Scottish & Southern Electricity Networks

TRANSMISSION

Skye 132kV Reinforcement Initial Needs Case Submission

30 July 2021

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

Table of Contents

Executive Summary

SSEN Transmission, the owner and operator of the transmission system in the north of Scotland, has set out an evidence-based and economically-justified case for replacement of the existing overhead line between Fort Augustus and Ardmore on the Isle of Skye.

Doing nothing is not an option. The current overhead line was built in sections between 1956 and 1989 and, despite intensive maintenance, has an increasing risk of failure. Replacement would improve security of supply to homes and businesses on the Isle of Skye and the Western Isles, and a new overhead line would be designed to meet modern safety and engineering standards.

Stakeholders and communities support investment that is sensitive to local needs. The environmental and community impacts of replacing the line have been examined in consultation with those affected. The proposed investment strikes a balance between those direct impacts and the economic costs and benefits to the wider GB energy consumer.

The need for growth is certain. The current overhead line is 'over capacity' and operates under a derogation that limits both renewable output and relies on standby diesel generation for demand security. Together these factors necessitate growth in the transmission capability. Over-and-above this, new renewable generation schemes (some with planning consent) are seeking connection to the grid from 2025 onwards and electricity demand is forecast to increase as the economy becomes 'greener'.

A pathway to net zero. The UK and Scottish Governments have legislated for net zero greenhouse gas emissions within the next three decades. Achieving those targets will require significant investment in renewable electricity generation and the network to transport that power to homes and businesses. This investment case is consistent with achieving net zero.

Analysis of economic, environmental and social factors clearly demonstrates that a new 132kV overhead line is the best solution with a net consumer lifetime benefit of over £400 million, creating hundreds of skilled jobs throughout the supply chain. The new line would be built as a double circuit steel tower from Fort Augustus to Edinbane and single circuit wood pole line from Edinbane to Ardmore. In addition, the existing substation at Broadford would be upgraded to improve security of supply on Skye. The current overhead line would be dismantled and the landscape restored, including compensatory woodland planting.

Subject to necessary regulatory and planning approvals, SSEN Transmission expects construction to be underway in 2023 with the new line energised in December 2025. The total investment cost will depend on the detailed design that is under consultation with stakeholders, but is currently estimated to be around £400 million (excluding generation connections).

1 Introduction

1.1 Overview

This Needs Case is presented under Special Licence Condition 3.13 for Large Onshore Transmission Investment (LOTI) Reopener in RIIO-T2 which allows for large transmission developments that benefit consumers to be brought forward during the course of the price control period on a case by case basis. This is an uncertainty mechanism that helps ensure investments are made at the right time when both need and cost is more certain, protecting both consumers and companies from over and under investment.

Following the submission of our Eligibility to Apply letter on the 31 March 2021, this submission is our Initial Needs Case (INC) for the Skye Overhead Line (OHL) Reinforcement project and meets the requirements as set out in Special Licence Condition 3.13 and the Large Onshore Transmission Investments (LOTI) Re-opener Guidance and Submissions Requirements Document.

The Skye OHL Reinforcement is fundamental to achieve a Network for Net Zero in the north of Scotland and the 2045 Scottish and 2050 UK Government net zero targets, whilst ensuring long term security of supply in the Skye and Western Isles area. Mindful of the fact that Skye is one of the most environmentally sensitive and valued wild landscapes in all of Scotland, we have a unique once in a generation opportunity to intervene to meet these current and future priorities for local and national consumers and stakeholders, and leave Skye in a better [or no worse] condition environmentally than we found it.

This LOTI submission presents the case for the replacement and reinforcement of the Skye OHL circuit from the Fort Augustus 400kV substation on the mainland to Ardmore on the Isle of Skye to address both the asset condition of the existing OHL and to enable renewable generation seeking to connect in the Skye area.

The need for the Skye Reinforcement Project can be summarised as follows:

- The existing OHL is reaching the end of its operational life and requires replacement in order to maintain security of supply for homes and businesses on Skye, and on the Western Isles that are currently supplied via a subsea cable from the north of Skye;
- Existing generation exceeds planning standards and is allowed under derogation. There is now a requirement to connect new renewable electricity generators on Skye which results in a requirement for an increase in capacity of the existing OHL; and
- Following commitment from both the UK and Scottish Governments to achieve net zero emissions by 2050 and 2045 respectively, SSEN Transmission set out an economically justified pathway for reinforcement that will meet net zero targets at the lowest risk to GB consumers. This will allow incremental increases in capacity to support the connection of additional renewables generation when such need has been clearly demonstrated.

Following the Ofgem LOTI guidance, this INC submission provides evidence of a well justified need for the reinforcement, evidence on the options considered and clear justification for the proposed solution. It also provides details of the delivery strategy to meet the project timeline, along with details of the significant stakeholder engagement undertaken as we have progressed the reinforcement options and confirmed the generation background.

SSEN Transmission is asking Ofgem to:

Support the evidence demonstrating the need for SSEN Transmission to undertake the reinforcement of the Skye OHL circuit which will cover the full 160km length of the Skye 132kV single circuit OHL from Fort Augustus substation to Ardmore on the Isle of Skye. The proposed solution for Skye is to replace the line from:

- **Fort Augustus to Edinbane with a high capacity double circuit steel structure OHL (2 x 348MVA summer rating)**
- **Edinbane to Ardmore section with a single circuit wood pole OHL (176MVA summer rating)**

1.2 Background of the project

The Skye transmission network consists of a single radial 132kV OHL extending over 160km of challenging and environmentally sensitive terrain from the Fort Augustus 400kV substation on the mainland to Ardmore on the Isle of Skye.

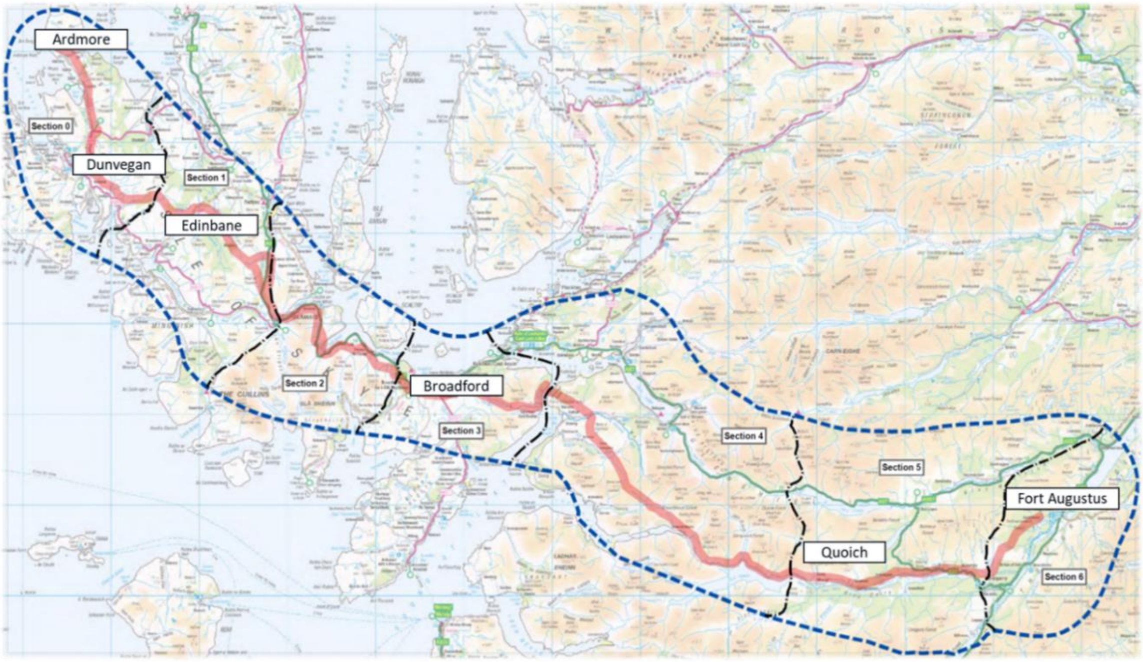


Figure 1. The Skye 132kV transmission line

From Ardmore, there are two Scottish Hydro Electric Power Distribution (SHEPD) owned 33kV subsea cables; one to Loch Carnan on South Uist and the other to the Isle of Harris. The line continues from Harris as a 132kV transmission circuit to Stornoway on the Isle of Lewis.

The **security of supply** on Skye and the Western Isles is dependent on the Skye circuit as the only connection to the main GB electricity grid. To enhance supply security on the Western Isles, there are SHEPD owned backup diesel generators at Battery Point and Arnish (both connected at Stornoway) to support Lewis and Harris, and diesel generators at Loch Carnan and Barra to support the Uists. Additionally, SHEPD use mobile backup diesel generation to secure supplies on the Isle of Skye. Therefore, in the event of a fault on the main line, customer supplies are solely reliant on ageing backup generators, with associated impacts on greenhouse gas emissions.

The existing Skye OHL is fast **approaching the end of its economic and operational life**. Asset condition assessment of the line has identified the need to urgently intervene in order to continue to safely operate the line and provide supply security on this part of the network.

Separate to this, there is a requirement to increase the capacity of the line, mainly driven by requests from developers to connect renewable generation on the line, including on the Isle of Skye.

The amount of generation connected to the existing Skye single 132kV circuit **already exceeds the rating of the existing line** when considering the level of demand connected, making this part of our network non-compliant with the National Electricity Transmission System (NETS) Security and Quality of Supply Standard (SQSS). Based on the provision that National Grid Electricity System Operator is able to manage the generation on this line economically, we applied to Ofgem for derogation from the relevant criteria of the NETS SQSS and this was granted in 2010. Connection of additional generation beyond what was assessed at the time was contingent upon undertaking the necessary reinforcement to the line in accordance with the relevant criteria of the NETS SQSS.

1.3 Ongoing commitment to stakeholders

The Isle of Skye is globally renowned for its natural beauty and is an **environmentally sensitive area** with the proposed OHL route running through some of Scotland's most valued wild landscapes. Understandably, many stakeholders have concerns about the potential disruption and lasting visual impact from the infrastructure and construction methods required to replace the existing line. This was clearly evident through our virtual consultation process where stakeholders informed us that while, "appreciating the need to upgrade, the visual intrusion and environmental impact should not be compromised"[1].

Consistent with our T2 Business Plan commitment and Ofgem's enhanced engagement approach in RIIO2, we have **worked closely with our stakeholders** to gather their feedback which has influenced our options and preferred solution. Stakeholders have informed us that any disruption in the area must be minimised urging us to develop an economic, co-ordinated solution that satisfies current **and** future consumers' needs and so avoiding the damaging cost of multiple incremental interventions. This approach is also **consistent with the recommendation from the Committee on Climate Change on the approach to build infrastructure to support net zero**[2].

For this reason, we propose a **'do it once and do it right'** approach that seeks to optimise the opportunities while avoiding the need to return for future construction works in later years.

We identified **future generation capacity needs as the key uncertainty**, mindful of this and the views of our stakeholders, we have undertaken an extensive assessment of the potential future generation in the Skye area, with the aim of ensuring that our proposed solution not only meets the immediate needs for generators in upcoming Contracts for Difference (CfD) Auction Round 4 (AR4) but also makes proportionate provision for future potential generation in the area. To do this, external consultants GHD have created a "**Probability of Generation Assessment Tool**" (PGAT) which provides an assessment of the likelihood of future generators materialising, allowing us to

---

[1] ssen-transmission-skye-reinforcement-virtual-consultation-summary, https://www.ssen-transmission.co.uk/media/4642/ssen-transmission-skye-reinforcement-virtual-consultation-summary_.pdf

[2] The May 2019 Committee on Climate Change report, Net Zero – The UK's contribution to stopping global warming, is available online at https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

balance the needs of our stakeholders and current and future customers against the potential risk of the end consumer funding underutilised assets.

1.4 Cost benefit analysis

Ofgem requires the ESO to undertake Load CBAs to underpin our LOTI submissions. However, the ESO's CBA tool has some limitations in modelling a small part of the GB network such as the Skye radial network. Building on the PGAT analysis developed by our consultants, we proposed a novel collaborative approach in which we supported the ESO by undertaking the assessment of the local Skye network, feeding into their CBA. This approach was agreed with the ESO and Ofgem prior to the CBA being undertaken.

We also undertook a Non-Load CBA to evaluate the asset intervention options based on Long-Term Risk Benefit (LTRB). LTRB is a relative measure of monetised risk reduction achieved through asset intervention which is measured over a defined period of time. It is calculated in accordance with the Transmission Network Asset Risk Metrics (NARM) Methodology in line with the principles set out in our RIIO-T2 Business Plan.

Both the Load and Non-Load CBAs concluded that the **proposed reinforcement is optimum** from the network operational cost and LTRB perspectives. The solution meets both the Load and Non-Load needs and is robust against the wide range of sensitivities considered. In the high generation capacity background consistent with net zero, the proposed solution provides a **net benefit of more than £400m to the GB consumer**. Across the four scenarios considered the solution has the least 'worst regret', with a worst regret of £143m in stark contrast to a worst regret of £573m for the 'minimum' option which only addresses the asset condition requirements.

1.5 Structure and content of Initial Needs Case Submission

The project background, giving the details of the existing single circuit 132kV OHL network and connected generation in Skye, is given in Chapter 2. The comprehensive stakeholder engagement undertaken to date and the plan going forward is described in Chapter 3. The outline of the Needs Case in Chapter 4 of the report discusses our Licence obligations and explores in detail the current asset health of the existing network in addition to the projected growth of renewable generation which are the two key drivers for the proposed reinforcement. The transmission reinforcement options are explored in Chapter 5, taking account of cable routing, technical, environmental, cost and design aspects.

The CBAs undertaken internally (non-load) and externally by the ESO and GHD (load) for the different reinforcement options are discussed in Chapter 6.

The preferred reinforcement option is discussed in Chapter 7 and the project timeline and delivery strategy are discussed in Chapter 8. Finally, the conclusions are given in Chapter 9.

This INC meets, and goes beyond, the requirements of the LOTI guidance.

2 Project Background

2.1 Project Background and Development

The need to reinforce the network in Scotland to accommodate increased north to south power transfers has been continually monitored by the Transmission Owners (TOs) since 2009, when options were considered as part of the Electricity Networks Strategy Group[3] (ENSG) report, "A Vision for 2020"[4] . A subsequent report[5] issued in February 2012 gave an updated view from the ENSG on how the electricity network might need to be reinforced to facilitate the Government's 2020 renewable targets.

The decarbonisation agenda is of critical importance to the TOs, ESO and Ofgem in determining the future shape of the transmission system. Aspirations for a clean energy future form a key part of government policies and are supported by wider stakeholders and consumers.

In June 2019, the UK Parliament legislated for a net zero greenhouse gas emissions (GHG) target by 2050. The Scottish Parliament has legislated for a target date of 2045 for net zero. The Scottish Government has also set a new target to reduce emissions by 75% by 2030, which it says is the toughest statutory target of any country in the world by this date, going above and beyond what the Intergovernmental Panel on Climate Change said is required worldwide to limit warming to 1.5^{O}C.

In order to achieve national net zero targets, analysis undertaken by the Climate Change Committee to advise the UK Government and devolved administrations illustrates the significant role of electrification as a means to abate GHG emissions. In all scenarios, electricity demand is forecast to increase over the coming decades and the source of electricity become fully low carbon within the next ten years. As Scotland has a vast renewable energy resource, it is assumed to contribute substantially to future electricity demand with the majority of the power produced being transported to demand centres in the south[6].

The investment that is demonstrated as required in this INC is needed to ensure that we can progress towards meeting the delivery dates for both contracted and forecast generation, as well as maintaining security of supply to customers currently connected in this critical region of our network. This generation is required to support the achievement of the legally binding net zero targets. As discussed above, these targets are now even more challenging, further increasing the need to progress timely investment. This investment not only supports the achievement of these targets, but also delivers an economical and efficient solution reducing the overall cost to end consumers.

2.2 Historical or legacy aspects of the project

In 2014 the "Fort Augustus to Skye Project" was initiated by SSEN Transmission in order to facilitate the connection of renewable energy generation on the Isle of Skye to the UK national grid. As part of this work a development option was publicly consulted on between 2016-2018, that was based upon a design proposing a new 132kV single circuit OHL of wood pole construction between Fort

---

[3] https://www.gov.uk/government/groups/electricity-networks-strategy-group
[4] ENSG 'Our Electricity Transmission Network: A Vision For 2020', July 2009
[5] ENSG 'Our Electricity Transmission Network: A Vision For 2020', February 2012
[6] https://www.theccc.org.uk/publication/sixth-carbon-budget/

Augustus substation and Broadford substation on the Isle of Skye, with the existing steel lattice OHL that connects the two substations remaining in place – effectively installing an additional 132kV circuit. The project also proposed a replacement 132kV single circuit wood pole OHL between Broadford and Dunvegan as part of the scope.

By late 2018, asset condition studies of the existing infrastructure undertaken as part of the Fort Augustus to Skye project, and increased capacity requirements from further generation connection requests, triggered the need for a strategic review of the reinforcement strategy for Skye. This considered both the upgrade and replacement of the existing OHL in its entirety between Fort Augustus and Ardmore north of Skye, as well as associated substation infrastructure along it. Given the change in both project need and scope, the previously named Fort Augustus to Skye project was renamed and replaced by the 'Skye 132kV Reinforcement project.'

2.3 Project Context

The existing single circuit 132kV OHL from Fort Augustus to Ardmore on the Isle of Skye extends over 160 km in length and is the sole connection from the mainland national grid to Skye and onwards, via subsea cable to the Western Isles – see Figure 2 below.

The security of supply on Skye and the Western Isles is dependent on this circuit. The existing OHL is made up of distinct sections, which were constructed at different times over the last 65 years in response to changing needs. This comprises the following:

1. Fort Augustus Substation to Skye Tee (near Invergarry) – 9 km section of 132kV OHL of single circuit trident wood pole construction from Fort Augustus to the Skye Tee point. Completed in June 2017 in order to provide enhanced security of supply and greater network resilience to the west of Fort Augustus.
2. Skye Tee to Quoich – 19 km of 132kV OHL of single circuit trident wood pole construction that will complete in September 2021. This section was constructed as a refurbishment of a section of single circuit steel lattice towers, strung with a single circuit 132kV OHL that was constructed in the mid-1950's to connect the Quoich hydroelectric power station to the grid;
3. Quoich to Broadford – 64 km of double circuit steel lattice towers, strung with a single circuit 132kV OHL constructed between 1979 and 1980; and
4. Broadford to Ardmore – 68 km of 132kV OHL of single circuit of trident wood pole, constructed in 1989.

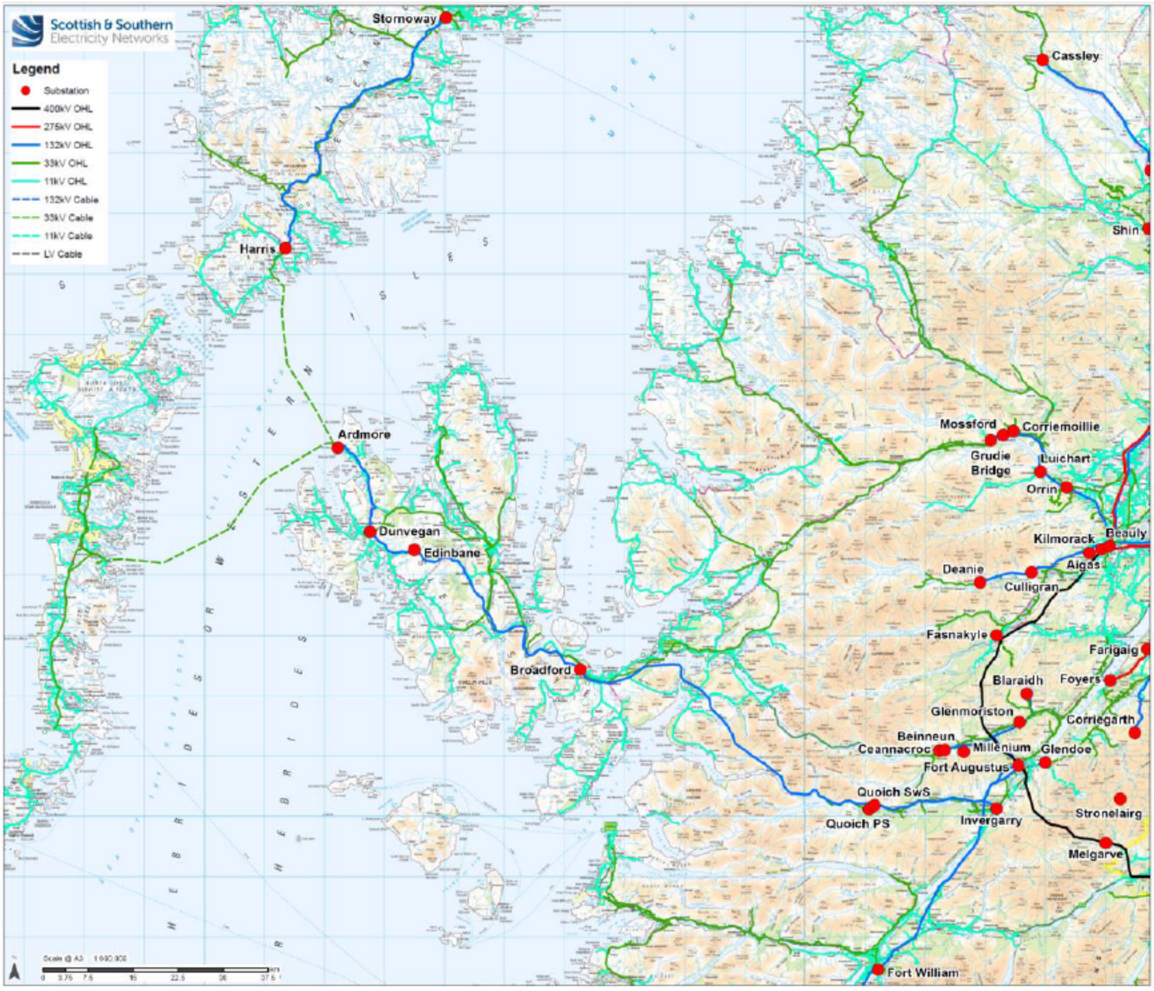


Figure 2. Skye 132kV Transmission Network

At the Ardmore Substation, the line voltage is stepped down to 33kV and proceeds to the Western Isles as two 33kV subsea cables. One that supplies North and South Uist, and the Isle of Barra, while the other heads to a substation on the Isle of Harris, where it is converted back to 132kV and connects to the existing Harris to Stornoway 132kV single circuit wood pole OHL.

In addition to the distinct sections listed above, the existing OHL and proposed reinforcement crosses some of Scotland's most highly valued natural landscapes and environments[7]. The primary areas of consideration are:

- The Cuillin Hills National scenic area,
- Knoydart National Scenic Area; and
- Kinloch and Kyleakin Hills Special Area of Conservation (SAC)

These designated landscapes[8], and other areas of wild land, have been identified by key statutory consultees, landowners, and other stakeholders, as important areas of interest that should be thoroughly considered through the project lifecycle and asset operation phase. Since the initial Fort

[7] NatureScot on NSA https://www.nature.scot/professional-advice/protected-areas-and-species/protected-areas/national-designations/national-scenic-areas

[8] NSA map https://www.gov.scot/binaries/content/documents/govscot/publications/map/2008/03/national-scenic-areas-of-scotland-map/documents/national-scenic-areas-of-scotland-map/national-scenic-areas-of-scotland-map/govscot%3Adocument/National%2BScenic%2BAreas%2Bof%2BScotland%2B-%2Bmap.pdf

Augustus to Skye project was initiated in 2014, through to the current Skye 132kV Reinforcement, feedback from stakeholders indicates a strong preference for a project that delivers the least long term environmental impacts through construction methods, does not require sections of multiple OHLs in the same landscape, and is built to limit the need for future reinforcement works in highly valued landscapes.

The Skye 132kV Reinforcement is a Large Onshore Transmission Investment (LOTI) project. The line will connect into the existing substation sites at Ardmore, Dunvegan, Edinbane, Broadford, Quoich and Fort Augustus at this voltage. Between Fort Augustus and Edinbane a double circuit at 348MVA is required, with a single circuit at 176MVA for the remainder of the OHL between Edinbane and Ardmore. A new Double Busbar substation at the existing Broadford 132/33kV substation site is also required as part of the proposed LOTI works.

The Skye 132kV Reinforcement will align with several other Load and Non-Load projects not funded under the LOTI mechanism, but still aligned through connection dates. These are:

- Quoich Tee Substation Works - replacement of switching station, and local OHL diversion works funded under the RIIO-T2 ex-ante allowance
- Broadford Substation asset replacement - replacement of circuit breakers, switchgear and associated equipment funded under the RIIO-T2 ex-ante allowance
- Broadford GSP SHEPD Demand Connection – Installation of a new 45MVA transformer and associated switchgear; and reconfiguration of the connection to the existing 30MVA transformer. Funded under the RIIO-T2 Uncertainty Mechanism
- Edinbane Collector Switching Station – Construction of a new 132kV double busbar collector switching station at a suitable site near Edinbane funded under the Medium Sized Investment Projects (MSIP) RIIO-T2 Uncertainty Mechanism
- Dunvegan GSP - Transmission construction works required to facilitate the connection of embedded generators. Funded under the RIIO-T2 Uncertainty Mechanism

Over recent years, several assessments have been carried out to determine the condition of the existing OHL and associated electricity infrastructure, including existing substation equipment. In addition, more applications for generation and demand connections on Skye have been received over that period. The need for the Skye Reinforcement project can be summarised as follows:

- The existing OHL is reaching the end of its economic and operational life and requires replacement in order to maintain security of supply for over 32,058 homes and businesses on Skye and on the Western Isles; and
- Consistent with both the UK and Scottish Government commitments to achieve net zero emissions by 2050 and 2045 respectively, there is a requirement to connect new renewable electricity generators on Skye which results in the need to increase the capacity of the line.

In response to the emergent drivers for reinforcement, further development work and studies were undertaken to identify viable options to provide the required capacity to meet current and future requirements. We published the Skye OHL Reinforcement Strategy[9] which considered potential future generation growth scenarios consistent with net zero objectives as well as security of supply requirements for customers on Skye and Western Isles. The strategy was included as part of the RIIO-T2 Business Plan submission to Ofgem.

[9] Skye Overhead Line Reinforcement Strategy: https://www.ssen-transmission.co.uk/media/4200/appendix-1-skye-overhead-line-reinforcement-strategy.pdf

In developing potential solutions to meet the identified need, we considered technical and geographic constraints relevant to the design and safe operation of the transmission infrastructure. In addition, it was recognised that there are technical/engineering design decisions that may be influenced by the views of the stakeholders, such as the design of the steel structures for the new OHL or alternative construction methods, such as underground or subsea cables. Chapter 3 outlines the key stakeholder interfaces and describes the processes and methods of engagement regarding our proposals and the ways in which they have informed the project development process

2.4 Base Transmission Network

2.4.1 The Skye and Western Isles region

The Skye OHL is located within the wider Skye and Western Isles region and therefore long-term network development plans for Skye must be considered against this background. SSEN Transmission has plans to reinforce the Skye and Western Isles network with three projects as follows:

- Skye OHL reinforcement projects covered in this INC,
- Harris to Stornoway OHL rebuild, a RIIO-T2 ex-ante Non-Load project, and
- Western Isles HVDC Link SWW project, conditionally approved by Ofgem and awaiting developer commitment.

