Scottish & Southern Electricity Networks

TRANSMISSION

Argyll & Kintyre Reinforcement Strategy Initial Needs Case Submission

11th March 2022

Contents

Executive Summary

SSEN Transmission is submitting the Initial Needs Case (INC) for the Argyll and Kintyre 275kV Reinforcement Strategy, under Special Licence Condition 3.13 of our Transmission Licence and Ofgem's Large Onshore Transmission Investment (LOTI) Guidance. This follows the submission of our Eligibility to Apply letter which was approved on 9 August 2021.

We are seeking Ofgem's support and approval for the recommended Argyll and Kintyre 275kV Reinforcement Strategy**.** This consists of the upgrade of the existing network to 275kV operation from Crossaig in the South to a connection point located to the east of the village of Dalmally on the SPT (Scottish Power Transmission) Dalmally – Windyhill 275kV Overhead Line (OHL).

Key Messages:

- **The current network is full and the need for growth is certain.** Continued growth of contracted and consented generation provides an imperative for reinforcement options development (chapter 4).
- Rigorous and extensive stakeholder consultation has shown that there is a strong and **increasing drive for network capacity to export renewable energy** to the Great Britain (GB) system from the Argyll and Kintyre network (chapter 3).
- We have **considered a wide range of possible solutions** to the need for increased capacity, narrowing these to a shortlist of deliverable options (chapter 5).
- Our system operability studies considered the operation of the local system under a range of generation scenarios and over the next decade (chapter 6). This demonstrates that:
  - Investment in network reinforcement is required
  - Partial / phased reinforcement options to 275kV produce an inoperable system
  - **That the 'do minimum' option aligns with our recommended Argyll 275kV Strategy (05).**
- Our **recommended option is ranked as highest value for consumers** by the Electricity System Operator's (ESO) Cost Benefit Analysis (CBA) results of operable network solutions (chapter 6).
- The recommended Argyll and Kintyre Reinforcement Strategy is in line with Future Energy Scenarios and is **an essential component of the pathway to a Net Zero energy system**.
- Enabling connection of significant volumes of renewable energy through new network capacity will provide **significant benefits to the GB consumer,** supporting the transition to a low-carbon economy.
- We expect construction to start in 2024 with the scheme fully energised in April 2027, at a current estimated cost of c.£400 million
- To meet our programme for delivery, we are seeking Ofgem's approval of the recommendations made in this INC. If necessary, a Final Needs Case (FNC) would be submitted by January 2023.

Background

A pathway to reach challenging Net Zero targets

As we strive for Net Zero, there is a requirement to increase the network capability to enable the connection of further renewable generation and to export to the wider GB network. Achieving those targets will require strategic investment in renewable electricity generation on the network, at the right time.

The Need

As we strive for Net Zero, there is a requirement to increase the network capability to enable the connection of further renewable generation and to export to the wider GB network. Achieving those targets will require strategic investment in renewable electricity generation on the network, at the right time.

The need for growth is certain

The current network is nearing capacity and will shortly be full with the connections of existing contracted generation. Continued growth in the need for generation connection capacity is certain. With a current total installed generation capacity of 582 Megawatts (MW) against a peak demand of approximately 64MW, the Argyll and Kintyre area is a net exporter of renewable generation.

The existing network can accommodate 690MW of connected and contracted generation. The current contracted background is approximately 670MW, with over 1,800MW scoping generation identified through stakeholder engagement. The trend in generators seeking connection to the grid from 2026 onwards will continue. As electricity demand increases and energy becomes greener, further renewable and pumped storage developments are expected.

There is an increasing need to maintain security of supply at the Grid Supply Points (GSPs) in the Argyll area and to increase the capacity of the network to accommodate the additional renewable generation seeking connection. This requires a stable and safe system which can be operated on a day to day basis by the ESO.

Assessment of Options

Robust and holistic system operability appraisal

We have completed extensive system studies to understand how the Argyll and Kintyre system would operate under different generation scenarios and with a range of reinforcement options in place. This invaluable work proves that investment is required and that the phased or partial investment options will not deliver a safe and secure system – even in the first year of operation.

Our analysis identifies that the ‘do minimum’ option is the recommended Argyll and Kintyre 275kV Reinforcement Strategy under both the low and high generation scenarios and in the short and medium term (2027 to 2035).

Robust and holistic economic appraisal

We have worked closely with the ESO to consider relevant economic factors and support our investment proposal.

The ESO's CBA methodology was designed to assess strategic wider system reinforcements. The local transmission network in Argyll exhibits its own system characteristics as demonstrated above. The macro-CBA analysis which the ESO is able to complete will not therefore identify the impact on operability or constraints. Both we and the ESO recognised that the generation in the Argyll area must be looked at in greater granularity and that the CBA results must be considered in conjunction with that granular analysis. We worked with the ESO to model the costs and benefits using local data to inform the reinforcement recommendation. While the model does not capture the necessary local system characteristics, it does continue to provide a valuable ranking of options using the data considered within the analysis. We have used this to rank the remaining viable options within our needs case.

Recommendation

Economic, efficient and coordinated reinforcement strategy

To connect low carbon, renewable generation customers at the volumes required, while maintaining a safe and secure system we are seeking approval for the Argyll and Kintyre 275kV Reinforcement Strategy. This consists of the upgrade of the existing network to 275kV operation from Crossaig in the South to a connection point located to the east of the village of Dalmally on the SPT Dalmally – Windyhill 275kV OHL. This will form a reinforced transmission network in Argyll, providing significant benefits to the GB consumer, supporting the transition to a low-carbon economy by enabling the connection of low carbon generation and provide benefits to the local economy. It consists of five key elements:

- Establishing a new 275/132kV substation at Creag Dhubh to enable connection to SPT's Dalmally-Windyhill 275kV OHL circuits. These are to be connected by c. 14km of new 275kV Double Circuit OHL - to be delivered for April 2026.
- c.10km of new 275kV Double Circuit OHL between Creag Dhubh and a tee point on the existing Inveraray-Crossaig circuits to enable 275kV operation of this section - to be delivered for April 2027.
- Construction of replacement An Suidhe and Crarae substations to enable them to maintain connection to the new 275kV network - to be delivered for April 2027
- Establishing a new 275kV substation at Craig Murrail and relocation of the Port Ann GSP to this site - to be delivered for April 2027.
- Establishing a new 275/132kV substation in the vicinity of the existing Crossaig Substation - to be delivered for April 2027.

