shortage of workers with the relevant skills, whereas in the South East high wages are due to the proximity to London. Wages might therefore develop differently in the future, which would then require an amendment to the grouping of regions (e.g. treating Scotland as its own region or treating all eleven regions separately). However, based on the data currently available (see Figure 3.12) an amended three-region approach with Scotland and the South East in the same category is appropriate. Overall, while not entirely unique, wages in certain areas are significantly higher than in other areas and would therefore need to be taken into account in Ofgem's cost assessment framework whether through regional factors or some other way.

Criterion 2—outside of management control, with efforts being made to mitigate the impact

Clearly, DNOs cannot affect the location that they operate in and thus regional wage differences are particularly relevant for frontline workers. However, they might be able to carry out some work in other areas. For this reason, Ofgem did not apply a regional wage adjustment to business support costs. SSE mitigates the impact of higher wages in its region by locating its offices in less expensive regions outside of the central belt, predominantly in Perth.

Criterion 3—incremental

Conceptually, a regional wage variable is not captured as part as any cost drivers used at ED1. If Ofgem were to use a density variable in the models for ED2, then this might already capture the effect of higher wages in London. This was the case in the water sector where Ofwat included a density variable. It did not find an incremental effect for regional wages above the impact already captured by the density variable.[55]

[54] Note that we also looked at ONS ASHE data using a sectoral, rather than occupational, breakdown. While the differences between regions over time are less clear, using a sector based pre-modelling regional wage adjustment further improves the estimated efficiency gap to the UQ for both SSEH and SSES.
[55] Ofwat (2019), 'Supplementary technical appendix: Econometric approach', January, p. 15.

Criterion 4—material

As evidence from the analysis above, labour costs in some areas are 20% higher than in others, which is clearly a material cost impact.

3.3.2 Proposed adjustment

If regional wages are not captured through a variable in the modelling, then cost adjustments need to be applied to account for regional wage differences. These could be based on occupational or sectoral wage data. When using the ED1 approach (based on occupational wages), it is clear that the previously used grouping of areas needs updating to account for higher wages in Scotland. In this case, we would therefore recommend retaining Ofgem's three region approach but group Scotland together with the South East.[56]

3.4 Other factors

There are a number of additional factors that have been investigated as potential regional factors. In annex A2, we first discuss weather conditions, which are clearly harsher for SSEH's network than for an average DNO. However, overall, the impact of these weather conditions is unlikely to pass Ofgem's materiality threshold, apart from Severe Weather 1-in-20 year events. SSEH experienced two such events during the five-year DPCR5 period and while there have been no such events to date during ED1, SSEN has included c. £9.6m in its draft RIIO ED2 plan for Severe Weather 1-in-20 events. Discussions prior to final submission of business plans in December are expected within the sector and with Ofgem as to whether there will be an Uncertainty Mechanism for this rather than an upfront allowance.

Similarly, soil conditions for SSES are particularly challenging. This factor is explained further in annex A2, but the impact has not been quantified at this stage with further work required before any potential inclusion.

Clearly, other factors (such as regional wages and density) may increase the costs of other DNOs apart from SSEH and SSES, most notably in London. These would also need to be accounted for by Ofgem and we have acknowledged this in the regional wages and sparsity/density sections.

[56] The results when adopting this amended three region approach are similar to those obtained when treating all eleven regions separately. Both for SSEH and SSES, the difference in efficiency scores when adopting the two approaches are limited, with the efficiency scores between 0.2% and 0.6% higher when using the 3-region approach (depending on the Bottom-Up or the Top-Down approach, respectively). As noted above, if wages develop differently in the future then a different grouping may be appropriate.

4 Conclusion

Regional or company-specific factors that are outside of a DNO’s control and affect costs need to be accounted for when setting allowances for ED2. This can either be done by including a variable that captures the effect in the modelling, or by applying a pre- or post-modelling adjustment. The need for additional cost adjustments therefore depends on the extent to which regional or company-specific factors are already captured within Ofgem’s ED2 modelling. As this is currently unknown, the analysis in this report is based on Ofgem’s ED1 models.