Figure 3 shows the overall planned network developments for the Skye and Western Isles region. It also shows the SHEPD owned Ardmore to Harris 33kV 23.4MVA cable which failed on 16 October 2020 and is currently being replaced with another 33kV cable rated at 35.5MVA. As a result, electricity supply to Harris and Lewis is currently being met by diesel generation connected at Stornoway.

The limited rating of the subsea cable from Ardmore to Harris has been an operational constraint for over a decade. Prior to the recent cable failure, generation exports from Harris to Skye were operationally managed by the ESO to stay within the rating of the cable, i.e. generation output was constrained. Likewise, during times of high demand on Western Isles (peak demand of 25MW), the cable is insufficiently rated to meet demand. This presented power import constraints onto the Western Isles resulting in the need to either reduce demand or to run local diesel generators in order to maintain supply.

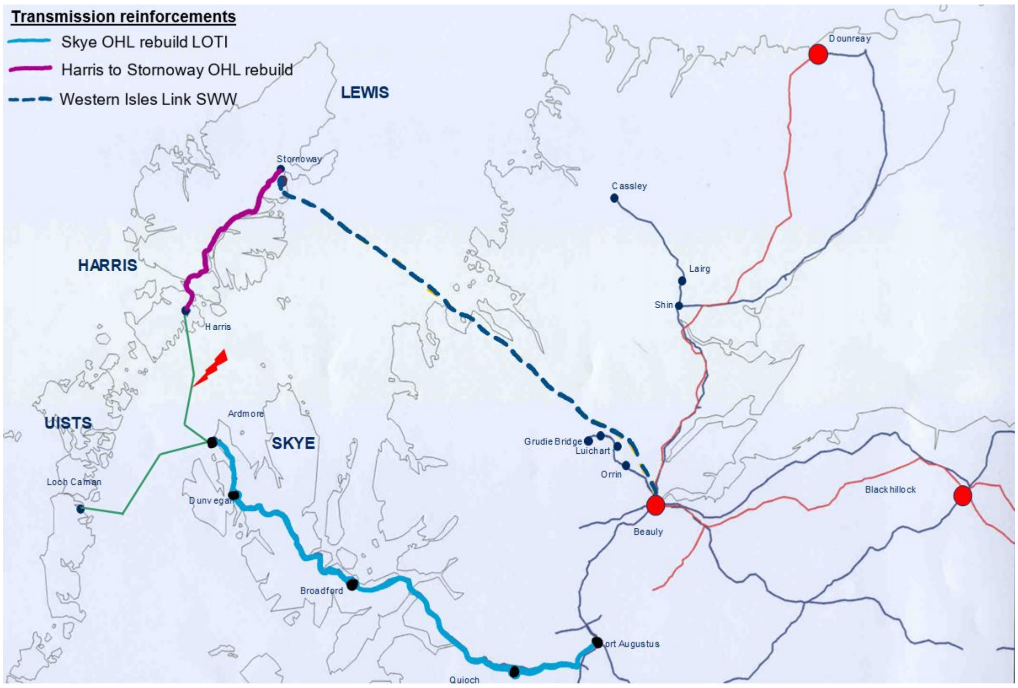


Figure 3. The Skye and Western Isles map showing planned transmission reinforcements and the faulted 33kV cable

SSEN Transmission worked closely with SHEPD in exploring whole system solutions for the replacement of the failed 33kV cable. A transmission option of 132kV cable was considered among other options but was not progressed as the delivery time was much longer compared to the 33kV solution and safeguarding security of supply was paramount. Our analysis indicated that a 132kV cable on its own or in addition to the SHEPD replacement 33kV cable would not meet all the generation capacity requirements on Western Isles. While a 132kV cable option would provide some capacity for renewable generation on Western Isles, it would not provide the primary solution for this. Due to the limited capacity of the 33kV subsea cable to Harris the case for the Skye OHL reinforcement is not strongly coupled to developments on Western Isles and the Western Isles link to Beauly at this time.

2.4.2 Existing Skye and Western Isles transmission network

Technical details of the Skye and Western Isles transmission network are shown in Figure 4 below, including the line section lengths, line summer pre-fault ratings and the generation and demand connected at various locations along the line.

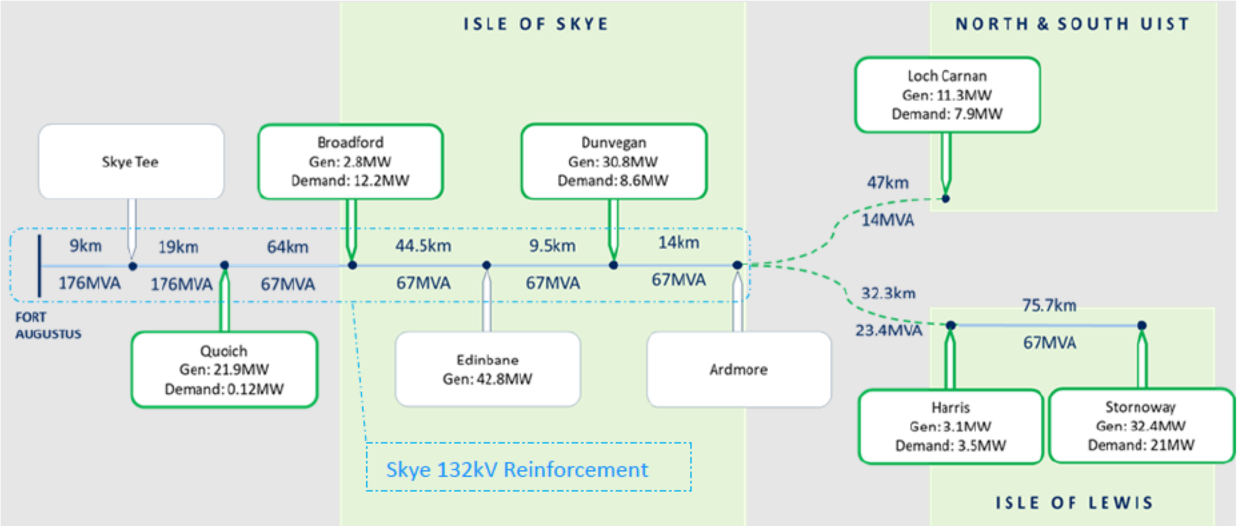


Figure 4. Existing Skye 132kV Transmission Network – Technical Details

From a Non-Load perspective, assessments on the existing steel construction OHL between Quoich to Broadford indicate that this section will need to be replaced by 2029. The strength of the wood poles on the line sections between Broadford and Ardmore is also deteriorating as the poles age, needing to be replaced by 2026. Further details of the asset condition of the line are presented in section 4.2. Both sections of the existing OHL have encountered repeated faults in recent years due to increased incidences of extreme events that are predominantly weather related, coupled with the deteriorating condition of the existing asset – the photographs in Figure 5 show recent line failures in 2018 and 2021.

Figure 5. a) Landslide in 2018 with toppled steel lattice tower highlighted, and b) 2021 wood pole failure

From a Load perspective, the Skye OHL is oversubscribed with a total of 137MW of generation connected on Skye and Western Isles against peak demand of 53MW. A derogation is in place to address this non-compliance with the NETS SQSS[10]. To enable connection of more generation to the Skye network, reinforcement of the line is required, following which the derogation will fall away. An additional 412MW of generation is contracted to connect on Skye.

[10] https://www.ofgem.gov.uk/sites/default/files/docs/2010/07/100709_shetl-western-isles-decision.pdf

3 Stakeholder Engagement and Co-creation

Stakeholder views have been instrumental in the development and design of the Skye Reinforcement project solution. This chapter describes our approach and plan for engaging with key stakeholders post-2018 following revision of the initial project scope, the full range of stakeholder views received and the ways in which these views have informed the project development process.

The 'golden thread' identified and evidenced throughout our engagement clearly indicates strong stakeholder support for a sustainable long-term solution to the replacement Skye line; which provides security of supply and allows incremental increases to capacity to support the connection of additional renewable generation, when such need is demonstrated.

It is abundantly clear that the majority of stakeholders are supportive of our overarching 'do it once, do it right' approach and we will continue to engage to deliver co-created detailed design proposals that are, on balance, mutually agreed and acceptable to local stakeholders along the Skye route and wider stakeholders too.

3.1 Stakeholder Engagement Plan

3.1.1 Our commitment to continuously improve

We are committed to continually improve our engagement with all stakeholders, conducting regular external assurance audits on both our Stakeholder Engagement Strategy[11] and delivery plans. We recently undertook the AA1000 Health Check, in association with the international consulting and standards firm, AccountAbility and are pleased to report a total score of 73% for their 2020/21 assessment. Our score means we continue to sit within the 'Accomplished' stage of the AccountAbility Stakeholder Engagement Maturity Ladder, increasing our score by 11% from 2019/20. Separately, we also maintained our 'Exceed' score in the audit of our compliance with RIIO T1 stakeholder engagement commitments and hope our scores give our stakeholders confidence in the quality of our stakeholder engagement.

3.1.2 Skye Reinforcement Project Overarching Engagement Plan

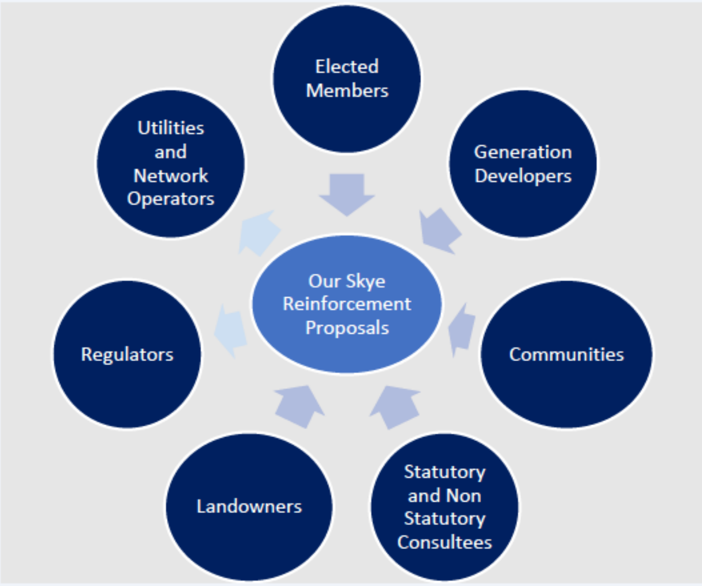
Our Stakeholder Engagement Plan for the Skye Reinforcement is closely aligned to our Stakeholder Engagement Strategy. It centres around timely engagement with a wide range of stakeholders and achieving, on balance, mutually acceptable outcomes and involved initially engaging with statutory stakeholders on viable solutions before engaging more widely with all stakeholders as we further refine the solution.

Engaging early with stakeholders means we have the best opportunity to develop mutually acceptable and agreed outcomes to inform the development and design of the Skye project solution.

To help support early engagement we initiated our Skye Reinforcement project optioneering and consultation relaunch as a pilot for consensus decision making through early and collaborative

[11] https://www.ssen-transmission.co.uk/media/5006/1-shet-stakeholder-engagement-strategy.pdf

engagement. This approach allows for meaningful stakeholder influence on decision making with robust and transparent processes for decisions on trade-offs and provision of stakeholder feedback.



Our Skye Reinforcement Project Stakeholders

Our engagement process began with identifying relevant stakeholders prior to appropriately engaging with each to help inform our approach.

The adjacent key stakeholder groups have been identified as having a direct or indirect interest, or influence, in the early project development through our robust stakeholder mapping methodology.

We continue to review our stakeholder identification approach ensuring the relevant stakeholders are included across each stage of the project development, construction and operational lifespan.

3.2 Stakeholder Engagement Process

In developing and testing options, through a series of proactive, timely and targeted engagements with key stakeholder groups, we have sought to understand stakeholder positions and will ensure as far as reasonably practical that these views are represented in the final design of the project solution, achieving consensual decision making.

90 landowners engaged with

Letters to 9,500 local properties

60 virtual constation attendees

11 meetings with elected members

130 consultation responses

To date, we have carried out extensive stakeholder engagement in the development of a co-created Skye proposal; an indication of the level of engagement undertaken can be viewed opposite, an overview of key engagement activity which has subsequently influenced decision making is outlined below and a full summary of engagement activities is contained within our supplementary documents and evidence, listed in Appendix 1.

3.2.1 Key Stakeholder Engagement Activities Undertaken

Collaborative Statutory Consultees Workshop – Q4 2019

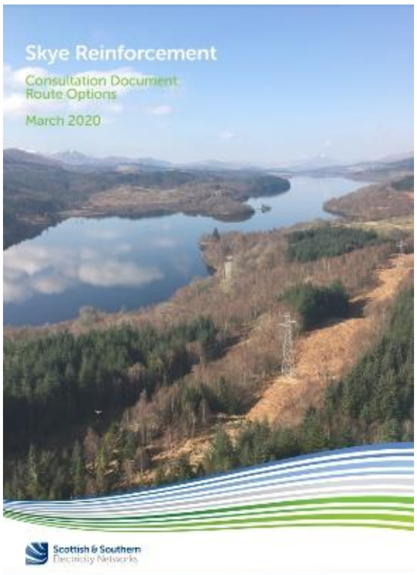
One of our first engagements since piloting our improved stakeholder approach was a collaborative workshop with the Energy Consents Unit at the Scottish Government, Statutory Consultees and

Elected Members in November 2019. This aim was to provide an overview of our Skye Reinforcement Strategy and approach to developing a long- term solution; and understand stakeholder's views to allow us to define the most appropriate development pathway. During this workshop, we co-created the stakeholder engagement plan for the optioneering and planning phase and provided first view of the potential options for the project, seeking feedback to assist in determining the preferred route option to take to formal consultation.

This session was attended by representatives from Scottish Environmental Protection Agency (SEPA), Scottish Natural Heritage, Historic Environment Scotland, Scottish Forestry, The Highland Council and the Energy Consents Unit.

Public and Statutory Consultation – Q2 2020

In March 2020, we began further detailing our plans for the project by seeking views on our Consultation Document[12] which presented the preferred 1km route corridor proposed for the replacement line. Virtual public consultation events in June 2020[13] (postponed from March due to COVID-19) provided an opportunity for local communities and wider stakeholders to put questions directly to the development team and share feedback on proposals[14]. Extensive supporting information was published to the project webpage and subsequent further engagements and meetings were undertaken to discuss stakeholder responses to proposals.



60 people attended the virtual consultation sessions, with 130 responses to the consultation received.

Understanding Skye's Future Energy Ambitions - Generation Developer Seminar – Q1 2021

To supplement our assessment of the generation potential on Skye and to provide further supporting evidence to the Cost Benefit Analysis (CBA), we invited all developers with plans to connect to the electricity network in this area, to confirm their connection interests via an on-line questionnaire.

The questionnaire was intended to form the basis of an objective view of generation development on Skye by better understanding the developer and development perspective. We wanted to explore the total capacity of projects that may emerge along with the timescales and location of these projects, including early stage development projects.

To help developers understand the need for this information and provide an update on the project, we hosted an online seminar including presentations from the project team and a Q&A session. This was also supported and attended by SHEPD staff representing the local DNO.

---

12 https://www.ssen-transmission.co.uk/media/4199/skye-reinforcement-project-consultation-document-march-2020.pdf
13 https://vimeo.com/419858095
14 https://www.ssen-transmission.co.uk/media/4642/ssen-transmission-skye-reinforcement-virtual-consultation-summary_.pdf

25 generators attended the seminar, and 13 questionnaires were received.

Stakeholder Advisory Panel and Network for Net Zero Stakeholder Group Feedback – Q1 2021

In early 2021, we also tested our stakeholder engagement approach for the Skye Reinforcement project with our SSEN Stakeholder Advisory Panel and SSEN Transmission Network for Net Zero Stakeholder Group. These are both made up of external stakeholders with a wide range of relevant expertise who advise and offer robust challenge to our proposals, and their views help us to understand the extent to which our plans reflect and meet the needs of stakeholders.

The Stakeholder Advisory Panel were supportive of our stakeholder engagement so far, recognising the value of holistic investment and encouraged us to continue to demonstrate the value of this to Ofgem. They also encouraged us to continue to clearly communicate to affected stakeholders where trade-offs were necessary and how these were decided. The Network for Net Zero Stakeholder Group were similar in their enthusiasm for our engagement approach and need for holistic investment. They also encouraged us to ensure the INC has stakeholder support and is stakeholder-led with clear evidence of where stakeholders have influenced the project development, including CBA assumptions.

Whole System Approach and CBA Engagement – Continuous

Our objective of assessing needs from a whole system point of view has led us to work closely with both the ESO and SHEPD on a continuous basis to ensure a whole system approach is considered. This involved collaboration in the exploration of options and discussions regarding impacts of considered solutions with both stakeholders, further described in sections 4 and 5.

Throughout the development of options and consideration of Whole System approach, the Skye reinforcement was regularly discussed with the ESO through the subgroup of the Joint Planning Committee at the fortnightly Project Coordination and Progress Review (JPC-CPR).

Throughout the CBA process, frequent ad hoc meetings were undertaken with the ESO to agree the CBA methodology and subsequent results once concluded, which has also included input from SHEPD. Engagement with the ESO has been integral to the CBA, as described in section 6.

3.3 Key Stakeholder Feedback and Actions Taken

In line with our commitment to undertake purposeful stakeholder engagement we have sought input, shared knowledge and built partnerships from our Skye Reinforcement stakeholder engagement activities. The following section highlights key feedback from our stakeholders and action taken so far based on their views.

3.3.1 Design and Build an Enduring Solution that recognises local and developer needs

Stakeholder feedback:

Stakeholders have asked that we develop an enduring solution which would avoid the need for additional infrastructure within the decade; to do it once and do it right, thus avoiding returning and disturbing the local environment and communities. Contracted customers require minimal risk of moving timescales and subsequent delay, whilst non-contracted customers want to ensure there is scope for facilitation of additional renewable generation. Recent supply failures have demonstrated to others, including landowners and elected members, that the existing assets require to be replaced and reinforced due to the connectivity limitations that constrain development on the Island and beyond. Network Operators wanted us to adopt a whole system approach to ensure an enduring, coordinated network solution was identified. These stakeholders provided recognition or support of the requirement for assets which are both reliable and alleviate connection constraints, and statutory consultees have confirmed that a holistic, long-term solution would be the optimum solution.

This feedback was predominantly derived from:

- Statutory and Non-Statutory Consultees
- Network Operators
- Landowners
- Developers
- Elected Members

Actions undertaken by SSEN Transmission:

- In identifying options, we undertook extensive and continuous engagement with the ESO and SHEPD, working collaboratively in order to deliver a whole system solution to the benefit of consumers
- The stakeholder ask to develop an enduring solution, required us to undertake an assessment of what additional generation will seek to connect in the coming years to provide us with a clear understanding, so that the project can be designed to accommodate this whilst delivering an efficient solution which reduces the overall costs to end consumers
- To supplement our view of the generation potential on Skye, we undertook a stakeholder engagement exercise consisting of an online questionnaire and webinar event, which alongside additional engagement identified some 1,071 MW of potential new generation projects in the Skye area.
- This data was then triangulated with data from multiple engagement sources including: review of projects with connection contracts; pre-application calls with developers; review of government data on renewable energy projects in scoping and planning; thus providing us with a vast amount of customer data
- This allowed us to support the ESO by providing them with the most accurate picture of future generation, which was subsequently accounted for within their CBA modelling and calculations. The ESO's approach to the CBA is therefore reflective of the power flows created by the generation of our developer stakeholders, validating an approach which encompasses the nuances in near team renewable energy growth.

3.3.2 Consider Alternative Technology in the Design of Infrastructure to Minimise Environmental and Visual impact

Stakeholder feedback:

As illustrated in Figure 1, in developing the route between Fort Augustus and Skye, the project was split in to seven Sections and stakeholder feedback was sought in regard to each Section of the route. We have been challenged to consider alternative design technologies for the infrastructure in localised areas, particularly in relation to Sections 2 and 3, where consultees highlighted a number of environmental sensitivities. Local Communities have also requested alternative technologies on sections of the preferred route based on concerns regarding the visual effect impacting tourism; especially during the anticipated economic recovery post COVID-19. Concerns have also been raised regarding wirescape in Section 6 on the approach to Fort Augustus Substation.

This ask was derived from feedback predominantly received from:

- Statutory and Non-Statutory Consultees
- Local Community Members

Action undertaken by SSEN Transmission:

- Investigation and further study of alternatives to steel lattice towers has been undertaken, particularly where there are concerns regarding visual amenity.
- We have initiated a subsea cable feasibility assessment to assess the potential use of the marine environment as a viable route within this section. An underground cable feasibility assessment is also being undertaken to review the potential for this technology within Route Option B in Section 3.
- In recognition of the concerns regarding wirescape impacts at Fort Augustus, use of alternative technology is also being considered in the vicinity of the Fort Augustus Substation.
- Close consideration of New Suite of Transmission Structures (NeSTS) as a potential OHL alternative is also being undertaken for further discussion with stakeholders during the preferred alignment consultations stage.
- We are currently seeking to host a follow up community meeting with residents in Section 3 to discuss the outcome of engineering assessments and share information on our bio-diversity strategy and examples of previous peat management successes.

Determination of proposed solution:

Following targeted meetings with key stakeholders, further information on undergrounding route options in regard to Section 2 and Section 6 will be shared during the Route Alignment Public Consultation Events which are due to be undertaken later in 2021.

This will allow the business to receive a full spectrum of comments on the proposed alternative technology; confirm if the proposed alternative solution meets stakeholder requirements and is mutually agreeable.

While engineering costs, environmental considerations, stakeholder feedback and likelihood consent approvals will be carefully considered and balanced in order to determine the final decision, the proposed technology will also be subject to regulatory approval.

3.3.3 Design an Optimal Route for Network Infrastructure Access and Deliver Compensatory Planting Locally

Stakeholder feedback:

Our stakeholders were clear that they require certainty and confidence that an optimal access strategy to the network infrastructure will be developed at any early stage of the process. This should take into account topography, must be tailored to landscape conditions and fully capture our short- and long-term requirements in relation to construction and future operation and maintenance. Access requirements are a key consideration in respect to landowners, forming the basis of discussion to date, and where applicable, landowners have requested we investigate the feasibility of utilising/upgrading the existing tracks used as part of the original Skye project.

During initial engagement there has also been a desire from Landowners along the length of the route to further explore compensatory planting proposals in collaboration with SSEN Transmission with the aim of ensuring all required compensatory planting is delivered on the individual properties impacted by the Skye project.

This feedback was received predominantly from:

- Statutory Consultees
- Landowners

Actions taken by SSEN Transmission:

- In Autumn 2020 we engaged a design contractor to provide confidence in an optimal access strategy tailored to local conditions, ensuring appropriate mitigations are designed in early on in the development process and considered in detail.
- On receiving our design contractor's initial proposal, we challenged them to provide a second more comprehensive and detailed reiteration, which will then be reviewed by our operations and engineering teams so that firm proposals can be presented to landowners and statutory consultees for comment.
- We've also began discussions regarding an alternative compensatory planting strategy which would see compensatory trees planted in the direct vicinity of the areas they are required to be removed from, rather than delivered in areas less relevant to the scheme.
- In doing so, we've created an early opportunity for more meaningful discussion regarding access requirements to take place during the preferred alignment consultation, allowing sufficient opportunity for stakeholder influence prior to final design.

3.3.4 Address Conflicting Concerns Regarding Impacts to the Landscape

Stakeholder feedback:

In relation to Sections 2 and 3 of the initially preferred route, consultees highlighted a number of visual or environmental sensitivities which may impact the landscape. In Section 2, concerns regarding potential significant effect on designated sites such as the Cuillin Hills National Scenic Area (Figure 6) caused some statutory consultees to suggest they may object whilst qualified support was provided by others, albeit whilst noting the landscape, visual and ornithological sensitivities. In Section 3, community stakeholders requested the route of the OHL be reconsidered based on concerns regarding proximity to dwellings, transport impact, noise, and visual impacts. This contrasted with the views of some statutory consultees, who cited the route as their preferred option based on aspects such as avoidance of wood removal.

Figure 6. Section 2: Cuillin Hills National Scenic Area

This feedback was predominantly provided by:

- Statutory Consultees
- Local Communities

Action taken by SSEN Transmission:

- Due to this feedback, no decision on proposed routes through Sections 2 and 3 was made
- An alternative route at Section 3, which would address community concerns is under consideration and further environmental and engineering surveys are in the process of being undertaken to seek to find an acceptable alignment and/or design solution.
- We are currently re-engaging key statutory consultees to enable early input and ensure a sound position regarding early design of the alternative Section 2 route is established prior to further wider Public Consultation in late Summer 2022.
- This process includes specific workshops to discuss Sections 2 and Section 3 respectively, the different types of design considered for these sections and our Habitat Regulations Assessment.

Determination of proposed solution:

As outlined in section 3.3.2, in regard to Section 2 of the route, underground cabling is being closely considered and final decisions will be subject to cost, technical and engineering considerations alongside regulatory approval.

Regarding Section 3 where there are competing interests in terms of route preferences, detailed design of viable route alignment options supported by environmental and legal consultancies is being undertaken to arrive at an option within the alternative route that is deemed to have the lowest possible impact on the designated.

Whilst it is believed this option will prove preferential to community stakeholders, we will continue to work with statutory consultees to agree a mutually agreeable route alignment and address subsequent consenting risks from statutory objection.

Ultimately, the final routing alignment will balance this risk with additional environmental, cost and engineering considerations.

3.3.5 Continue to Review and Improve Stakeholder Engagement Methods During the Pandemic

Stakeholder feedback:

The Skye Reinforcement was the first SSEN Transmission project to undergo virtual consultation in response to COVID -19. Following the engagement events in Summer 2020, suggestions for improvement were received and an eagerness to return to face to face engagement expressed from community stakeholders, with some communities reluctant to engage until such time that face to face meetings can be held.

This feedback was predominantly received from:

- Local Communities
- Elected Members

Actions taken by SSEN Transmission:

- Based on stakeholder feedback received, our project teams have explored and tested a variety of ways to improve stakeholder accessibility to project proposals. This includes distributing project information materials in advance to stakeholders in local postcodes; ensuring information is more visual; increasing map sizes in literature and offering supplementary online meetings and calls with project team members.
- Where there has been reluctance from community members to engage directly, elected members have offered to facilitate discussion and reiterate to constituents that we are flexible to engage in a format most suitable to them.
- We've utilised this offer to ensure we reach stakeholders and subsequently, a facilitated local MSP meeting was set up in early 2021, allowing the business to liaise with stakeholders whom until then, had not engaged directly with the process.
- We're working to identify ways in which face to face engagement can be safely achieved to accommodate stakeholder requests during Route Alignment consultation anticipated to be undertaken in late Summer/early Autumn 2021.

3.4 Next Steps in the Planning and Consent Phase

Initial engagement with key stakeholders has been extensive and is ongoing. The development of the proposed solution is currently transitioning from the routing process to the alignment process, whereby proposed alignments within the preferred route will undergo stakeholder consultation prior to formal selection.