Subject to necessary regulatory and planning approvals, we expect construction to be underway in 2024 with the scheme fully energised in April 2027. The total investment cost will depend on the detailed design that is under consultation with stakeholders but is currently estimated to be around c.£400 million (excluding generation connections).

1. Introduction

1.1 Project Background

This Initial Needs Case (INC) for The Argyll and Kintyre 275kV Reinforcement Strategy (Argyll 275kV Strategy) is submitted under Special Licence Condition 3.13 for LOTI Reopener in RIIO-T2, which allows for large transmission developments to be brought forward during the course of the price control period on a case-by-case basis. This submission follows our Eligibility to Apply letter, submitted to Ofgem on 25 June 2021.

The Argyll 275kV Strategy 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. The UK Government recently updated its interim target to reduce emissions by 78% by 2035[1].

To keep up growth of renewable capacity, key infrastructure investments must be progressed at pace to ensure costs are efficient for consumers today, and tomorrow. The ESO's modelling demonstrates that after NOA 2020/21 investments, constraint costs are increasing from around £500 million per year now, to between £1 billion and £2.5 billion per year at a maximum, before falling away towards 2040[2]. The right investment in the network, delivered at the right time, is essential to meet Net Zero targets.

This LOTI submission presents the case for the Argyll 275kV Strategy which consists of the upgrade of the existing network to 275kV operation from Crossaig in the South to a connection point located to the east of the village of Dalmally on the SPT Dalmally – Windyhill 275kV OHL. This will form a reinforced transmission network in Argyll, providing significant benefits to the GB consumer, supporting the transition to a low-carbon economy by enabling the connection of low carbon generation, and provide benefits to the local economy.

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.

1.2 The Need

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.

A significant and sustained increase in renewable generators is seeking to connect to the Argyll and Kintyre transmission network since late 2019. Power system studies undertaken on the existing network to assess the connection of the contracted generation has identified that network reinforcement is required to maintain compliance with the National Electricity Transmission System (NETS) Security and Quality of Supply Standard (SQSS), as the capability of the existing network would be exceeded with the connection of the generation

These combined drivers justify the need for the required reinforcement works proposed in this INC for the Argyll 275kV Strategy.

[1] https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035
[2] https://www.thetimes.co.uk/article/new-wind-farms-threaten-2-5bn-constraints-bill-for-consumers-chzwcfs2n

1.3 Ongoing commitment to stakeholders

Stakeholder engagement has been ongoing since early 2016 on a project-to-project basis due to the changing generation background in the Argyll and Kintyre region. The recent rapid increase in generation connection requests across Argyll and Kintyre has consequently resulted in an accelerated engagement process for the wider Argyll 275kV Strategy. We subsequently adopted a holistic engagement approach to ensure all stakeholders are aware of the full breadth of the project remit and requirement and provided with opportunities to feed into the decision-making process.

Consistent with our T2 Business Plan commitment and Ofgem's enhanced engagement approach in RIIO-T2, we have worked closely with our stakeholders to gather their feedback which has influenced our options and preferred solution. Further details can be found in **Chapter 3**.

1.4 Structure and content of Initial Needs Case Submission

The project background, including the context and history of the Argyll 275kV Strategy and characteristics of the current network, is discussed in **Chapter 2**.

The comprehensive stakeholder engagement we've undertaken, including an overview of stakeholder views and how these have informed our recommended Strategy, is discussed in **Chapter 3**.

The need for reinforcement of the Argyll and Kintyre network is discussed in **Chapter 4** and is driven by the requirement to provide efficient capacity to accommodate renewable generation seeking to connect in the area.

The transmission reinforcement options are explored in **Chapter 5**, taking account of how we appraised options, including consideration of costs, technical complexity and deliverability, and other risks and opportunities.

The assessed reinforcement options were subjected to system operability studies. In **Chapter 6** we summarise this work and identify any reinforcement options which can deliver an operable, safe and secure system. This results in our 'do minimum' option.

The CBA and additional economic analysis undertaken by the ESO for the different options are discussed in **Chapter 6**, building on the system operability conclusions. Here we demonstrate the expected long-term value for money of the proposed solution for consumers when compared to alternative approaches.

The preferred reinforcement option is discussed in **Chapter 7**.

The project timeline and delivery strategy are discussed in **Chapter 8**.

Finally, the conclusions are given in **Chapter 9**.

Chapter 10 is the Appendices. Supporting documents are clearly signposted throughout the submission. The Appendices also sets out a list of the supporting documents and a description of its purpose and contents.

2. Project Background

2.1 Project Context

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". A subsequent report[4] 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.

While the ENSG report mainly focused on network reinforcement options for addressing north to south bulk power transfer requirements, it also acknowledged the need for regional transmission reinforcements to enable the renewable generation to connect. The Kintyre – Hunterston subsea link[5] project was included in the report to facilitate renewable generation connections in the Kintyre and Argyll area. This project was completed in 2015, allowing 143MW of renewable generation to connect to date. We continue to see a strong interest in renewable generation developers to connect in this area, driven mainly by the decarbonisation agenda.

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 net zero target date of 2045. 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. Further, in October 2021 the UK Government unveiled plans to decarbonise UK power system by 2035.

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 to become fully low carbon within the next decade. The Sixth Carbon Budget report[6] acknowledges that, together with Wales and Northern Ireland, Scotland has an integral role to play in delivering the UK's Sixth Carbon Budget on the path to Net Zero. As Scotland has vast renewable energy resource which outstrips demand, it will contribute substantially to the Sixth Carbon Budget, with the majority of the power produced being transported to demand centres in the south of GB.

