Scottish & Southern Electricity Networks

TRANSMISSION

North of Beauly Dynamic Line Rating/ANM

Medium Sized Investment Project (MSIP) Submission

31 January 2022

Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk

Contents

Executive Summary

In accordance with Part C of Special Condition 3.14 Medium Sized Investment Projects (MSIP) Re-opener, this application presents the case to develop and install a Dynamic Line Rating (DLR) system on the existing 275kV overhead line (OHL) circuits from Beauly – Loch Buidhe and Loch Buidhe – Dounreay. This MSIP submission is presented alongside the proposal to install DLR on the Skye 132kV circuit (subject to a separate MSIP submission), which will inform the deployment and provide technical and operational learnings to the North of Beauly DLR project.

[redacted]GW of renewable generation is currently contracted to connect in the Caithness area of our network, north of Beauly substation, with the volume of renewable generation continuing to grow as we progress towards the UK and Scottish Government's net zero targets. In addition to onshore generation, there is the possibility of offshore wind projects connecting to the network north of Beauly through the ScotWind leasing round which will play a key role in achieving the UK Government's target of 40GW of offshore wind by 2030.

Connection of a large number of these generation schemes is contingent on the proposed 'Beauly to Loch Buidhe 275kV OHL Reinforcement', which has an Earliest In-Service Date (EISD) of 2030. Ahead of this reinforcement, and due to the volumes of renewable generation looking to connect in the mid-2020s, there is expected to be network constraints in the area from 2024. Working with the Electricity System Operator (ESO), we investigated a number of minimum build solutions which could help the ESO manage the system, mitigate constraints, and enable additional transport of renewable electricity prior to full reinforcement. Through a Cost Benefit Analysis (CBA), the ESO has recommended that we proceed with installing DLR on the existing 275kV OHL from Beauly to Loch Buidhe and Loch Buidhe to Dounreay, alongside OHL re-profiling which is to be funded separately through the RIIO-T2 Volume Driver mechanism.

The DLR system will consist of meteorological stations placed at approximately 21 locations on the circuits. These will relay real time environmental conditions to an Active Network Management (ANM) system to calculate the real time temperature of the conductor and in turn the OHL rating, maximising the capacity of the existing OHL to securely transport more renewable electricity.

The anticipated increase in year-round capability in the north of our network will allow more renewable generation onto the network, supporting our ambition to develop a network for net zero and providing timely, cost-effective whole system solutions to deliver decarbonisation at pace. Deploying DLR will aid the ESO in managing the system north of Beauly and will see GB consumers benefit from reduced network constraint costs. We expect there to be additional benefits in better understanding the technology through completion of this scheme, as well as the associated proposal to install DLR on the Skye 132kV circuit. By taking technical and operational learnings from these projects, DLR can be introduced to other areas of the network where economic and efficient to do so, as business as usual, to deliver further benefits to the GB system and the GB consumer.

The RIIO-T2 allowances requested for this the project is [redacted] with the works to be completed by 2024 when constraints are expected to occur. This cost is made up of [redacted] capex and [redacted] of associated opex allowance, as calculated through the Opex Escalator mechanism[1]. However, the full lifetime total project cost is [redacted] which is the cost used within the ESO Cost Benefit Analysis (CBA) to reflect the full cost of the project and the associated benefits that will be realised in the longer term beyond RIIO-T2. We are requesting funding based on a Class 1 estimate. As the bulk of our funding request relates to the stable cost of the DLR and ANM systems we are confident that the costs presented for these components are robust.

[1] In accordance with Scottish Hydro Electric Transmission Plc Electricity transmission licence Special Condition 3.36 Opex Escalator (OEt)

Given the volume of renewable generation looking to connect in the mid-2020s, and the predicted significant constraints in the area from 2024, any delay to progressing the project will ultimately delay our net zero ambitions and result in constraint costs for consumers. We are hopeful that a regulatory decision will be made within four to six months of this submission to ensure existing project timescales can be met.

While the total cost of the project does not exceed the minimum threshold for MSIPs this submission is being presented alongside other applications which have a cumulative value above 0.5% of ex ante average base revenue, and follows Ofgem's suggestion from discussions on our RIIO-T2 Business Plan that MSIP is the appropriate funding mechanism for DLR projects.

1. Introduction

1.1 Scope of submission

This MSIP application sets out our plans to design and install a DLR system on the existing 275kV double circuit OHL from Beauly to Loch Buidhe to Dounreay at the upper north of our license area, as shown on the map in Figure 1.

Figure 1: Map showing the existing Beauly to Loch Buidhe to Dounreay 275kV OHL

1.2 Structure and content of MSIP Submission

The MSIP submission is structured as follows:

Section 2: Need

This section provides an explanation of the need for the project. It provides evidence of the drivers for undertaking the planned works and where appropriate it provides background information and/or process outputs that generate or support the "need".

Section 3: Optioneering and preferred option

This section presents all the options considered to address the "need" described in Section 2. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for detailed assessment in a Cost Benefit Analysis.

Section 4: Stakeholder engagement

This section includes identification of relevant stakeholders and information on how this has supported development of the project.

Section 5: Whole system

This section discusses our Whole Systems approach.

Section 6: Cost information

Includes evidence of expenditure justification, cost drivers, forecasting and mitigation whilst identifying the costing approach and rationale for each element of the project.

Section 7: Conclusion

This section provides a summary of pertinent points from the preceding chapters, as well as providing indication of timeline and next steps.

1.3 Meeting the scope of the licence condition and reopener guidance

Table 1 details where the submission meets the minimum requirements set out in Special Condition 3.14 and associated Reopener Guidance.

Licence and Guidance Requirement	Submission Section
Statement setting out what MSIP the application relates to	Section 1
Amendments requested to outputs, delivery dates or allowances	Section 7
Clear statement on needs case	Section 2
Justification of technical need and, where relevant, the consumer benefit that the MSIP is expected to deliver	Section 2
Explanation of options assessment	Section 3
Clear description of preferred option	Section 3
Explanation of how expenditure which could be avoided as a result of the change has been accounted for	Section 3

Clear description of stakeholder engagement and whole system opportunities	Section 4 & 5
Statement that costs (incurred or expected) exceed the Materiality Threshold, but are less than £100m	Executive summary
Statement that costs are confined to those incurred or expected on or after 1st April 2021	Section 6
Explanation of the basis of the calculation any amendments requested to allowances	Section 6

Table 1: Requirement mapping

2. Need

2.1 Background

A significant quantity of renewable generation is contracted to connect in the Caithness area of the Scottish Hydro Electric Transmission plc (SSEN Transmission) network, north of Beauly substation. Connection of a large number of these generation schemes is currently contingent on the proposed 'Beauly to Loch Buidhe 275kV OHL Reinforcement' (SHET-RI-058) to rebuild the existing Beauly to Shin to Loch Buidhe 132kV double circuit OHL for 275kV operation. The estimated cost of this reinforcement is [redacted] (2020/21 price base). This reinforcement provides B0 boundary benefit and has been submitted as an option into the Network Options Assessment (NOA). It did not receive a 'Proceed' recommendation until the most recent NOA (2020/21) which concluded that SHET-RI-058 (NOA code BLN2) is to be progressed to maintain an Earliest In-Service Date (EISD) of 2030.

Due in part to NOA recommendations prior to NOA 2020/21, we currently have a derogation from Section 2 'Generation Connection' criteria of the National Electricity Transmission System (NETS) Security and Quality of Supply Standard (SQSS) and Connect and Manage criteria under Section 13 of the Connection and Use of System Code (CUSC), to permit connection of renewable generation in the north of Scotland ahead of the SHET-RI-058 reinforcement. This was a time-limited derogation which was granted on the 23 November 2018 for a 3-year period and which expired on the 31st October 2021.

[redacted] The original derogation was granted by the Authority on a number of grounds which included:

- we continue considering a wide range of options for the B0 boundary in future NOA submissions, covering both build and minimal build solutions.
- we continue to work with the Electricity System Operator (ESO) to develop options that will mitigate the impact of constraint costs in the event of a fault or other event on the network.

Regarding the first condition, we have continued to offer a range of solutions for the B0 boundary through the annual NOA process which has resulted in a Proceed recommendation for SHET-RI-058 (NOA code BLN2) in NOA 2020/21.

Regarding the second condition to mitigate constraints, we have continued to work with the ESO and have now developed minimal build solutions such as line re-profiling of the Beauly – Loch Buidhe 275kV double circuit OHL and application of DLR to the Beauly – Loch Buidhe – Dounreay 275kV double circuit OHL. The exploration of which, through a Cost Benefit Analysis (CBA) undertaken by the ESO, has led to the ESO recommending that we proceed with both DLR and the line re-profiling option.

In accordance with Part C of Special Condition 3.14 on the MSIP Re-opener, we are therefore applying to the authority for funding to develop and install DLR in relation to the activity 3.14.6 (i) ii. 'system studies by the ESO or the licensee showing a need for DLR'.

The request is for [redacted] of funding to develop and install a DLR system on the 275kV circuits from Beauly – Loch Buidhe – Dounreay by 2024. [redacted]. This solution will provide necessary constraint cost alleviation from delivery in 2024, enable additional transport of renewable electricity from the very north of our system, and potentially allow for earlier connection of some

contracted onshore wind farm schemes. This is in line with our RIIO-T2 business plan to develop a network for net zero and to provide timely, cost-effective whole system solutions to ensure national net zero emissions targets are met.