Due to differing stakeholder views in some areas and ongoing works regarding feasibility of alternative options, we are mindful that decisions made at the route alignment selection stage are unlikely to reflect the full spectrum of stakeholder views.

Where there are competing interests meaning the final design proposals do not reflect the full views of all stakeholders, we will clearly explain any necessary trade-offs. This will include analysis of the hierarchy of stakeholders needs influencing how decisions have been considered. The rationale will also be fully explained and outlined within the Final Needs Case.

Upcoming stakeholder engagement activities

Based on the current programme, key stakeholder engagement activities associated with the planning and consent phases are outlined below.

The upcoming activities include detailed discussions and workshops with key stakeholders ahead of wider public consultations to share the preferred alignment and proposed technology for the Skye Reinforcement project. Table 1 shows the list of upcoming activities.

Table 1. Upcoming stakeholder engagement activities

Stakeholder	Activity	Anticipated Date
Statutory Consultees	Pre-Consultation Meetings/Workshops to discuss alignment, design technology and access	Q2/3 2021
All	Skye Reinforcement Newsletter	Q3 2021
All	Route Alignment Consultations – seeking comment on preferred alignment and proposed technology	Q3 2021
All	Publish Alignment Consultation Feedback Report	Q4 2021
The Highland Council (THC)	Ward Councillors Update Meetings and Leader of THC update meetings	Ongoing
Ofgem	Interface and update meetings	Ongoing
Elected Members	Project briefing notes and follow up meetings	Ongoing
Communities	Community Council, Community Liaison Group and Community Forum Meetings	Ongoing
Customers	Bi-Monthly interface meeting with primary developers	Ongoing
All	Pre-Application Public Information Sharing Events	Q1 2022
All	Submit Final Needs Case	Q2 2022
All	Submit S37 Application	Q3 2022

3.5 Stakeholder Engagement Conclusion

Our comprehensive engagement with key stakeholders and approach to triangulation to date has enabled the identification of requirements and requests at a stage in the development process which allows adequate time for these to be adapted into project refinement where necessary. This also allows space to discuss any required stakeholder trade-offs in working to determine the final project alignment. To this end, a golden thread between our stakeholder engagement strategy, engagement process and determination of solutions can be clearly demonstrated.

Key findings and stakeholder asks currently under consideration can be summarised as follows:

- Design and build and enduring solution that recognises both local and developer needs
- Sections 2 and 3 of the OHL route can be considered the most sensitive in terms of stakeholder opinions due to the conflicting stakeholder views identified and volume of feedback received
- Alternative technologies in locally and environmentally sensitive areas must be, and subsequently are being considered
- Any risks to programme and subsequent customer connection dates are a concern to our customers
- The Project Access Strategy is of significant interest to local stakeholders, needs to be designed optimally (including compensatory planting plans) and shared with all interested parties for comment ahead of refinement.
- Conflicting visual and environmental landscape concerns need addressed
- Ongoing stakeholder engagement methods should continue to be reviewed and improved in light of the Pandemic and must be carried out with local communities where concerns have arisen, preferably face to face

The engagement process to date evidences clear stakeholder understanding for the project need and support for the proposed 'build once' solution. Whilst concerns regarding some specific project details remain, these have been identified at an early stage and we are committed to continue working closely with stakeholders to ensure that, where reasonably practicable, these views are represented in the final project design.

Our engagement thus far has allowed us to conclude that:

- **The need for the project is widely recognised by stakeholders, both in terms of generation and demand requirements for facilitating renewable generation, and crucial for the maintenance of security of supply**
- **The proposed long-term solution outlined in subsequent chapters is strongly supported by key stakeholder groups**

4 The Need

The need for reinforcement of the Skye OHL is driven by the asset condition of the line and the requirement to provide efficient capacity for security of supply and accommodation of renewable generation seeking to connect on the Isle of Skye. We consider these drivers from a whole system perspective, looking at the long-term view of security of supply and generation requirements for the Skye/Western Isles region. In this chapter, we provide details of the drivers for undertaking the proposed works.

To meet future generation and demand capacity requirements and maintain security of supply, our development of the Skye reinforcement considers both the generation and demand (load requirements) and the risk associated with the asset condition of the existing OHL (non-load requirements). In order to reach a long-term economic solution, we take a long-term view of the asset risk as well as network capacity required for connection of renewable generation beyond the currently connected and contracted generation. We also consider the cost of asset intervention and the environmental impact.

4.1 Non-Load Need

The existing 132kV single circuit OHL from Fort Augustus to Ardmore is made up of distinct sections. In June 2017, we completed the rebuild of the 9km Fort Augustus to Skye Tee (near Invergarry) section of the line as a trident wood pole construction. This provides enhanced security of supply and greater network resilience to the Sky and Western Isles network. We are shortly due to complete the rebuild of the 19km Skye Tee to Quoich section as a trident wood pole construction by September 2021, replacing the original section which was constructed in the mid-1950s.

The 64km Quoich to Broadford (QB1) section, with double circuit steel lattice tower construction but strung on one side, was constructed in 1979. The line is strung with 125mm2 ‘Tiger’ ACSR phase conductors and supports a 60mm2 ‘Skunk’ ACSR earthwire.

The 68km Broadford – Edinbane – Dunvegan – Ardmore (BE1, ED1, DA1) single circuit trident wood pole section of the line was constructed in 1989. All sections of the of the BE1, ED1 and DA1 OHL were constructed to the ENATS 43-50 Trident wood pole design. Similar to the QB1 section, the OHL is strung with 125mm^2 ‘Tiger’ aluminium conductor steel reinforced (ACSR) phase wires, however no earthwire is present on the Trident design.

A comprehensive explanation of both the current and historical condition aspects of these assets is provided in the Asset Condition Assessment Report (ACAR)[15]. The recommendations of this report identified need for significant interventions on both the steel lattice tower and the wood pole OHL sections between Quoich and Ardmore.

It is worth noting that the current designs of both the steel and wood pole lines are no longer adopted in SSEN Transmission and any significant changes to their material requirements may constitute redesign or rebuild.

[15] Asset Condition Assessment Report: Quoich – Broadford (QB1) & Broadford–Edinbane–Dunvegan–Ardmore (BE1, ED1 and DA1) 132kV Overhead Lines, reference number T2BP-ACR-052

4.2 Asset condition assessment

Due to the remoteness, accessibility and general network sensitivity of the OHL circuits between Quoich and Ardmore routine inspections, data gathering, and appropriate remedial maintenance activities are a challenge but continue to be addressed. All available information from sources including asset records held in the Electronic Document Management (EDM) system, operational records and historic project files have been used to create an Asset Condition Report (ACR) on these circuits. Furthermore, recent information from sources such as Cyberhawks iHawk database platform and high-resolution digital imagery from PDG Helicopters have assisted in the asset condition assessments.

The findings from this assessment are summarised below and further detailed in our document reference: T2BP-ACR-052 'Asset Condition Assessment Report for Quoich – Broadford (QB1) & Broadford–Edinbane–Dunvegan–Ardmore (BE1, ED1 and DA1) 132kV OHLs.

4.2.1 Asset Condition Summary - QB1 – Steel Tower Line

The key findings of the asset condition assessment of the QB1 line are as follows:

A significant presence of surface rust is noted on the tower structure steelwork of QB1 in the more exposed and coastal regions towards the Kylerhea crossing between the mainland and Isle of Skye. The towers are largely exhibiting surface corrosion on the face due to the prevailing weather conditions. Without intervention it is forecast that the steelwork will deteriorate further to beyond a state from which it can be refurbished. Similarly, step bolts are also exhibiting significant rusting throughout the route.

Phase fittings, specifically U-bolts and shackles are generally in good order following their replacement in recent years.

Approximately 23% of earthwire fittings and attachments are graded '3' or above indicating poor overall asset condition with medium to high levels or rusting and component wear.

No significant deterioration has been identified in the electrical performance of insulator strings. However, the mechanical condition of insulator dishes has highlighted moderate to severe corrosion across the ferrous components of almost all insulator bodies. These condition factors, considered in conjunction with the age of the insulator string components (47 years against a 40-year design life), indicates that they are within their 'end of life' window and that their replacement should be considered in any asset intervention strategy.

Non-destructive conductor assessment studies carried out in 2001 and 2019 indicate an ongoing process of zinc loss from the galvanic coating of inner steel conductor strands. Analysis of the results indicates that the point at which zinc protection is expected to have been lost currently sits between 7 and 10 years taking the latest period for intervention to the RIIO-T3 period in years 2026-2029. This prediction is based on typical degradation rates seen in conductor samples.

Minor concrete wear and a loss of the protective paint coating are the primary deteriorative states presented by the foundation muffs. It is reported that approximately 6% of foundation muffs are exhibiting significant concrete wear and/or damage and thus will require remedial action to be taken.

Around fifty-six towers have been identified as having six-stranded anti-climbing devices (ACD) installed rather than the currently specified nine-stranded design. These, along with all tower signage, should be upgraded as part of any works to bring the circuits up to current specification standards.

An analysis of fault records would indicate that are a number of historic lightning strikes recorded but not in significant quantities or groupings such as to raise concern.

A landslip event near to Quoich dam in November 2018 is not considered to be an asset component failure as all sustained asset damage resulted from extreme external influencing factors out with practicable design considerations.

Failure of an insulator shackle at the middle crossarm of Tower 92 in March 2021 was due to mechanical wear over the life of the asset. This resulted in the circuit being out of service for an extended period while repair and maintenance activities were conducted at Tower 92 on all three phases and adjacent suspension towers. The shackle failure resulted in the full inspection of all fittings on the QB1 circuit, the results of which have contributed to this report. Figure 7 shows details of this failure.

*Figure 7. **a**) Tower 92 QB1 Circuit Middle Phase Shackle Failure and **b**) example of similar Shackle and point of Failure showing Extreme Wear*

4.2.2 Asset Condition Summary – BE1-ED1-DA1 – Wood Pole Lines

Testing of the wood poles on these circuits in 2010/2011 identified that the modulus of rupture (MoR) of installed poles equates to approximately 77% of specified standard values in ENATS 43-88. Wood poles installed along the length of the circuit therefore have a lower structural capability than expected of assets of this type, when subject to bending moments. This indicates that there is a significant increase in the risk of wood pole failure, particularly on single wood pole configurations in the exposed extreme environmental conditions typical to the location of these assets.

A pole failure on the BE1 circuit in February 2021 confirmed the presence of white rot fungi (Basidiomycetes) along the length of a section of the failed pole recovered from the field. This form of wood decay results in significant loss in strength through Pocket rot. This provides further evidence of the overall weakening of these wood pole structures and the need for intervention. Details of this failure are shown in Figure 8.

(a) Pole 190 failure on BE1 Circuit *(b) Pole 190 section*

Figure 8. graphic details of the failed pole 190 on BE1 line on 23 February 2021

It is clear that the existing wood pole assets no longer meet the design criteria of these OHL circuits. The strength and capabilities of the wood pole configurations, under extreme weather conditions, will result in further asset failures, indicating that replacement is required.

A review of the conductor between Broadford to Ardmore indicates it approaching its design life during RIIO T3 period and will follow a similar trend in deterioration to the conductors strung on the QB1 circuit, given they are the same type and subject to the same environmental conditions.

Assessment of the steelwork identified twenty-two crossarms which are classed as grade ‘4’ (surface rust covering greater than 40% of the bar surface area) with a further twenty-one classed as grade ‘3’ (surface rust covering less than 25% of the bar surface area) on the DA1 section. This is primarily due to this section of the line’s proximity to the coast. Visual assessment of the available imagery indicates that the corrosion is not severe.

All insulators and fittings, including insulator bracket supports and conductor clamps, are in good condition with no issues identified.

ACDs have been assessed to be in good condition with only minor corrosion identified at two locations.

Signage including circuit IDs, colour plates and safety signs have been assessed as ‘readable but degraded’ throughout due to fading or rust stains.

4.2.3 Asset Report Conclusions

The conclusions drawn from the Asset Condition Report on the QB1 and BE1-ED1-DA1 line is that the following non-load interventions are required:

QB1

On-line refurbishment of the existing tower line to include:

- replacement of existing phase and earthwire conductor.
- replacement of all insulator assemblies, including shackles and U-bolts.
- preparation and painting of tower steelwork and replacement of any damaged or significantly deteriorated members.

Given the extensive scale of the works, the challenging terrain, the impact of outages on security of supply and the change in OHL design standards since the line was built, a wider range of intervention options needs to be investigated considering these and other requirements for the Skye network. Section 5 of this document explores these options.

BE1-ED1-DA1

Replacement of all wood pole structures as they are no longer deemed 'fit for purpose' for the environment in which they were installed and are now at the end of their useful life. Based on this, a full structural replacement of the existing wood pole overhead line is recommended.

4.3 Load need

There are two key elements to the load driver for the Skye reinforcement project. These are the need to provide demand security at Broadford Grid Supply Point (GSP) and overall improvement of supply security for both Skye and the Western Isles and to increase the capacity of the Skye transmission system to accommodate additional renewable generation seeking connection.

4.3.1 Security of Supply

The security of supply for Skye and Western Isles is mainly dependent on the single transmission circuit running from Fort Augustus, augmented by standby diesel generation and very limited distribution backfeeds from other points on the network. Any reinforcement works must deliver improved security of supply by improving the reliability of the Skye transmission network. It is also advantageous to reduce reliance on diesel which is both costly and environmentally damaging.

Security of supply on Skye and Western Isles

With only one OHL supplying Skye and the Western Isles, any outages on this line – whether planned or unplanned result in loss of supply. Table 2 shows the maximum and minimum demand at each GSP supplied by the Skye circuit. The maximum coincident peak demand on Skye and Western Isles is 53MW.

Table 2. Existing demand supplied by the Skye 132kV single circuit line

Grid Supply Point	Maximum Demand (MW)	Minimum Demand (MW)
Quoich	0.12	0.07
Broadford	12.2*	2.64
Dunvegan	8.6	1.72
Ardmore (Loch Carnan)	7.9	1.68
Harris	3.5	0.35
Stornoway	21	3.46

* This is the existing demand and does not include the contracted 10MW demand.

Secure demand connection at Broadford

SHEPD has applied for, and signed a connection contract for, a 10MW firm demand connection at Broadford GSP by 2025. Currently, there is a single 30MVA grid transformer at Broadford GSP. As part of the connection modification works, a second transmission infeed is required to achieve the required security for the Broadford demand.

4.3.2 Compliance with demand security criteria

In accordance with the demand security criteria of the Engineering Recommendation ER P2/7 (applicable to Distribution) and the NETS SQSS (applicable to Transmission), group demand supplied by the Skye 132kV radial line is classified as Class C. In the event of loss of supply, the security standards require that the smaller of the group demand minus 12MW and two thirds of the group demand should be restored within 15 minutes with the total group demand restored within 3 hours. The existing demand security compliance is met for the following criteria:

i) NETS SQSS - Demand Connection Criteria Applicable to the Onshore Transmission System

The existing 132kV Transmission circuit is a single radial circuit, therefore does not provide for redundancy. The demand is secured to the distribution system under legacy Customer Choice provisions under 'Variation to Connection Design' criteria in sections 3.17 to 3.20 of the NETS SQSS.

ii) Engineering Recommendation ER P2/7

Demand security compliance at the Distribution level is achieved through ER P2/7 and the provision within the Distribution Code DPC4.2.1 which allows SHEPD to plan its distribution network to an alternative standard set out in PO-PS-037 (Distribution Planning: Standards of Voltage and Security of Supply).

To restore supplies during prolonged outages of the Skye transmission circuit, SHEPD relies on mobile diesel generators on Skye and the diesel generation at Stornoway as well as diesel generation on the Uists – at Loch Carnan and Barra. Given the light construction of the transmission line over the most challenging terrain and its age-related condition, its reliability is poorer compared to other lines. This line also has an environmental impact due to the high carbon intensity of the backup diesel generators. As the line is coming to the end of its economic life, this presents an opportunity within this reinforcement project to improve its performance.

On completion of the proposed Skye reinforcement, Demand Security would comply with the NETS SQSS requirement for Skye, however the Western Isles would remain dependent on the provision within the Distribution Code DPC4.2.1 and would be subject to additional reinforcements outside the scope of this submission to meet the NETS SQSS and ER P2/7 criteria.

4.3.3 Future demand

In February 2021, the Scottish Government published a draft Heating in Buildings Strategy which will introduce greater levels of support for fuel poor households to install zero emissions heating systems such as heat pumps and heating networks[16]. The government is committed to taking action to rapidly scale up deployment of zero or low emissions heating systems in order to meet climate targets and ensure long-term delivery of net zero objectives. By 2030 around 50% of homes or over a million households, will need to convert to zero or low emissions heating systems. Reducing emissions from homes will mean converting the vast majority of the 167,000 off-gas grid homes that currently use high emissions fuels such as oil, liquefied petroleum gas (LPG), and solid fuels to zero emissions heating.

The rural and remote areas of the Highlands and Islands such as Skye and Western Isles experience high prices for oil, LPG and solid heating fuels. This has already resulted in high levels of electrified heat in these areas. With 44% of homes in Scotland (including Skye) not connected to the mains gas network,[17] it is likely that heat pumps will play a strong role in heat decarbonisation in Scotland which has the potential to further increase the electricity demand. Furthermore, a joint study by SSEN Transmission and NGESO found that the opportunity to provide demand side flexibility services to reduce network constraints costs by avoiding curtailment of wind generation could incentivise consumers to switch to electric heating[18].

Demand growth for Skye and Western Isles is considered in the context of NGESO's four Future Energy Scenarios[19] namely; Steady Progression (SP), Consumer Transformation (CT), System Transformation (ST) and Leading the Way (LtW). The Consumer Transformation scenario is one of the most aggressive demand growth scenarios and is most aligned with the increase in electric heating, high energy efficiency, uptake in electric vehicles and demand side flexibility. Under this scenario, peak demand in the Skye and Western Isles could increase by up to 68% by 2050. This included electric vehicles demand and it would still be much lower than the currently installed generation capacity.

4.3.4 Need for network capacity to connect generation

There is significant interest from renewable generation developers to connect to the network on Skye and Western Isles. Whether connection interests are at transmission or distribution level, ultimately their impact on the transmission system is significant. It is important to quantify the need for network capacity based on currently known information and a view of potential development

[16] Draft Heat Buildings Strategy. Available at: https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings-consultation/pages/2/
[17] SSEN DFES 2020. Available at: https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=20282
[18] 4D Heat. Available at: https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=19929
[19] Future Energy Scenarios: Available at: https://www.nationalgrideso.com/document/174541/download

consistent with the net zero pathways. Further details on potential future generation developments are provided in section 4.3.6.

4.3.5 Compliance with generation connection criteria

The amount of generation connected to the existing Skye single 132kV circuit, directly or via the distribution network, is 137MW excluding diesel generation. This includes around 100MW generation on Skye. With the capacity of the line at 67MVA summer pre-fault rating, considering the level of current demand and potential future demand growth, the line is oversubscribed. In 2009, SSEN Transmission applied to Ofgem for derogation from the generation connection criteria of the NETS SQSS in respect of this line. This was granted in 2010[20] based on the provision that the ESO is able to manage the generation on this line economically, with no new generation connections beyond that assessed at the time allowed until suitable reinforcement of the line is completed.

4.3.6 Generation growth

The north of Scotland transmission network has grown significantly over the past decade in response to the need to accommodate new, predominately renewable generation. Looking forward, prevailing national policy objectives associated with achieving net zero greenhouse gas emissions by 2045 in Scotland indicate continued growth in renewable generation.

In order to address uncertainties in future generation growth, a multi-scenario approach, consistent with the ESO Future Energy Scenarios (FES) was adopted. We contracted GHD to develop four generation scenarios for the Skye area with a yearly resolution to 2050. The Skye scenarios were developed through a combined approach of stakeholder engagement and the use of GHD's probability of generation assessment tool (PGAT). In order to align the Skye scenarios with the most up-to-date FES, they were compared to the FES 2020 for the Skye area, with differences identified and justified. Further details on the development of the Skye generation scenarios are available in the GHD CBA report (provided in the list of supporting documents in Appendix 1).

2020 FES

FES 2020 for Skye identified up to 320 MW of new generation that could emerge over the period to 2050, adding to around 100 MW of generation currently existing in the Skye area. Figure 9 shows the FES 2020 new generation for the Skye area over the period to 2050.

[20] The Ofgem letter on the granting of the derogation is available online at https://www.ofgem.gov.uk/sites/default/files/docs/2010/07/100709_shetl-western-isles-decision.pdf

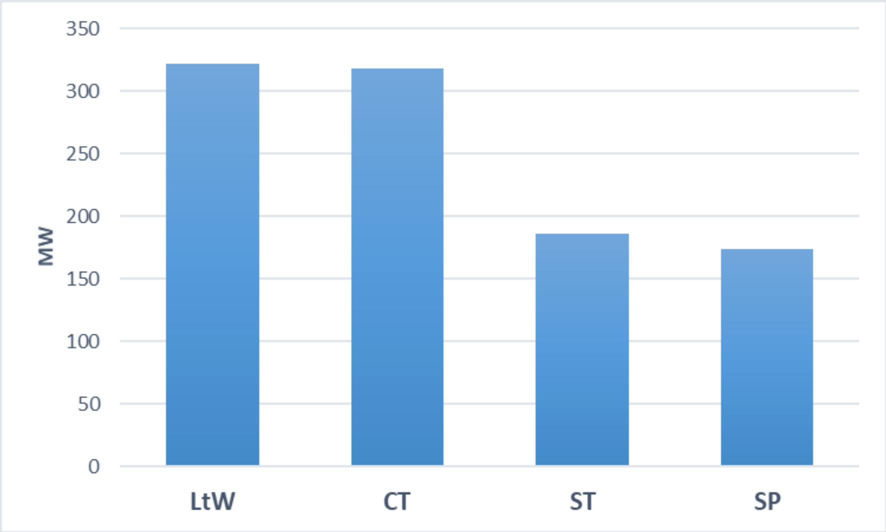


Figure 9. FES 2020 new generation development on Skye by 2050

New generation in LtW (Leading the Way) and CT (Consumer Transformation) is around 320 MW whereas growth in ST (System Transformation) and SP (Steady Progression) is considerably lower at 184 MW and 174 MW respectively. SP, with its considerably lower renewable growth, fails to meet the UK government's net zero target and also fails to meet the Scottish government's more ambitious net zero by 2045. LtW meets the 2050 target early and is more aligned to the Scottish government's 2045 target, while CT and ST meet net zero by 2050, although ST is highly dependent on a significant, unprecedented move to hydrogen, in particular 'blue' hydrogen produced via steam methane reforming using natural gas combined with Carbon Capture, Usage and Storage (CCUS).

The Scottish government has made clear its climate change targets mean Scotland will need to continue to move from a low to a zero carbon electricity system, including developing further onshore wind identified as one of the lowest cost forms of new generation[21].

However, the FES are GB scenarios and are not intended to capture the specific detail of generation development at a highly granular level, such as the relatively small Skye network. Furthermore, the FES are annual 'rolling' scenarios used for 'what if' planning purposes and are updated annually in response to market, policy and economic developments. It is worth noting that wind generation in the north of Scotland FES has been upwardly evolving on an annual basis over the past five years as the UK moves towards net zero aspirations and policies and technologies evolve – as shown in Figure 10.

[21] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/pages/7/

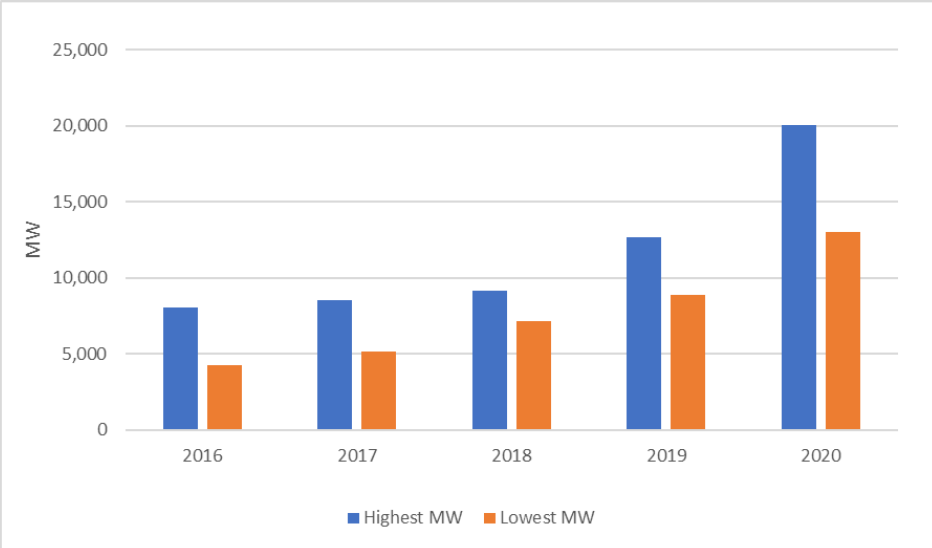


Figure 10. North of Scotland 2016-2020 FES total installed wind generation assumptions by 2040

Contracted generation

Since the FES 2020 were developed in early 2020, contracted generation on Skye has grown substantially. Figure 11 shows the growth in contracted generation capacity between January 2020 and July 2021 – with contracted capacity increasing over fourfold. Contracted capacity is highly influential in the development of the FES as the key indicator of generation potential. The recent growth in contracted capacity is partly as a direct result of our Skye Strategy paper published in December 2019, with developers anticipating an increase in grid capacity and therefore the potential to connect. Given the relatively high costs of generation development, developers are reluctant to invest in pre-development without the real prospect of a connection.

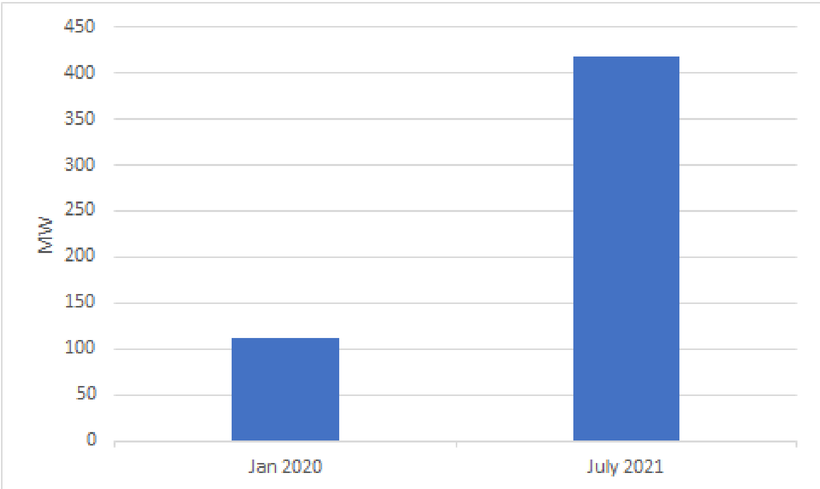


Figure 10. Contracted generation growth on Skye (distribution and transmission)

Table 3 shows a list of contracted generation dependent on the Fort Augustus to Ardmore 132kV line comprising of eight generation schemes with a total capacity of 418MW and one demand scheme with a capacity of 10MW. Four generation schemes, including extensions, with a total capacity of 107.6MW have obtained planning consents, while the rest are in scoping or the early stages of development. Five generation schemes with a total capacity of 86MW and the one demand scheme have a contracted connection date of December 2025.