The investment proposed in this INC is required to ensure that we can progress towards meeting the connection dates for both contracted and forecast generation, thereby contributing to the GB security of supply and supporting the achievement of the legally binding net zero targets. The climate change emergency, now reflected in policy, makes these targets even more challenging, further increasing the need to progress timely, economic and efficient investment in enabling transmission infrastructure.

[3] https://www.gov.uk/government/groups/electricity-networks-strategy-group
[4] ENSG 'Our Electricity Transmission Network: A Vision For 2020', February 2012
[5] Kintyre – Hunterston Strategic Wider Works project, approved in 2013 and energised in 2015
[6] https://www.theccc.org.uk/publication/sixth-carbon-budget/

2.2 The Early Network

The 132kV transmission network in the Argyll and Kintyre area, situated in the south west of our network area, was originally developed in the late 1950s and early 1960s. The network was constructed to serve demand customers in the main population centres within the area, as well as to connect a number of hydro power stations.

The original steel lattice eads were of a light construction, running over 80km long, in close proximity to coastal areas and including a number of loch crossings. These lines supplied customer demand via GSP's[7] which are located near the settlements in this area. The transmission network consisted of a 132kV double circuit OHL from Sloy to Inveraray switching station. From Inveraray, there were two 132kV radial double circuit OHLs, one to Taynuilt in the north, and the other to Carradale in the south. The Port Ann – Carradale section of the OHL was reconductored in 1992 to address asset condition issues. Figure 1 shows the location map of the Kintyre and Argyll area on the Scottish network and an enlarged view showing the network connectivity.

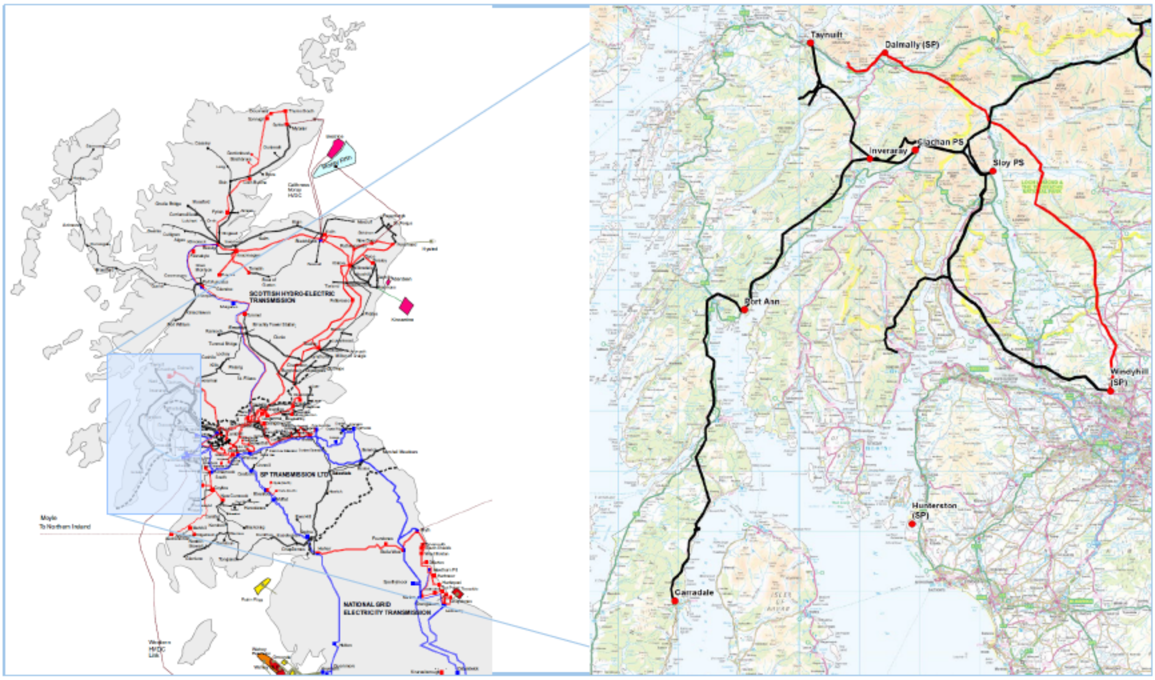

Figure 1 Argyll and Kintyre area map showing early network connectivity

From Sloy, the 132kV connects into SPT's network at Windyhill to the south and Inverarnan to the north. We therefore work closely with SPT on all connections and wider network requirements as well as coordinating any customer connection and wider reinforcement works.

The geography of the region comprises a varying landscape of craggy upland and mountains cut through by deep glens, freshwater and sea lochs. This results in terrain in which construction, operations and maintenance is challenging. Within the region, there are key protected areas including the Loch Lomond and Trossachs National Park, Glen Etive and Glen Fyne Special Protected Area and scheduled monuments. These designated landscapes have been identified

[7] A Grid Supply Point (GSP) is a system connection point at which the Transmission system is connected to a Distribution system. The GSP is SSEN Transmission's interface point with SHEPD

by key statutory consultees as important areas of interest that should be thoroughly considered through the project lifecycle and asset operation phase.

Any new transmission network development is subject to the same geographical constraints, and in addition is required to be routed to maintain statutory distances to existing transmission infrastructure. The proximity of this area to the coast, and the subsequent saline environment, drives a need for substation equipment to be housed indoors in line with our current requirements due to the corrosive effects of this.

2.3 Network Development to 2015

The original Kintyre – Hunterston 132kV network had one export route between Inveraray and Sloy, consisting of a double circuit OHL. In order to provide a first phase of export capacity increase on the local network to accommodate early windfarm connections in the area, an additional 132kV single circuit was constructed between Inveraray and a tee point on the Sloy to Inverarnan circuits. Since the completion of this circuit in 2007, there has been continued growth in renewable generation seeking to connect in the area.