Taking into account Ofgem’s criteria on regional or company-specific factors (criteria of being unique, non-controllable, incremental and material), we identify the following factors that require cost adjustments.

Table 4.1 Summary of regional factors and proposed treatment

Factor	Quantification p.a.	Proposed treatment
Islands - submarine cable (listed for SSEH only; includes CV7, CV26, CV30, CV31, HVP, C5 and C7)	**£36.90m**	Exclude from regressions and assed separately.
Islands – submarine cables team (SSEH)	**£1.50m**	Cost adjustment
Islands – specialist travel, deployed staff prior to storm, RIGs (SSEH)	**£7.52**	Cost adjustment
Sparsity (SSEH)	**£14.88m**	Cost adjustment
Regional wages (SSES and SSEH)	**7%** higher wages in Scotland and the South East compared to the rest of GB	Pre-regression adjustment of labour costs
Severe weather 1-in-20 (SSEH)	**£9.6m**	Upfront allowance or uncertainty mechanism

Note: All prices in 2020/21 terms. Submarine cables costs listed here only include costs for SSEH. Note that there may be additional submarine cable costs as part of an uncertainty mechanism.

Source: Oxera and SSEN.

These are set out in more detail below.

- **Islands.** Serving islands off the GB mainland causes additional costs. The most significant of these are submarine cables, which can lead to high asset replacement and fault costs. Submarine cables continue to be a significant cost factor and expected to be around **£38m p.a.** for ED2 (including . The corresponding cost drivers in the TOTEX models do not sufficiently capture this. We therefore propose to exclude these costs (and associated cost drivers) from the regression models. This significantly affects **SSEH, improving its efficiency scores by 4–6 percentage** points.[57] Other DNOs with submarine cables are also affected (e.g. SSES’s cable to the Isle of Wight). The efficiency of these costs will need to be separately assessed. Additionally, SSEH incurs a number of other costs in relation to its islands (travel to islands, on-island generation) that other DNOs do not incur. Costs should be adjusted for these factors, which amount to around **£7.5m p.a.** in ED2 excluding submarine cables.

[57] This only excludes asset replacement and fault costs. Other costs related to submarine cables, such as SSEH‘ subsea cables team, were not considered as consistent data across the DNOs is not available.

- **Sparsity/density/topography.** Operating in particularly sparse or dense areas causes additional costs compared to an averagely sparse network. The former effect has been quantified in a bottom-up way as part of this report and using cost estimates provided by SSEN (see annex A3). This amounts to around **£14.88m p.a.** additional costs in ED2 that SSEH incurs due to its sparsity compared to an averagely sparse network.[58] Costs need to be adjusted to account for sparsity.
- **Regional wages.** If regional wage differences are not already captured as part of a cost driver, they need to be accounted for through cost adjustments. Ofgem's ED1 approach used regional wages based on occupations and distinguished between three regions: London, the South East, and the rest of GB. Updating Ofgem's ED1 index with the most recent data shows that wages in Scotland are actually very similar to those in the South East. Given the current data it would therefore be most appropriate to group Scotland and the South East together.

There may also be additional regional factors (e.g. in relation to net zero) that can only be analysed once ED2 forecast data is available. We will examine these issues when the forecast data becomes available.

[58] The impact for dense networks has not been explicitly quantified in this report, but the analysis recognises that density leads to additional costs.

A1 Mapping between job types and cost categories

The following table shows the mapping we used to link the Skedulo job types with the cost categories for which labour costs are available.