The type of contracted developers on Skye are a mix of experienced large and independent developers. [redacted]

Due to the radial nature of the network on Skye and the generation capacity requirements against the proposed line capability, the schemes are connected on both firm and non-firm connection arrangements. The non-firm access to the system has been contracted under the NETS SQSS Design Variation[22] based on customer choice. [redacted] Any future additional generation would also be expected to Connect on a non-firm basis subject to size and assessment at time of application. This is the most economically optimal network investment.

[redacted]

Table 3. List of contracted generation dependent on the Skye OHL reinforcement

Developer	Project	Capacity [MW]		Date	T/D▪	Consent Status
		Dem.	Gen.			
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
	Total Capacity	**10**	**417.6**			

* Also known as [redacted]

▪ Transmission (T) or Distribution (D) contracted

While contracted capacity is a useful indicator, it will not identify all potential growth as other projects may emerge over the 45-year economic life of a new network that are at much earlier stages of development. The generation scenarios developed for the Skye CBA attempt to balance the rolling annual upward trajectory of Scottish wind generation growth evident in the FES with a granular view of long-term generation potential on Skye. The Skye generation scenarios also provide a single 'snapshot' that adequately identifies a sufficiently broad range of long-term potential generation growth.

[22] NETS SQSS paragraphs 2.15 to 2.18 provide criteria for variation to generation connection designs arising from customer choice.

Stakeholder input

To supplement our view of the generation potential on Skye, we undertook a stakeholder engagement exercise via an online questionnaire and webinar event. Views were also sought from the Highland Council via a virtual presentation and discussion. The stakeholder engagement and additional analyses identified some 1,071MW of potential new generation projects in the Skye area, considerably in excess of the potential identified in FES2020 and more than double current contracted capacity. The substantial potential generation background identified projects at a range of development stages, from scoping to fully contracted with planning permission, and is consistent with the recent growth in contracted capacity, highlighting the impact of grid investment anticipation. The projects identified include credible developers and some projects ready to build to add to those already operating. We consider the level of interest uncommonly high in an area that does not have sufficient existing grid capacity to energise any new projects of even moderate scale

The online questionnaire formed the basis of an objective view of generation development on Skye by better understanding the developer and development perspective. This allowed us to explore the total capacity of projects that may emerge – the scenario 'envelope' – along with the timescales and location of these projects. It also allowed us to gain a better understanding of potential projects at the earlier stages of development. The questionnaire asked about additional factors that influence project development such as expected capacity factors, levelised cost of energy, constraint costs, community involvement, route to market, connection costs and potential project capacity ranges. This information informed the generation capacities underpinning the generation scenarios.

Figure 11 shows a summary of questionnaire responses for expected capacity factors of proposed wind farms on Skye, expected levelised cost of energy (LCOE) and anticipated constraint cost developers would consider acceptable. Expected capacity factors on Skye are good for onshore wind, ranging from [redacted] while LCOE estimates range from [redacted]. The range of acceptable constraint costs is wider – [redacted].

[redacted]

Figure 11. Questionnaire responses – ranges for some key project factors

While projects that have achieved planning have a known capacity, those in the earlier stages of planning are likely to have an evolving capacity, with planning, terrain and turbine choice all influencing overall project capacity. Developers indicated a greater expectation of downside capacity adjustments, with the average view that their projects would remain viable at 65% of their expected capacity. Conversely, the use of larger turbines, improved access and positive planning resulted in a potential upside of [redacted] of expected project capacity.

We also asked stakeholders about their preferred route to market, for example subsidy or an alternative 'revenue' stacking approach. [redacted] of respondents stated they are seeking a revenue stacking model, including power purchase agreements (PPAs), ancillary services, balancing market, private wires and capacity market revenues. Of the remaining [redacted], the majority suggested subsidy would comprise around [redacted] of projected revenues. [redacted]

The insights gained from the stakeholders were useful in the development of generation scenarios for Skye and they helped us to reach credible outcomes. We also used this information to inform our views on appropriate sensitivities on market balancing costs. These sensitivities are covered in section 6.3.7.

Generation assessment

Our engagement showed that there are [redacted] projects at various stages of development. Information from the engagement was processed using GHD's 'probability of generation assessment tool' (PGAT). PGAT 'scores' projects against a range of criteria identified as primary indicators of project development potential. The key project drivers and their respective weightings in the project scoring system are outlined in Table 4.

Table 4. PGAT criteria and weightings

<table>
<tr><th colspan="2">Project drivers</th><th>Weighting (%)</th></tr>
<tr><td colspan="2">Network Contractual Status</td><td>12.5</td></tr>
<tr><td colspan="2">Project Planning Status</td><td>32.5</td></tr>
<tr><td colspan="2">Ownership / Financial Considerations</td><td>10</td></tr>
<tr><td colspan="2">Distribution or Transmission</td><td>10</td></tr>
<tr><td colspan="2">Economies of scale</td><td>10</td></tr>
<tr><td colspan="2">Distance to Connection</td><td>25</td></tr>
<tr><td colspan="2">Total</td><td>100</td></tr>
<tr><th colspan="3">Additional project drivers for projects in the pre-planning phase</th></tr>
<tr><td rowspan="3">These drivers are used as an additional scoring factor to further differentiate projects in pre-planning/planning</td><td>Location favourability</td><td>Projects scored against Council's wind spatial plan</td></tr>
<tr><td>Tip height</td><td>Tip height in excess of 150m is considered unfavourable for planning – based on Council feedback</td></tr>
<tr><td>Community funding</td><td>Projects with more generous community funding plans score higher</td></tr>
</table>

While six key project drivers are identified, it is clear that the 'planning' criterion is the most important driver of project success and is therefore awarded the highest weighting of 32.5%. While projects that have planning or are in the planning process are relatively simple to score against the criteria, those that are at earlier stages of development are harder to score. As a result, we created a range of 'additional project drivers' to be used for those projects that are in the pre-planning/planning stages of development.

Achieving planning is a major factor in potential project development, but it is also a relatively costly exercise requiring detailed site design and environmental impact assessments, including bird studies. Developers are more reluctant to engage in extensive planning if the availability of grid capacity is uncertain to fully facilitate project development. The additional drivers considering projects in the pre-planning/planning phase are intended to provide further clarity around the current development potential of these prospective projects.

Council engagement identified some project characteristics that would be considered beneficial for a wind farm as it enters the planning process, including tip height and community funding. The Highland Council has a wind 'spatial' plan that outlines areas it considers broadly amenable to wind farm development and areas of more significant protection. However, the Council also stressed that this was a guide only and individual wind farms might be developed outside the areas highlighted as 'potential for development.' In an attempt to provide differentiation between the projects at the pre-planning/planning stage that would all score similarly against the 'planning' criteria – we further scored these projects on the additional criteria of:

- Tip height
- Community funding
- Spatial plan

Detailed descriptions of all the project drivers are provided in the GHD Skye CBA report.

Skye generation scenarios

The PGAT process provides an overall 'score' for each project and ranks projects. In addition, it provides each project with a 'probabilistic' capacity based on how it scores across the criteria. A project's PGAT 'score' is used to identify which Skye scenario the project falls within. Those scoring in excess of 60 out of 100 are assumed to progress in Scenario 1 – with the '60' score and resulting scenario generation broadly aligning with the lowest FES 2020. At the other end of the scale, projects scoring above 45 progress in Scenario 4 – where around two thirds of the 1,071MW of potential generation identified progresses.

Projects over [redacted] and at an early planning stage also have their proposed capacity adjusted to reflect uncertainty around planning in particular – with their 'probabilistic' capacity calculated by PGAT used in the scenarios rather than their higher proposed capacities.

The result is a set of four plausible scenarios with a relatively wide range of outcomes based on an objective evaluation of all projects identified within the Skye area. The outcome provides a suitable scenario snapshot of potential long-term generation outcomes for Skye. The scenarios were developed to broadly fit within the evolving FES. The resulting scenarios are shown in Figure 12.

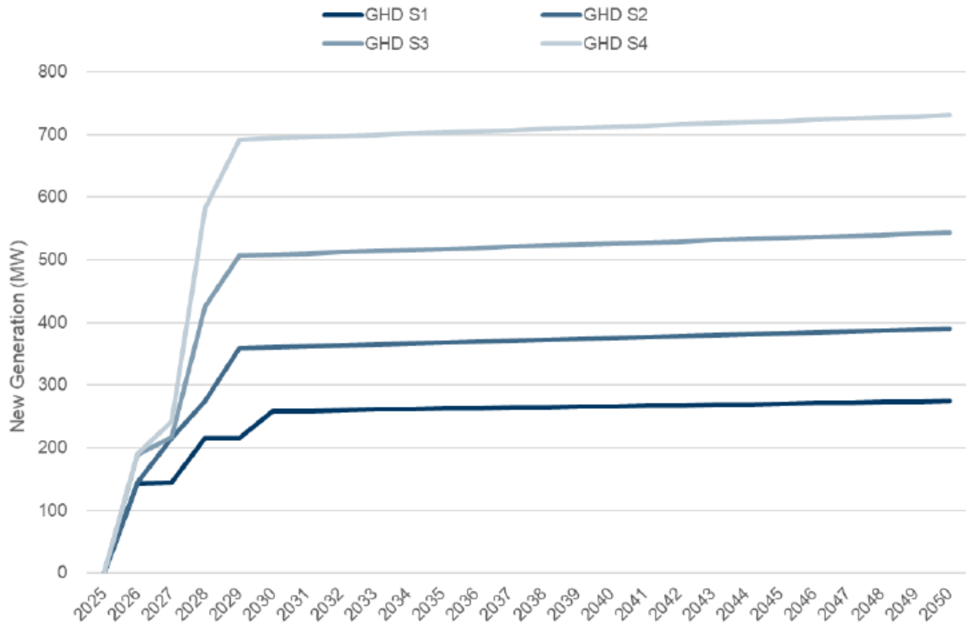


Figure 12. Skye new generation scenarios

Ofgem feedback

While Ofgem is broadly content with the PGAT approach and its results, it suggested changes to the criteria weightings in the model Table 5 shows Ofgem's adjustments to PGAT's criteria weightings.

Table 5. Ofgem adjustments to PGAT criteria weighting

Categories	Original Weighting (%)	Ofgem Weighting (%)
Network Contractual Status	12.5	10
Project Planning Status	32.5	40
Ownership / Financial Considerations	10	10
Distribution or Transmission	10	5
Economies of scale	10	10
Distance to Connection	25	25
Total	**100**	**100**

Ofgem's proposed elevated 'planning' weighting to 40% heavily skews the scenarios to the current planning status of all projects. Planning is a vital component of project development – but a project's planning status can and will change over time, driven in part by the availability of grid capacity. Planning is the criterion where there is most movement in scores over the next few years, particularly as the 'anticipatory impetus' associated with the Skye network reinforcement increases. Weighting planning heavily distorts the scenarios to the short term leading to the current planning status of all projects more strongly driving the scenarios. The impact of this shown in Table 6 on a long-term horizon to 2050.

Table 6. Impact of Ofgem criteria weightings on scenarios

	S1	S2	S3	S4
Original [MW]	273.3	387.8	539.2	723.9
Ofgem criteria [MW]	204.8	330.5	448.4	560.7

With planning set at a 40% weighting, S1 would represent a scenario where only an additional 97MW of generation without current planning permission is developed on Skye over the next 30 years, including large wind, hydro, solar and small-scale wind. With 20MW of S1 growth assumed to be small scale embedded generation growth (rooftop solar PV, small hydro and small-scale wind), the Council would be awarding planning to only 77MW of new, larger scale wind farms. With the Scottish and UK government net zero targets and Council commitment to renewable energy development, and exploiting its benefit for the fuel poor, including community benefits, we are concerned that S1 will lack credibility. The scenario 'threshold' scores were set at a level to create a plausible and yet very low scenario that also broadly related to the FES. We consider a low scenario of around 275 MW more plausible and justifiable to stakeholders given the strong generation background.

Similarly, a high scenario of 561 MW does not represent a true 'stress test' of potential renewable capacity growth for the area over the next 30 years. While this is a plausible scenario – we do not consider it truly represents a 'high' potential long-term scenario outcome.

Ofgem sensitivity

As three of the 'Ofgem scenarios' sit within the existing GHD scenario envelope, it was agreed that Ofgem's S1 would be run as an additional lower scenario 'stress test' to GHD's scenarios. Total new generation in the 'Ofgem' scenario is 205 MW.

Western Isles sensitivity

Skye connects to the Western Isles via two 33kV subsea cables – one of which recently failed. In order to expedite power restoration to the Western Isles, SHEPD is replacing the failed 33kV cable with another 33kV cable. However, when considering the wider Skye/Western Isles region in the longer term, there will be need to provide additional capacity to Western Isles for connection of renewable generation there. In considering replacement options for the failed 33kV cable, a 132kV cable option was considered on its own or additional to a 33kV cable but in both cases, it would not provide the capacity required for all the contracted generation on Western Isles. On the other hand, there are established plans to construct an HVDC link[23] from Western Isles to Beauly to provide capacity for Western Isles generation. To evaluate the impact of potential additional power flows from Western Isles onto the Skye network should an additional 132kV cable be installed between Skye and Harris in the future, we have developed a scenario allowing around 115MW of generation to flow from Western Isles to Skye. This was used as a higher scenario 'stress test' to the GHD scenarios.

The impact of both the lower Ofgem scenario and the higher WI scenario on the existing scenario envelope is shown in Figure 13.

[23] The Western Isles HVDC Link SWW Final Needs Case was conditionally approved by Ofgem and is currently awaiting developer commitment. Further details available on Ofgem's website https://www.ofgem.gov.uk/publications/update-western-isles-transmission-project-and-potential-next-steps

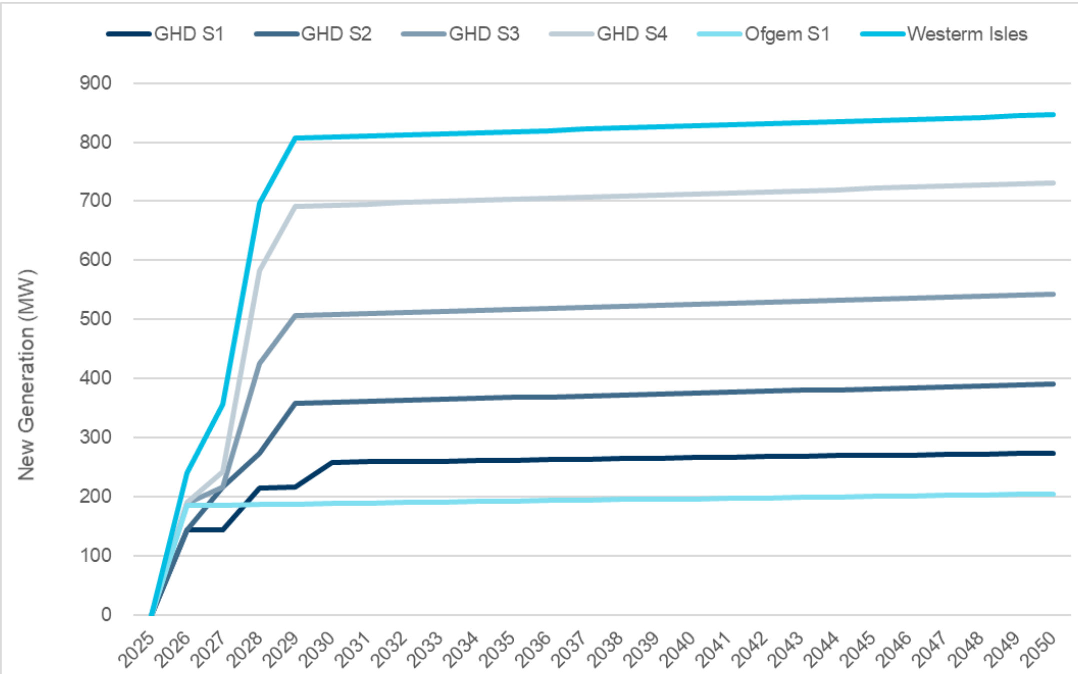


Figure 13. Scenarios with Ofgem and Western Isles sensitivities

4.4 Summary of Need

The load and non-load need for the Skye reinforcement is presented in this section, with the non-load need forming the primary driver for this reinforcement. The non-load need is driven by the asset condition of the line, which is approaching the end of its economic life. At the same time, the load need is driven by the requirement for network capacity to provide security of supply and to connect renewable generation in the Skye area, consistent with our RIIO-T2 Business Plan to deliver a network for net zero. The non-load driver is critical to ensure ongoing safe and reliable and economic operation of the Skye transmission network.

Intervention on asset condition basis is required by 2026 on the Quoich to Broadford steel tower section and by 2029 on the Broadford to Ardmore wood pole section of the Skye OHL. From a load perspective, capacity enhancement is required for accommodating contracted generation and demand mainly between 2025 and 2026, with a significant amount of interest from renewable generation developers on Skye. While the need for asset intervention and for the scale of capacity required to support net zero targets is clear, there is some short-term uncertainty with the level of capacity requirement for renewable generation on Skye, as well as the impact of other potential future reinforcements such as the Skye to Harris additional cable and the planned Western Isles HVDC link. We take a whole system approach in determining the overall need for the Skye intervention, considering the timing of the load and non-load drivers as well as the uncertainties associated with them.

To address the key short-term uncertainties on the capacity of generation, we developed a scenario-based approach in assessing this need. This approach was stakeholder led, in keeping with our stakeholder engagement strategy (section 3). Building upon previous approaches and lessons learned from strategic Wider Works, we engaged stakeholders to provide additional clarity on scenario assumptions and highlight the significant renewable generation potential in the Skye area. Our Skye Strategy has initiated renewed developer interest in the area.

The results of this engagement allowed us to outline the total capacity of project potential – 'the scenario envelope', with projects evaluated against a set of criteria we consider pertinent indicators of a project's likelihood of progression. We developed a set of four plausible scenarios that adapt to the GB FES scenario envelope to allow the ESO to undertake its CBA modelling.

We also developed two sensitivities outside the scenario envelope to be used for stress testing the potential solutions. Working with Ofgem, we developed a 'Low' sensitivity which is lower than the lowest of the four core scenarios. This sensitivity considers the unlikely scenario where developers and wider stakeholders do not respond to the climate emergency. We also developed a 'High' sensitivity which is higher than the highest of the four core scenarios. This sensitivity considers the potential for an additional Skye to Harris cable to allow some of the contracted generation to connect and export via Skye.

5 Reinforcement Options

We identify the load and non-load needs for the Skye network in Section 4. In order to meet these needs simultaneously, we considered a wide range of reinforcement options ranging from 'non-build' to 'build' options and we consider potential development pathways for the network on Skye and in the overall Skye/Western Isles region. We consider the following factors in the development of the options:

- the asset condition of the line and potential interventions;
- known and potential future generation capacity requirements;
- security of supply for the Skye and Western Isles area;
- the possibility of the proposed Western Isles HVDC link;
- economic and environmental aspects of different development pathways; and
- stakeholder feedback received on relevant development work undertaken to-date.

We recognise the importance of a whole system approach to the development of the Skye network. In our paper, Enabling Whole Energy System Outcomes Policy[24], we outline how we assess system needs from a whole system point of view, and consider a wide range of potential solutions to meet network needs. These range from the more traditional asset solutions to innovative solutions that require us to work with the ESO and SHEPD, the Distribution Network Operator in our area, and third parties to deliver a whole system optimum solution to the benefit of consumers. This approach was adopted in the assessment of need in section 4 and in the development of options in this section to meet the need.

5.1 Option development overview

Applying a whole system approach, we categorise the need for the Skye network into its constituent components listed below to allow us to explore the effectiveness of different potential solutions against each of them.

- Non-load need – asset condition based
- Load need – network based security of supply
- Load need – network based capacity for renewable generation

The asset condition based need is critical for the continued safe and reliable operation of the network. We therefore consider that all credible solution options must address the asset condition need. Given the inherent short-term uncertainty of the load need, we consider solution options covering a wide range of cost/capacity points, environmental and economic performance.

Following the identification of an initial set of options, we undertake optioneering to further explore potential phased development and configuration of options. This is done in two steps. Firstly, we run a local assessment on the Skye options to identify and exclude or modify options which do not perform well from a capital cost vs constraints perspective. Secondly, we then consider potential

[24] The SSEN Transmission "Enabling Whole Energy System Outcomes Policy" is available online at https://www.ssen-transmission.co.uk/riio-t2-plan/enabling-whole-energy-system-outcomes-policy/

phasing of options to provide capacity in an incremental way to address generation uncertainty. This results in an expanded set of options on which a local CBA is also used to identify a short list of options to be taken into detailed 'national' CBA undertaken by the ESO. In creating the short list of options, we also consider stakeholder feedback alongside the local CBA results. Detailed information on optioneering is available in the Skye CBA report prepared by GHD.

5.2 Meeting the non-load need

Our paper on Net Zero – A Risk Based Approach to Asset Management[25] details our approach to risk-based asset management. In this approach, we compare the monetised risk of 'no intervention' against the 'intervention' options. Section 4.2 provides a comprehensive explanation of both the current and historical condition of these assets. The report identifies need for significant interventions on both the existing lattice steel structures from Quoich to Broadford and the wood pole OHL from Broadford to Ardmore. There are a number of concerns in addressing these proposed interventions due to the line being a single circuit and the sensitivity and difficulty such intervention would require. We consider the following options to meet the non-load need in the first instance and additionally against the load need.

5.2.1 Non-intervention

Do nothing

The 'do nothing' option assumes that an asset is replaced when it experiences a catastrophic failure. The mechanical integrity of the line is critical for its safety performance, thereby ruling out the 'do nothing' option. This option degrades the security of supply and does not create additional capacity for connecting renewable generation. **It was therefore discounted given the supply security, safety and operational cost implications of running the assets to catastrophic failure due to non-intervention.**

5.2.2 Intervention options

Refurbishment

Refurbishment with or without temporary diversions

Refurbishment of the steel tower line between Quoich and Broadford OHL as outlined in the ACAR without appropriate temporary diversion, would result in an extended period of disruption, with the associated costly and environmentally damaging result of running diesel backup generation. This would also increase the risk to the security of supply for Skye and the Western Isles.

Use of temporary diversions has the potential to reduce the duration of supply interruptions and could be considered in one of two ways:

a) Hybrid option – Refurbish existing line and string the other side of the existing overhead steel tower line

[25] Net Zero – A Risk Based Approach to Asset Management, SSEN Transmission paper available online at https://www.ssen-transmission.co.uk/riio-t2-plan/a-risk-based-approach-to-asset-management/

To potentially address this option a complete structural survey would have to be undertaken on the existing 63km of OHL route to determine if the existing structures and foundations are capable of withstanding the additional mechanical loading of a second circuit as well as ensuring statutory ground and circuit to circuit clearances could be maintained with the new conductor installation.

It is clear however that the existing PL16 'light' steel lattice structures of the QB OHL for the changes necessary under this proposal would not comply with the current design codes as specified under BS EN 50341.

b) Refurbishment – Conduct on-line refurbishment by providing staged temporary wood pole diversions along sections of the existing steel tower line.

This option would require significant development with construction and then dismantlement of an alternative single circuit Trident design OHL along diverted routes of the existing QB1 line. However, construction of any temporary diversions is extremely challenging and will be costly as a result of significant environmental impact due to the challenging terrain.

While these refurbishment options have the potential to meet the non-load need, they do not provide the additional capacity required to meet the load need.

This approach fails to recognise the need for intervention on a whole system basis as outlined in the section 5.1. The options to refurbish the line have a high cost and do not allow any additional generation to connect, against a background of a large volume of contracted generation with a significant proportion consented (see section 4.3.6), hence inconsistent with the net zero ambitions of the UK and Scottish governments. They also increase the security of supply risk and do not meet modern safety and engineering standards. For these reasons, refurbishment was not progressed further.

Asset replacement

Asset replacement – 'do-minimum'

A do-minimum option is considered as a baseline to meet the non-load requirement only. This option builds a 132kV OHL between Quoich and Ardmore. Due to improvements in OHL technology since the existing line was built, the capacity of the new line would be higher than that of the existing line (summer pre-fault rating increase from the current 67MVA to 176MVA). This option would therefore provide some additional capacity to connect some, but not all contracted renewable generation on Skye. The do-minimum option was considered in the initial list of options for optioneering.

Asset replacement beyond do-minimum

In exploring potential asset replacement options, relevant factors relating to supply security, capacity for renewable generation connection, technical performance and stakeholder feedback are considered. Other options capable of meeting the non-load need and also capable of providing capacity beyond the do minimum above are considered. These options are considered in Section 5.4.2.