In May 2009, Ofgem introduced a new 'Connect and Manage' interim regime that allowed earlier grid access to new and existing generation projects. To enable the first tranche of generators that had been identified as able to connect to the Argyll and Kintyre network under the Connect and Manage interim regime, we applied for a derogation against Section 2 of the NETS SQSS for the Argyll and Kintyre network in 2009. The derogation was granted[8] in 2010 following extensive analysis between ourselves and the ESO on the impacts of connecting the generation, continued monitoring of the network and the identification of additional reinforcement to restore compliance. The Kintyre – Hunterston Project was identified as required to provide efficient network capacity to connect further renewable generation in the area. Following the success of the Connect and Manage interim regime, the Government announced the implementation of a new enduring Connect and Manage regime for grid access in July 2010.

The continued increase in renewable generation seeking connection to the transmission network in the Argyll and Kintyre area resulted in the need for further reinforcement of the local network. A Strategic Wider Works (SWW) Needs Case was submitted to Ofgem in 2013 for the Kintyre – Hunterston project. This was approved by Ofgem, leading to the completion of the project in 2015. The reinforcement consisted of:

- The establishment of a new 132/220kV substation at Crossaig on the Port Ann to Carradale double circuit OHL
- Installation of two 220kV, 240MVA subsea cable circuits between the new Crossaig 132/220kV substation and SPT's new Hunterston 220/400kV substation
- The rebuild of the 132kV double circuit between Crossaig and Carradale substations

Figure 2 shows the two significant reinforcements to the Argyll and Kintyre network between 2007 and 2015.

[8] https://www.ofgem.gov.uk/sites/default/files/docs/2010/07/derogation-granted-to-scottish-hydro-electric-transmission-limited-from-standard-condition-c17_0.pdf

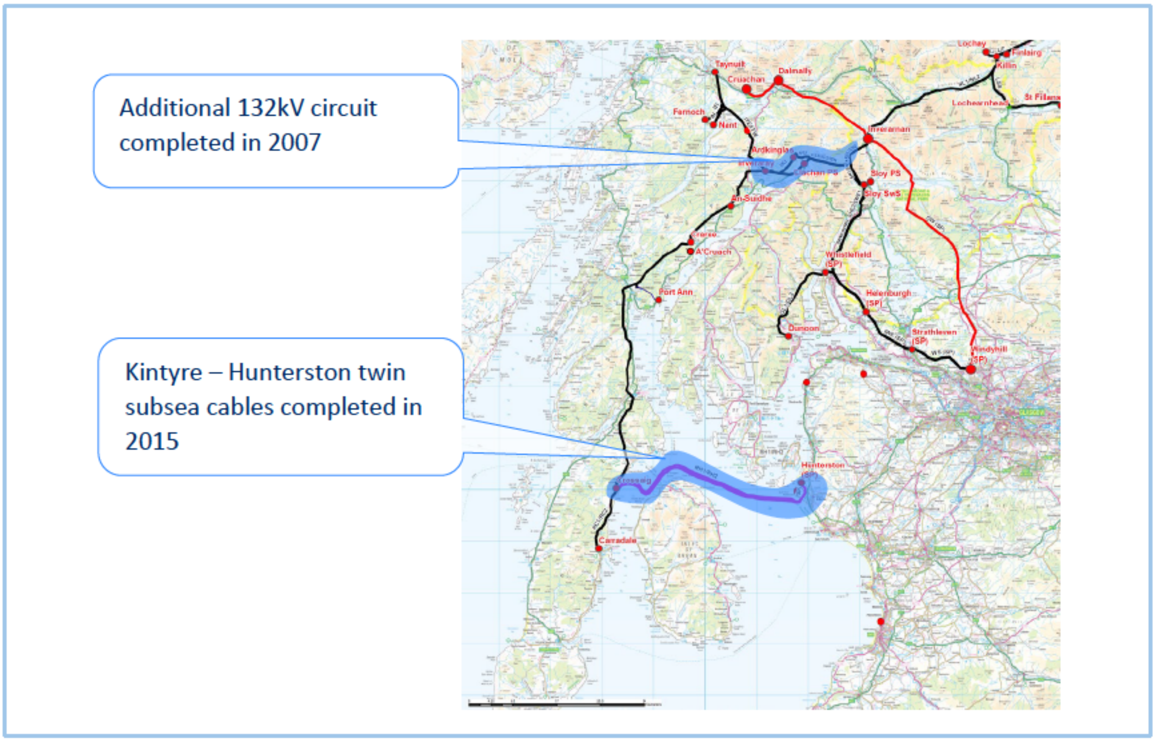

Figure 2: The Argyll and Kintyre network showing the two significant reinforcements completed in 2007 and in 2015

This project was the first major element of the long-term development strategy for the Argyll and Kintyre transmission network. The local network stretching from Inveraray to Crossaig is now interconnected as a result of this project. The Kintyre – Hunterston project increased the capability of the local transmission network by adding an additional export route. As a result, the non-compliance on the Sloy – Inveraray – Carradale circuit was mainly resolved, leaving a low risk NETS SQSS non-compliance which was agreed with Ofgem as part of the Kintyre Hunterston SWW project. However, as the Taynuilt – Inveraray circuits were not reinforced as part of the SWW project, the derogation on those circuits remained. Following the completion of the Kintyre Hunterston project, we submitted an updated derogation report[9] in July 2016, detailing the remaining non-compliance in line with the Needs Case.

As a result of the residual non-compliance, generators that have connected to this network post completion of the Kintyre – Hunterston project have been subject to intertrips for the loss of both subsea cables. These generators have firm access to the wider transmission network and therefore would be compensated for this low risk outage scenario.

2.4 Further Network Development

Following the completion of the Kintyre – Hunterston project, the volume of generation in the local area continued to grow. Figure 3 shows key developments in renewable generation activities and network interventions in the Argyll area since completion of the Kintyre – Hunterston project in 2015.

[9] Argyll and Kintyre Derogation Update Report Rev1.0

2015	• **Kintyre – Hunterston project completed:** Two subsea cables from Crossaig substation in Kintyre to Hunterston substation.
2015–2016	• **Continued generator conection applications** triggering the need for further reinforcement. Options assessment undertaken.
2016–2017	• **Generator terminations and contract delays** following the removal of onshore wind incentives. Only North Argyll project progressed development to provide generation connection capacity.
2017 – 2019	• **Development progressed on North Argyll project**, including public consultations. • **Inveraray – Port Ann and Port Ann – Crossaig OHL** rebuilds progressed primarily on asset condition basis.
2019–2020	• **Significant increase in generator connection applications** over the preceding 18 months. Over 860MW total generation applied for a connection.
2021	• **Return of incentives for onshore wind generation**. This has resulted in an increase in generation applications, prompting SSEN Transmission to revisit the wider Argyll and Kintyre strategy and the reinforcement options. • Contracted generation receiving planning consents.