2.2 Enhancing existing circuit capability

The full list of generation contracted to connect in the Caithness area is provided in Appendix B. A total of [redacted] of additional renewable generation capacity is to connect to our network, of which [redacted] is marine (tidal) generation located in the Pentland firth, and the rest ([redacted]) is onshore wind located in Caithness ([redacted]), Shetland ([redacted])[2] and Orkney ([redacted]). Currently, a total of [redacted] of generation capacity is connected of which [redacted] is from onshore wind. This upper north area of our licence area comprising the north of the Highlands, Caithness, Sutherland, and Orkney is separated from the rest of the GB system by the B0 boundary which cuts across the following circuits:

- Beauly to Fyrish to Loch Buidhe 275kV double circuit OHL;
- Beauly to Shin 132kV double circuit OHL; and
- Caithness – Moray (CM) HVDC multi-terminal link (specifically the Spittal – Blackhillock link via Noss Head switching station)

Figure 2 shows the current transmission network north of Beauly (the 275kV infrastructure is red, 132kV infrastructure is black, and the HVDC link is brown). There are phase shifting transformers (PSTs) located at Beauly on the 132kV double circuit OHL to Shin. Loading on the 275kV double circuit OHL from Beauly to Fyrish to Loch Buidhe can therefore be controlled indirectly by the PSTs and the CM HVDC link dispatch controlled by the converter station at Spittal. A 600MW HVDC link from Shetland to the Noss Head switching station, which concludes the formation of the Caithness Moray Shetland (CMS) multi-terminal link, is currently under construction for delivery in 2024. The transmission contracted generation to connect on Orkney ([redacted]) is contingent on a transmission link connection to the GB mainland. The Final Needs Case for our proposed 220MW transmission connection to Orkney remains subject to developers on Orkney meeting certain conditions before 31 December 2022.

[2]Output of Shetland generation will be limited to the rating of the HVDC link from Shetland to the GB mainland ([redacted])

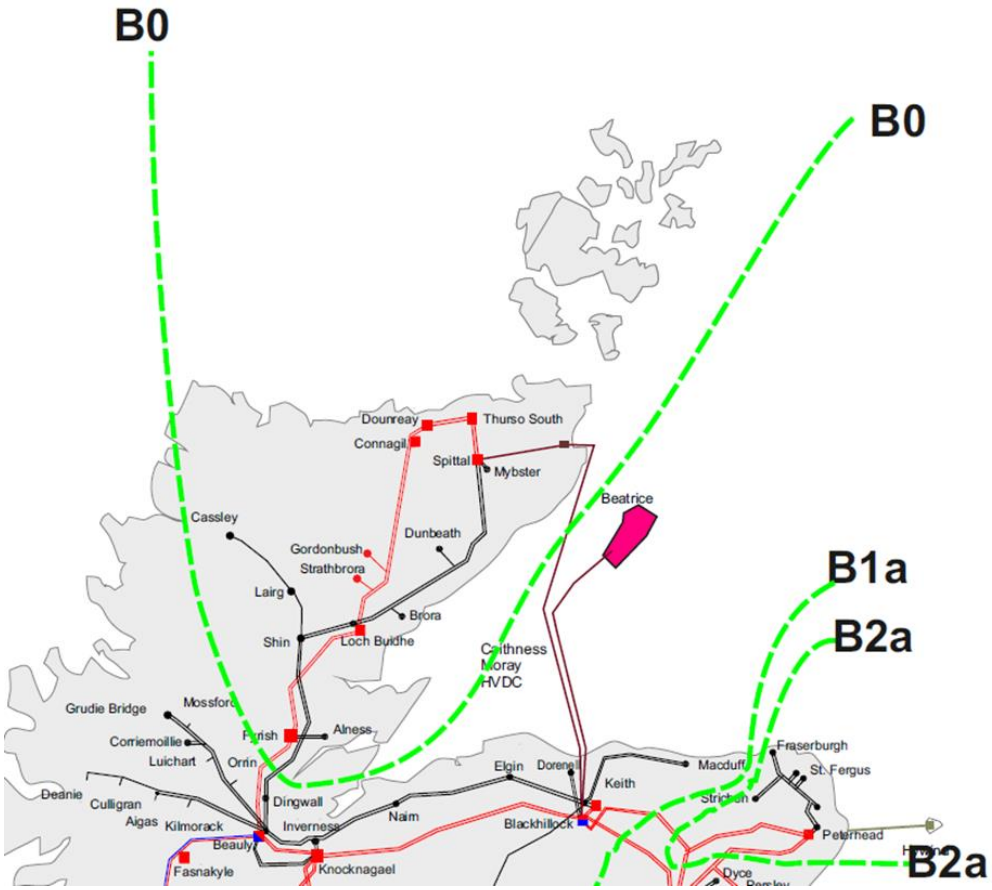


Figure 2: Transmission network north of Beauly

The current winter capability of the B0 boundary as determined in NOA under NETS SQSS Section 4/5 year-round operational criteria, following optimisation of PST settings and CM HVDC link dispatch, is ~1.6GW rising to ~1.9GW following connection of the Shetland HVDC link in 2024. The network limitation is the Beauly – Loch Buidhe 275kV double circuit OHL, following the fault outage of the CM HVDC link, as this becomes the main corridor to transfer power south through Beauly following loss of the CM HVDC link. Figure 3 details total generation (current and contracted) due to connect north of Beauly compared to the capability of the B0 boundary according to year-round operational criteria[3]. Total generation (and, indeed, onshore wind generation only) is predicted to exceed B0 capability in 2024 which will lead to increased annual network constraint costs.

[3]Consistent with NOA

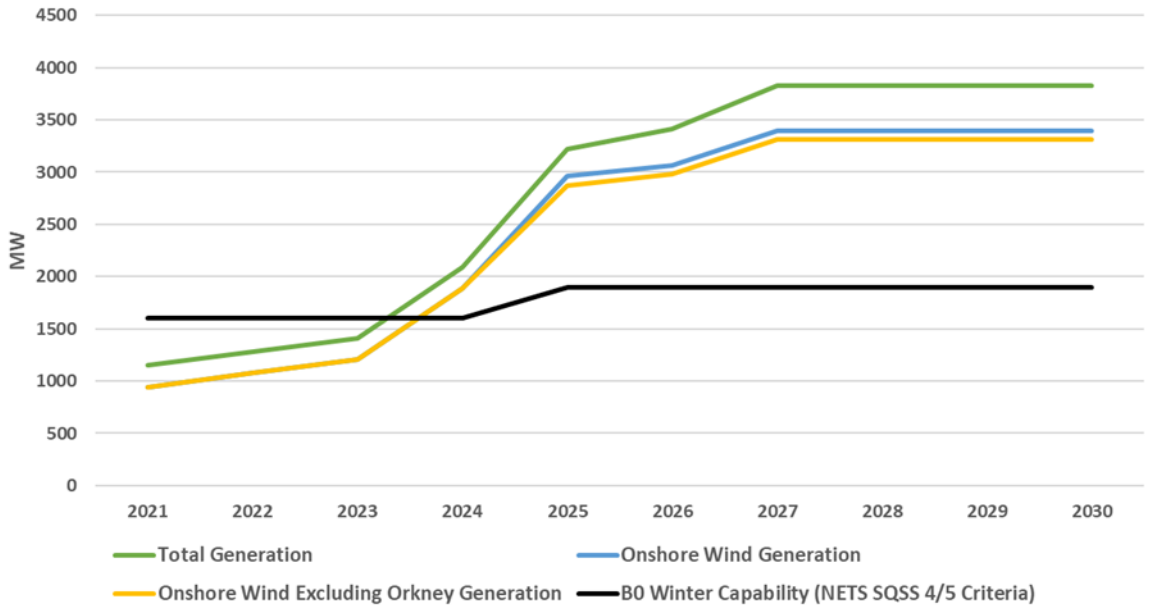


Figure 3: Connected and Contracted Generation North of Beauly compared to B0 boundary capability

In addition, Figure 4 details the winter peak required transfers across the B0 boundary for the GB Future Energy Scenarios (FES) for 2020 and 2021 in accordance with the NETS SQSS Section 4 Economy Background (in MW). The current capability of the B0 boundary (in accordance with NETS SQSS Section 4 criteria for winter peak demand) is approximately 1GW. This is lower than the capability calculated under NOA NETS SQSS Section 4/5 year-round operational criteria, due to the requirement to secure the system under Section 4 winter peak demand criteria against the fault outage of a double circuit OHL (under year-round operational criteria the system only needs to be secured against the fault outage of a single circuit). Similar to Figure 3, which shows that total generation exceeds B0 capability around 2024, as can be seen in Figure 4 the required transfers also exceed B0 capability around 2024 in all GB FES for 2020 and 2021 except for Steady Progression.