A summary of options considered in this section is shown in Table 7. The outcome from this section is that is that **an offline asset replacement is the only credible asset intervention option.**

Table 7. Summary of options to meet non-load needs

Option		Need addressed			Outcome
		Asset	SoS▪	Capacity	
1	No intervention (do nothing)				Not progressed
2	Refurbishment*	✓			Not progressed
3	Hybrid option (refurbish + second circuit)	✓	✓	✓	Not progressed
4	Asset replacement (do minimum)	✓		✓	Progressed
5	Asset replacement beyond do-minimum	✓	✓¥	✓	Progressed

* With and without temporary diversions
▪ Security of supply at Broadford
¥ Depending on configuration of solution

5.3 Meeting the security of supply need

To meet the additional 10MW firm contracted demand at Broadford, a second infeed is required in accordance with the demand security criteria of the SQSS. Three options are considered for this as follows:

33kV backfeed from to Grudie Bridge

Working with SHEPD, we explored the viability of an existing 33kV backfeed from the Grudie Bridge GSP (highlighted in yellow in Figure 14). SHEPD indicated that the capacity of the existing 33kV line is very limited due to the long distance from Grudie Bridge. Consequently, this backfeed cannot reach Broadford GSP although it can supply a small part of the Broadford demand. SHEPD also indicated that it would not be economical to upgrade the line. In addition to not being able to meet the demand security requirement at Broadford, this option would not provide capacity to accommodate generation or demand growth. **This option was therefore not progressed.**

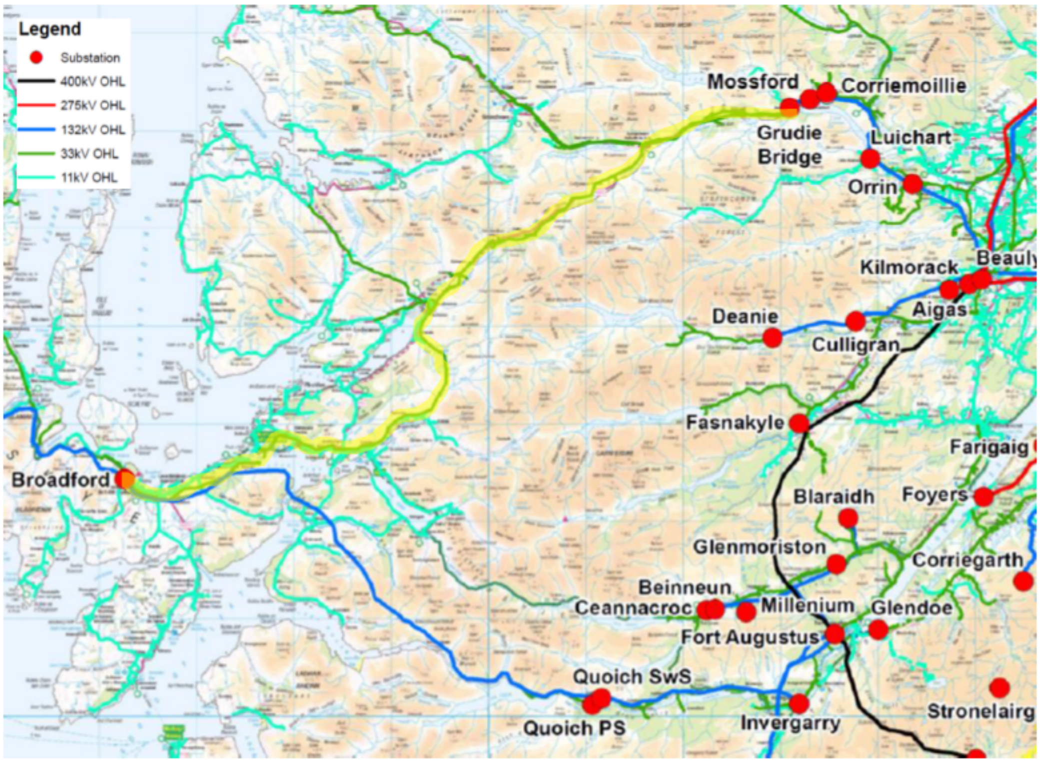


Figure 14. Map showing the existing Grudie Bridge to Broadford 33kV route (highlighted)

New 132kV Interconnection to Grudie Bridge

We explored the option to construct a new 132kV OHL to interconnect Grudie Bridge to Broadford. Grudie Bridge is connected to the Beauly substation via Corriemoillie, a new 132kV substation completed in 2015, and the Corriemoillie to Beauly 132kV OHL completed the same year. There are two drawbacks with this option: (i) the terrain is very challenging, with limited access which would result in high costs and (ii) while this option could provide demand security at Broadford, it would neither address the non-load need nor provide capacity for generation growth on Skye due to the limited capacity towards Beauly as more generation has connected around Corriemoillie following the reinforcement of the Beauly to Corriemoillie line. **This option was therefore not progressed.**

New 132kV Interconnection to Corriemoillie

The option to construct a 132kV OHL from the Corriemoillie 132kV substation to Broadford was also explored but **discounted for the same reasons as the interconnection to Grudie Bridge.**

Second Skye Infeed via the planned Western Isles HVDC link

Another option considered is predicated on the Western HVDC link Strategic Wider Works (SWW) (going forward LOTI) Strategic Wider Works reinforcement progressing. This option involves the construction of an HVDC link between Beauly and Stornoway. The option would provide a second infeed to Broadford via the Harris to Skye SHEPD owned 33kV cable currently being installed as a replacement of the failed original cable. It is also important to note that the Stornoway to Harris 132kV line will be rebuilt as part of our RIIO-T2 Business Plan non-load works. While this option potentially provides the security of supply for demand on both Western Isles and Skye (including Broadford), we note that asset intervention would still be required on the Skye circuit and additional capacity would still need to be provided on the 132kV circuit on Skye to allow the generation there to connect. **Due to the uncertainty around the Western Isles link, and the unmet need for asset intervention on the Skye OHL, this option has not been progressed at this time.**

A summary of options considered in this section is shown in Table 8. Options 2, 3 and 4 are credible from a demand security 'single' driver perspective. However, taking a whole system approach, considering the non-load and generation capacity needs, all three options are discounted as they would not meet these needs. The options progressed in Table 7 for non-load need will be considered instead. Further options are considered in section 5.4.

Table 8. Summary of options to meet security of supply needs

Option		Need addressed			Outcome
		Asset	SoS▪	Capacity	
1	33kV backfeed from Grudie Bridge				Not progressed
2	New 132kV Grudie Bridge to Broadford interconnection		✓		Not progressed
3	New 132kV Grudie Bridge to Broadford interconnection		✓		Not progressed
4	Second Skye infeed via Western Isles (Planned HVDC link)		✓		Not progressed

* With and without temporary diversions
▪ Security of supply at Broadford
¥ Depending on configuration of solution

5.4 Meeting renewable generation capacity need

We used a range of credible future energy scenarios informed by stakeholders to determine the load need. These covered potential growth scenarios on Skye. In developing the solutions to meet this need, we engaged extensively with SHEPD, who own and operate the adjoining distribution network served by the Skye transmission line. SHEPD has demand customers on Skye and Western Isles, and we have discussed our respective network future development plans and associated drivers to ensure they are coordinated. We engaged with a wide range of stakeholders including communities, statutory and non-statutory bodies to ensure that the options appropriately consider the impact to the environment while providing a pathway to net zero in an economic manner.

To meet the generation capacity requirements, we considered a wide range of options covering non-asset solutions, minimal asset solutions including dynamic line rating, active network management, flexibility services and asset solutions. These are summarised below.

5.4.1 Smart and flexible options

Before considering asset solutions to meet the additional capacity needs, we consider minimal build and commercial solutions. The main smart and flexible solutions we looked are dynamic line rating, active network management and flexibility services.

Dynamic line rating (DLR)

Due to lack of capacity on the existing line, we have considered the possibility of developing a dynamic line rating (DLR) solution to potentially accommodate more generation. Given the asset condition of the line, it was considered that the capacity that would be released would be minimal.

We engaged with the ESO on whether any possible constraint relief due to DLR could be sufficient to allow an embedded contracted 2MW generation scheme (Alt Na Moine Hydro) at Broadford. Given the existing derogation on the Skye OHL, the ESO confirmed that the DLR scheme would not create capacity to connect any additional generation.

We recognise that there might be some operational benefits from a DLR scheme, and so propose to trial DLR on the existing line prior to replacement. We expect this to be subject to a MSIP UM application. **However, provision of material additional capacity on the existing line on the basis of dynamic line rating to meet known requirements was ruled out**.

Active network management (ANM)

Active network management (ANM) releases capacity by allowing the network to operate close to its loading limits on the basis that any potential breaches are dealt with automatically in real time without manual operator action. On the basis that there is only one radial transmission circuit which is already constrained, it was concluded that ANM would not release additional capacity. **This option was therefore not taken forward.**

Flexibility services

In addition to the balancing mechanism actions already taken by the ESO on this line, we considered whether SHEPD's distribution-based flexibility services solutions through the Constrained Manage Zones (CMZ)[26] could potentially release capacity on the transmission system. CMZ offer a suite of options for customers in addition to traditional reinforcement and therefore potentially allow quicker connection of generation and at lower cost. Currently, there are CMZ contracts which have a total capacity of 5.9MW. This level of capacity relief is insignificant compared to the currently contracted 418MWof generation awaiting connection between 2025 and 2026. **We are therefore not progressing this concept on this network at this time.**

All of the above smart and flexible options have been discounted since they:

- **(i) Neither address demand security nor additional capacity requirements; and**
- **(ii) do not address the non-load need.**

5.4.2 Asset options

In addition to options detailed above, we also considered asset solutions over and above the asset condition-based need. This section focuses on the development of options to reinforce the existing line. It considers different line technologies, capacities and voltages to develop a wide range of options. The development of asset options also considered environmental, planning and consenting, cost, constructability and operability of the potential solutions.

Technology considerations

The constructability and maintainability of the Skye line is challenging due to both the terrain and prevailing weather from the Atlantic. All options require significant enabling works, access tracks, and the use of helicopters during installation. Elsewhere, Composite Poles, Wood Pole and Lattice Towers have all been installed with the support of a helicopter. The ground works required for

[26] More information on SHEPD's Flexible Connection Options and Flexibility Services can be found online at https://www.ssen.co.uk/FlexibleConnections/

trident wood pole arrangements are limited when compared to a steel lattice tower. Several factors were considered in determining credible options for the reinforcement of the Skye OHL. Table 9 provides a summary of the OHL technologies considered.

Table 9. Parameters and assumptions used to inform analysis

		132kV Wood Pole	132kV Composite Poles	132kV L7 Steel DC* Tower	275kV L8 Steel DC Tower	400kV SSE400 DC Tower
Maximum pre-fault rating (MVA per circuit)	**Summer**	176	176	348	1020	2090
	Spring/ Autumn	193	193	375	1100	2240
	Winter	203	203	390	1140	2330
Span Length (m)		100	200	300	400	450
Structures per km		10-12	4-5	3-4	2-3	2-3
Height of structures (m)		10-14	25-30	27-35	40-50	45-55
Maintenance (work hours/km)		8	7	6	6	6
Inspection (work hours/km)		84	25	25	25	25

* Double circuit

Wood poles

Wood poles are typically used on 132kV circuits that require lower capacity provision and single circuit security. From a cost perspective, they offer the cheapest asset option when providing new transmission infrastructure due to the use of wood over steel and the less intrusive civils activities needed for construction. Wood poles also have a lower visual impact when compared to composite or steel alternatives. This is because the wooden pole structures have a maximum height of 12 metres, and so, although more structures and shorter span lengths are required (100m), the limited height provides a lesser visual impact within the landscape when compared to alternatives. This benefit, however, can become a limiting factor where a double circuit is required because wood poles can only carry a single circuit and an additional OHL of wood pole structures would be required, which has a higher visual impact. Operationally, wood poles are less reliable that composite or steel structures, and more prone to failure during storms. Additionally, they require a more regular inspection regime to allow for any defects to pole integrity to be spotted and treated before point of failure.

Composite poles

Composite poles are used at present as intermediary between Trident wood poles and steel lattice towers. They have relatively small foundations and they form an insulated system with improved lightning characteristics. The foundation design used for the composite poles on the Dorenell Wind Farm connection[27] required less plant and smaller excavations than a steel lattice tower.

The use of composites within Europe is relatively limited, with a recent SSE procurement survey suggesting that a total of around 14,000 poles are currently in service with a meaningful service history limited to fifteen years. Composite poles have already been Type Approved and used within SSEN Transmission for the Dorenell double circuit wind farm connection.

[redacted] The development and approval of a revised composite design is planned for completion in 2021, with Type Approval following this date. This solution does not fit with the present Skye programme for consenting and construction. **This technology option has therefore not been considered further at this time.**

Steel towers

Table 9 provides an overview of the typical suite of steel tower infrastructure that is used by SSEN Transmission. Depending on the capacity requirements there are tower suits available at 132kV, 275kV and 400kV. At the 132kV rating, L7 towers are typically 27-35m tall, with an average span length of around 300m, allowing for 3-4 towers per km. Towers of this scale can already be found on the existing Skye network between Quoich and Broadford substations. As they are markedly bigger than the wood pole infrastructure, there is a greater visual impact with these towers, particularly in scenic environments. From a cost perspective, 132kV steel infrastructure is much more expensive to construct than wood poles, specifically due to the greater cost in materials, but also the civils works required to install them safely, namely access tracks and tower foundation construction.

The next step up is the L8 tower, which is most commonly used for 275kV OHL infrastructure. These towers are 40-50m in height, with an average span length of circa 400m, allowing for 2-3 towers per km. Even more so than the 132kV L7 towers, the L8 towers can have significant visual impact on the environment they are situated in due the size of each tower and the civils works associated with their installation, which is greater due to the increased size of the infrastructure.

The largest steel tower design that SSEN Transmission utilises is the SSE400, a 400kV tower that is 45-55m in height, with an average span length of 450m, allowing for 2-3 towers per km. Due to the size of the SSE400 tower, there is greater risk of negative visual impact posed by these towers, particularly when compared to the L7 tower, which is significantly smaller. As with the L7 and L8 towers, the higher cost of these towers is driven by the need for installation of safe access and tower foundations during the construction phase, which is greater than the other two steel tower types due to being bigger in size.

[27] Details about the Dornell Wind Farm connection project are available online at https://www.ssen-transmission.co.uk/projects/dorenell-wind-farm-connection/

From an operations and maintenance perspective, all three of the steel tower options have similar requirements. The more robust steel design means that there is increased reliability in the OHL and a reduced occurrence of faults, which is a key advantage over the lower cost wood pole option.

Cables

Given the length of the line, cable options are generally not considered viable as they present significant cost and engineering challenges relating to stable and safe operation of the line due to high voltages, switching challenges and operational performance relating to impact of cable faults on restoration times. The option to explore cable solutions for mitigation purposes on short sections of the line was retained and it is noted that electrical compensation may be required due to the introduction of cabling. The cost of cable installation is highly dependent on the protection (including burial) of the cable. A summary of considerations for the introduction of cable sections is given below:

- Electrical compensation requirements;
- Ground conditions, especially the presence of shallow rock or deep peat;
- Additional allowances for shallow waters requiring specialist vessels;
- A seabed survey would indicate the cable protection requirements such as; burial methodology, rock placement, cast iron shells, sand wave clearance;
- A landfall assessment would be required to determine suitable landfall locations and if the cable can be trenched or if an HDD landfall is required;
- Consenting requirements from Marine Scotland and the Crown Estate Scotland; and
- Fisheries compensation.

Considering the above, a full cable solution has been discounted as a credible option. However, short cable sections will be considered as mitigation where OHL sections present either technical or environmental challenges.

Environment and Town Planning Considerations

The OHL route options are restricted due to the limited road network in the area and the extreme terrain in some parts. There is only one road to Skye from Fort Augustus (A87) and it is recognised as a major tourist route to the island and as such any new OHL following the A87 is likely to be met with significant opposition, as was the reason for the public inquiry in 1975. The existing OHL route avoids the A87 by following a route across the mainland that has little or no road infrastructure and is dwarfed generally by the scale of the terrain and therefore has less visual impact on tourism.

Archive information relating to the options for the original QB circuit states that "From an engineering viewpoint the preferred route would have been from Ceannacroc through Glen Shiel, but such a line would have been obtrusive and seen by many thousands of tourists" Accordingly the North of Scotland Hydro Electric Board concluded that the amenity objections to the Glen Shiel route were on balance stronger, and in November 1974 applied to the Secretary of State for Scotland for consent to erect a line on the Kinloch Hourn (current) route.

Since construction of the existing OHL was completed in 1979/80, the adjoining estates of Sconser, Torrin and Strathaird on Skye have been purchased by the John Muir Trust. These three estates lie across the central area of Skye through which any new OHL will need to pass to reach Ardmore, via Dunvegan from Broadford. It is likely that the trust will oppose any new OHL through the Cuillin Hills leading to consideration of cable mitigation options which would increase the project costs and also introduce other environmental issues. Although this section is of particular sensitivity from a landscape and visual perspective, it is not the only section that could face consenting challenges that lead to land or subsea cables sections being considered as part of the project design. In particular, the Fort Augustus area, Knoydart National Scenic Area (NSA), and Kinloch and Kyleakin Hills Special Area of Conservation, all pose significant challenges in terms of finding an acceptable OHL solution to pass through them. **A summary of the environmental constraints can be found in the Consultation Document: Route Options[28] and the Environmental appraisal of route options[29].**

5.5 Summary of credible options to meet load and non-load needs

Table 10 shows the summary of all credible options identified to meet both the load and non-load needs. The cost estimates for the options are [redacted] defined in accordance with the SSE Group's project governance framework. To enable a fair comparison of options, the same cost classification class was used. The preferred option cost estimation classification has progressed to Class 1. This is reflected in the 'Proposed Reinforcement Option' section Table 24.

These form the initial set of options considered in the optioneering exercise. Option 0 is the do-minimum solution – a single circuit 132kV wood pole from Fort Augustus to Ardmore, which provides additional capacity. This option replaces the existing line from Quoich to Ardmore, leaving the existing circuit between Fort Augustus and Quoich. Option 1 increases the capacity of Option 0 by including an additional wood pole from Fort Augustus to Broadford. Option 2 further increased capacity with a steel tower circuit from Fort Augustus to Broadford. Option 3 considered a variant of Option 2 the, 'Invergarry variant' – assuming a 400 KV substation is developed at Invergarry in around 2028 to support the pumped storage generation development in that area. Option 4 considers a double circuit steel tower from Fort Augustus to Edinbane, with a single 132 kV trident to Ardmore. Finally, Option 5 considered a 275kV solution from Fort Augustus all the way to Ardmore – a more challenging option to deliver with a correspondingly later delivery date of December 2027. All options are based on OHLs, with the flexibility to consider cables should any mitigations be required.

The capacities of the options depend on the specific construction type on each section. The 132kV trident wood pole line construction has a rating of 176/193/203 MVA (Summer/Spring_Autumn/Winter). The 132kV steel tower structure line construction has a rating of 348/375/390 MVA per circuit while the 275kV steel tower structure line construction has a rating of 503/559/589 MVA per circuit. The existing line from Fort Augustus to Quoich has the same rating as the proposed trident wood pole line stated above while the remainder of the line to Ardmore has a rating of 67/77/83 MVA.

[28] Skye Reinforcement - Consultation Document: Route Options, SSEN Transmission, March 2020, available at https://www.ssen-transmission.co.uk/media/4199/skye-reinforcement-project-consultation-document-march-2020.pdf
[29] Environmental Appraisal of Route Options, SSEN Transmission, available at https://www.ssen-transmission.co.uk/media/4203/appendix-4-environmental-appraisal-of-route-options.pdf

Table 10. Initial Skye reinforcement options considered

Option	Description	Capex* (£m)	EISD[30]
0	Baseline - Single Circuit Trident 132kV wood pole from Fort Augustus to Ardmore	[redacted]	2025
1	Two 132kV wood pole single circuits from Fort Augustus to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	[redacted]	2025
2	132kV steel tower double circuit from Fort Augustus to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	[redacted]	2025
3	Two 132 kV wood pole single circuits from Fort Augustus to Invergarry, 132kV steel tower double circuit from Invergarry to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	[redacted]	2025
4	Double Circuit 132kV steel tower from Fort Augustus to Edinbane with single 132kV trident to Ardmore	[redacted]	2025
5	Double Circuit 275 kV from Fort Augustus to Edinbane with single trident 132kV to Ardmore	[redacted]	2027

* Price base of 2019/20, Class 0 Cost Estimates [redacted]

Option Cost Estimates and Earliest in-Service Dates (EISDs)

The option cost estimates have been developed in line with the corresponding level of detail available. At this stage, the costs are based on development and capital expenditure only. Operation and maintenance costs are excluded as they are not likely to be significantly different between options and are therefore considered for the shortlist of options post optioneering.

In some cases, as development has progressed and further information has become available, the estimates have been refined. For example, refinement of pre-construction spend has been included as early engagement with the supply chain has also taken place, which allowed refinement of cost assumptions associated with this phase of the project.

In addition to identifying unit rates associated with the infrastructure, the cost estimates consist of additional items such as internal staff costs, pre-construction activities (as noted above) including rates for planning application and environmental studies, land costs, engineering studies and assessments, and risk contingency. The estimates for non-tendered elements were developed based on reviewing historic projects of similar scope. These will be refined as the project is progressed.

The spend profile for all options is also based on those of similar projects. Further development and engagement with the supply chain will allow refinement of programmes and milestones, with the potential for a corresponding impact on the spend profiles and delivery dates.

The project costs will continue to evolve as the design definition further improves through selection of a preferred OHL alignment, identification of preferred technologies and further engagement with the supply chain.

Delivery programmes for each of the reinforcement options considered produced the earliest in-service dates (EISDs). These cover, but are not limited to, the scope of the reinforcements, procurement methods, consent requirements, delivery timescales based on our experience, and

[30] The Earliest In-Service Date (EISD) is based on the completion date, with the first year of full operation being the following year.

commissioning timelines. As we engage with the market and are able to better understand the project risks through further development, the EISDs may be updated. The EISDs represent a best view of the earliest the reinforcement options can be delivered, assuming an optimal delivery programme, including regulatory milestones. The EISD is used within the CBA to show the year at which a network reinforcement option can be feasibly delivered, thus providing constraint relief.

5.6 Optioneering

5.6.1 Approach to Optioneering

We assess the initial options summarised in Table 10 to explore how they cover the solution space considering a wide range of option costs and capacities. The outcome of this analysis is a short-list of refined options for considering in the detailed cost benefit analysis which is covered in Section 6. The optioneering process was undertaken using GHD's Constrained Energy Flow Model (CEFM) and a 'local' CBA, also referred to as 'micro' CBA which considers annualised reinforcement option CAPEX plus annual OPEX and benefits in the form of constraints relieved relative to the counterfactual (the do-minimum – Option 0). The constraint costs used in the micro CBA were informed by responses to the stakeholder engagement questionnaire and GHD's evaluation of the levelised cost of energy – also partially informed by the questionnaire response, in particular Skye wind farm capacity factors. The detailed optioneering methodology including details of the micro CBA and the outcome of the analysis are covered in the GHD CBA report.

5.6.2 Analysis of options

Analysis of the generation scenarios indicates that much of the generation is connecting around the Edinbane area, supported by The Highland Council who consider this area to be particularly conducive to onshore wind development. The results of the CEFM modelling show the highest constraints occurring on the Skye network in Option 0, and few in Options 4 and 5 – even under the highest scenario. Option 1 failed to meaningfully reduce constraints in the heavily congested Edinbane area and therefore performed only moderately, particularly in the higher scenarios. Options 2 and 3 performed poorly due to higher capital costs compared to Option 1 and limited capacity between Broadford and Edinbane. Option 5 performing well in the higher scenarios, but not as well as Option 4 with its lower cost and earlier delivery date.

With a significant cluster of generation around Edinbane, further optioneering of that area was undertaken – particularly for Option 1. It was also clear that, while Option 4 was performing well, with additional modifications, some resulting in a lower cost, Option 4 might be further improved. With the planned development of the 400kV substation at Invergarry and 400kV line back to Fort Augustus by 2027 for the connection of the contracted and consented Coire Glas pumped storage scheme, a variant of Option 4 was considered to connect into the proposed Invergarry 400kV substation. The proposed 400kV OHL shares the same route corridor as the Skye OHL therefore it was considered necessary to explore the potential interactions between the two projects.

The initial six options were thus expanded into 12 reinforcement elements shown in Table 11 to provide flexibility to consider different potential development pathways to better address generator uncertainties and also specific constraint hotspots along the Skye network.

Table 11. Summary of expanded options derived from the initial options

Option		Dependency	EISD
0	Baseline: 132kV trident wood pole single circuit from Fort Augustus to Ardmore.		2025
1a	Two 132kV trident wood pole single circuits from Fort Augustus to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	Stand alone	2025
		Incremental to Option 0	2030
1b	Two 132kV trident wood pole single circuits from Fort Augustus to Broadford, a 132kV single circuit on a double circuit steel structure from Broadford to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore.	Stand alone	2025
		Incremental to Option 0	2030
2	132kV steel tower double circuit from Fort Augustus to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	Stand alone	2025
		Incremental to Option 3, if Invergarry 400kV does not proceed	2028
3	Two 132kV wood pole single circuits from Fort Augustus to Invergarry, 132kV steel tower double circuit from Invergarry to Broadford and a 132kV wood pole single circuit from Broadford to Ardmore.	Only to be considered as the first stage leading to Option 2	2025
4a	132kV steel tower double circuit from Fort Augustus to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore.	Stand alone	2025
		Incremental to Option 4a0, with Fort Augustus - Invergarry completing 2027	2028
4a0	Two 132kV wood pole single circuits from Fort Augustus to Invergarry, 132kV steel tower double circuit from Invergarry to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore.	Only to be considered as the first stage leading to Option 4a if Invergarry 400kV does not proceed or Option 4a1 if it proceeds	2025
4a1	132kV steel tower double circuit from Invergarry to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore. At Invergarry, the line connects to the new 400/132kV Invergarry substation and the Fort Augustus to Invergarry 132kV line is dismantled.	Can only be considered as an incremental reinforcement to Option 4a or 4a0 if Invergarry 400kV goes ahead	2028
4b	132kV steel tower double circuit from Fort Augustus to Edinbane, two 132kV wood pole single circuits from Edinbane to Dunvegan and a 132kV wood pole single circuit from Dunvegan to Ardmore.	Stand alone	2025
		Incremental to Option 4a	2028
4c	132kV steel tower double circuit from Fort Augustus to Edinbane and two 132kV wood pole single circuits from Edinbane to Ardmore.	Stand alone	2025
		Incremental to Option 4a.	2028
5a	275kV steel tower double circuit from Fort Augustus to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore.		2027
5b	275kV steel tower double circuit from Fort Augustus to Dunvegan and a 132kV wood pole single circuit from Dunvegan to Ardmore.		2027

Based on the expanded options in Table 11, 19 options were developed for the full optioneering of the Skye reinforcement options. The options cover a wider range of standalone solutions and phased solutions.

Option 1 was split into Options 1a and 1b based on additional reinforcement in Edinbane in Option 1b. A staged Option 1b was also considered, with Option 0 initially in completing in 2025, with a second phase in 2030 upgrading to Option 1b.

Despite their relatively poor performance in the initial analysis, initial Options 2 and 3 remained, with some modification assessing the potential staging of analysis of Option 3 to Option 2. Option 3 is dependent on the development of the 400kV substation at Invergarry, an analysis of Option 3 was developed assuming Invergarry does not progress, requiring Option 3 to be modified into Option 2.

As the initial Option 4 had performed well in constraint terms, a range of variations to the original Option 4 were developed – involving relatively small capacity changes on different line sections to optimise design. An additional Option 4 variant was also developed assuming the Invergarry substation progresses (Option 4a1). An alternative Option 5 was also evaluated – with differing capacity around Edinbane to Dunvegan.

5.7 Shortlist of options for detailed CBA

Based on the optioneering results, five options were selected to be taken forward to the ESO for full GB CBA modelling, also referred to as the 'macro' CBA in section 7:

- Option 0 – 'Minimum option'
- Option 1b
- Option 4a
- Option 4a0 to 4a1
- Option 5a

The five options chosen to take forward for wider macro analysis encompass a combination of lower and higher capacity reinforcements, deliverability and economic performance in the micro CBA optioneering. It should be noted that Option 4a is the 'base' Option 4 that can be modified for various sections.

A brief description of each option, CAPEX, OPEX (Operations and Maintenance costs) and earliest in-service date (EISD) is outlined in Table 12, with a further schematic of each option in Figure 15 below. It should be noted that the EISD refers to the year of completion, with a project's full year of operation being the following year.