Figure 3: Key developments in the Argyll and Kintyre area since 2015

2.5 Early optioneering

An optioneering assessment commenced in 2015 to consider a range of reinforcements to enable the connection of new generators in accordance with the NETS SQSS criteria. The options assessed were based on enabling connection works included in developer contracts. The options were assessed under a multi criteria assessment that took into consideration aspects such as asset condition, system benefits, costs, engineering and constructability, environmental and planning. A scoping stage CBA was undertaken at this early stage to provide some insight into the comparison between the reinforcement options. Early indications from the optioneering pointed towards the reinforcement of the 275kV onshore upgrade from Dalmally to Crossaig. While asset condition drivers were considered in the background, it was the load driver due to connections activity that was considered as the primary driver.

2.5.1. Withdrawal of onshore wind subsidies

While the optioneering work was in progress, there was a significant change in UK energy policy which saw the removal of subsidies for onshore wind by the UK government. In June 2015, the Government announced its intention to end new public subsidies for onshore wind farms by legislating to close the Renewables Obligation across GB to new onshore wind generating stations from 1 April 2016. This impacted upon contracted generators and resulted in a number of terminations and applications to delay connection dates. Under the reduced generation background, the full 275kV strategy could no longer be justified as only the North Argyll was required in order to connect contracted generation. The North Argyll project consisted of establishing a new 275/132kV substation (Creag Dhubh) in the north Argyll area, and a new 275kV OHL to connect onto the SPT Dalmally to Windyhill circuit.

2.5.2. Network development

Project development work progressed on the North Argyll project on load basis, with the development of the Inveraray – Crossaig 132kV OHL progressed on asset condition basis. The 132kV double circuit OHL between Inveraray and Port Ann was included as a non-load baseline project within the RIIO-T1 Business Plan, while the OHL section between Port Ann and Crossaig was included in the RIIO-T2 Business Plan. Given that the load driver had diminished for the Inveraray – Crossaig section of the OHL following the withdrawal of onshore wind subsidies, the asset condition became the primary driver.

Details of the asset condition of the Inveraray – Crossaig line, together with future load requirements and CBA considered at the time are included in the 2019 RIIO-T2 Engineering Justification Paper[10] for the Port Ann to Crossaig line. The approved scope for the Inveraray – Crossaig OHL was to rebuild the line to 275kV specification to be initially operated at 132kV. This strategic reinforcement addresses the asset condition requirements as well as the future load requirements to accommodate further renewable generation connections onshore. The Inveraray – Port Ann section of the line was completed in July 2021, and the Port Ann – Crossaig section is under construction with a completion date of October 2023.

Following these works, the next stage in the long-term Argyll and Kintyre network development strategy will be the conversion of the line to 275kV operation which will unlock additional capacity together with the North Argyll reinforcement work. A request for Pre-Construction Funding for the Argyll 275kV Strategy was submitted to Ofgem as part of the RIIO-T2 Business Plan. The request for funding was granted for this project at [redacted].

2.5.3. The return of onshore wind subsidies

From January 2020, we witnessed a significant and sustained increase in generator applications seeking connection to the network in Argyll and Kintyre. The result of the increased connection activity has seen the requirement for further reinforcement of the network in the area, prompting us to revisit the Argyll 275kV Strategy. There has also been a significant level of scoping generation identified as well as the return of onshore wind farm subsidies in the form of Contracts for Difference (CfDs). The fourth CfD allocation round (AR4) opened to applications on 13 December 2021. In February 2022, the UK Government announced that CfD auctions will be held annually, speeding up UK adoption of renewable power and boosting energy security. The next round will open in March 2023 and will be the first in a series of annual auctions.

2.6 Base Transmission Network for the next reinforcement stage

The base transmission Argyll and Kintyre network is used in assessing future connection applications and includes the following reinforcements in the background:

- Inveraray – Sloy/Inverarnan Tee 132kV single circuit, completed in 2007

[10] https://www.ssen-transmission.co.uk/media/3840/port-ann-crossaig-132kv-ohl-justification-paper.pdf

- Kintyre – Hunterston 220kV twin subsea link, completed in 2015
- Inveraray – Port Ann 275kV construction (initially operated at 132kV), completed in 2021
- Port Ann – Crossaig 275kV construction (initially operated at 132kV), under construction and planned to complete in 2023.

This base network comprises two export route corridors out of the Argyll and Kintyre area: the three 132kV OHL circuits from Inveraray towards Sloy, and the two 220kV subsea cables from Crossaig to Hunterston in the south. These two routes are interconnected by the Inveraray to Crossaig 132kV double circuit OHL via Port Ann GSP. From Crossaig there is a radial 132kV double circuit OHL connected to Carradale GSP, and from Inveraray there is a radial 132kV double circuit OHL connected to Taynuilt GSP.

Clachan GSP is connected to one side of the 132kV double circuit from Inveraray to Sloy, while Ardkinglas GSP is connected to the 132kV circuit from Inveraray to Sloy/Inverarnan Tee point. Port Ann GSP is tee connected to the Inveraray – Crossaig OHL.

There are also a number of transmission connected generators in the local area. An Suidhe wind farm (An Suidhe substation) and A'Cruach wind farm (Crarae substation) are tee connected to either side of the Inveraray to Crossaig circuit, north of Port Ann GSP. Nant Hydro and Carraig Gheal wind farm are tee connected to either side of the Inveraray to Taynuilt line, north of Loch Awe. A single line diagram showing the network configuration and circuit ratings is shown in Appendix 1 Existing Network – Circuit Ratings and Appendix 2 Existing Network Diagram within this document.