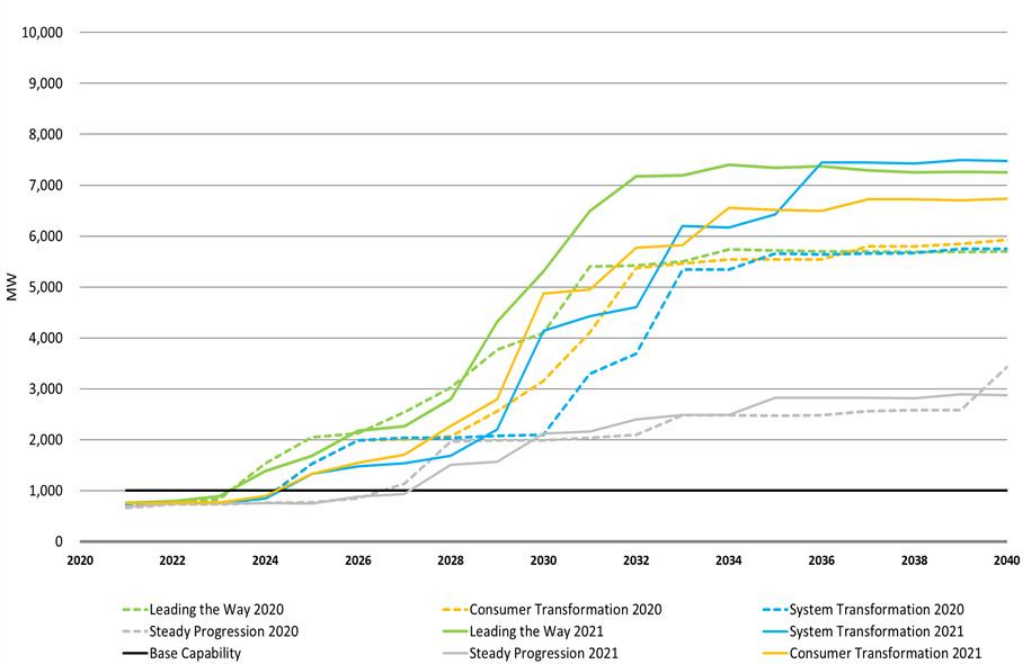


Figure 4: Required Transfer (MW) according to FES across the B0 boundary

For the three scenarios in FES which achieve the net zero GB target by 2050 or earlier (Leading the Way, Consumer Transformation and System Transformation), the required transfers then quickly ramp up to between [redacted] and [redacted] in FES 2020, and between [redacted] and [redacted] in FES 2021 by 2030 – the current delivery date and Earliest In Service Date (EISD) of the 'Beauly to Loch Buidhe 275kV OHL Reinforcement' (SHET-RI-058) recommended to proceed in the last NOA (2020/21).

It is clear from Figure 3 and Figure 4, that ahead of the 'Beauly to Loch Buidhe 275kV OHL Reinforcement' in 2030, there is likely to be network constraints from 2024 which will require minimum build solutions to help the ESO manage the system north of Beauly and mitigate these constraints in the event of a fault or other event on the network. In addition to onshore renewable generation, there is the strong expectation of offshore wind connecting to our network north of Beauly through the ScotWind leasing auction process to help achieve UK and Scottish Government targets for offshore wind connection by 2030. There has been significant interest in connections associated with a number of the leasing zones that have been identified off the coast of Scotland. The continued connection of offshore wind is necessary to meet GB net zero targets and ScotWind associated offshore wind generation is included in the FES 2020 and FES 2021 backgrounds (and therefore included in the required transfer values in Figure 4) from around 2028.

In order to ascertain the need for a minimum build solution north of Beauly, given uncertainty in network requirement in and around 2030, we have been working with the ESO to undertake a CBA to assess the economic benefit of three minimum build solutions to mitigate network constraints for the five-year period 2024-2028. We stop at 2028 to ensure that there is no impact from ScotWind connections in the generation background as this is liable to distort what is, otherwise, a shorter-term intervention for constraint relief. The minimum build solutions assessed in the CBA and developed to reinforce the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL (the network limitation north of Beauly on the B0 boundary) are detailed in Section 2, where a summary of the ESO CBA and outcome is also included.

2.3 Alignment with SSEN Transmission RIIO-T2 Business Strategy

The application of DLR on the Beauly to Loch Buidhe to Dounreay 275kV double circuit overhead line (OHL) delivers the following outputs and benefits relating to our RIIO-T2 business strategy:

- increases the year-round capability in the north of our network in line with our RIIO-T2 goal to transport the renewable electricity that, in total, powers 10 million homes;
- facilitates effective competition in the generation and supply of electricity in line with our licence obligations and our goal to provide network connections to meet our customer needs, on time and on budget; and
- aligns with our Innovation strategy, correlating with the five values of the Innovation Framework: Sustainable Ambitions, Support Customers, User Driven, Deliver Efficiently and Collaboration.

We presented an Engineering Justification Paper (T2BP-EJP-0050, provided for reference as Supplementary Evidence) through the RIIO-T2 Business Plan submission outlining our approach to the use of DLR across our system. Ofgem rejected the submission as costs were deemed to be uncertain and therefore contained too much risk. It was suggested that MSIP would be a more appropriate funding mechanism once cost certainty could be achieved.[4]

[4] As set out in Ofgem's Final Determinations on 8th December 2020

3. Optioneering & Preferred Option

3.1 Option assessment

This section presents all the options considered to address the "need" that is described in Section 2. Each option considered here is either discounted with supporting reasoning provided or is taken forward for Detailed Analysis.

The current and projected network limitation of the B0 boundary is the Beauly to Loch Buidhe 275kV double circuit OHL. The proposed 'Beauly to Loch Buidhe 275kV OHL Reinforcement' (SHET-RI-058) which rebuilds the existing Beauly to Shin to Loch Buidhe 132kV double circuit OHL for 275kV operation is a build solution of significant cost (estimated at £[redacted] in 2020/21 price base) which provides a significant increase in capability of the B0 boundary. SSEN Transmission is progressing this reinforcement, alongside the other reinforcements north and east of Beauly recommended in the upcoming NOA (NOA 2021/22).

However, ahead of this reinforcement and ahead of the potential connection of offshore wind through ScotWind, a minimum build solution is needed to mitigate network constraints (as summarised in Section 1). By enhancing the capability of the 275kV OHL into Beauly, PST settings and CM HVDC link dispatch can be further optimised to increase transfer across the boundary.

The minimum build solutions we considered to reinforce the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL route and mitigate projected network constraints for the period 2024-2028 are detailed in Table 2, with an added explanation (where needed) of why they have been rejected or progressed for further analysis below.

Option	Description	Delivery Date	Progressed to detailed analysis	Full Lifetime Project Cost (2018/19 Price Base)
Do nothing	Seasonal OHL post-fault rating will remain as 599/665/702MVA for Summer, Spring/Autumn and Winter respectively	N/A	Yes	N/A
DLR	Application of DLR on the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL. Involves the monitoring of weather conditions and ambient temperature in real time to determine the maximum rating of the OHL for a specified time resolution.	2024	Yes	£[redacted]
Re-profile Beauly – Loch Buidhe 275kV OHL	Re-profile the Beauly to Loch Buidhe 275kV double circuit OHL to increase the operating temperature of the OHL from 70°C to 90°C – providing a seasonal OHL post-fault rating of 714/777/814MVA (for Summer, Spr/Aut and Winter)	2025	Yes	£[redacted]
Re-profile Loch Buidhe – Dounreay 275kV OHL	As above, but re-profiling the OHL from Loch Buidhe to Dounreay	2025	No	N/A

Scottish & Southern Electricity Networks
TRANSMISSION
Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk

Option	Description	Delivery Date	Progressed to detailed analysis	Full Lifetime Project Cost (2018/19 Price Base)
DLR + Re-profile Beauly – Loch Buidhe 275kV OHL	A combination of the two options above. DLR provides similar operational benefit to the enhanced re-profiled OHL rating compared to the base rating for 'Do nothing'.	2025	Yes	£[redacted]

Table 2: Reinforcement options for the Beauly to Loch Buidhe to Dounreay 275kV route

Do nothing

This is the counterfactual option in the CBA on which the benefit of the minimum build solutions is derived from. The existing 275kV double circuit OHL between Beauly, Fyrish, Loch Buidhe and Dounreay substations is comprised of steel lattice towers, built in 1971, of L3 construction currently strung with a single LAMFIL TAAAC conductor operated at 70°C. At the time the towers were constructed the conductor was only strung on one side (a single circuit). The LAMFIL conductor was strung on the second side of the Beauly – Dounreay OHL in 2012, with the original side reconductored between Beauly and Loch Buidhe in 2017 and between Loch Buidhe and Dounreay in 2020. The section from Beauly to Loch Buidhe is 66km in length, and the section from Loch Buidhe to Dounreay is 88km, giving a total length of ~154km.

Re-profile Beauly – Loch Buidhe 275kV OHL

Line re-profiling increases the static rating of the OHL and involves works to remove ground to conductor clearance infringements as a result of the increased sag from an increased operating temperature along the OHL. A light imaging, detection, and ranging (LIDAR) survey of the OHL from Loch Buidhe to Dounreay has been conducted which has been used to model the Beauly to Loch Buidhe section of the OHL, on a pro rata basis, for operation at 90°C and to identify clearance infringements. The cost estimation for the OHL works includes tree cutting and ground works to mitigate any increased sag.

- As this option provides a static rating increase to the OHL, we will look to fund this option through the RIIO-T2 Volume Driver mechanism.

Ahead of utilising this mechanism, we will undertake a LIDAR survey on the OHL from Beauly to Loch Buidhe to get a more detailed assessment of the works necessary and the associated cost.

Re-profile Loch Buidhe – Dounreay 275kV OHL

Power system analysis undertaken by us concluded that the network limitation following re-profiling of the Beauly to Loch Buidhe OHL and following the combination of DLR and line re-profiling, remains the Beauly to Loch Buidhe 275kV double circuit OHL. Therefore, there is currently no B0 boundary benefit in re-profiling the OHL from Loch Buidhe to Dounreay in the near term and this option was therefore not taken forward to the ESO CBA.

DLR

For this option, noting the above decision not to take forward the 'Re-profile Loch Buidhe – Dounreay 275kV OHL' option, there is very little cost difference (<[redacted]) between applying DLR to the Beauly to Loch Buidhe 275kV OHL only, compared to the whole Beauly to Loch Buidhe to Dounreay 275kV OHL. As the OHL from Beauly to Dounreay comprises of the same towers and conductor, the majority of the DLR cost is the ANM tool, with extension of the application to cover the Loch Buidhe – Dounreay OHL section therefore only needing additional monitoring points. We therefore anticipate that the

minimal increase in cost to extend application of DLR to Dounreay is more than justified by the operational benefit that the scheme will provide the ESO to manage constraints north of Loch Buidhe should another event (different to the most critical event i.e., loss of the CM HVDC link) occur on the network during the course of a year of operation from 2024 to 2028.