Table A1.1 Mapping of job types to cost categories

Skedulo Job Type	Cost category
Defects: HV overhead	Faults—CV26
Defects: HV underground	Faults—CV26
Defects: LV overhead	Faults—CV26
Defects: LV service	Faults—CV26
Defects: LV underground	Faults—CV26
Defects: service fault	Faults—CV26
Faults: HV overhead—full repair	Faults—CV26
Faults: HV overhead—restoration only	Faults—CV26
Faults: HV underground—full repair	Faults—CV26
Faults: HV underground—restoration only	Faults—CV26
Faults: LV overhead—restoration only	Faults—CV26
Faults: LV overhead full repair	Faults—CV26
Faults: LV service	Faults—CV26
Faults: LV underground—full repair	Faults—CV26
Faults: LV underground—restoration only	Faults—CV26
Cable Damage	Repairs and maintenance—CV31
Maintenance	Repairs and maintenance—CV31
Inspections	Inspections—CV30
Connections overhead	Connections inside price control—C2
Connections underground	Connections inside price control—C2
Tree cutting	Tree cutting—CV29
Tree harvesting	Tree cutting—CV29
Automation	Other
Network construction	Asset replacement—CV7
Power Station	Remote generation OPEX—C8
STD: attendance only	Faults—CV26
STD: repair overhead	Faults—CV26
STD: repair underground	Faults—CV26
Strategic investment	Asset replacement—CV7
Technical Delivery Manager	Other
Unmetered: non-urgent	Connections inside price control—C2
Unmetered: urgent	Connections inside price control—C2
General enquiries and other small works	Faults—CV26
General enquiries and other small works OH	Faults—CV26

Source: Information provided by SSEN.

A2 Weather and environmental factors

Weather conditions

The extreme weather conditions experienced in SSEH's network area leads to additional costs associated with operating and maintaining SSEH's network. Discussions with SSE have highlighted the following areas.

- **Corrosion of assets.** The exposure to both wind and salt pollution in the Highlands and Islands of Scotland causes increased corrosion of overhead lines, ground mounted plant and buildings, reducing the life expectancy of assets.[59]
- **Faults.** Snow, line icing, corrosion and wind speeds in the Highlands of Scotland all increase the risk of faults.[60]
- **Specialist vehicles.** SSEH requires specialist vehicles and equipment to operate in the Highlands of Scotland. For example, winches must be attached to vehicles for snow events.[61]

Criterion 1—unique

SSEH's network area is exposed to the harshest weather conditions in Great Britain. For example, SSE state 'during winter storms, overhead lines can be exposed to wind speeds of up to 150 MPH'.[62] The west and north coast islands are also exposed to salt pollution that can reduce the life expectancy of assets.[63]

Using annual Met Office data on average rainfall, average wind speed, number of days with ground frost and number of days with snow lying, we show that SSEH's network area has more extreme weather conditions compared to all other DNOs.[64] SSEH experiences the highest average rainfall and wind speeds and days of snow lying compared to all other DNOs and the second highest number of days with ground frost.

[59] SSEN (2013), 'Scottish Hydro Electric Power Distribution RIIO-ED1 Business Plan Regional Factors Supporting Paper', 1 July.
[60] Ibid.
[61] A winch is a hauling or lifting device consisting of a rope or chain winding round a horizontal rotating drum, turned typically by a crank or by motor.
[62] SSEN (2013), 'Scottish Hydro Electric Power Distribution RIIO-ED1 Business Plan Regional Factors Supporting Paper', 1 July.
[63] Ibid.
[64] Met Office (2020), 'HadUK-Grid Climate Observations by Administrative Regions over the UK, v1.0.2.1 (1862-2019)', Centre for Environmental Data Analysis, 21 October.

Table A2.1 Average annual weather conditions within DNO network areas

DNO	Rainfall (mm)	Wind speed (mph)	Ground frost (days)	Snow lying (days)
SSEH	1,646	12	105	14
SWest	1,275	11	63	3
SWales	1,583	11	82	4
SPD	1,303	10	98	6
SPMW	1,447	11	73	6
ENWL	1,537	11	93	8
WMID	952	10	97	3
SSES	901	8	95	4
NPGN	997	9	107	7
NPGY	944	10	95	4
EMID	858	10	92	3
EPN	632	9	96	2
SPN	836	9	88	2
LPN	662	8	73	2

Note: We also used SSEH's asset data to cross-check that harsher weather conditions occur in areas where assets are located. However, the data was not available for all DNOs.

Source: Oxera analysis based on Met Office data.