3. Stakeholder Engagement

3.1 Introduction

Stakeholder views have been instrumental in the development and design of the Argyll 275kV Strategy project solution. Our approach to engagement demonstrates our commitment to seeking mutually acceptable outcomes with relevant stakeholders.

In engaging on the full remit of the wider Argyll 275kV Strategy, we identified key stakeholder views and continue to take action to ensure they are reflected in the progression of the strategy. There are four distinct areas where stakeholder feedback has had a strategic impact on the proposal:

- In recognition of the ask of an enduring solution, we ensured we had a comprehensive view of local generation potential, in turn identifying 1815MW of scoping generation, triangulating this with other data and stakeholder views to refine it within our proposals, ensuring a robust CBA.
- In responding to requests from a significant proportion of the community, we thoroughly assessed options for undergrounding and alternative OHL routing and ruled out options that were unsuitable due to environmental impact concerns or guidance from statutory consultees that these options would result in objections to planning applications. Through assessment of alternative options, we identified and subsequently changed the preferred alignment of the Creag Dhubh – Dalmally 275kV OHL, resulting in an 85% reduction of properties within 500 metres of the proposal.
- Where consultees have requested further in-depth environmental survey works and assessments, we have built these into the project programme to be captured within the Environmental Impact Assessments (EIA) process.
- Transparency and accessibility are a key stakeholder ask. We adopted a holistic regional approach to engaging, to ensure the full remit was communicated as early as possible, and continue to review communication methods and materials to aid understanding.

This chapter describes our stakeholder engagement plan including the range of stakeholders involved and how we tailored engagement to these groups based on segmentation. We have set out the full range of stakeholders' views on each aspect of the proposal and explained where stakeholders' views have informed the proposal, and where the proposal differs from the views of stakeholders, we have explained the justification for such differences. This includes explanation of necessary trade-offs between the interests of different stakeholder groups.

3.2 Our Argyll and Kintyre Reinforcement Stakeholder Engagement Plan

The Argyll and Kintyre Reinforcement Stakeholder Engagement Plan is aligned to our Stakeholder Engagement Strategy. It is designed to deliver a proposal that is mutually acceptable across the influential, impacted and interested stakeholder groups through early, collaborative and transparent engagement.

The initial engagement on the project pre-dates this strategy, having begun in early 2016 on a project-by-project basis in response to changing generation expectations in the region and delivery of non-load related projects to upgrade existing infrastructure in the area. Feedback on this early engagement in Argyll was that stakeholders wanted to understand the full strategy for electricity network infrastructure development in the region, not just each individual project as required.

This feedback was an input into the design of the new Stakeholder Engagement Strategy, where the importance of providing stakeholders with the full infrastructure strategy for their region was recognised and built into our objectives. Within Argyll, in response to stakeholder feedback, and in-line with our engagement objectives, we adopted a holistic engagement approach to ensure all stakeholders are aware of the full breadth of the project remit, ensuring there are ample opportunities to feed into the decision-making process.

The key objective of the stakeholder engagement plan is to deliver a stakeholder led **whole system approach to the overall Argyll 275kV Strategy and ensure transparency of our proposals and decision making.** We are doing this by:

- Enabling and encouraging stakeholder input by providing easy access to ourselves and appropriate information as well as ensuring our communications are inclusive
- Engaging to build intelligence on stakeholder needs and energy related ambitions on a regional level, applying this to determine the solution that will best meet these needs and ambitions
- Working together with stakeholders to design and adapt our proposals to meet needs identified during development and refinement of the solution, aiming for mutually acceptable outcomes; and,
- Ensuring we feedback to stakeholders on the above.

Stakeholder profiling and mapping

We systematically identified and profiled relevant stakeholders for the project by identifying who would have an influence, interest, or be impacted by the project. These stakeholders were further segmented based on organisational, geographic and psychographic differences. This let us factor in considerations of knowledge, values, locational factors and behavioural differences. This ensured purposeful, meaningful and accessible dialogue at all stages. This included actions to involve hard to reach stakeholders and non-responders in our engagements, for example organising additional community meetings and webinars.

We then undertook a robust mapping and prioritisation exercise, allowing for targeted engagement aligned to the requirements and preferences of each group, and ensuring purposeful, meaningful dialogue at all stages. An example of this exercise can be viewed in Appendix A Argyll and Kintyre Reinforcement Stakeholder Engagement Plan - Stakeholder Profiling.

For further example, we targeted engagement on selection of options for project elements on local communities, statutory consultees and planning authorities that had best knowledge of the local area and whose views would be instrumental in planning decisions. We ensured that the materials for these engagements were appropriately tailored to the level of knowledge of each stakeholder group e.g. Consultation Reports which described full technical and environmental details were issued to statutory consultees whilst Consultation Brochures which provided a more accessible summary tailored to the wider community were created and distributed alongside this. Both documents were made available online however should each stakeholder require to view the alternative version.

Tailoring engagement methods

Engagement methods were also tailored to the identified segments. Methods include: workshops, calls, seminars, surveys and overarching engagements such as open webinars and public consultations.

Face to face engagement was prioritised for local communities in line with their stated preferences. This was adapted to online engagements when restrictions were in place due to the COVID 19 pandemic. To ensure inclusion of those who had difficulty engaging digitally, traditional methods including mail and telephone were used. When COVID 19 restrictions in Winter 21/22 impacted planned further face-to-face engagement, we created an online portal allowing stakeholders to view 3D visualisations of the Creag Dhubh - Dalmally 275kV Connection project in the local area. We also supplemented our Argyll 275kV Substation's consultations with a stakeholder webinar aimed at local elected members and statutory consultees, and are in the process of creating supplementary project videos which will include 3D visualisations, animations, interviews and maps, subsequently making detailed information more accessible.

In comparison, for current and future customers that were informing the need, who are generally not located in the region of the project, we undertook engagement through online surveys to increase accessibility and ran an online webinar to provide potential respondents with background information on current network capacity and upgrade projects to ensure that they had the knowledge necessary to provide informed responses.