3.1.1 Outline of the proposed DLR system

DLR works by going beyond the current carrying capacity defined by static thermal ratings. Static thermal ratings are defined as the maximum current carrying capacity of an OHL at a given conductor temperature under defined ambient conditions, which doesn't infringe on ground clearance standards. Conductors sagging and resultant clearances are dependent on conductor design tension and temperature. While design tension doesn't vary, real time conductor temperature is influenced by many factors, such as line current, actual ambient temperature, solar emissivity, solar absorption, wind speed and direction. For the static rating conservative conditions for these factors are assumed. Using sensors that measure conductor temperature and sag will allow us to measure the resultant clearances in real time and allow the static rating to be exceeded if the conditions are right.

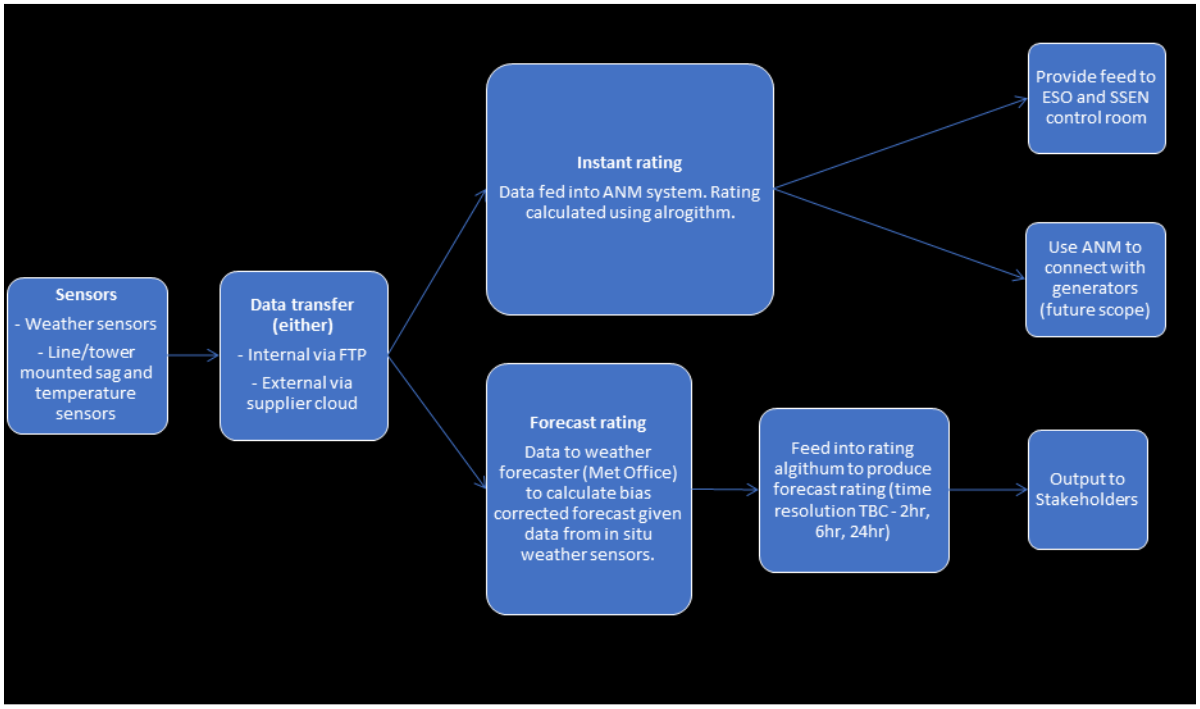


Figure 5: Overview of DLR system for North of Beauly

An overview of the DLR system for north of Beauly is provided in Figure . The DLR system is to include two fleets of sensors, the locations of which are still to be defined and will be determined through a detailed assessment of the surrounding geographical topology and orography. The likely and current assumption is that there will be at least one sensor every 7.5km – equivalent to around 21 (the total OHL length from Beauly to Dounreay is ~154km). One fleet of sensors will consist of weather sensors and the other fleet will consist of line or tower mounted sensors. These will be used to run two parallel systems to allow corroboration in defining OHL rating.

The weather sensors serve two purposes:

- to provide instantaneous weather conditions (capable of 15-minute resolution) which are then fed into an algorithm to calculate the instantaneous rating for each location. The limiting segment of the OHL is then identified and fed into the ANM system; and

- to provide local weather data to a weather forecaster (such as the Met Office) to allow them to bias correct their forecast. This can be used to produce a rating forecast for use by various stakeholders – the granularity of which (i.e. 2hr, 6hr, 24hr and 48hr) is dependent on what is produced by the weather forecaster.

The line/tower mounted sensors (likely to be at the same locations as the weather sensors) will measure rather than calculate conductor sag and temperature, and again the limiting segment of the OHL will be identified and fed into the ANM system.

The ANM system will therefore be provided with two ratings – one calculated (from the weather sensors) and the other directly inputted (from the line/tower mounted sensors). Only one rating is needed and therefore the ANM system will have a built-in corroboration method for self-checking and to ensure only a predefined limit of divergence between the two methods occurs. The ANM system for North of Beauly will also have the functionality to enable direct communication with generator schemes. This would be of use if we were to offer new generator schemes, or modify existing contracted connection arrangements, to provide additional network access based on the dynamic changes in OHL rating. However, this is a future option and a secondary use of the DLR system. The main objective (similarly to the re-profiling option) is to mitigate network constraints and therefore enhance the ESO's ability to manage the system north of Beauly.

The DLR system will provide a feed to both the ESO and SSEN Transmission control room. The DLR system will be capable of providing an updated OHL rating every 15 minutes, however the resolution that will ultimately be used for managing the system will be determined by the ESO. We have held initial discussions with the ESO to determine what resolution is feasible for use in the ESO control room.

3.2 Detailed analysis

3.2.1 B0 Capability Uplift Calculation for options considered in the ESO CBA

For use in the ESO CBA, we carried out studies to determine the seasonal capability uplifts for the B0 boundary that would be provided by each of the minimal build solutions. The seasonal uplifts are detailed in Table 3. The full list of capability values determined for the B0 boundary for each FES, each season and each year of the CBA is detailed in Appendix B of the accompanying ESO CBA report.

Option	Delivery Date	Winter Uplift (MW)	Spring/Autumn Uplift (MW)	Summer Uplift (MW)	Summer Outage Uplift (MW)
Do nothing	N/A	-	-	-	-
DLR	2024	+210	+130	+70	+70
Re-profile Beauly – Loch Buidhe 275kV OHL	2025	+210	+140	+120	+120
DLR + Re-profile Beauly – Loch Buidhe 275kV OHL	2025	+230	+140	+160	+160

Table 3: Seasonal uplifts on the B0 boundary provided by the minimal build solutions

The re-profiling option provides a static rating increase of 112/112/115MVA per circuit for the Winter, Spring/Autumn and Summer seasons respectively (this totals a rating increase of 224/224/230MVA for the double circuit OHL). This does not always translate to an equivalent capability uplift – for Spring/Autumn and Summer in particular the uplift on B0 is only 140MW and 120MW respectively. This is due to the network thermal limitation, when determining boundary capability, moving from the Beauly to Loch Buidhe 275kV double circuit OHL (following outage of the CM HVDC link) to the Shin to Loch Buidhe 132kV circuit (following outage of the adjacent 132kV circuit) – a network issue resolved by the SHET-RI-058 reinforcement to be delivered for 2030.

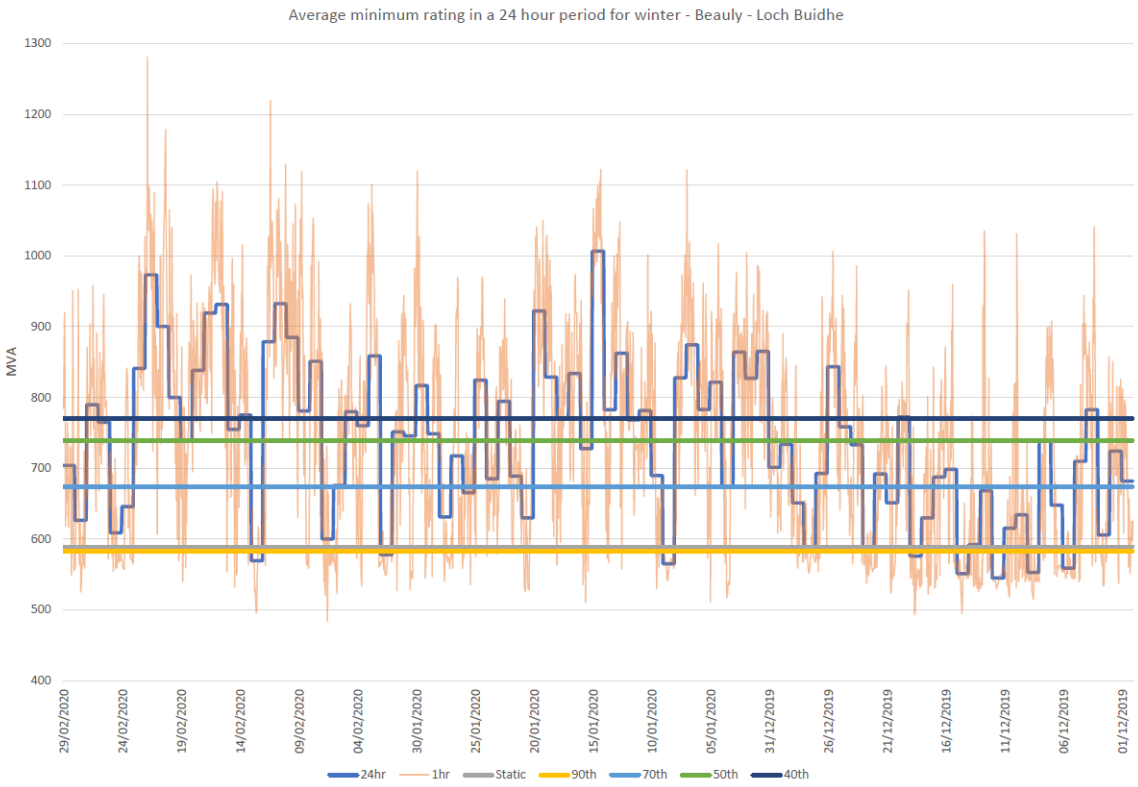


Figure 6: Example of statistical analysis undertaken to determine seasonal DLR rating for ESO CBA