The extremeness of SSEH's weather conditions is corroborated by Table A2.2 below. SSEH incurred the highest average costs for category 1 severe weather by customers, network length and MEAV, and incurred the highest average costs for category 2 severe weather by customers, second highest by MEAV and third highest by network length, from 2011 to 2019.

Table A2.2 Average DNO category 1 and 2 severe weather costs by customers, network length and MEAV

	Severe weather costs: category 1			Severe weather costs: category 2		
DNO	By customers	By Network length	By MEAV	By customers	By Network length	By MEAV
SSEH	0.56	8.75	0.08	0.87	13.77	0.12
EMID	0.06	2.13	0.01	0.04	1.55	0.01
ENWL	0.05	1.88	0.01	0.40	16.33	0.09
EPN	0.11	4.17	0.03	0.36	13.34	0.09
LPN	0.00	0.00	0.00	0.00	0.00	0.00
NPgN	0.17	6.67	0.04	0.25	9.49	0.05
NPgY	0.09	3.71	0.02	0.05	1.93	0.01
SPD	0.20	6.96	0.05	0.66	21.56	0.14
SPMW	0.11	3.40	0.02	0.22	6.99	0.04
SPN	0.09	3.83	0.02	0.18	7.84	0.04
SSES	0.06	2.52	0.01	0.28	11.07	0.06
SWALES	0.18	5.62	0.04	0.20	6.14	0.04
SWEST	0.21	6.66	0.05	0.39	12.07	0.09
WMID	0.07	2.80	0.02	0.18	6.94	0.04

Source: Oxera analysis based on 2019/20 cost and volume tables.

This supports the fact that SSEH's network is more exposed to severe and harsh weather compared to other DNOs.

Criterion 2—outside of management control, with efforts being made to mitigate the impact

Clearly, weather conditions are an external factor outside of management control that impacts upon the operation and maintenance of the network and the asset base.

There is no meaningful way for SSEH to mitigate the impact of severe weather without incurring greater cost. For example, SSEH place assets indoors in some areas to reduce corrosion and damage from harsh weather conditions, however this can be at significant cost.

Criterion 3—incremental

In RIIO-ED1, Ofgem accounted for the effects of severe weather with pre-modelling adjustments to costs based on accepted regional factor claims by SSEH.[65] However, these adjustments were very small and their quantification specific to islands rather than SSEH more generally so they are now listed under section 3.1.

Criterion 4—material

At RIIO-ED1 Ofgem granted SSEH an allowance of £0.12m p.a. for severe weather—specifically, the cost to deploy staff to islands prior to forecast storm events.[66] However, this is specific to islands and is therefore already captured under section 3.1.

Looking at all regional and company-specific factors in the round, including severe weather conditions, clearly shows that SSEH faces a number of factors that increase the cost to operate and maintain its network. However, given that no additional regional factor for weather conditions was identified at ED1 and that a regional or company-specific factor must be more than 0.5% of gross unnormalised total expenditure to be considered material,[67] this company-specific factor is unlikely to pass the materiality threshold.