Where existing relationship-based engagement channels were already established we undertook engagement through these to minimise stakeholder fatigue. This included project and portfolio reviews with contracted customers, socially distanced face to face meetings with landowners and quarterly meetings with the energy consents unit.

Where specific engagement is required on individual project elements (e.g. individual substation planning consultations), our project team have made efforts to present each element within the context of the wider strategy – ensuing we are transparent about the extent of work required in communication materials, 'joining the dots'. They have also taken opportunities to amalgamate consultation activities where possible, to avoid engagement fatigue.

The following table outlines our stakeholders identified preferred methods of engagement and is subject to variation based on feedback.

Stakeholder	Preferred Primary Engagement Method	Secondary Engagement Method
Communities	Face to Face Consultation	Online event/Postal Information (where broadband is limited)
Statutory/Non-Statutory Consultees	Statutory Consultation (online reports, figures and feedback forms)	Online Meeting
Landowners	Face to Face Meetings	Phone calls
Elected Members	Face to Face/Online Meeting	Webinars
Generation Developers	Online Meeting	Emails
Network Operators	Online Meeting	Emails

Timing of engagement

The programme of engagement was designed to deliver the critical path for assessment of need, identification of options, selection of preferred solution, submission of planning applications and analysis of Cost Benefit. Delivery against this critical path is essential to meeting the expectations of connections customers with contracted connection dates. Any delay in the project will lead to delays in the connection of these low carbon generation customers and subsequent deferral of carbon displacement and community and societal benefit resulting from these projects.

A constant and extensive programme of stakeholder engagement activity has been delivered and we continue to review stakeholder interest as the project progresses, ensuring those with direct or indirect interest or influence are included across each stage of the project development, construction and operational lifespan.

Engagement on selection of options has been significantly enhanced beyond the requirements of the planning process to deliver the request from local and community stakeholders for a holistic view of development and early opportunity to review and influence proposals. Rather than wait until engagement was required as part of the consenting process, the project team engaged with local stakeholders as soon as certainty regarding the requirement for the wider strategy was obtained. This was vital in ensuring the communities' ask that visibility regarding the full strategy was shared as soon as it was confirmed.

A chronological summary of engagement activities, outputs and outcomes is included in Appendix B Argyll and Kintyre Reinforcement Stakeholder Engagement Activity 2020 _Present. Figure 4 provides an indication of the extent of stakeholder activity undertaken since 2016.

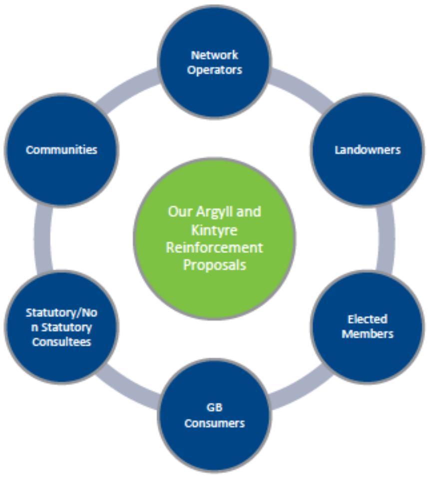

Figure 4: Our Argyll and Kintyre Reinforcement Strategy stakeholders

Figure 5: Extent of engagement undertaken 2016-2022

3.3 Key Milestones in Our Argyll Stakeholder Engagement

The need for network reinforcement began back in 2016, and we have been engaging with stakeholders regularly since then.

Between 2016-2020, engagement centred around the Creag Dhubh – Dalmally (or North Argyll) element of the strategy and resulted in significant changes to the alignment of the OHL. These changes were made in response to the strength of local opposition regarding our initial proposals, where community members cited concerns regarding proximity to residential properties, visual impact and the proximity of the project to the existing Scottish Power 275kv Transmission OHL which currently runs through the village.

Further information regarding our response to feedback during this period can be accessed in Appendix C Overview of Creag Dhubh - Dalmally Project History and Consultation (2016-2021) and Appendix D Alternative Options Based on Stakeholder Feedback.

The following table gives an overview of key milestones in this engagement; setting out how we have gone above and beyond statutory engagement requirements and providing an understanding of the project history and the stakeholder input which has helped shaped the proposed solution.

Date	Milestone
2015-2016	**Removal of Offshore Wind Incentives** Initial engagement on the Argyll 275kV Strategy was driven by new generator connection requirements. It focused on the North Argyll element only, because the removal of onshore wind incentives for new windfarms led to generator terminations and contract delays, meaning only the North Argyll element of the strategy was required to progress at this point.
March 2016	**North Argyll Project, Introductory Consultation**[11] Consultation on early development of the North Argyll project, proposed to connect renewable energy in the region commenced in early 2016, with an initial search area for the OHL and the substation shared with stakeholders. Initial feedback was limited, as can often be the case until proposals are further refined.
October 2016	**North Argyll Route Consultation**[12] The preferred route between the proposed Creag Dhubh Substation and Dalmally switching station was shared in late 2016. Local stakeholders and statutory consultees requested undergrounding to be considered.
January 2018	**Dalmally Community Centre - Cable Feasibility Update**[13] During a town hall Community Council meeting, stakeholders were informed of the outcomes of cable feasibility studies carried out based on community feedback from 2016, which requested undergrounding solutions were investigated. The community were informed that we had chosen not to proceed with an undergrounding cable as requested, due to the volume of cabling constraints identified. The intention to therefore proceed with an OHL solution was communicated during this meeting.
March 2018	**Preferred OHL Alignment Consultation**[14] The project was renamed the Creag Dhubh – Dalmally 275kv Connection and the preferred OHL alignment and substation location shared. A local campaign group formed, objecting to an OHL crossing the Strath of Orchy. Feedback from communities, landowners and consultees at this time centred around requests for further underground investigations.