For DLR, where the calculated rating could change every 15 minutes, we carried out statistical analysis on an internal rating calculation model of the Beauly to Loch Buidhe to Dounreay double circuit OHL using Met Office weather data from 2019 and 2020. This was to establish a credible seasonal rating increase to feed into the studies to determine seasonal capability uplift on the B0 boundary (as detailed in Table 3) for use in the ESO CBA. Figure shows an example of the statistical analysis that was undertaken using the internal rating calculation model to determine credible seasonal ratings for DLR. For each day of winter 2019/2020, and Summer, Spring and Autumn in 2020 we calculated the average minimum rating (across multiple sections of the OHL) for DLR and determined different ratings for different percentiles, before deciding to use the 50th percentile rating (the median) – a rating which is neither overly optimistic nor pessimistic on the potential application and benefit of DLR. The median seasonal post-fault rating determined for DLR is 853/742/667MVA for the Winter, Spring/Autumn, and Summer seasons respectively. The outcome of this analysis is therefore a rating increase of 151/77/68MVA respectively (this totals 302/154/136MVA for the double circuit OHL), with DLR therefore providing a higher rating increase in the Winter, but a lower rating increase in the Spring/Autumn and Summer seasons. This translated in the boundary capability studies to DLR providing an equivalent capability uplift to the re-profiling option in Winter, but a lower capability uplift in the other seasons.

For the combination option of DLR and re-profiling, the same rating increase determined from the statistical analysis for DLR was applied on top of the OHL rating after re-profiling, giving a seasonal rating of 965/854/782MVA for Winter, Spring/Autumn and Summer respectively. This translated in the boundary capability studies to the combination option providing a higher capability uplift to the re-profiling option (only) in the Winter and Summer seasons.

3.2.2 ESO CBA summary

We requested that the ESO to undertake a CBA to assess the economic benefit of the minimum build solutions proposed to mitigate network constraints for the five-year period 2024-2028. The ESO CBA is covered in more detail in the accompanying ESO CBA report[5]. In addition, we requested two contracted scenarios to be considered in the CBA:

- **Scenario 1** – All contracted generation north of Beauly (as detailed in Appendix B)
- **Scenario 2** – All contracted generation north of Beauly except transmission contracted generation located on Orkney ([redacted]MW) and Marine generation ([redacted]MW)

The asset life assumed for the DLR option in the CBA is 15 years. This is the typical lifetime for operational solutions which involve IT system architecture. An annual service charge and therefore operational cost for utilising the ANM system has been included for the full 15-year asset lifetime and incorporated into the total cost of the DLR option (£[redacted]) and associated cost profile provided to the ESO for the CBA. For the re-profiling option, a standard 40-year asset life has been assumed in line with typical build solutions.

The ESO CBA, assessed against the FES 2020 background and the two requested contracted scenarios, concludes that the B0 boundary is constrained between 2024 and 2028 and that the volume of constraints and associated cost justify the need for both DLR on the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL and line re-profiling of the Beauly to Loch Buidhe 275kV double circuit OHL at a cost of £[redacted]. The ESO therefore recommends that we proceed with both options as this combination is determined as having the least-worst regret in all scenarios and each generation background to help manage network constraints for the period 2024-2028.

Table 4 shows the regrets calculated by the ESO for the different options and scenarios included in the CBA. The worst regret for the combination option considering FES 2020 scenarios only is determined by the ESO as being £147m compared to £230m for the 'do nothing' option. When including the two contracted scenarios, this rises to £335m compared to £447m for 'do nothing'. For DLR only, the worst regret considering FES 2020 is £158m, which rises to £351m when including the two contracted scenarios. The worst regret is therefore still significantly lower for DLR only than for the 'do nothing' option. Even for the Steady Progression scenario, the regret for the combination option and DLR only option is £4m and £8m respectively but this is still significantly lower than the regret for 'do nothing' of £21m considering the cost of the minimal build solutions proposed.

Option	FES 2020				Contracted Scenario 1				Contracted Scenario 2				Worst Regret
	LW	CT	ST	SP	LW	CT	ST	SP	LW	CT	ST	SP	
Do nothing	230	71	70	21	447	234	236	84	323	141	142	45	447
DLR	158	35	34	8	351	168	170	56	240	89	89	25	351

[5]North of Beauly – dynamic line ratings and re-profiling CBA Report (issue 3)

Option	FES 2020				Contracted Scenario 1				Contracted Scenario 2				Worst Regret
	LW	CT	ST	SP	LW	CT	ST	SP	LW	CT	ST	SP	
Re-profile Beauly – Loch Buidhe 275kV OHL	154	33	32	7	345	164	165	55	235	86	86	24	345
DLR + Re-profile Beauly – Loch Buidhe 275kV OHL	147	27	26	4	335	156	158	50	227	80	80	20	335

Table 4: Regrets (£m) calculated in the ESO CBA

In addition, the ESO carried out tipping point analysis which has determined that the investment cost of the combination of DLR and re-profiling (£[redacted]) would be recouped (from savings made in constraint cost) by 2025 for Leading the Way, 2026 for Consumer Transformation and System Transformation, and 2027/2028 for Steady Progression. For DLR only, the investment cost (£[redacted]) would be recouped one year earlier for Leading the Way (2024), Consumer Transformation and System Transformation (2025) – no change for Steady Progression.

The ESO carried out the CBA under the assumption that the B0 boundary is considered in isolation from the rest of the GB transmission network. Due to the cost of constrained generation being so much higher than the reinforcement costs, the ESO believes that this serves to mitigate any concerns on the modelling approach. As the area under study is at the top of the GB transmission system from a prevailing direction of power flow perspective, and given the operational uncertainty around the nature of network events and/or planned network outages (for maintenance and construction) that could occur north of Beauly during the course of a year of operation for the period 2024-2028, we agree with the ESO's approach to treat the B0 boundary in isolation. More detail on the ESO CBA is available in the accompanying ESO CBA report.

A sensitivity analysis was not considered necessary as the ESO CBA provided a suitable amount of detail.

3.3 Preferred Option

Given the significant quantity of generation due to connect north of Beauly (as detailed in Section 1 and in Appendix B), and the current network derogation we have in place to permit connection of renewable generation in the north of Scotland ahead of the SHET-RI-058 reinforcement (for which we have requested an extension to), our preferred option is the combination of DLR along the Beauly to Loch Buidhe to Dounreay 275kV OHL, as well as line re-profiling of the Beauly to Loch Buidhe 275kV OHL. This option combination is still low cost (<£[redacted]), compared to either component being deployed independently, and provides the highest enhancement to existing circuit capability which we can achieve using minimal build solutions. As line re-profiling provides a static rating increase to the OHL and is not applicable for funding under Part C of Special Condition 3.14 of the MSIP reopener, we will look to fund this part of the combination solution through the RIIO-T2 Volume Driver mechanism.

The combination of DLR and line re-profiling is also the best solution according to the ESO CBA. From the options provided (as outlined in Table 4), this combination option is determined as having the least-worst regret in all scenarios and each generation background considered. The cost associated with this solution is therefore fully recovered by the savings made to the GB consumer in alleviating network constraint costs associated with the significant quantity of onshore wind contracted to connect north of Beauly and needed to meet the GB net zero target (as determined by FES 2020). Even

for Steady Progression, the slowest credible decarbonisation FES 2020 scenario (only a 68% reduction by 2050 in UK greenhouse gas emissions compared to 1990), the minimum constraint cost in the period 2024-2028 determined by the ESO, is over three times the cost of the combined minimal build option.

Note that there is no option to delay as this would generate the same outcome as the do-nothing option.

These solutions sit within the footprint of the existing OHL and there is therefore minimal work required in the installation and maintenance of both options. DLR, although innovative in its application to our network, has already been employed through an innovation project as a real-time thermal rating (RTTR) system in SPEN's distribution network in north Wales – covering over 90km of 132kV network. We also plan on using lessons learned from the closely aligned Skye DLR project (our demonstration project for delivery in 2023) in the design, installation, monitoring and operation of the system for north of Beauly to mitigate any perceived technological risks.

The project is managed using our Large Capital Project governance framework which ensures that project is governed, developed, approved and executed in a safe, consistent and effective manner. As part of this governance a project programme and Project Development Plan are used to guarantee sufficient resources are in place, reporting mechanisms are present and a clear event schedule is followed. Both documents are located in the Supplementary Evidence of this submission. The introduction of a technology-based Price Control Deliverable (PCD) will be most appropriate for this project as the output is dependent on the annual variability of wind. For example, we would suggest that the PCD is based on our commitment to install a DLR system from Beauly to Loch Buidhe and Loch Buidhe to Dounreay consisting of consisting of weather and tower/line mounted sensors and an ANM system.

4. Stakeholder Engagement

4.1 Our Commitment to Stakeholder Engagement

We are a stakeholder-led business which delivers leading stakeholder engagement standards through its work with global consulting and standards firm, AccountAbility. AccountAbility works with organisations internationally to adopt responsible business practices and transform long-term performance and as committed to in our Stakeholder Engagement Strategy, we work to achieve the externally accredited AA1000 Stakeholder Engagement Standard. This is considered the 'gold standard' in stakeholder engagement accreditation. As of December 2021, following its latest AA1000 Follow-up Consultation, we have achieved a further uplift in stakeholder engagement performance, now operating at 76% within the 'Accomplished' level of AccountAbility's Stakeholder Engagement Maturity Ladder. We have increased our score overall by 14% since our initial 2019/20 review and we hope this strong performance provides stakeholders with confidence in the quality of our stakeholder engagement and our commitment to continuous improvement.