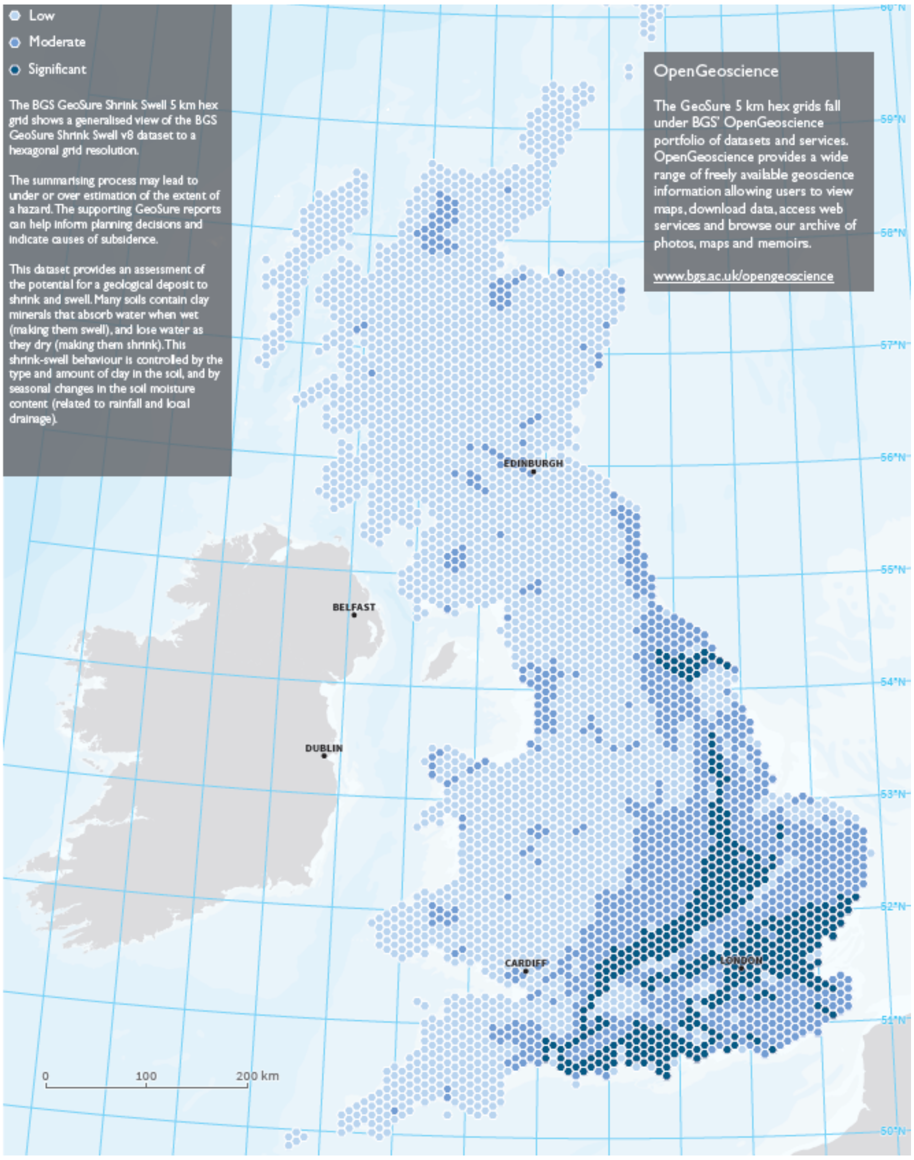
Soil conditions

Soil conditions differ across the country with some soil being more suitable for underground assets than other. Specifically, shrink-swell soil is a particularly challenging type that leads to assets breaking more quickly.

The British Geological Survey state that '[shrink-swell] soil is the most damaging geohazard in Britain and present[s] significant geotechnical and structural challenges to anyone wishing to build on or in them'.[68] Damage to network assets can occur as soil expands and shrinks as the water content of the soil changes, causing heave and subsistence. The rock formations most susceptible to shrink-swell behaviour are found mainly in the South-East of Britain,[69] and are common within SSES's network area. A map of this type of soil is shown below.

[65] Ofgem (2014). 'RIIO-ED1: Final determinations for the slow track electricity distribution companies Business plan expenditure assessment', 28 November, chapter 4, paras 4.20–4.37.
[66] Ibid.
[67] Ofgem (2020) 'RIIO-ED2 Sector Methodology Decision: Annex 2 Keeping bills low for consumers', 17 December, chapter 3, Table 1.
[68] British Geological Survey (N.D.), 'Swelling and shrinking soils', available at: https://www.bgs.ac.uk/geology-projects/shallow-geohazards/clay-shrink-swell/ (last accessed 27 May 2021).
[69] British Geological Survey (N.D.), 'Swelling and shrinking soils', available at: https://www.bgs.ac.uk/geology-projects/shallow-geohazards/clay-shrink-swell/ (last accessed 27 May 2021).

Figure A2.1 Shrink-swell soil



Source: British Geological Survey (2019), 'Shrink Swell – England, Scotland and Wales'.

While shrink-swell soil is a significant concern for SSES, it is unlikely to be a sufficiently material factor on its own. However, there are other environmental factors (e.g. tree growth) that also cause higher costs for SSES's network. Jointly, these factors may be material, but this would need further analysis in the future.