Table 12. Five options taken forward for detailed CBA by the ESO

Option	Description	CAPEX (£m)	OPEX (£m p.a.)	EISD
0	Baseline (Minimum option) – Single Circuit Trident 132kV wood pole Fort Augustus to Ardmore	[redacted]	[redacted]	2025
1b	Two 132kV wood pole single circuits from Fort Augustus to Broadford, 132kV double circuit steel structure strung on one side from Broadford to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore	[redacted]	[redacted]	2025
4a	132kV steel tower double circuit from Fort Augustus to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore	[redacted]	[redacted]	2025
4a0 to 4a1	Two 132 kV wood pole single circuits from Fort Augustus to Invergarry, 132 kV double circuit steel tower strung both sides from Invergarry to Edinbane then single circuit wood pole to Ardmore. If the Invergarry 400 kV substation progresses, the Fort Augustus to Invergarry section will be dismantled and the line turned into the new substation	[redacted] [redacted]	[redacted] [redacted]	2025 2030
5a	Double Circuit 275 kV from Fort Augustus to Edinbane with single trident 132kV to Ardmore	[redacted]	[redacted]	2027

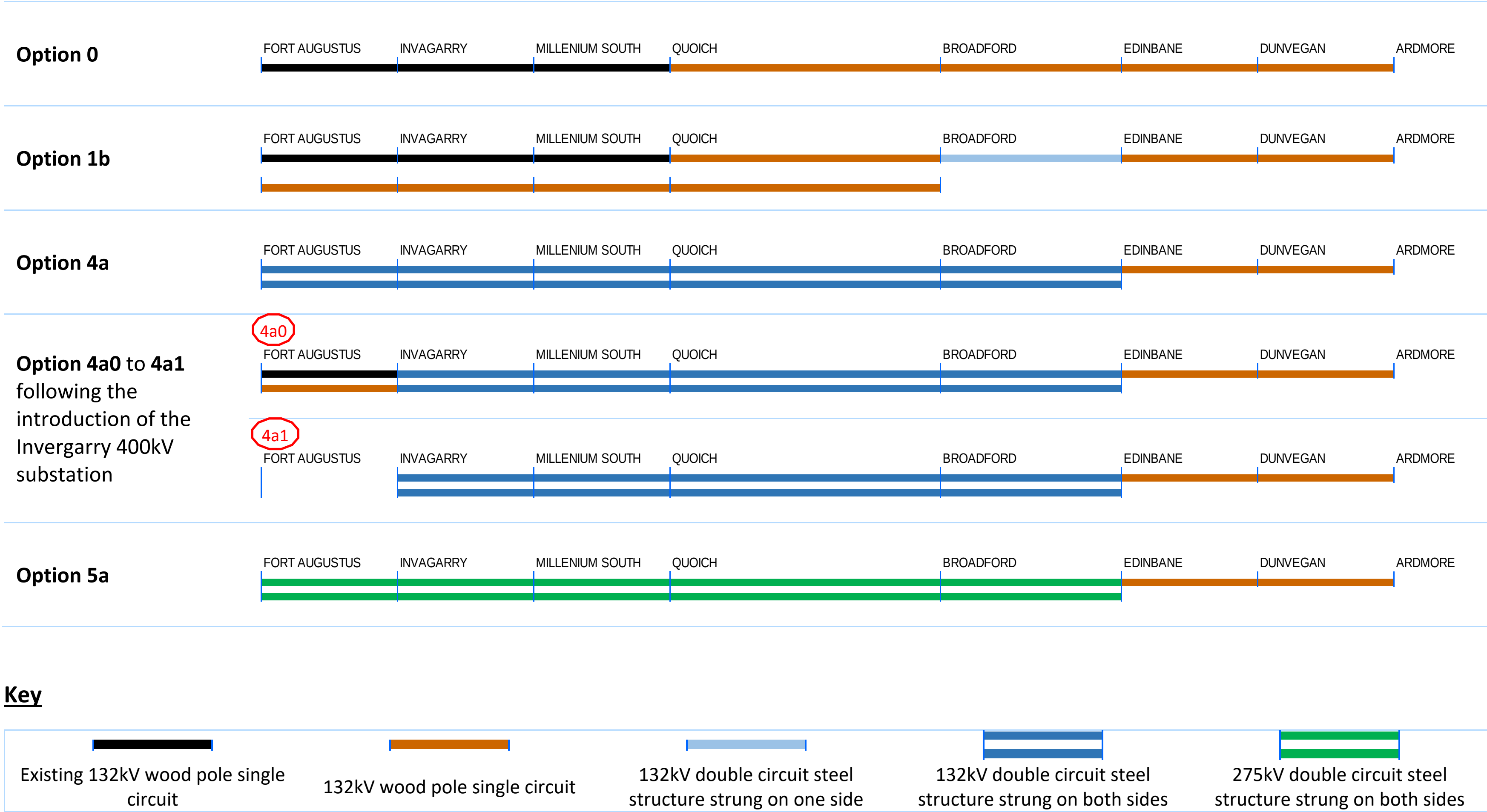


Figure 15. Pictorial list of the shortlist of options taken forward to the ESO detailed CBA

6 Cost Benefit Analysis

6.1 Introduction

The purpose of the Cost Benefit Analysis (CBA) is to assess the economic justification for the proposed investment into the Skye region. The aim of the CBA is to determine which of the options discussed in Chapter 5 produces the highest overall net benefit for the GB energy consumer. As detailed in Chapter 5, there are both Non-Load and Load investment drivers. The options developed in Chapter 6 address both drivers. This chapter presents the Non-Load and Load CBAs on the 5 shortlisted reinforcement options listed in table 12 in section 5.6.2. Whilst key to analyse load and non-load drivers and an important contributor to investment recommendations, CBA is a tool which should not be viewed in isolation. We have therefore considered the analysis is the context of wider issues such as environmental impacts, stakeholders views and the Net Zero agenda.

The non-load CBA determines the Long-Term Risk Benefit (LTRB) for each of the options to identify the optimum option based on the monetised risk of failure of assets. It aims to determine the most efficient asset intervention option to provide consumer benefit based on maximising the Long-Term Risk Benefit. The load CBA also seeks to maximise consumer welfare through balancing the cost of network reinforcement with the benefit in the form of reduced system operational costs, with the optimum solution providing the highest positive net present value. We undertook the Non-Load CBA internally while, in parallel, the ESO carried out the load CBA.

The asset condition of the existing line dictates that do-nothing is not an option, therefore signalling that asset intervention is required. This means that the do-nothing option is not applicable when undertaking the Load CBA. The do-minimum option therefore becomes the baseline option against which all other options are compared within the Load CBA.

The Load CBA consisted of two stages of investigation. We undertook the first stage with our appointed consultants, GHD. This stage provided detailed local assessment of power flows and local constraints resulting from the Skye generation scenarios developed in Chapter 5 and demand profiles. We agreed the methodology for this assessment with the ESO and discussed it with Ofgem before undertaking the Load CBA. For each generation scenario and reinforcement option, we provided the outputs of our local model to the ESO who used it in their national CBA. Further details on the process and respective dependencies of these analyses are presented in the Load CBA section in this chapter. The Non-Load CBA methodology, assumptions and results are presented in the following section.

6.2 Non-Load CBA

6.2.1 Non-Load CBA methodology overview

Asset intervention reduces network risk. A non-load CBA is used to determine intervention options which provide the highest Long-Term Risk Benefit (LTRB). The LTRB is the relative measure of monetised risk reduction achieved through asset interventions and measured over a defined period of time. Figure 16 shows an illustration of the LTRB concept. The LTRB is calculated in accordance with the Transmission Network Asset Risk Metrics (NARM) Methodology Issue 18[31], developed in collaboration with the other GB Transmission Owners, using the same principles used in the preparation of the RIIO-T2 Non-load Business Plan. In addition to the NARM methodology is Network Asset Risk Annexes (NARAs) as well as Licensee Specific Appendices (LSAs) which describe in more detail the methodology for the calculation of the Long-term Monetised Risk Benefit of asset interventions.

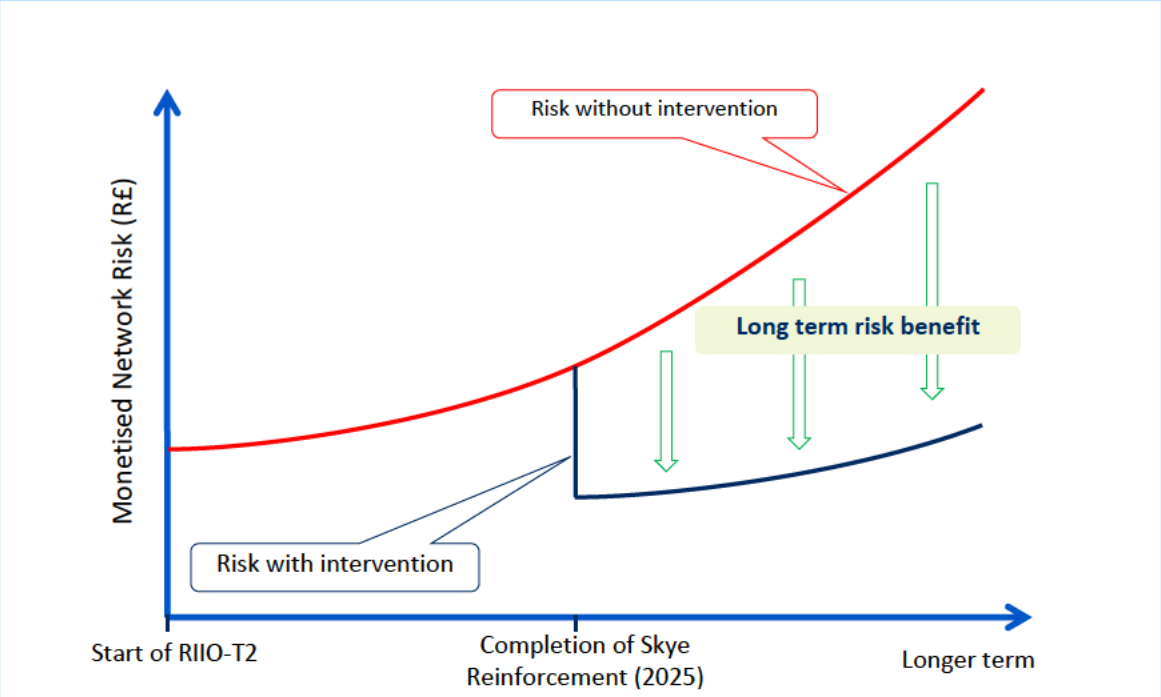


Figure 16. Illustration of LTBR as a result of asset intervention

The model uses the idea of "survival risk" or as commonly referred to "adjusted risk". This concept supports the scenario that if an intervention is delayed now, the asset will eventually fail (on a long enough time frame, the probability of survival = 0). The total LTRB is the sum of the difference between an intervention and a "No Intervention scenario." The calculation of LTRB uses the following assumptions:

- The benefit is considered for a defined set of years into the future. Consistent with our RIIO-T2 submission, the value we use is relative to lifetime of the intervention;
- For this calculation, the intervention is assumed to be carried out at the point of completion of the intervention; and

[31] Transmission NOMs Methodology Issue 18, available online at https://www.ofgem.gov.uk/system/files/docs/2018/08/noms_common_methodology_issue_18.pdf

- The Spackman approach is applied for the discount rate; 3.5% for the first 30 years and then 3% thereafter. This is applied to future values of the Monetised Risk Benefit to derive a net present value (NPV).

The LTRB is a useful measure of consumer benefit in a cost benefit analysis and can be used to compare the efficiency of different asset interventions options over a defined assessment period. While monetised risk is denoted as a financial figure, it is important to note that it is not "real" money and does not correspond to the cost that SSEN Transmission would incur if an asset was to fail. These values are thus identified with R£ prefix.

6.2.2 Non-Load CBA inputs

We carried out extensive research to determine all the cost and benefits associated with the Skye investment. We consider capital and operational costs associated with each proposed investment. Operational costs include operation and maintenance costs as well as diesel costs associated with outages. The benefits considered are electrical losses savings, whole life carbon savings and carbon savings associated with outages. Details of how these are calculated are provided in the 'Skye CBA Excel model'.

Costs

CAPEX

The capital cost included in the Skye CBA is the total cost of the infrastructure for each reinforcement option. These costs are shown in Table 12 in section 5.7

Operation and maintenance (OPEX) costs

Operating cost estimates were calculated for lead assets only (i.e. towers, wood poles, composite poles, conductor and fittings). We used the policies detailing the inspections and maintenance regimes as the basis for estimating operating costs over the life of an asset (i.e. over 45 years). These policies are developed by the SSEN Transmission Asset Management and Operations team who have experience in managing and operating the assets on our network. For each inspection and maintenance activity the lifetime cost is calculated and spread annually. It is calculated on a span basis and differentiates between steel towers, wood poles and composite poles. OPEX costs are added as CAPEX costs in each reinforcement option. These costs are shown in Table 12 in section 5.7.

Diesel costs associated during outages

During outages of the Skye OHL, costs are incurred in the running of the diesel power stations on the Western Isles and mobile standby diesel generators on Skye to supply customers. The diesel cost is added to the total cost in each reinforcement option.

Benefits

Electrical losses savings

Replacement assets with higher rated and more efficient technologies reduce network losses for the same amount of transmitted energy. This saves consumers money and leads to a reduction in the carbon. We used a unit cost of [redacted] as the energy wholesale price including carbon cost. This unit cost is multiplied by the estimated losses in MWh to obtain the annual losses cost for each reinforcement option. Reduction in losses for each reinforcement option is included in the CBA as societal benefits.

Whole life carbon footprint

We consider the carbon emissions associated with the manufacturing, construction and installation of the network assets which are to be procured and installed as part of the project (the embodied carbon), the carbon emissions associated with operating these assets over a 45-year design life and the carbon emissions from the decommissioning of these assets at the end of their design life. The whole-life carbon emissions in the Skye CBA are a high-level estimate that is based on the 'lead assets' being installed (e.g. transformers, circuit breakers, reactors, OHL towers/wood poles/composite poles, conductor & fittings). It is included in the Skye CBA Excel model as a Societal benefit or Avoided cost for each reinforcement option.

Carbon associated with outages

Greenhouse gas emissions are produced when running the diesel power stations and mobile standby diesel generators to supply customers. Reduction in the GHG emissions associated with the outage performance for each reinforcement option is included in the CBA model as a Societal benefit.

6.2.3 Options

The 5 options determined from the optioneering section in Table 12 were considered in the non-load CBA with the two-stage option (Option 4a0 to 4a1) considered as two distinct options. The 4a0 version assumes that the two single circuits are retained on an enduring basis between Fort August and Invergarry in the event the Invergarry 400kV substation does not progress. The 4a1 version assumes that the Invergarry 400kV substation progresses, with the Skye overhead solution connecting into it, with the 132kV infrastructure between Invergarry and Fort Augustus dismantled.

6.2.4 Risk Benefit Analysis results

A Risk Benefit Analysis was carried out to compare "no intervention" against the selected "with intervention" options with detailed results contained within the Skye LTRB Excel Model that accompanies this paper. The results are set out in Figures 17 and 18.

[redacted]

[redacted]

Figure 17. PV Risk annual profile

[redacted]

Figure 18. Long Term Risk Benefit

The results show that there is a large LTRB for all of the options, this is due to the current condition of the assets on the route and the significant risk reduction which is realised by replacing the assets.

Option 0 stands out as significantly lower than the rest by [redacted]. This is the only option which does not change the route from a single circuit to a double circuit, but only increases the capacity of the existing configuration. There is a significant reduction in system risk contribution due to the increased resilience of a double circuit configuration as the failure of one conductor span or set of insulators or fittings between Fort Augustus and Edinbane is no longer enough to cause a loss of supply.

Overall, the other options have a very similar level of LTRB, with no one option standing out as the clear favourite. This benefit is delivered for the first 30 years, after this point slight variances in failure modes of the various components start to become apparent. This starts with fittings flowed by conductors around 8 years later and finally the difference between poles and conductors is only just starting to show in year 49 of the 50-year model resulting in very little to differentiate between them.

Option 4a0 is the best option as it delivers double circuit replacement of assets from Fort Augustus to Edinbane. The section of double circuit wood poles between Fort Augustus and Invergarry is slightly more resilient than double circuit steel towers in Option 4a, hence why it is better than it. This is because the loss of a tower, although rare, will result in lost demand whereas the loss of a pole will not take out the other circuit. Option 4a1 is ranked second due to the removal of assets between Fort Augustus and Invergarry removing risk from the network. Option 1b performs considerably better than Option 0 as it has two circuits between Fort Augustus and Broadford compared to one circuit in Option 0.

6.2.5 Analysis of CBA results

The results of the Non-Load CBA are contained within the Skye CBA Excel Model that accompanies this paper and are summarised in Table 13. In order to determine the optimum solution for consumers that addresses both the Non-Load and Load drivers for the proposed intervention, we must also include the Long-Term Monetised Risk Benefit of each solution within the CBA.

Table 13. Summary of Non-Load CBA results

Non-Load CBA Option No.	Engineering Option No.	Total Forecast Expenditure (£m)	Total NPV	Delta (on baseline)	Total NPV (Incl. R£m)
Baseline	**Option 0**	[redacted]	[redacted]	[redacted]	[redacted]
Option 1	**Option 1b**	[redacted]	[redacted]	[redacted]	[redacted]
Option 3	**Option 4a**	[redacted]	[redacted]	[redacted]	[redacted]
Option 4	**Option 4a0**	[redacted]	[redacted]	[redacted]	[redacted]
Option 5	**Option 4a1**	[redacted]	[redacted]	[redacted]	[redacted]
Option 6	**Option 5a**	[redacted]	[redacted]	[redacted]	[redacted]

The outcome of the CBA is clear – from a pure Non-Load intervention perspective – the baseline (Option 0) intervention has the lowest NPV.

This is as expected, because the Baseline (Option 0) solution represents the Non-Load, like for 'modern equivalent' like replacement engineering intervention and Options 1 to 6 deliver a range of network reinforcement intervention options to address the network resilience & Load drivers on this circuit.

While there are 6 options considered within the CBA, Option 4 (Option 4a0) and Option 5 (Option 4a1) are modelled as variants of Option 3 (Option 4a) and are outcomes that could occur if the Coire Glas pumped storage scheme and the associated 400kV network developments take place. We have included these potential alternatives for optionality, with decision to be taken when more information on Coire Glas is available, and before submission of the Final Needs Case.

The CBA results show that Option 4 (Option 4a0) delivers the highest Long-Term Monetised Risk Benefit to Consumers with an NPV of [redacted] over the lifetime of the intervention.

6.2.6 Summary of the non-load CBA

The different variants of Option 4 all perform well and are close to each other. While from a purely non-load perspective Option 4a0 performs best, practical consideration taking into account other factors such as capacity requirements for renewable generation and stakeholder and environmental considerations mean that either Option 4a or 4a1 are more favourable in the long term. Option 4a0 presents a capacity bottleneck towards Fort August, therefore is less favourable.

Option 4a1 is contingent on the Invergarry 400kV substation progressing. In this case, it would be the optimum solution. Without the Invergarry 400kV substation, Option 4a would be the optimum solution.

6.3 Load CBA

6.3.1 Load CBA Methodology overview

The reinforcement of the network on Skye presents some challenges to the ESO's standard CBA modelling approach adopted to date. The Skye network is relatively small and is embedded within a larger zone of the ESO's CBA model setup in BID3[33]. The ESO's model determines the balance of supply and demand within each zone on the national GB network and evaluates the net power flows across the transmission boundaries. Figure 19shows the map of the transmission system in the north of Scotland and the national transmission boundaries, zones within the ESO's BID3 model and the location of the Skye network wholly within Zone Z (the zone between transmission boundaries B0 and B1). Thus, the existing boundaries cannot capture the transmission constraints in Skye region and the impact of different Skye reinforcement solutions.

[33] BID3 is the CBA modelling tool used by National Grid ESO. It uses a power market dispatch model that uses mathematical techniques to model the dispatch of power stations, market prices, capacity evolution, and other important features of power markets. https://afry.com/en/service/bid3-power-market-modelling

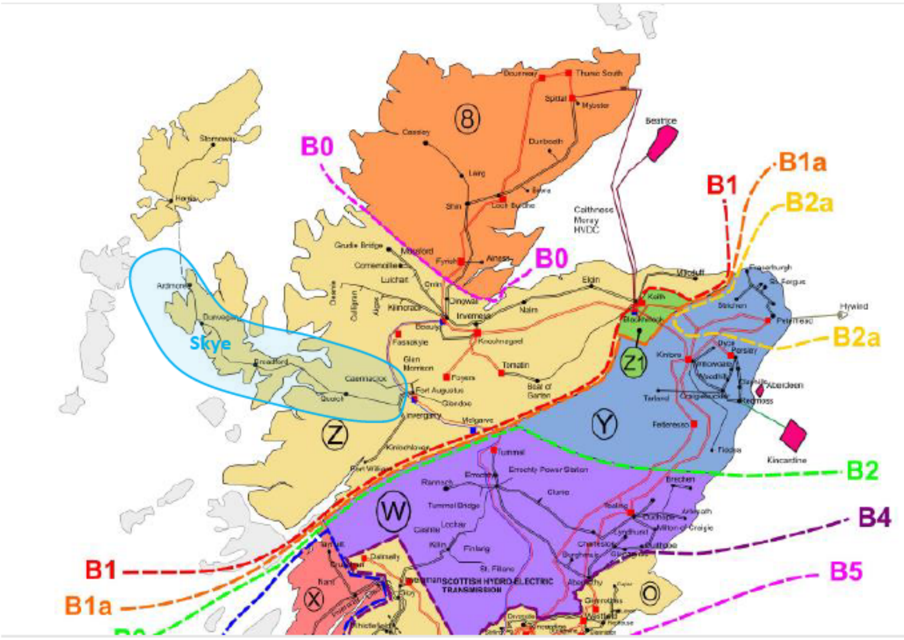


Figure 19. Map showing the transmission boundaries and zones within the ESO's BID3 model

We supported the ESO to establish an approach that provides detailed modelling of power flows within the Skye area for the different reinforcement options. Within this approach SSEN Transmission developed a model for assessing power flows on the local Skye network, with the outputs provided to the ESO for modelling within the national CBA model. To maintain the ESO's independence and to ensure transparency, we provided details of the methodology and assumptions to the ESO for critique, taking feedback on board as necessary. This methodology is transparent, verifiable, and repeatable for application in other areas similar areas. The overall approach is a two-stage process to conducting the CBA for the Skye network as shown in Figure 20 and summarised as follows:

- A 'micro' analysis of the Skye network conducted by SSEN Transmission and GHD which evaluates power flows over the Skye network for each reinforcement option and generation scenario to determine constraints on the local Skye network.
- A 'macro' analysis conducted by the ESO which takes the outputs of the micro analysis and incorporates them into the national CBA model to assess the impact of the Skye reinforcement options on the wider GB network.

Thus, the power flow constraints arising from the micro analysis of the Skye network form an input into the ESO's macro CBA model to arrive at the overall ESO CBA outcome.

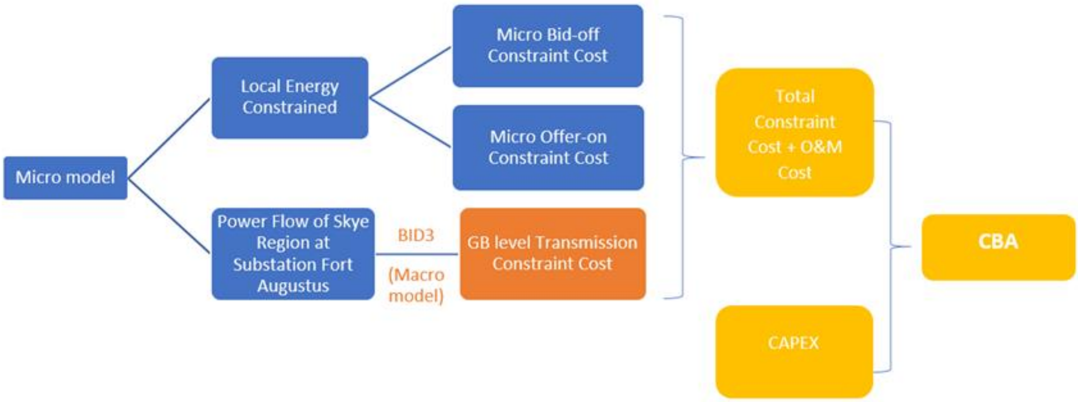


Figure 20. The two-stage CBA model used for Skye

The approach more accurately combines the specific requirements of the Skye network, in terms of generation growth and network options, with the wider FES and the ESO's CBA. Jointly with the ESO, we have worked with Ofgem to convey the development of the ESO's methodology, including roles and responsibilities within this approach. Through discussion with Ofgem, we built in their feedback accordingly prior to undertaking the CBA. Details of this approach are covered in the Skye LOTI CBA Methodology report[34].

6.3.2 Reinforcement options

CAPEX and OPEX costs were prepared by SSEN Transmissions Project Development and Asset Management teams in accordance with our Large Capital Project (LCP) governance. Costs were reviewed at a set of decision gates following the LCP guidance and approved by a senior staff in the respective departments.

Following an optioneering process, as detailed in Chapter 5.6, five credible options were selected for submission to the ESO's detailed CBA. These options and their CAPEX, OPEX and their EISDs are shown in Table 12 in section 5.7.

6.3.3 Assumptions

An efficient CBA outcome is dependent on the robustness of the methodology that underpins it. As noted, we believe the approach utilised by the ESO considers the relevant local characteristics of the Skye reinforcement options against a credible range of local generation scenarios within the wider GB context which allows the economic impact on the GB consumers to be assessed objectively. The combination of the established ESO's CBA methodology and the detailed representation of the local network allows a rigorous assessment of the economic case for investment.

We made a number of key assumptions were in order to allow the CBA to be undertaken; these relate to: i) generation disposition within the Skye FES relative to FES2020 and the network background, ii) generation and demand profiles and iii) CBA calculations.

[34] Skye Overhead Line Reinforcement Large Onshore Transmission Investment Cost Benefit Analysis Methodology, 4 March 2021.

i) FES and Network Background

The Skye FES build on the ESO's FES 2020 data for Skye, taking into account additional stakeholder input in the area as described in section 4.3.6. In order to ensure that changes in constraint volumes within the ESO's CBA captured the true impact of the Skye reinforcement options at GB level, the ESO maintained the total generation capacity within Zone Z FES values. This was achieved by adjusting generation elsewhere in Zone Z to compensate for the differences between the Skye FES and the ESO's Skye FES data. The ESO's CBA was based on a network background with recommendations from the NOA 2020/21 report which is based on FES2020. The Skye CBA was therefore based on FES2020 background for consistence.

ii) Generation and demand profiles

Key information exchange between the micro and macro analysis is the net power flows and the power flow constraints arising from the micro model for input into the macro model. The micro model evaluates half hourly power flows based on historic timeseries data for generation and demand over the scenario time horizons.

Wind generators in each BID3 wind zone are currently represented as an hourly load factor in a given study year. The base year of the study data is 2013 as a broadly representative long-term average (based on 30 years of source data). GHD provided timeseries (8760 hour) net power flow profiles for each combination of generation scenario and Skye transmission reinforcement option to ensure the data aligns with the requirements of BID3. Each net power flow profile for a given generation scenario and transmission reinforcement option combination is unique and will vary across the deployment timescales for the scenario as generation is built up over time.

iii) CBA Calculations

Costs are defined as reinforcement CAPEX annualised at a weighted average cost of capital (WACC) of [redacted] plus annual OPEX and benefits are defined as the constraints relieved relative to the counterfactual (do-minimum investment option in this case).

A combined constraint saving from the micro and macro models combined forms the benefit element of the CBA calculations, compared against CAPEX and OPEX costs over a 45-year period.