4.2 Key Themes of our Stakeholder Engagement Activities

Figure 7: DLR Stakeholders

Given the DLR kit will sit within the footprint of the existing OHL, will cause minimum, if any disruption in its installation and maintenance; the main theme of engagement with communities, local landowners and environmental stakeholders will be to inform and promote the use of this progressive technology.

The key themes of stakeholder engagement relating to both the Skye and North of Beauly DLR projects are outlined below. As a trial project, investigating the use of a flexible operating regime, stakeholder feedback has primarily come from wider industry stakeholder themes, which support a more flexible use of the system:

4.2.1 Deliver a smarter, flexible electricity grid to help deliver net zero

Energy partners and stakeholders including the ESO, other Transmission Owners (TOs), generators and politicians generally agree that the evolution of a smarter, more flexible electricity grid will be required to meet the changing needs of GB as it adapts to deliver net zero. The North of Beauly DLR project is one small way to trial and test the adaptability of existing infrastructure to operate more flexibly using

weather and temperature data. In the ESO Future Energy Scenarios 2021 publication, it highlights the need for the grid to become more adaptable.

4.2.2 Reduce constraint costs ultimately paid by GB energy consumers

The GB energy market is often criticised publicly for the cost of electricity generation constrained off, due to grid constraints during periods of high wind, with these additional charges ultimately paid by GB energy consumers. Given the additional flexibility that DLR technology provides to increase the capacity of the line, this investment helps reduce GB consumer additional charges, and is provided at low cost when compared to traditional alternatives.

During our direct engagement with the Citizens Advice policy team, they have confirmed these concerns stating that they are concerned by the current size of constraint payments that are added to consumer bills because they appear to reflect system inefficiency, and adding it is important that timely investment is made to ensure that networks can facilitate efficient constraint costs.

The ESO has begun a 5-point plan to relieve increasing congestion projected on the NETS, in ways additional to what is already being recommended by the NOA process. The five points are:

- Clearer forecasts of BSUoS costs
- Inter-trip pathfinder (Constraint Management Pathfinder)
- Regional Development Programme with DNOs & TO's
- Storage (CMP)
- Network improvement targeting and acceleration

All three GB onshore TOs have committed to supporting this process. In relation to the fifth point, this includes the identification of year-round constraint periods at a greater resolution than is currently used by NOA with a view to providing additional network development options for congestion relief – for which DLR has been highlighted as one of the options by the ESO.

4.2.3 Flexible connection contracts for generation customers

Given the footprint of our network, there is high demand for additional connections from new windfarms, along with many non-firm connection contracts for existing generation customers. The DLR technology would increase the potential for additional capacity on the existing network, helping meet these customer needs and is therefore generally supported in principle by them. Contractual terms and conditions are at an exploratory stage and will be further developed as the projects move towards delivery.

4.2.4 Share best practice as the energy industry work towards delivering net zero

Energy stakeholders including regulators, industry partners and politicians increasingly encourage organisations to work together to share best practice as the world tackles climate change and focuses on the road to net zero. While the north of Beauly DLR project would lead the investigations on our network to use this kit, we are aware that our peers at National Grid Electricity Transmission are carrying out similar investigations. We are reaching out to hear more about their developments and how we can share learnings.

4.3 Stakeholder Engagement Next Steps

Given there is no need for a s37 planning application, next steps regarding stakeholder engagement on the DLR projects are primarily around:

- identifying and securing supply chain procurement

- working with the ESO to identify an adequate resolution for OHL rating change and the preferred data sharing method/format for feeding this rating change to the ESO control room, to ensure efficient management of the system north of Beauly
- working with generation customers to develop contractual terms which will facilitate and optimise the use of the additional capacity when it is available; and
- share learnings with other TO's developing similar projects.

5. Whole System

We have held a number of discussions with SSEN Distribution to identify if there are any alternative reinforcement proposals north of Beauly. Given that the significant proportion of generation connected and contracted to connect north of Beauly is to connect to the transmission network and taking into account the low cost of the minimal build solutions proposed, no credible alternative solutions have been identified.

Concerns were raised by SSEN Distribution around signalling requirements for embedded customers if utilising the ANM system to directly manage generation output in the area. Whereas the ANM system for north of Beauly DLR will have the functionality to enable direct communication with generator schemes, this is a future option and a secondary use of the DLR system – the primary objective being to mitigate network constraints caused by the existing and currently contracted generation pool.

The North of Beauly DLR system was discussed with ESO alongside the proposed installation on the Skye circuits. In collaboration with ourselves, the ESO conducted a Cost Benefit Analysis, the results of which are discussed in the Optioneering & Preferred Option section of this document.

6. Cost Information

6.1 Costing Approach & Cost Breakdown

This section provides an overview of current and the next phase of the project cost status and identifies the key assumptions and exclusions. The RIIO-T2 allowances requested for this the project is £[redacted] with the works to be completed by 2024 when constraints are expected to occur. This cost is made up of [redacted], as calculated through the Opex Escalator mechanism which we are seeking full recovery for as part of this MSIP submission as detailed in the Table 5. The total cost for the project is £[redacted] which includes a 15-year service agreement contract with the years following RIIO-T2 being funded through business as usual network operating costs. The Class 1 estimate includes for all pre-construction and construction costs, this has been developed and approved in full compliance with our Large Capital Project (LCP) Governance Manual (available on request).

Category	Project Class 1 Estimate north of Beauly DLR (MSIP)	SSEN Transmission Project Cost Class	SSEN Transmission Indicative Estimate Tolerance	Supporting Documentation
Total	£[redacted]	Class 1	-30% / +40%	Framework Agreement/ Contract/ Bill/ Spreadsheet/ Quotations

Table 5: Cost Summary

- The Estimate has a Class 1 accuracy range from -30% / +40% based on the project status and scope maturity as identified in Chapter 2. Any material change in scope will result in the project cost estimate being updated accordingly.
- The Estimate has been produced in line with our Costing Methodology and all principles contained therein adhered to.
- A more accurate cost estimate (Class 2 accuracy -15/+25%) will be developed and approved at Gate 2 which is currently planned for May 2022.
- The final Class 3 estimate (-5/+10% accuracy) will be completed in September 2022 once all main construction contracts have been subject to competitive process and fully negotiated at Gate 3.
- Our procurement and contracting strategy is still being developed, however it will consider all potential options to drive efficiency and will deliver the most competitive prices that the current international market has to offer.

6.2 General Assumptions

The general assumptions that have been made in developing the cost estimate are listed below:

- Cost Base: All costs are based on prices deemed to be 2018/2019 cost base unless stated otherwise.
- Due to current market volatility the cost estimate may be subject to price increases once tender returns are available from the supply chain.

Exclusions

The cost estimate which forms part of this submission excludes the following key items:

- Extreme weather events (meaning a worse than 1 in 10 probability for land-based activity, and equivalent provisions for marine-based activity).
- The imposition of additional terms or conditions of any statutory consent, approval or permission (including but not limited to planning consent).
- Movement of agreed outages by the System Operator.
- Changes in the project scope that could not have been reasonably anticipated during the assessment process.
- Foreign exchange (Fx), Metal Prices (LME) fluctuations are excluded at this time.
- Accommodation and Logistics.
- Any Public Road Improvements.
- DNO Diversions.

6.3 Cost Estimation, Regional Variations and Site-Specific Factors Driving Costs

The geographical location of Beauly and the innovative nature of the works to be carried out presents significant challenges during the development, planning, construction and operational phase. At this stage we are undertaking significant review of our existing frameworks, market conditions and geographical factors to ensure we provide the best possible procurement and contracting strategy, which will enable significant progress towards UK and Scottish Government net-zero targets.

The Cost Estimate has been developed in line with our Costing Methodology and in accordance with our LCP Governance process.

The basis of the current cost Estimate is a budget estimate and has been calculated, by [redacted] comprised of Subject Matter Experts (SME) in June 2020 and is based on a high-level assessment, local knowledge and experience, the scope and site-specific information available, and the assumptions listed.

6.4 Project Benchmarking & Metrics

Due to the innovative nature of the project and that we have not embarked on a DLR project previously, we have been unable to Benchmark the current estimate against Internal or Regulator Cost Metrics.

6.5 Competition & efficiency procurement

This section identifies why the proposed procurement and commercial strategy to be implemented for the north of Beauly DLR Project which will demonstrate efficiencies and the optimum economic solution for this investment in the transmission network. The chosen multi-contract strategy will ensure competition to facilitate increased innovation and drive efficiencies which will help deliver further benefit to consumers.

Our procurement and contracting strategy will consider different options to drive efficiency and demonstrate value for money. A hybrid multi-contract procurement approach which will assess various lotting / bundling options with each of the DLR projects is the current preferred solution as it will deliver the most competitive prices that the current international market has to offer following competitive regulated tenders.

Given the innovative nature of the DLR technology, the intention is to approach the market to identify a range of different DLR technologies and allow these to be tested on the network to determine which technology choice is best suited for the business's requirements. Using information gained from the completion of this trial a whole system specification will be produced stipulating the requirements of the DLR system.

As per the Utilities Contracts Regulations, the trial will be conducted in a manner that allows and encourages the identification of a range of acceptable solutions or options. Processes will be in place to ensure avoidance of the development of relationships with any particular party which could hinder a fair and open process or limit competition. Any information gathered during such exercises will be shared with all interested parties at the stage of tender.