A3 Cost estimates for islands and sparsity provided by SSEN

The following table shows costs for different factors, including reasons for differences between estimated ED2 and ED1 costs. The table was provided by SSEN.

All in 20/21 prices.

Additional costs specific to Islands incurred and forecast for ED2:

Cost Category	ED1	18/19	19/20	20/21	**ED2 (p.a.)**	Description	Variance (Reasoning)
Specialist Travel Modes							
Ferries / Boat Hire		0.24	0.24	0.22	0.24	Calmac etc Ferries to Islands (in Travel)	During ED1, ring fenced cost centres for Islands Operations have been put in place to enable all costs to be identified (and hence the variance between ED1 vs ED2 request)
Airfare to Islands		0.07	0.10	0.02	0.10	Travel Desk for Flights to Islands	
Accommodation Islands		0.09	0.09	0.04	0.09	Accommodation costs for Islands	
Island Flights, accommodation and Ferries ED1 Allowance	**0.16**				**0.43**		
Helicopter - storms / weather		0.01	0.11	0.03	0.1	PDG Helicopter costs in Faults	Similar level of costs ED1 vs ED2
Helicopters ED1 Allowance	**0.10**				**0.10**		
Weather/Climate (1 in 20 events)		0.26	0.26	0.26	0.26	Costs for imported staff / contractors as contingency for storms. Included within ongoing fault costs.	In ED1, ring fenced projects to capture deployment of operational staff prior to forecast severe weather events have been put in place (and it is due to cost capture methods that there is a
Deployed staff prior to forecast severe weather events	**0.12**				**0.26**		

							variance between ED1 v ED2 request)

Telecoms equipment due to remote areas:

Private Mobile Radio (PMR) System		1.07	1.07	1.07	1.07	PMR system per ED1 paper still in use	The increase in ED2 is based on actual costs for this cost category (with increment being above RPI)
Private Mobile Radio (PMR) System	**0.78**				**1.07**		

Subsea Cable Team costs - SHEPD specific

Subsea Cable Team		0.88	1.13	1.26	1.5	Dedicated Subsea Cable Team - £1.5m for ED2 (completely separate to regional operational work)	Incremental increases due to increase in size of subsea cable team due to higher volume of work
Subsea Cable Team	**-**				**1.50**		

Load Managed Areas		0.27	0.29	0.56	0.56	ENA charge for Radio Tele Switching associated with LMA areas within SHEPD (circa 90k customers) based on invoices across ED1	Not included in Regional Factor paper for ED1
Load Managed Areas	**-**				**0.56**		

Scanning telemetry		1.17	1.17	1.17	1.17	Scanning telemetry radio systems are extensively in SHEPD (in addition to PMR). Due to the topography of the land with more	Not included in Regional Factor paper for ED1

						hilltop sites in the North of Scotland this significantly increases the costs of this telecommunication infrastructure.	
Scanning telemetry	**-**				**1.17**		

Remote Island Generation ED1 Allowance	**5.05**		**3.20**		The ED2 Remote Island Generation cost of £3.m excludes any O&M / Fuel usage for Subsea which is the cause of the variance here

Depots by DNO	No	Delta
SSEH	30	10
SSES	20	

Average Island Depot Size (sq.ft.)	Average Island Depot Price (£/sq.ft.)	**Annual Rental Cost for 1 depot (Average Island Depot)**
		£ 25,000
5000	£5	Note: Rental £ per sq.ft provided by SSE Property

BAU running cost of fuel	MWh	k Litres	£/k Litre	
Stornoway	3,768	1,192,084	£846,379	The basis of the £1.8m is on a 4-year average usage (16-17 to 19-20) excluding subsea faults for the remote generation stations assuming £0.71 per litre of fuel (based on average cost to date). These costs exclude impact of subsea cable faults.
Arnish	2,931	655,880	£465,674	
Loch Carnan	1,955	634,428	£450,444	
Barra	206	44,967	£31,926	
Total	**8,861**	**2,527,358**	**£1,794,424**	

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