With respect to constraints, the micro bid-off condition assumes that energy constrained is from a wind farm with a Contract for Difference (CfD) with a strike price of [redacted] and that the replacement energy required from a different area of the network will be from technologies such as Combined Cycle Gas Turbine (CCGT) generation at a cost in the range of [redacted]. Sensitivities are performed on these in section 6.3.7 below, with more detail available in the ESO's CBA report.

6.3.4 Micro Analysis

The micro analysis was used in two distinct ways: firstly, to inform the optioneering exercise and secondly, to provide input to the ESO for the macro CBA as described in section 6.3.5. The purpose of the optioneering exercise was to reduce the number of options to a manageable number for the ESO's detailed CBA. The level of constraints and costs for the different options provided an objective way to rank the options in terms of value for money. In addition to other factors such as stakeholder feedback, this helped guide the shortlisting of credible reinforcement options for the detailed CBA. More details on optioneering are provided in section 5.6 and in the GHD CBA report.

Power Flow Modelling on Skye

To model power flows on the Skye network, the Skye FES generation is represented within the network model according to individual scheme geographical locations and capacity timing. The outputs from these generators and demand levels for each simulation period (one hour) is calculated within the Constrained Energy Flow Model (CEFM). The CEFM is a tool developed by GHD to calculate the net power flows across the Skye network based on the generation output and demand. The tool also allows for the potential interactions with the Western Isles and Skye.

The Skye network is separated into local zones and the resulting net power flows from each zone are calculated for each hour. Line sections and boundaries are modelled by connecting individual zones together, cascading power flow exports over the entire transmission line. Testing these power flows against the line capacity associated with the different reinforcement options, produces the resulting constraints across the Skye network and the net power flows reaching Fort Augustus.

All reinforcement options, presented in Chapter 5, were modelled for each Skye generation scenario to produce the set of constraints, forming a critical input into the ESO's detailed CBA. These constraint values provide means to objectively compare the respective costs of each reinforcement option, allowing the determination of the most economic investment to enable greater power flow across Skye.

6.3.5 Macro CBA and Results (ESO)

The CBA undertaken by the ESO was designed to reflect the overall impact of Skye reinforcement option on the GB network under different generation scenarios. In the amended CBA methodology, the combined effect of the network reinforcement options and the generators on Skye, is reflected as a composite generator, connected at Fort Augustus. By keeping the rest of the GB network consistent, the changes in power flows on the wider GB network boundaries are attributed to the combined effect of the reinforcement option and generation combinations on Skye.

The management of constrained energy involves both the 'bid-off' process of curtailing generation behind a constrained boundary and the 'offer-on' process of sourcing replacement energy on the other side of the constrained boundary. Therefore, to fully understand the impact of constrained energy on the CBA outcomes, both processes were modelled.

The 'bid-off' cost is based on the CfD strike price for onshore wind. The strike price is used as a proxy for bidding off the generation, assuming future onshore wind farm in Skye region would receive CfDs. This is consistent with the Network Options Assessment (NOA) and in line with the ESO's wider approach to constraint flow modelling. A range of different CfD arrangements were considered in the analysis as sensitivities to understand how varying this element changed the constraint cost. The results of this are shown in section 6.3.7.

When generation is restricted behind a boundary, replacement generation elsewhere is sourced via the balancing mechanism to maintain the generation/demand balance. In the analysis, this 'offer-on' process results typically in generation brought onto the network from Combined Cycle Gas Turbine (CCGT) plant. Given the need for a flexible energy system to balance the network at any given time, the utilisation of CCGT plant or equivalent will be required in the medium to long term.

The ESO conducted the Skye CBA of the reinforcement options based on this market setup over a period of 45 years. This CBA uses a 'savings approach' to assess the reinforcement options. A counterfactual has been established, which is the do-minimum option (Option 0). By assessing the total expenditure over the reinforcement's lifetime, and the associated constraint savings the CBA aims to find the most cost-effective reinforcement option using the least worst regret methodology.

The CBA compares the Present Value (PV) of the various reinforcement options CAPEX with the PV of forecasted constraint cost savings. For each reinforcement option, the PV of both the annual constraint savings and the associated capital cost is calculated; their difference gives the option's Net Present Value (NPV). The options' NPVs are used to perform regret analysis, and subsequently to determine the preferred option based on a Least Worst Regret (LWR) approach. Further information regarding the ESO's CBA modelling can be found in the ESO's CBA report.

Table 14 shows the results of the ESO's overall CBA. [redacted]

Table 14. ESO's overall CBA results showing NPV, Worst Regret and Least Worst Regret

[redacted]

The CBA results show that Option 4 performs the strongest and is the option of least 'worst regret' (LWR). The notation 'Option 4' is used to collectively represent the two options: Option 4a (Skye_4a) and Option 4a0 – 4a1 (Skye_4a01). These options are close in performance, with the scopes broadly the same apart from the variation between Fort Augustus and Invergarry due to the possibility of the new Invergarry 400kV substation being developed before 2030.

Option 4 delivers a positive net benefit of over £400m to GB consumers in the high generation scenario. Across the four scenarios it has a worst regret of £143m compared to the worst regret of £573m for the do-minimum option (Skye_0). Option 4 performs decisively better that Options 1b and 5a, making it a clear winner overall.

Option 4a has the highest positive NPVs in the two net zero compliant high scenarios, LW and CT. In the ST scenario, Option 1b has the only economic option and has the highest NPV of £8m. In the SP scenario which is not net zero compliant, all options are not economic with Option 0 having the lowest net cost.

6.3.6 Load CBA Discussion

Given the range of drivers previously discussed, reinforcement must go ahead on Skye in order to meet the Non-Load need and to provide capacity for renewable generation. For the consumer therefore, we must make sure that this investment is justified by addressing and alleviating a comparatively greater level of constraint costs, thereby creating value for the consumer and the network at large. The purpose of the load CBA is to assess the economic justification for the proposed investment on Skye.

It is our ambition to not only undertake investments which improve the economic performance of the network for the long term, but also design a reinforcement which allows the maximum possible connection of low carbon generation to contribute to the UK's net zero targets. Furthermore, our extensive stakeholder engagement across Skye has clearly shown a desire for an investment decision for the long term (and preferably a 'build once' solution), rather than multiple incremental investments with associated disruption and environmental impacts. Investing now in a solution which has the capacity to accommodate increasing levels of generation in the long term therefore meets these expectations and delivers network reinforcement in a timely fashion.

Based on the rigorous analysis undertaken, the solution which will deliver the optimal solution is Option 4; 132 kV steel tower double circuit from Fort Augustus to Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore. This option has two possible practical deployments; Option 4a or a phased approach Option 4a0 – 4a1; the selection of which is dependent on the development of the Corie Glas 1,296MW hydro pumped storage scheme, which triggers a new 400kV substation near Invergarry and a 400kV OHL back to Fort Augustus.

Coire Glas is contracted to connect in December 2027. Due to limitations in land corridors for circuit infrastructure connecting into Fort Augustus, the proposed Skye double circuit may be required to interface with the proposed 400/132kV substation at Invergarry and the 400kV OHL circuit connecting to Fort Augustus substation. The location of the Invergarry substation is under consultation with stakeholders.

Due to the contracted demand and generation connection requirements, the Skye Circuit is required by December 2025 which is ahead of the proposed Invergarry substation. To deliver the optimal solution which minimises the potential for asset stranding, we assessed options through CBA with and without transitioning the Skye OHL to the proposed 400kV substation at Invergarry. Both options 4a and '4a0 – 4a1' performed strongly in the CBA. The option to transition at Invergarry will therefore be maintained at this stage with the decision to be finalised depending on developments with Coire Glas and by the time of Final Needs Case submission.

6.3.7 Sensitivity Analysis

The results of the CBA process were tested against a range of sensitivities to assess the robustness of the outcome. These considered generation scenarios, underground cabling costs, CAPEX (±10% and ±20%) and balancing costs.

Generation Scenarios

To manage the uncertainty of future generation, two further scenarios were assessed as sensitivities in addition to the Skye FES. These are:

i) a low generation scenario (SP2), as discussed and agreed with Ofgem, and

ii) a higher scenario taking into account potential future power flows from the Western Isles (LWWI).

From a whole system perspective, it is important to consider the potential future power flows which may be experienced by the Skye network should the connection to the Western Isles be upgraded beyond the 33kV cable currently being installed to replace the failed 33kV cable. Given the volume of generation seeking to connect on Western Isles, it is important to note that the Skye route is not currently considered a credible option for meeting this need fully. However, it is important to understand the sensitivity of the CBA outcome should an additional cable (rated up to 132kV) be developed to augment the 33kV cable in order to meet part of the need on Western Isles. Details of these generation scenario sensitivities are provided in section 4.3.6 together with the four core Skye FES.

The results of the sensitivities are provided in Tables 15 and 16 which show that the preferred option remains Option 4 (Skye_4a/Skye_4a01). Option 4a remains the clear option of least worst regret. The highest regret is for the do-minimum option (Skye_0), with some improvement in regret for options 1b and 5a.

Table 15. Regret Analysis with Introduction of Ofgem low scenario (SP2)

[redacted]

Table 16. Regret Analysis with Extra Western Isle flow in Leading the Way (LWWI)

[redacted]

Underground Cabling

Stakeholder feedback during the development process of these options highligted that two key areas along the Skye transmission network may require underground cable rather than OHL. These are: the section into the Fort Augustus substation area and the section between Broadford and Edinbane, as detailed in sectons 7.3.2 and 7.2.4 in Chapter 8. Table 17 provides the associated CAPEX increases resulting from this sensitivity based on high level assumptions of cable lengths:

Table 17. CAPEX Present Value with Cable and Without Cable (£m)

[redacted]

These sensitivities provide the results in Table 18 with the preferred option clearly remaining Option 4.

Table 18. Regret analysis with additional underground cable cost

[redacted]

Across all scenarios, Option 4a remains the option of least worst regret, providing over £380m net benefit to the GB consumer in the high scenario. The worst regret for this option is £162m, significantly lower than the worst regret for the do-minimum option at £554m. This shows that if cable mitigations are required, option 4 remains optimum.

CAPEX ±10% and ±20%

The impact of changes to the CAPEX of each option was also tested to assess to the robustness of the preferred option. In order to represent reasonable levels of cost risks during project development, CAPEX was modelled at both an increase and decrease of 10% and 20%. The results of the ±10% CAPEX sensitivities are provided in Tables 19 and 20.

Table 19. Regret analysis following 10% increase in CAPEX

[redacted]

With this sensitivity, under the high capacity generation scenario, Option 4a produces over £380m net benefit to the GB consumer. Across all scenarios, this solution has the least 'worst regret', with its worst regret being £159m against the worst regret of £557m for the do-minimum option.

Table 20. Regret analysis following 10% decrease in CAPEX

[redacted]

With this sensitivity, under the high generation scenario, Option 4a produces over £450m net benefit to the GB consumer. Across all scenarios, this solution has the least 'worst regret', with the worst regret being £126m. The worst regret for the do-minimum option is £589m.

The results of the ±20% CAPEX sensitivities are shown in Tables 21 and 22.

Table 21. Regret analysis following 20% increase in CAPEX

[redacted]

With this sensitivity, under the high generation scenario, Option 4a produces over £350m net benefit to the GB consumer. Across all scenarios, this solution has the least 'worst regret', with the worst regret of £175m against the worst regret of £540m for the do-minimum option.

Table 22. Regret analysis following 20% decrease in CAPEX

[redacted]

With this sensitivity, under the high generation scenario, Option 4a provides over £480m net benefit to the GB consumer. Across all scenarios, this solution has the least 'worst regret', with the worst regret being £110m, considerably lower than the worst regret of £606m for the do-minimum option.

In all CAPEX sensitivities above, Option 4a remains the strongest performer, with the least worst regret across the for scenarios. This is closely followed by Option 4a01. These two options perform distinctly better that the rest of the options making them robust to CAPEX sensitivities.

Balancing cost sensitivity

As detailed above in section 6.3.5, the analysis of local constraints as a result of generation scenarios consisted two main elements; the bid-off process of constraining energy behind a constrained boundary and the offer-on process of sourcing replacement energy with whatever cheaper energy source from less constrained area. The balancing actions assume that (i) all new onshore wind farms in Skye region would have CfD with a strike price [redacted] as indicated by BEIS indicated in their round 4 impact analysis; and (ii) CCGT would be used as offer-on generation to balance the market.

There are uncertainties over future wind prices and subsidy arrangement for low carbon generation. It is unknown to what extent future onshore wind farms on Skye will succeed in future CfD auctions and what the strike price might be. Our engagement with prospective developers on Skye indicated that [redacted] of respondents to our questionnaire stated they are seeking a revenue stacking model, [redacted].

For the offer-on process, CCGTs have traditionally been used as a market balancing tool given their quick start-up and effectiveness. In future, it possible that increasing volumes of low carbon technologies will be used as balancing plant. In addition to intermittent renewables, it is expected that there will be a variety of low carbon flexible technologies such as Bioenergy with Carbon Capture and Storage (BECCS), Hydrogen thermal plants and fossil plant with carbon abatement which would have fuel costs, and some of which are likely to require subsidies.

In order to understand the impact of uncertainties in future system balancing costs on the Skye network investment decision, the ESO investigated sensitivities around different market balancing behaviours. Table 23 shows that either bid-off or offer-on cost applied to Skye local constraints has an impact on the overall net present value of each option and further influence which network option is optimal under the different generation scenarios. For presentation purposes the ESO adopted a streamlined naming convention to simplify the information across the different sensitivities. In the results table, “0” represents Option 0, “1” represents Option 1b and “4” represents the Options 4a and ‘4a0 – 4a1’, while “5” represents Option 5a.

Increasing either of the balancing costs results in the do-minimum option (Option 0) having the highest constraint cost increase given its highest local constrained energy. On the contrary, Options 4a, ‘4a0 – 4a1’ and 5a become relatively more attractive. It’s noticeable in Table 23 that Option 4a/ ‘4a0 – 4a1’ is preferred when the bid-off cost for the future Skye onshore wind farms is higher than [redacted] **or** when offer-on cost is higher than [redacted]. It also shows that if the future Skye onshore wind farms were subsidy free (CfD free), then low offer-on cost [redacted] would make do-minimum the most cost-effective solution. However, renewable subsidies would get paid by the consumer ultimately at the end of the supply chain – these haven’t been included in this study. Given that most developers on Skye are seeking a revenue stacking model and not heavily reliant on CfD, and have indicated an expectation of a bid-off price in the range of [redacted], and that flexible low carbon plant is likely to be required for operability reasons in addition to the intermittent renewables it is highly unlikely the balancing costs will be zero for subsidy-free schemes and future flexible plant.

Table 23. Market balancing cost tipping point on Skye option selection

[redacted]

Overall, this sensitivity shows that in order to facilitate rapid growth of renewable generation on Skye, reinforcing the Skye transmission network to 132kV double circuit steel structure between Fort Augusts and Edinbane and 132kV single circuit wood pole to Ardmore (Option 4) is necessary.

6.4 Summary of CBA

This chapter presented the Load and Non-Load CBA methodologies, assumptions and results as well as the Load CBA sensitivity results of the CBA for Skye reinforcement options. The analyses assessed the levels of net benefit realised by the reinforcement options. As detailed in this chapter, both the Load and Non-Load CBAs deliver comparable results and demonstrate that an investment on the Skye region is warranted and will produce strong long-term net benefit to the GB consumer.

The Non-Load CBA provides evidence of LTRB as a result of investing in the network, given the current condition of the assets and the reduction in probability of failure through intervention. Specifically, the results point towards a 132kV double circuit steel tower OHL intervention between Fort August and Edinbane and a 132kV wood pole single circuit from Edinbane to Ardmore (Option 4 and its variants) as the solution which produces the highest LTRB.

For the load CBA, we supported the ESO to enhance their methodology by refining the local area modelling on Skye to ensure their CBA considered the relevant local factors relating to the performance of the reinforcement options in the wider GB context. We calculated and provided inputs to the ESO which considered stakeholder's views, practical deliverability of options and future generation profiles to identify the most economic investment option. The outcome of this analysis revealed that the most economic option for reinforcement is Option 4, and that this option is the optimal solution to meet all identified investment Load and Non-Load drivers.

Rigorous engineering and economic appraisal of the investment drivers and options to address them demonstrates the strong investment case to replace the ageing Skye OHL with higher capacity infrastructure to support the connection of renewable projects and, in doing so, increasing the security and resilience of the electricity network infrastructure to this remote part of Scotland. The solution is robust against a wide range of sensitivities including future generation capacities, CAPEX and system balancing costs.

In the high generation capacity background consistent with net zero, the proposed solution provides a net benefit of more than £400m to the GB consumer. Across the four scenarios considered the solution has the least 'worst regret', with a worst regret of £143m in stark contrast to a worst regret of £573m for the 'minimum' option which only addresses the asset condition requirements.

The proposed reinforcement is to rebuild the full 160km length of the Skye OHL from Fort Augustus to Ardmore on the Isle of Skye as follows:

- **Rebuild the Fort Augustus to Edinbane section with a high capacity 132kV double circuit steel tower OHL (2 x 348MVA summer rating)**
- **Rebuild the Edinbane to Ardmore with a 132kV single circuit wood pole OHL (176MVA summer rating)**

The proposed solution has optionality between Fort Augustus and Invergarry due to [redacted] the Invergarry 400kV substation which is required for the Coire Glas pumped storage scheme contracted to connect in 2027. The Invergarry variant of the proposed solution involves transition of the Skye OHL to Invergarry when it is built. As the future location of the Invergarry substation is under consultation with stakeholders, the decision to consider the Invergarry variant of the preferred solution is left open at this point since both deliver strong and comparable value for money for the GB consumer. Conclusion on this will be reached before submission of the Final Needs Case, allowing stakeholder input to be considered appropriately. This also allows us to manage the uncertainty.

7 Proposed Reinforcement Option

7.1 Overview of proposed option

Based on the CBA presented in this Needs Case and optimising any transmission reinforcement to Skye for current need, future export capacity, asset replacement and net zero considerations. SSEN Transmission has identified an optimal investment path based on the installation of a double circuit of 348 MVA (per circuit) between Fort Augustus and Edinbane Substations, with the remaining sections between Edinbane and Ardmore proposed to be a single circuit rated at 176 MVA. This will form a reinforced transmission network to Skye, reducing the security of supply risk, as well as significant benefits presented to the GB consumer, the transition to a low-carbon economy and the local economy. The proposed option also aligns with the feedback the SSEN Transmission has received through consultation, particularly the desire to see a project delivered that provides a secure transmission network to Skye that allows for generation scenarios that account for the longer term, meaning that future upgrades or reinforcements to the network requiring major construction works in sensitive environments are avoided as far as possible.

A high-level breakdown of cost for the Skye 132kV Reinforcement Project is provided in Table 24. These are Class 1 cost estimates which were also included in the Eligibility to Apply submission to Ofgem for this project. The costs have been derived from historical project costs and have been informed and updated with the most recent tender information relevant to the project where available.

Table 24. High level cost breakdown

Cost Breakdown	Cost (£m)*
SSEN Project Management	[redacted]
Regulatory & Consents	[redacted]
Pre-Construction	[redacted]
Principal Contractor	[redacted]
Commissioning	[redacted]
Project Risk & Insurance	[redacted]
Total	[redacted]

*Class 1 Cost Estimates [redacted]

7.2 Scope and benefits

7.2.1 The GB Consumer

In meeting the expected transmission export demand assessed in the CBA chapter from the Skye Reinforcement Project, the proposed option can accommodate new renewable generation to the levels of SSEN Transmissions current contracted position.

The regret of building various other higher and lower capacity options, as well as adopting incremental approaches to developing the network has been assessed and the proposed option returned a lower value of regret in all scenarios as well as being the overall option of LWR. The generation capacities considered in the range of scenarios provide a robust and realistic generation base for the CBA. Based on this the proposed 132kV reinforcement option provides the best balance of reducing risk of underfilling of the capacity provided with associated costs being passed to the GB consumer instead of being recovered from developers via TNUoS charges, while also not protecting against the need for further reinforcement of the Skye network in the short to medium term, which was presented in the lower capacity or non-load only options.

7.2.2 The Low Carbon Economy

The UK and Scottish Governments are committed to transitioning to a low carbon economy and the realisation of these strategies depends on both the immediate deployment of new renewable generation assets. This commitment also considers the need to large infrastructure project, such as the Skye 132kV Reinforcement, to be designed with the construction of a renewable generation projects in mind and will enable developers on Skye to bid into earlier CfD auctions, increasing chances of progression of renewable energy schemes on the island.

7.2.3 The Local Economy

The selection of the proposed 132kV reinforcement option, with its CAPEX cost and EISD allows increased chances of renewable generation projects progressing on Skye as noted above. This in turn creates earlier benefits for the local island economy in terms of investment potential on the back of a high capacity link to the GB mainland with an ability to export renewable generation. An example of this can already be seen in the way that both contracted and known interest from generators has increased since undertaking stakeholder engagement seminars with developers to gauge interest as part of the CBA work. This could provide further benefits for GB consumer.

7.3 Configuration and Design of the proposed option

7.3.1 Overview of the proposed solution

The system will consist of:

a) 137km of New Build 132kV Double Circuit between Fort Augustus and Edinbane Substations;

b) 24km of New Build 132kV Single Circuit between Edinbane and Ardmore Substations;

d) A 132kV switching station at the existing Broadford Substation to connect to the current and planned additional GSP.

The Skye 132kV Reinforcement solution described above is detailed in Figure 21 showing the preferred route.

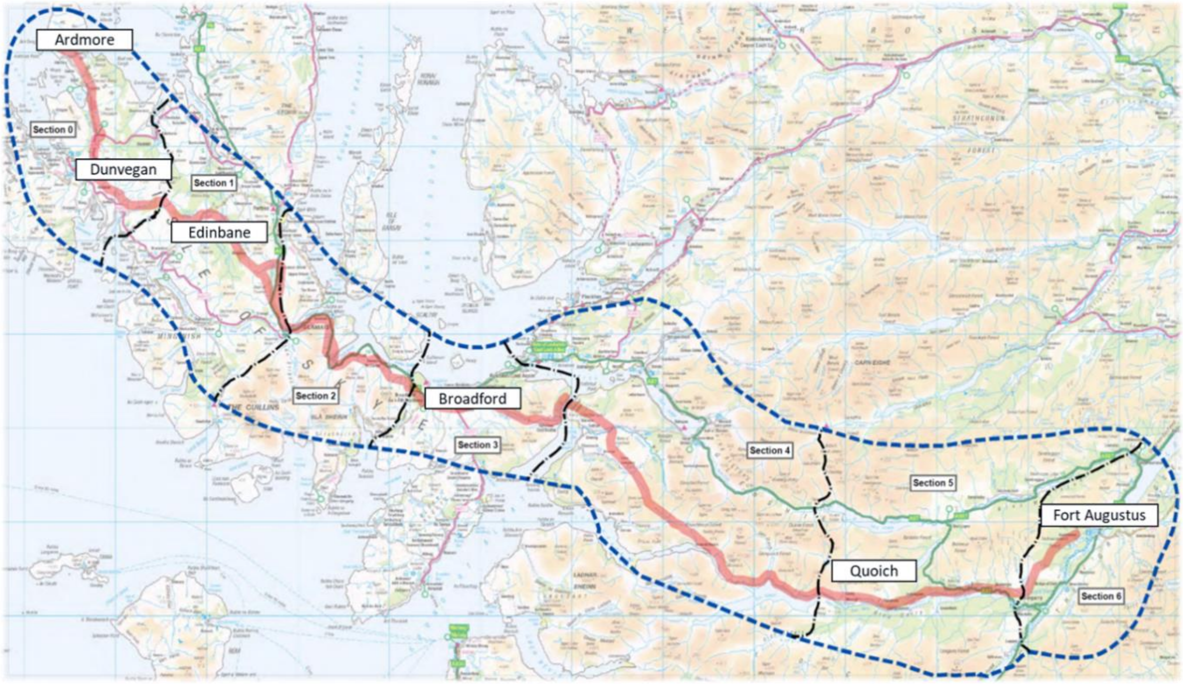


Figure 21. Preferred route map

7.3.2 Fort Augustus to Quoich

The Fort Augustus to Quoich section is comprised of 28km of a double circuit 132kV OHL, predominantly using OHL. At the Quoich end the OHL will turn into the new Quoich Tee Substation, which has been approved by Ofgem in the RIIO-T2 Final Determinations. Consultation on the primary project design option of OHL with key statutory consultees and Landowners has indicated that visual impact mitigation may be required due to the cumulative visual impact of proposed and existing transmission infrastructure in and around the Fort Augustus substation area (see section 3.3.2). Mitigation of this impact will be via the use of underground cables, the exact extent of any cable required will be determined in during the detail design phase of the project and presented within the Final Needs Case (FNC) submission to Ofgem.

7.3.3 Quoich to Broadford

Between Quoich and Broadford substations a double circuit 132kV OHL will run for 64km across some of Scotland's most remote and challenging landscapes, passing through the Knoydart National Scenic Area, Kinloch and Kyleakin Hills Special Area of Conservation (SAC), and areas of Wild Land. It will then connect to a new 132kV Switching Station that is proposed at the existing Broadford substation site. Due to significant routing limitations, this section will also retain and reuse the existing crossing towers as the point of connection between the mainland and the Isle of Skye.

7.3.4 Broadford to Edinbane

From Broadford the double circuit 132kV OHL skirts the north eastern coast of the Isle of Skye, crossing through the Cuillin Hills National Scenic Area before heading North West towards an existing generator substation site at Edinbane. Within the Cuillin Hills National Scenic area a section of underground cable is likely to be required to mitigate significant landscape and visual impacts identified through environmental assessment of an OHL option following feedback from consultation with Key Statutory Consultees and Landowners (see section 3.3.2). The exact extent of any cable required will be determined in during the detail design phase of the project and presented within the FNC submission to Ofgem. At Edinbane the double circuit 132kV OHL connects to a new 132kV Collector Switching Station that is required to facilitate various generators seeking to connect in the Edinbane area and is not funded under the LOTI mechanism.

7.3.5 Edinbane to Ardmore

After Edinbane, the OHL changes from double to single circuit, following a similar route to the existing 132kV circuit for 9.5km up to Dunvegan substation. Here the line is connected into the local distribution network at Dunvegan GSP. The OHL then mostly follows the route of the existing circuit for another 14km north to Ardmore substation where the 132kV network terminates and two 33kV subsea cables connect to Western Isles, the islands of South Uist and Harris.

7.4 Competition

As part of the NOA process, the ESO undertakes assessment for competition eligibility for generation connection projects. This assessment is undertaken against Ofgem's criteria for competition which is based on three criteria namely; high value (above £100m), new and separable. In the 2020/21 NOA report, the ESO assessed the Skye project as eligible for competition. We note that the decision on whether the project is delivered through competition rests with Ofgem.

There are a number of interfaces with both existing and planned new connections along the line as well as Non-Load works at Quoich Tee and Broadford substation. The associated projects are not funded under the LOTI mechanism, but still aligned, mainly through connection dates. Our design and delivery plan capitalises on efficiencies through alignment of both Load driven capacity upgrades, connections and asset condition replacement activities. Delivering this project as a coordinated scheme will provide efficiencies through not re-mobilising contractors later to establish welfare, access and to undertake works on an uncoordinated programme. Furthermore, combining these two activities significantly reduces outages on this critical circuit which would otherwise be required to rely on diesel generators to provide security of supply.