Following successful trial of the DLR technology, a contract will be awarded subsequent to a regulated tender event.

The procurement strategy will utilise the awarded Framework Agreement for the ANM System. The Framework Agreement has been procured following a compliant EU regulated tender process which demonstrates a competitive process has already been undertaken. To maximise competitiveness the ANM package will be subject to further mini-competitive process with the awarded framework contractors.

This strategy places programme and integration risk with us and consequently we have implemented a risk management strategy to safeguard consumers; allocating responsibility for risk to the party most suited to manage it and in the most efficient manner.

This section has clearly demonstrated that our high quality and robust approach to governance, strategy selection and implementation, comprehensive competitive tendering and negotiation processes will successfully contribute to the most appropriate allocation of contractual risk, deliver added value and reduced costs.

6.6 Procurement Strategy

The main objective of north of Beauly DLR Systems Project procurement strategy is to deliver a high quality and reliable system in the most economic and efficient manner. The strategy considers the unique innovative and remote location factors of this project whilst ensuring an efficient outcome for all contract costs. Finally, the strategy will take cognisance of any supply chain constraints, assess methods to obtain maximum value for customers and the most appropriate allocation of risk considering different contract and construction delivery models.

6.7 Governance – Procurement, Insurance and Legal

It is critical that all major investment projects are governed, developed, approved and executed in a consistent and effective manner whilst achieving safe, sustainable and timely execution of major projects/portfolio. The financial governance threshold for Large Capital Projects is a project investment value greater than [redacted]. As such, the north of Beauly DLR Systems Project is not subject to the Large Capital Project (LCP) Governance process. Despite the project not being required to follow the LCP process we are still following governance set out in the process.

A stage and gate procedure structure as identified in the LCP framework governs the entire lifecycle of the project undergoing five stages to completion as illustrated within Figure 8 below. The north of Beauly DLR Systems Project passed through Gate 1 in November 2021 and is planned to go through Gate 2 in May 2022

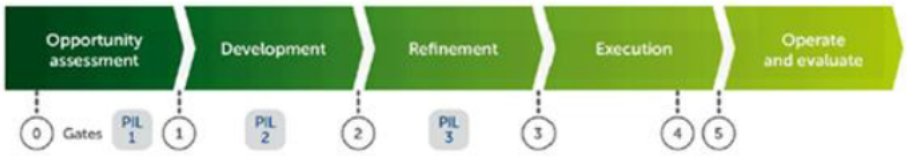


Figure 8: LCP and PIL Governance

The process is phased with six gates (0-5) at appropriate decision points, with clear consistent deliverables for each gate. This section will focus on the specific Procurement and Commercial deliverables contained therein.

6.8 Commercial and Contracting Strategy

At Gate 1 (November 2021) all potential options were developed and assessed, and a preferred solution is selected, as outlined in Section 3. A further strategy will be drafted and implemented for Gate 2 which is planned for May 2022. The strategy is finalised at Gate 3 when main approvals are sanctioned, and contract awards are executed.

Framework Agreements

SSE PLC operates a category management process as highlighted previously which is used in SSEN Transmission. This aligns procurement and commercial activities with business priorities providing a platform for effective supplier management. Performance is monitored and enhanced by using key performance indicators (KPI) and continuous improvement initiatives throughout the life of the framework agreements. The use of framework agreements provides the following key benefits:

- Enhanced quality;
- Improved safety performance;
- Superior programme management and delivery; and
- Commercial benefits i.e. continuous work programmes enable bulk discounts and promote efficiencies.

The following works, goods and services (outlined in Table 6) will be supplied via a combination of one-off regulated tenders and framework awards. A further explanation of each Work Package is provided below.

Work Package	Scope of Works	Quantities	Procurement Strategy
A	Dynamic Line Rating (DLR) System Trial	1 Trial	Request for Information via Find a Tender
B	DLR System	21 Units	Regulated One Off – Competitive
C	DLR System Annual Manufacturers	315 Months	Regulated One Off - Competitive

	Service Agreement (x15 Years)		
D	Active Network Management (ANM) System	1 Unit	ANM Framework – Mini Competition
E	Weather Data Analysis	1 Unit	Low Value, Low Risk One Off

Table 6: Procurement of Works, Goods and Services

Work Package A – Pre-Market Engagement: DLR System Trial

Given the innovative nature of the Dynamic Line Rating technology, the intention is to approach the market to identify a range of different DLR technologies and allow these to be tested on the network to determine which type of technology meets the business's requirements. Using information gained from the completion of this trial a whole system specification will be produced specifying the requirements of the DLR system. Our overhead line specifications will be updated to include an option for DLR.

As per the Utilities Contracts Regulations, the trial will be conducted in a manner that allows and encourages the identification of a range of acceptable solutions or options. Processes will be in place to ensure avoidance of the development of relationships with any particular party which could hinder a fair and open process or limit competition. Any information gathered during such exercises will be shared with all interested parties at the stage of tender.

The procurement strategy has been agreed to meet at Gate 1 to best align with the following:

- multi-contract strategy;
- Innovation;
- Allow for all scope items to be competitively tendered excluding direct award scope items;
- Supply chain capability;
- Provide the most cost-efficient contract price; and
- Reduce and mitigate interface risk.

The competitive process must be robust, transparent and ensure equal treatment of potential bidders and protect information appropriately. A compliant EU regulated two-stage tender process (Prequalification and Invitation to Tender (ITT) will be administered for all one-off contracts to provide the most economically advantageous solution for the consumer as it maximises the supply chain opportunities.

Work Package B – DLR System Supply, Design and Install

This section details the procurement process and scope of works associated with the Supply, Design and Installation of the DLR System in relation to the north of Beauly project.

The proposed Package B is to supply, design and install a Dynamic Line Rating System which is capable of using local weather monitoring and conductor measurements to accurately determine the true real time rating of the conductor, therefore increasing the capacity to the circuit and alleviating the network constraints.

Item	Quantity (approx.)
DLR System	21 units

Table 7: DLR System equipment

Work Package C – DLR System Annual Manufacturers Service Agreement

Item	Quantity (approx.)
DLR equipment	15 years

Table 8: Manufacturers Service Agreement

Work Package D – ANM System

This section details the procurement process and scope of works associated with the Supply, Design and Installation of the ANM System in relation to the north of Beauly project.

The proposed Package D is to supply, design and install a AMM System which measures the power flows at several measurement points on the network. The network is divided into zones which represent constraint points in the network and the system receives real time information from the measurement points.

Tender Evaluation Reports

We will prepare detailed Tender Evaluation Report (TER) for all key contracts which describes the entire procurement process undertaken from inception to final recommendation. The TER is a mandatory SSE PLC governance requirement and captures a number of the key requirements tabled by the Regulator to justify the procurement process undertaken.

6.9 Consistent approach to the SSEN Transmission RIIO T2 Business Plan Competition Strategy

We outline our RIIO T2 Business Plan Competition Strategy in our document titled "SSEN Transmission – Competition Strategy". We recognise that our business, together with our stakeholders, plays a key role in enabling GB's transition to a low carbon economy. The challenge to deliver Net-Zero in the timescales proposed is significant and demands a coordinated and immediate response of the energy industry. In RIIO-T1 we reshaped our business to meet the challenge of a renewable energy boom, and are on course to connect over 3GW, on-time and under agreed allowances through efficiency measures. To meet the growth in electricity demand in a sustainable way, our network must support increasing volumes of renewable generation, as well as new forms of energy interactions and ways of working across industry. We recognise this and reflect it in our Strategic Objective for RIIO-T2, which is to enable the transition to a low carbon economy.

Many of the challenges we will face during the RIIO-T2 period are similar to those we have experienced and successfully managed during the past ten years. By building upon our experience, we are well placed to manage these challenges and so deliver cost-effective outcomes that keep down the household energy bill.

We seek to ensure that we operate a comprehensive tender process that is fit for purpose for each project or portfolio of projects (described below). Whilst retaining these key principles, we have sought to simplify our procurement processes where practicable, to both reduce the programme timescales, and the cost burden for consumers.

6.10 Risk Strategy

The north of Beauly DLR Project is managing risk in accordance with ISO31000, the International Standard on Risk Management, and the agreed SSE Large Capital Projects (LCP) Governance Manual and requirements therein.

The Project has a Risk Management Plan that sets out the approach and process the Project will use to manage risk (threats and opportunities) over the lifetime of the Project.

Within the Risk Management Plan are the key risks (threats and opportunities) the project faces, the risk process that the project will follow to manage risk, project teams roles and responsibilities in respect of managing risk, and that the Project is using KERIS, the SSE LCP Risk Management Information System (RMIS) for managing risk on the project.

KERIS will act as the repository for all project risks (threats and opportunities) as it allows the users to create and assess all risks, impact assess these risks and track mitigating risk actions through to successful closure. All risks and actions are assigned owners who are then accountable for updating the KERIS system. Risk owners can simultaneously access the RMIS, that is an ongoing project activity to ensure that risk data is captured, up to date and can be used to support project decision making. To supplement the ongoing updates to the RMIS, the north of Beauly DLR Project team holds strategically timed risk workshops to collectively review and challenge the Project Risk Register ahead of each key gate stage.

The development of the project risk register follows the LCP Governance Gated Process in the Manual, and the risk register is a live document that evolves through continuous updates and contributions from the project team over the life of the project.

Risk will be reviewed by the Project Manager with:

- Updated reports detailing the status of Risks and Actions to highlight risks/ actions requiring attention; and
- Monthly report, showing risk progress (new risks, opportunities, new actions, and closed items); risk gaps, usage, quality of the information being recorded and where the risk focus needs to be going forward for the Project.