Based on the above we do not believe the project meets Ofgem's separable criteria. Coupled with the fact, given the complexity of this project, the significant environmental sensitivities involved, requiring extensive and coordinated stakeholder engagement throughout the development cycle of the project, we do not believe that the delivery of this project through competition is in the best interest of GB consumers.

8 Project Timeline and Delivery Strategy

8.1 Overview of project delivery strategy and monitoring

In compliance with the SSE Group's project governance framework, the Skye 132kV Reinforcement Project is classed as a Large Capital Project (LCP) and is subject to full LCP governance. The project will progress through 5 phases to project completion; 3 development stages and 2 construction stages as demonstrated in Figure 22 below. The project is currently in Development and will move into the Refinement phase following a successful "minded to" Ofgem decision. Following this and upon securing the necessary contents and funding the project will move to the construction phases (Execution and Operate & Evaluate). The LCP Governance Manual is provided in the list of supporting documents in Appendix 1.

Figure 22. SSE LCP Project Phases

8.2 Programme of key activities

Further to the project timeline provided in section 3.4, the Skye 132kV Reinforcement project summary programme, provided in the list of supporting documents in Appendix 1 presents the key project activities with anticipated start, finish and duration. The project duration shown is from 2019 to 2026 and covers the outstanding project development, consenting and approvals activities in addition to the full construction programme.

A description of the key activities under each project phase as noted is provided below.

8.2.1 Opportunity Phase

The project successfully completed the opportunity phase in December 2020. During the opportunity phase the project team undertook the selection process described in section 5 resulting in the preferred Skye 132kV Reinforcement option. To support the selection of this preferred option, SSEN Transmission project team held several public and statutory authority consultation events to gain feedback on their key considerations about the design solution and routing. The project team consulted with local mainland and communities on Skye, the Highland Council (HC), Nature Scot (NS), Scottish Environment Protection Agency (SEPA) and Historic Environment Scotland (HES).

8.2.2 Development Phase

During the Development phase the Skye Reinforcement project has focused on concluding an alignment for the 132kV OHL. This alignment is based on the engineering contractor design, initial results of the environmental assessment and multiple engagements with stakeholders. The LCP project documentation has been referred to and updated throughout this phase of the project. The key milestones for this phase of the Skye 132kV OHL reinforcement are:

- Review LCP project documentation to confirm scope, update the documentation at the end of this phase in preparation for the next phase, including programme, risk and finance project information for the project.
- Confirm the technologies for the 132kV OHL
- Undertake an OHL routing study to confirm the OHL routes
- Write and tender the contractor design scope; award scope of work to undertake ground investigation of the OHL route and initial OHL alignment and cable design during this phase
- Undertake environmental surveys that include visual and landscape, noise and habitat along the OHL route and substation tie-ins
- Engage with 80 landowners along the OHL route
- Undertake stakeholder engagement throughout this phase with landowners, statutory stakeholders, local government, community and other interested stakeholders
- Regulatory submission of the INC

Following on from the conclusion the works described above, development will focus on detailed engineering designs and confirmation of each tower position and substation layouts. This work also includes for site investigation works, covering bore holes and trial pits that will inform foundation, access and accommodation design.

Further engagement will be sought with landowners to agree and negotiate wayleaves, the supporting information from the OHL design will be used to aid these discussions. The deliverables from the technical design, outcome of the environmental studies and further engagement with stakeholders during this phase will support completion of the Environmental Impact Assessment which will then be submitted as a S37 application to the Energy Consents Unit (ECU) for review and determination. During this phase the Needs Case will be submitted to Ofgem. The second Development phase is normally concluded after planning application submission. The LCP stage gate documentation will be referred to and updated throughout this phase of the project. The key milestones for the second Development phase of works for the Skye 132kV OHL reinforcement are:

- Review LCP project documentation to confirm work undertaken within the previous phase, update the documentation at the end of this phase in preparation for the next phase, including programme, risk and finance project information for the project.
- Undertake the final pre-construction alignment study to confirm all tower positions
- Undertake bore holes and trial pits at each OHL tower location
- Write and tender the contractor construction scope for construction.
- Continue negotiation with landowners to agree wayleaves and Heads of Terms based on the outcome of the alignment study and substation site confirmation
- Undertake stakeholder engagement throughout this phase with landowners, statutory stakeholders, local government, community and other interested stakeholders
- Finalise the environmental surveys and complete the Environmental Impact Assessment, when finalised, submit the S37 planning application to the ECU.

- Regulatory submission of the FNC referring to the refined design work within this

8.2.3 Current Position

The Skye project is currently within this initial phase of design, due to the length and risk of objection for the new OHL S37 planning application, an approach of early detailed design has been taken to facilitate detailed discussions with stakeholders earlier in the planning process and aid and support minimising risk of time delay and objection to the planning application.

In order to facilitate this approach, during Q1 and Q2 of 2020, SSEN Transmission prepared Works Information and undertook a tender process to key suppliers on its high value OHL framework to obtain competitive market pricing for the design phase of the Skye 132kV Reinforcement Project. The contractor works are split into two phases, alignment design (first development phase) and detailed design (second development phase).

The Skye 132kV Reinforcement Project design work has recently concluded the first development phase, which covered OHL alignment and constructability.

Developer Engagement

SSEN Transmission has been working closely with the major developers and SHEPD to fully understand the generation and demand requirements on Skye. This has provided significant input to the tendering and design process above and allows SSEN Transmission to work up the reinforcement works to meet for known and future generation demand.

Regulatory Needs Cases

The development of the Skye 132kV Reinforcement Needs Case began during the Opportunity phase and has continued into the Development phase. Dedicated engagement on the Needs Case with Ofgem commenced in Q3 of 2020 and, following submission of this INC in July 2021, further engagement is planned throughout Ofgem's review. We are seeking a 'minded to' decision by the end of Q1 in 2022. Following on from Ofgem's decision on the INC, a FNC will be drafted accounting for any project changes in cost or design prior to submission of necessary planning consents in Q3 of 2022. SSEN Transmission will hold off from submitting the FNC to Ofgem until six months prior to the anticipated consents approval date in July 2023.

8.2.4 Refinement Phase

The Refinement phase is the last of the 3 pre-construction phases that the project will complete. This project will have undertaken most of the detailed design within the previous phase, the main deliverables will be any changes to the detailed design arising from stakeholder discussions after the previous phase and confirmation of expected construction costs, confirmation of planning approval and signed Heads of Terms agreements with landowners. The construction design will be tendered during this phase to support efficient progression to construction phase. When all pre-construction deliverables are confirmed, reviewed and agreed the project will be ready to start construction. The key milestones for the last phase of pre-construction activity are:

- Review LCP project documentation to confirm work undertaken within the previous phase, update the documentation at the end of this phase in preparation for the construction phase, including construction programme, risk and a Class 3 estimate to confirm required finance for the project

- Undertake any additional engineering studies required before Gate 3 this would include changes to engineering design for landowners, and any engineering requirements required to discharge planning conditions
- Confirmation of expected detailed construction costs for the project post Gate 3
- Further ground investigation may be required if the detailed design is amended
- Place orders any long lead items of equipment
- Write and tender the contractor construction scope for construction
- Finalise all negotiations with landowners and have all Heads of Term signed
- Continue to engage with stakeholder engagement throughout this phase with landowners, statutory stakeholders, local government, community and other interested stakeholders
- Receive feedback from the planning authority on the status of the planning applications; if successful prepare to discharge conditions.

8.2.5 Project Assessment

The Project Assessment will be submitted to Ofgem following confirmation of the SSEN Transmission CAPEX and OPEX costs. As shown in the project programme, SSEN Transmission will undertake a competitive tender exercise for the execution phase of the project during Q3 and Q4 of 2022, using the final design output of the works outlined above as the basis of this. The tender exercise will allow refinement of the construction programme and costs and allow SSEN Transmission to finalise other project costs such as risk and project management values. Following submission (proposed for July 2022), it is anticipated a programme of meetings will be arranged with Ofgem to assist the review process.

Outstanding Planning and Consents

SSEN Transmission will complete core elements the Skye 132kV Reinforcement planning and consents requirements with the submission of the section 37 application to the Scottish Government ECU in July 2022. Following periods of consultation and review, granting of this consent is expected to be in place for July 2023. Additional planning and consents required for the via Town and Country Planning Applications for the project substation works are programmed to be submitted and consented in the same timeframes at the section 37 application.

Further individual permissions such as Controlled Activity Regulations licences to cross watercourses will be sought by SSEN Transmission or our appointed contractors during the Execution Phase once detailed design is completed.

8.2.6 Execution

The Execution stage includes the manufacture and installation of equipment, as well as commissioning and energisation. We will review and reconfirm project delivery programme and cost for detailed design, construction and installation inclusive of consent conditions before awarding the project contracts in mid-2023. The contractors will mobilise project teams and set up site offices on the mainland and Skye with SSEN Transmission taking a major interface management role. The construction period allows for confirmation of the design detail, manufacture and installation of equipment. Commissioning is due to take place from Q3/4 2025 and the planned energisation of the Skye 132kV Reinforcement is December 2025.

8.3 Lessons Learned

To aid in efficient project progress we have reviewed previous projects and submissions similar to the works proposed for the Skye 132kV Reinforcement Project. Following these reviews, we have incorporated the learning gained from the performance of the past projects. We discuss this learning below.

8.3.1 Caithness Moray – Health, Safety and Environment

The Caithness Moray project successfully implemented a series of safety, health and environment improvements with SSEN Transmission contractors including:

- Substation, OHL and underground cable contractor safety forums;
- Mental and physical health wellbeing monitoring programmes for employees; and
- Environment engagement sessions with local communities.

Evidence of action

The successful initiatives noted above have been included as requirements under the Works Information for the successful tenderer for the design phase of the Skye 132kV Reinforcement Project. Our established supply chain of contractors are already involved in the safety forums and have raised their own standards as a result of working with SSEN Transmission on previous projects.

8.3.2 Western Isles – Site Investigations

During the development phase of the Western Isles Project, site investigations were undertaken. The contractor provided comprehensive results and reports. However, the review and discussion of the scope and safety documentation before site work commenced was not completed within a timely manner, resulting in a delay.

Evidence of action

To enable commencement of the work in a timely manner and to ensure a clear understanding of scope and safety by the contractor and ourselves, pre-commencement meetings were arranged on the Skye 132kV Reinforcement Project with the contractor site team and our project team. This allowed the site and project team to review the works, question and answer from relevant site and project team and confirm safe working conditions. Overall this led to open communication and quicker site set-up.

Western Isles Connection – Stakeholder Engagement

The Western Isles Connection review of options (including CBA studies by the SO and GHD) provided differing outputs in terms of optimal capacity for a transmission reinforcement. The choice between an option that provided lower capacity and circuit security, or those that produced high capacity and greater security was finely balanced depending on the generation scenario achieved with differing solutions showing as the option of LWR for different analysis sets.

SSEN Transmission therefore expanded the review with our stakeholders and asked for input on the wider implications of providing a lower and higher capacity reinforcement. This provided valuable feedback on the increased opportunities afforded to the local island community and the wider Scottish and GB economies through provision of a higher capacity option, as well as the environmental benefit of limiting the need to have further construction works in highly sensitive environments if capacity upgrades are need in the future. These discussions helped SSEN Transmission submit a Needs Case that considered wider aspects of the proposed solution than just economic outputs from CBA studies.

Evidence of action

The Skye 132kV Reinforcement Project has maintained the relationships made with Scottish and UK Governments through stakeholder consultation on the Western Isles project and looked to mirror any unique local stakeholder relations, for example with the Highland Council. We have kept our stakeholders informed of the development of options throughout the development of the project and have considered their inputs in making a recommendation reinforcement option in this submission.

8.3.3 Fort Augustus to Skye Project – Lack of Design Certainty

The Fort Augustus to Skye Project struggled in reaching agreements with Statutory Consultees and Landowners due to the environmental sensitivity and technical challenges presented during the routing and alignment phase. Key information on construction methods and maintenance regimes post construction was requested through consultation phases, though enough levels of detail could not be provided due to the lack of a contractor being involved in the early optioneering and design phases of the project.

Evidence of action

The Skye 132kV Reinforcement Project recognised that in order to not get entangled in the same situation as the preceding Fort Augustus to Skye Project, early contractor engagement should be adopted to allow for better certainty of design at an earlier stage, and ensure that the Statutory Consultees and Landowners could be brought along the design journey with greater confidence on a fixed design and the associated impacts of it.

8.4 Procurement Strategy

8.4.1 Internal Governance

The Skye 132kV Reinforcement Project is considered a Large Capital Project (LCP) under the SSE Group LCP governance framework and will therefore follow the SSE LCP governance process, which is outlined in Figure 23 below.

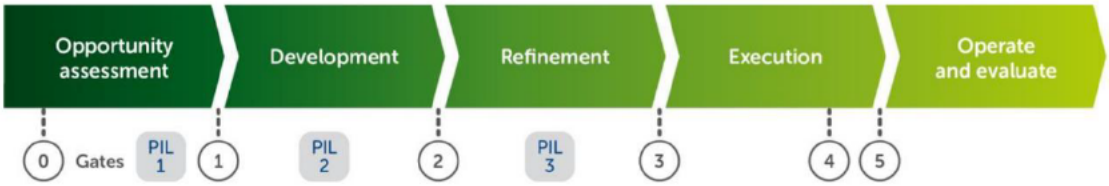


Figure 23. Procurement, Insurance and Legal (PIL) Internal Governance

The project will undergo five stages to completion, which have been outlined above. In addition, to support the project's objectives critical Procurement, Insurance and Legal (PIL) responses to project risks and opportunities are developed and implemented. The PIL responses are co-ordinated through PIL Review meetings as identified in Figure 23 above

8.4.2 Procurement Strategy

A variety of factors will influence the strategy of a major SSEN Transmission project including programme, project and interface management, technical capabilities, system integration, supply chain availability and risk allocation. Value for money and quality of product are consistent considerations.

8.4.3 Supply Chain Contracts

The New Engineering Contract 3 (NEC3) suite of contracts will typically be used for all key contracts on the Skye 132kV Reinforcement. This suite of contracts has been used successfully on other large projects delivered by us. The planned key contract and procurement awards are shown in Table 25.

Table 25. Skye 132kV Reinforcement Project Procurement Summary

No.	Works	Contract Conditions	Special Conditions
1	OHL works – wood pole	NEC3 ECC, Option A Lump Sum (via SSE Wood pole Call Off Framework)	Various 'Z' Clauses
2	OHL Works – steel towers	NEC3 ECC, Option A Lump Sum. Either to be awarded under the new T2 Frameworks or a standalone regulated tender	Various 'Z' Clauses
3	UGC Works – to mitigate landscape and visual impact in designated landscapes and for substation "Tie In's"	NEC3 ECC, Option A Lump Sum. Mini Competition via new framework (potential to include above)	Various 'Z' Clauses
4	Substation works – switching station technology including civils	NEC3 ECC, Option A Lump Sum. Mini Competition via new framework (potential to include above)	Various 'Z' Clauses

A summary of the main contracts and associated tendering strategy is discussed in the following sections. It is envisaged that value will be maximised using competitive tenders for all key procurement awards via framework and one-off contracts.

8.4.4 Works Package 1: OHL works – Wood Pole

The scope for Package 1 comprises the design, supply, installation and commissioning of the wood pole OHL infrastructure between Edinbane and Ardmore Substations.

Contract Strategy

The scope and scale of Package 1 requires the works to be tendered to the EU market in accordance with EU Procurement Rules. The contract conditions are the NEC3 ECC with employer drafted amendments. The contract conditions comprise the NEC EEC Option A which includes a lump sum offer with activity schedule.

The tender process is being undertaken in two stages:

• Stage 1

A Pre-Qualification Questionnaire (PQQ) selection process utilising the Achilles online platform will be utilised.

The selection process is based on objective and transparent criteria to evaluate the suitability of potential applicants to carry out the scope of the contract. Through the PQQ tender evaluation six suppliers will be identified and notified that they will be invited to competitively tender for the works.

• Stage 2

The second stage of the process, the Invitation to Tender (ITT), will involve issuing Works Information electronically to suppliers who were successfully shortlisted to participate in the ITT process, contract negotiation and award.

The ITT will run for six months between September 2022 and February 2023. Best and Final Offer (BAFO) responses will then be negotiated with the preferred tenderer to be appointed by SSEN Transmission in July 2023.

8.4.5 Works Package 2: OHL works – Steel Towers

The scope for Package 2 comprises the design, supply, installation and commissioning of the steel tower OHL infrastructure between Fort Augustus and Edinbane Substations

Contract Strategy

The scope and scale of Package 2 requires the works to be tendered to the EU market in accordance with EU Procurement Rules. The value of this contract package will comprise the majority of the overall project total cost. The contract conditions are the NEC3 ECC with employer drafted amendments. The contract conditions comprise the NEC EEC Option A which includes a lump sum offer with activity schedule.

The tender process is being undertaken in two stages:

• Stage 1

A Pre-Qualification Questionnaire (PQQ) selection process utilising the Achilles online platform will be utilised.

The selection process is based on objective and transparent criteria to evaluate the suitability of potential applicants to carry out the scope of the contract. Through the PQQ tender evaluation six suppliers will be identified and notified that they will be invited to competitively tender for the works.

• Stage 2

The second stage of the process, the Invitation to Tender (ITT), will involve issuing Works Information electronically to suppliers who were successfully shortlisted to participate in the ITT process, contract negotiation and award.

The ITT will run for six months between September 2022 and February 2023. Best and Final Offer (BAFO) responses will then be negotiated with the preferred tenderer to be appointed by SSEN Transmission in July 2023.

8.4.6 Works Package 3: Under Ground Cable (UGC) works

The scope for Package 3 comprises the design, supply, installation and commissioning of the UGC works required for any consenting purposes, and substation “tie-ins” along the 160KM OHL route.

Contract Strategy

The scope and scale of Package 3 requires the works to be tendered to the EU market in accordance with EU Procurement Rules.   The contract conditions are the NEC3 ECC with employer drafted amendments. The contract conditions comprise the NEC EEC Option A which includes a lump sum offer with activity schedule.

The tender process is being undertaken in two stages:

• Stage 1

A Pre-Qualification Questionnaire (PQQ) selection process utilising the Achilles online platform will be utilised.

The selection process is based on objective and transparent criteria to evaluate the suitability of potential applicants to carry out the scope of the contract. Through the PQQ tender evaluation six suppliers will be identified and notified that they will be invited to competitively tender for the works.

• Stage 2

The second stage of the process, the Invitation to Tender (ITT), will involve issuing Works Information electronically to suppliers who were successfully shortlisted to participate in the ITT process, contract negotiation and award.

The ITT will run for six months between September 2022 and February 2023. Best and Final Offer (BAFO) responses will then be negotiated with the preferred tenderer to be appointed by SSEN Transmission in July 2023.

8.4.7 Works Package 4: Substation works – switching station technology including civils

The scope for Package 4 comprises the design, supply, installation and commissioning of the Broadford Switching Station equipment, and GIS Substation equipment, as well as technological works at the other existing substations along the route: Fort Augustus, Quoich, Broadford GSP, Edinbane, Dunvegan, and Ardmore.

Contract Strategy

The scope and scale of Package 4 requires the works to be tendered to the EU market in accordance with EU Procurement Rules. The contract conditions are the NEC3 ECC with employer drafted amendments. The contract conditions comprise the NEC EEC Option A which includes a lump sum offer with activity schedule.

The tender process is being undertaken in two stages:

• Stage 1

A Pre-Qualification Questionnaire (PQQ) selection process utilising the Achilles online platform will be utilised.

The selection process is based on objective and transparent criteria to evaluate the suitability of potential applicants to carry out the scope of the contract. Through the PQQ tender evaluation six suppliers will be identified and notified that they will be invited to competitively tender for the works.

• Stage 2

The second stage of the process, the Invitation to Tender (ITT), will involve issuing Works Information electronically to suppliers who were successfully shortlisted to participate in the ITT process, contract negotiation and award.

The ITT will run for six months between September 2022 and February 2023. Best and Final Offer (BAFO) responses will then be negotiated with the preferred tenderer to be appointed by SSEN Transmission in July 2023.

8.4.8 Risk

The Skye 132kV Reinforcement project is managing risk in accordance with the LCP Governance Manual and requirements. The Project has a Risk Management Plan, which sets out the Process the Project will use to manage risk (threats and opportunities) over the lifetime of the Project. Within the Plan it sets out the risk process that should be followed to manage risk, project teams' roles in respect of managing risk, and that the Project is using the SSE LCP Risk Management Information System, KERIS (Knowledge Exchange Risk Information System) as the tool 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 and track mitigating risk actions. All risks and actions are assigned owners who are then accountable for updating the KERIS system. Risk owners can simultaneously access KERIS, this is an ongoing project activity to ensure that risk data is reliable and can be used to support project decision making. To supplement the ongoing updates to KERIS, the Skye project team hold regular risk workshops to collectively review and challenge the Project Risk

Register. These workshops are independently facilitated by the SSE Large Capital Projects Risk Team who will bring challenge, experience and learnings from other similar large capital projects.

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

Before Gate 3 in the LCP Governance Gated Process, the Execution risks, and risks that the project cannot transfer to the Contractor, and should be ALARP (as low as reasonably practicable) are validated, and used as inputs in a probabilistic risk model (Quantitative Risk Analysis (QRA)), the output of which will provide a range, and will input to the Project Assessment submission risk figure.

This risk figure, and the risks that are the key drivers of it, will be further reviewed and refined for presentation in the Project Assessment following conclusion of the multi-contract procurement process and a better understanding how risks will be apportioned between SSEN Transmission and our contractors. The risk allocation split will be agreed with the contractors to ensure the party in the best position to own, mitigate and control any given risk takes ownership to reduce the impact of the risk and keep costs to a minimum. Costing of the SSEN Transmission and contractor risk allowances will be developed in line with this approach to provide the best Value for Money (VFM) and to reduce the likelihood of the risks of materialising and becoming issues.

The Skye 132kV Reinforcement Project Risk Register is also informed by risk data and lessons learned from other projects held on KERIS, for example, the Inveraray to Crossaig 275kV OHL project, the Knocknagael to Tomatin 275kV OHL project, and the Beauly Mossford 132kV OHL project. The Skye 132kV Reinforcement Project has access to records of risks that have impacted other projects and risks that were successfully mitigated; this is a form of lessons learned and will inform the quality of the Risk Register and accuracy of the Project Assessment.

To assist the project team and development advances and improve performance, risks will be organised into sub- registers for OHL, substations, land cable, and general project risk. This breakdown will ensure greater ownership from Subject Matter Experts and visibility of what risks sit on each sub-register The SSE LCP Risk Team is responsible for monitoring and reporting on the performance, of Risk Management on the project as per the Skye 132kV Reinforcement Risk Management Plan, produced as part of the LCP Governance documentation for the project. The LCP Risk Team provide the Project Manager with weekly reports detailing the status of Risks and Actions to highlight risks/actions requiring attention. The top five pre-construction risks for the project are set out in Table 26.

Table 26. Top 5 Pre-Construction risks

Description	Risk Control Actions
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

9 Conclusion

The ongoing need for the replacement and reinforcement of the Skye OHL circuit has been clearly demonstrated through the evidence of the current asset condition of the existing circuit and through the volumes of generation looking to connect to the Skye transmission network.

There are three clear drivers which evidences the need to intervene on the Skye OHL circuit during the RIIO-T2 price control period. This includes:

- **Non-Load Driver and Security of Supply** – The existing OHL is reaching the end of its operational life and requires replacement in order to maintain security of supply for homes and businesses on Skye, and on the Western Isles that are currently supplied via a subsea cable from the north of Skye.
- **Load Driver** – the current amount of generation connected on the Skye circuit exceeds the rating of the existing line and has a derogation from the relevant parts of the NETS SQSS. In addition, we have a requirement to connect new renewable electricity generators on Skye which results in a requirement for an increase in capacity of the existing OHL; and
- **Net Zero** – Following the commitment from both the UK and Scottish Governments to achieve net zero emissions by 2050 and 2045 respectively, SSEN Transmission set out an economically justified pathway for reinforcement of this line that will meet net zero targets at the lowest risk to GB consumers. This will allow the connection of additional renewables generation.

In addition to these primary drivers, it's extremely important to note that the Isle of Skye is an environmentally sensitive area with the proposed OHL route running through some of Scotland's most valued wild landscapes. Understandably, many stakeholders have concerns about the potential disruption and lasting visual impact from the infrastructure and construction methods. Mindful of the views of our stakeholders, we have undertaken an extensive assessment of the potential future generation in the Skye area, with the aim of ensuring that our proposed solution not only meets the immediate needs for generators looking to connect in this area but also makes proportionate provision for future potential generation in the area. In generating the proposed solution, we have worked closely with our stakeholders to develop an economic, co-ordinated solution that satisfies current and future consumers' needs and so avoiding the damaging cost of multiple incremental interventions.

In order to reach a long-term economic solution, we must look beyond currently connected, contracted and scoping generation recognising the cost and environmental impact of any significant network augmentation in the short to mid-term. A view which is supported by our stakeholders who acknowledged the importance that the Skye OHL is upgraded to allow renewables on Skye to be connected to the national grid[35].

We believe the preferred solution, outlined below, is the most economic and efficient solution to address these need drivers, meet our stakeholders needs and to contribute towards the UK's net zero targets by 2050 (and 2045 for Scotland).

The information and evidence provided within this submission clearly demonstrates that Ofgem should be approving the Initial Needs Case and supporting the proposed solution which is to replace the circuit from:

[35] ssen-transmission-skye-reinforcement-virtual-consultation-summary_.pdf

- **Fort Augustus to Edinbane with a high capacity double circuit steel structure OHL (2 x 348MVA summer rating)**
- **Edinbane to Ardmore section with a single circuit wood pole OHL (176MVA summer rating)**.

9.1 Next Steps

Following the submission of this INC, we anticipate that Ofgem will take 6 to 9 months to publish its INC response (end of April 2022 at the latest), as per paragraph 4.3 of the LOTI Guidance document[36]. During this time, SSEN Transmission will continue to progress its work with stakeholders to obtain all the necessary wayleaves, environmental and planning consents.

Following Ofgem's decision on the INC, we will submit our FNC in December 2022 6 months prior to when we anticipate receiving our s37 planning consents, as set out in our Eligibility to Apply letter and agreed with Ofgem. As soon as we submit our FNC for Skye, we will start to prepare our Project Assessment submission for a planned submission at the same time we expect to receive Ofgem's decision on our FNC in June 2023. These timings are critical in order to ensure that Ofgem's LOTI assessment process does not become a blocker from SSEN Transmission meeting its contracted dates with its generators.

We have welcomed Ofgem's pragmatic and flexible approach to the assessment of the Skye project so far and we hope this continues throughout the LOTI assessment process for the project.

We will continue to work closely with Ofgem throughout the process in order to ensure we are being as open and transparent as possible, whilst ensuring that Ofgem has no surprises from any of the information submitted at any stage throughout the assessment process.

[36] Large Onshore Transmission Investments Reopener Guidance (ofgem.gov.uk)

Appendices

Appendix 1: List of supporting documents

Document name	Description
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]