7. Conclusion

A significant quantity of renewable generation is currently contracted to connect in the Caithness area of our network, north of Beauly substation, with the volume of renewable generation continuing to grow as we progress towards the UK and Scottish Government's 2030 and 2045/50 net zero targets. Connection of a large number of these generation schemes is currently contingent on the proposed 'Beauly to Loch Buidhe 275kV OHL Reinforcement', which has an Earliest In-Service Date of 2030. Ahead of this reinforcement, and due to the volumes of renewable generation looking to connect in the mid-2020s, there is likely to be fairly significant network constraints in the area from 2024. This requires minimum build solutions which can be delivered earlier than 2030 to help the ESO manage the system, mitigate constraints north of Beauly and enable additional transport of renewable electricity. We have worked with the ESO to explore a number of minimum build solutions including line re-profiling and/or the application of DLR on the Beauly to Loch Buidhe and Loch Buidhe to Dounreay 275kV double circuit OHL.

Our preferred minimum build solution is the combination of DLR along the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL for delivery in 2024 as well as line re-profiling of the Beauly to Loch Buidhe 275kV OHL for delivery in 2025. This option combination is low cost (<£[redacted]) and provides the highest enhancement to existing circuit capability which we can achieve using minimal build solutions. The line re-profiling element of the combined solution will be funded separate to the DLR system using the RIIO-T2 Volume Driver mechanism. These minimal build solutions sit within the footprint of the existing OHL and there is therefore minimal work required in the installation and maintenance of both options. We plan on using lessons learned from the closely aligned Skye DLR project (our demonstration project for delivery in 2023) in the design, installation, monitoring and operation of the system for north of Beauly to mitigate any perceived technological risks.

Our preferred solution of the combination of DLR and line re-profiling is also the best solution according to the ESO CBA which assessed the economic benefit of various minimum build solutions, including a 'do nothing' option, to mitigate network constraints for the five-year period 2024-2028. This combination is determined as having the least-worst regret in all scenarios and each generation background considered. The worst regret for the combination option considering the FES 2020 scenarios is determined by the ESO as being £147m, and for DLR only is £158m, compared to £230m for the 'do nothing' option.

The cost associated with the combination of DLR and line re-profiling is therefore fully recovered by the savings made to the GB consumer in alleviating network constraint costs associated with the significant quantity of onshore wind contracted to connect north of Beauly, and needed to meet the GB net zero target (as determined by FES 2020). Even for Steady Progression, the slowest credible decarbonisation FES 2020 scenario (only a 68% reduction by 2050 in UK greenhouse gas emissions compared to 1990), the minimum constraint cost in the period 2024-2028 determined by the ESO is over three times the cost of the combined minimal build option.

DLR is an innovative solution that has the potential to provide significant benefit to the GB consumer by mitigating network constraints across the GB system and aiding the ESO in managing the system. The needs case shows that without implementation of the DLR system on the Beauly to Loch Buidhe to Dounreay 275kV double circuit OHL at the very north of our system, it is projected that there will be considerable constraints on the OHL of which costs will be paid for by the GB consumer.

To enable the industry to keep pace with the projected growth of windfarm generation it is imperative that innovative technologies are installed and tested on the network to allow for introduction to the rest of the network as business as usual. In understanding the technology through the completion of this project as well as the associated project to install DLR on the Skye 132kV circuit, DLR can be introduced to other areas of our network where economic and efficient to do so, to deliver further benefits to the GB system and the GB consumer.

The RIIO-T2 allowances requested for this the project is £[redacted] with the works to be completed by 2024 when constraints are expected to occur. This cost is made up of £[redacted] capex and £[redacted] of associated opex allowance, as calculated through the Opex Escalator mechanism[6].

Next Steps

Following submission of the MSIP application, we anticipate a decision from Ofgem within four to six months. During this time, we will further collaborate with the Met Office to define optimal locations for the DLR equipment installation, as well as completing the design and specification of the DLR system. Further collaboration will also be undertaken with the ESO to identify an adequate resolution for OHL rating change and the preferred data sharing method/format for feeding this rating change to the ESO control room, to ensure efficient operation of the DLR system.

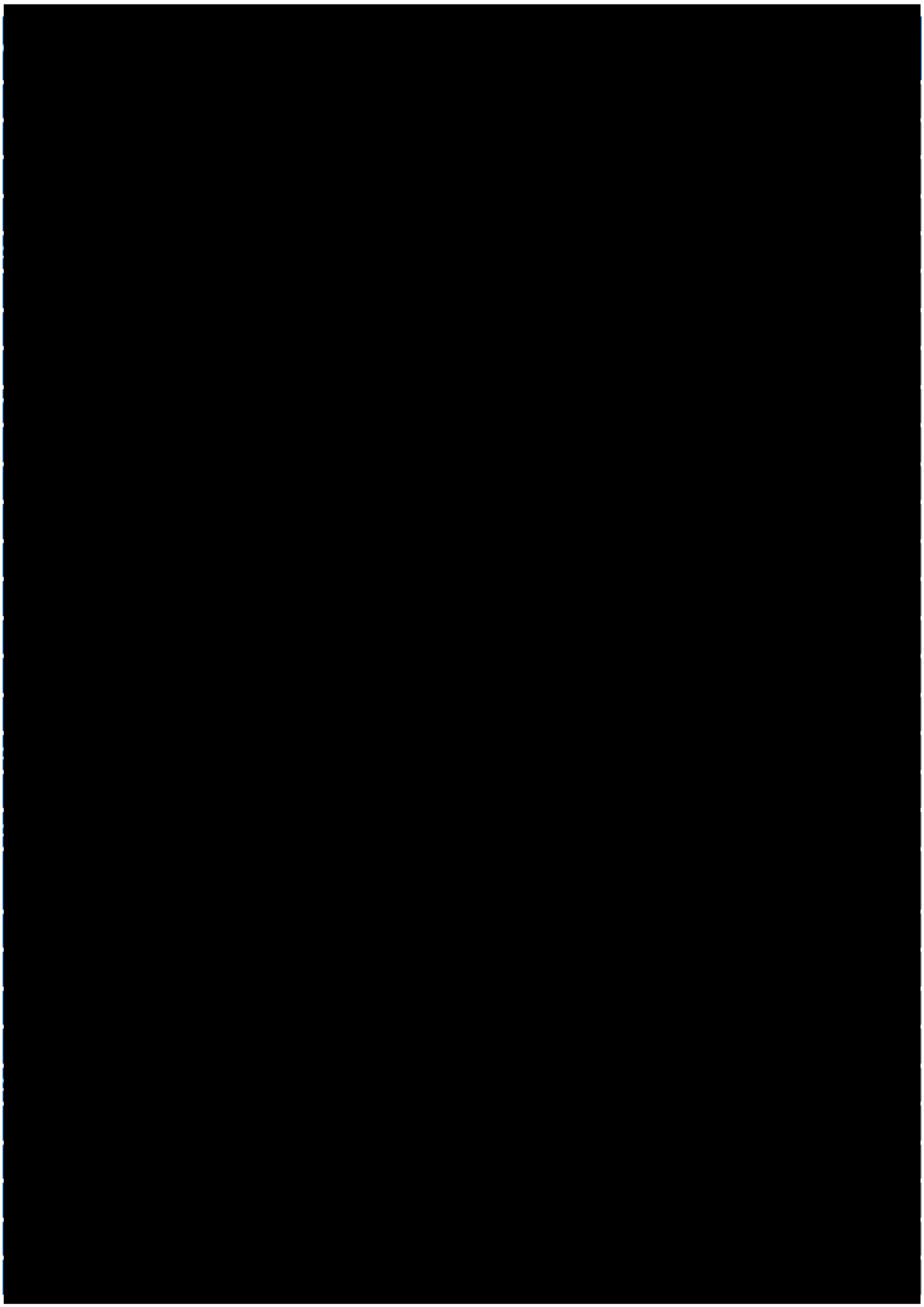
[6] In accordance with Scottish Hydro Electric Transmission Plc Electricity transmission licence Special Condition 3.36 Opex Escalator (OEt)

Appendix A Glossary of Terms

Acronym	Definition
ANM	Active Network Management
CBA	Cost Benefit Analysis
CfD	Contracts for Difference
CM HVDC	Caithness-Moray High Voltage Direct Current link
CUSC	Connection and Use of System Code
DLR	Dynamic Line Rating
EISD	Earliest In-Service Date
ENA	Energy Networks Association
ESO	Electricity System Operator
FES	Future Energy Scenarios
LCP	Large Capital Project
LIDAR survey	Light imaging, detection and ranging survey
MSIP	Medium Sized Investment Project
NETS SQSS	National Electricity Transmission System Security and Quality of Supply Standard
NOA	Networks Options Assessment
NPV	Net Present Value
OHL	Overhead Line
PSTs	Phase shifting transformers
RTTR	Real-time thermal rating
TO	Transmission Owner
STC	System Operator Transmission Owner Code
TOCA	Transmission Owner Construction Agreement

Appendix B Contracted Generation North of Beauly

A list of the contracted generation North of Beauly substation in the Caithness area of our network is provided below:



Appendix C List of supplementary documents and evidence

Title	Description
T2BP-EJP-0050 Dynamic Line Rating	Engineering justification paper submitted as part of RIIO-T2 Business Plan
LT00031_North of Beauly DLR Programme	Project programme for North of Beauly DLR
LT000331 NofB DLR FO-PMO-LCP-201 Project Development Plan	Project Development Plan (PDP) outlining the strategy for the North of Beauly DLR
North of Beauly – DLR and re-profiling CBA Report (issue 3)	ESO CBA report
LT331 NofB DLR – KERIS Risk Register	Risk register for North of Beauly DLR

Scottish & Southern Electricity Networks
TRANSMISSION
Inveralmond House, 200 Dunkeld Road, Perth PH1 3AQ ssen.co.uk