[11] https://www.ssen-transmission.co.uk/media/4485/north-argyll-information-boards-march-2016.pdf
[12] https://www.ssen-transmission.co.uk/media/4486/north-argyll-consultation-booklet-oct-16.pdf
[13] https://www.ssen-transmission.co.uk/media/5866/microsoft-powerpoint-cabling-update-presentation-january-2018-compatibility-mode.pdf
[14] https://www.ssen-transmission.co.uk/media/4487/mar-18-north-argyll-booklet.pdf

Date	Milestone
Throughout 2019	**Further Underground Cabling Investigations and Results** In recognition of consultation feedback, we announced plans to further explore undergrounding across the Strath of Orchy, conducting ground investigation studies throughout 2019. Potentially technically feasible options were identified, however, due to high risk of environmental pollution and engineering challenges; a decision was made to investigate other potential connection options which would aim to respond to the community's landscape and visual concerns.
Early 2020	**Glen Lochy Alternative OHL Solution Identification** An alternative connection location, avoiding the Strath of Orchy was identified to the east of Dalmally; which would link to the existing OHL between Dalmally and Inverarnan substation.
September 2020	**Project Update and Alternative Connection Options Virtual Consultation**[15] Following on-site ground investigations for underground cabling and identification of an alternative OHL solution, three project options were presented for consultation with stakeholders asked to select a preference: 1. Our preferred solution from March 2018 (0% of responders selected) 2. The undergrounding solution (38% of responders selected) 3. The alternative OHL solution (24% of responders selected) The remaining 38% of responders cited none of the proposals were suitable
November 2020	**Report on Consultation (ROC)**[16] In the ROC, we communicated our new preferred route option (the alternative OHL solution, Option 3 above) to stakeholders and the rationale in that it addressed a number of concerns that local community members had raised about the visual and cumulative impacts of connecting to the existing network infrastructure in Dalmally. It also avoids the significant environmental challenges associated with the undergrounding option, which presented a significant risk of pollution to Loch Awe, due to the risk of local watercourses flooding in the area. At this stage of development Covid-19 continued to impact in person engagement, and due to broadband limitations, local stakeholders were reluctant to, or faced issues with engaging online.
January 2021	**Argyll and Kintyre Reinforcement Strategy Externally Launches**[17] Throughout 2019/2020 there was a significant increase in generator connection applications in the region, triggering revisiting the wider Argyll and Kintyre Reinforcement Strategy.
March 2021	**Argyll and Kintyre Reinforcement Strategy Information Sharing Webinar**[18] Historical feedback suggested that our engagement was fragmented, and stakeholders asked to be provided with the 'full picture', prompting an early introduction session to the full Argyll 275kV Strategy attended by over 100 stakeholders, including statutory consultees, elected members, community members, regulators and customers.
April 2021	**Understanding Argyll and Bute's Future Energy Ambitions Webinar**[19] To test and investigate connection customers' ambitions, we hosted a

[15] https://www.ssen-transmission.co.uk/media/4625/ssen-creag-dhubh-to-dalmally-argyll-12pp-24126-artwork-web.pdf

[16] https://www.ssen-transmission.co.uk/media/6073/creag-dhubh-dalmally-275kv-connection-roc-with-figures-november-2021.pdf

[17] https://www.ssen-transmission.co.uk/projects/argyll-and-kintyre-275kv-strategy/

[18] https://vimeo.com/526016551

[19] https://www.ssen-transmission.co.uk/media/5347/argyll-generation-seminar-slide-pack.pdf

Date	Milestone
	developer seminar and issued a corresponding questionnaire, ensuring developer information was best reflected in our final proposal, as evidenced in Chapter 4 – Need.
April/May 2021	**Argyll and Kintyre Reinforcement Strategy Options – Statutory Consultees Online Workshop** To effectively test options for the wider strategy proposal and check viability, proactive workshops with key statutory stakeholders were held regarding the refreshed options assessment review. Workshops were attended by representatives from Scottish Forestry, Nature Scot, Argyll and Bute Council, Historic Environment Scotland and Loch Lomond and Trossachs National Park
July/August 2021	**Argyll and Kintyre Reinforcement Strategy Public and Statutory Online Consultation**[20] Following selection of the preferred option for the wider strategy, to aid transparency and reduce engagement fatigue, all 275kV Strategy elements were amalgamated for consultation. Throughout the 5-week consultation period, 117 feedback forms were received; the majority of which relate to the Creag Dhubh – Dalmally 275kv Connection as opposed to the new additional elements introduced as part of the wider strategy. Feedback received regarding the other strategy elements was limited, partly due to the earlier stage of the engagement progress and this feedback was applied in further project development. Local Dalmally residents now strongly objected to the alternative OHL solution, citing that no infrastructure should be erected in the vicinity of the village.
Oct 2021	**Dalmally Information Sharing Meeting, Roundtable and FAQ** As restrictions eased, face to face engagement recommenced with a roundtable meeting with local Community Council representatives and the local Members of Scottish Parliament (MSP). The rationale behind continuing with the alternative OHL solution was discussed and, in the evening, a townhall wider community meeting to take questions was held, with around 70 locals in attendance. Significant misinformation was apparent in the questions and statements made by some members of the community during the meeting, such as tower heights and impact to transport and telecoms. To further help community understanding of the project, and address misinformation, a subsequent succinct community Q&A document was issued[21] to all residents in the Dalmally area.
October 2021	**Generation Certainty Engagement** Over and above regular interface meetings with customers; and following on from the developer seminar in April 2021, we engaged again with our customers to gain further insight into the certainty of new generation projects and route to market. This was to ensure the CBA and INC are both based on the most up-to-date developer information and provide an additional source of data for triangulation of these inputs to that analysis.

[20] https://www.ssen-transmission.co.uk/media/5535/argyll-and-kintyre-275kv-strategy-consultation-brochure-2021.pdf

[21] https://www.ssen-transmission.co.uk/media/5936/dalmally-community-qa-21-oct-2021.pdf

Date	Milestone
December 2021	**Argyll 275kV Substations Consultations – Pre-Application Virtual Consultation and Supplementary Webinar**[22] Following further project development since the Summer 2021 consultations, an online pre-application consultation was held specifically relating to the Argyll 275kV Substations project, via an online portal which included 3D visualisations and allowed for instant messaging sessions with the project team. These sessions were poorly attended, which raised concerns on representativeness of the feedback. To address this and ensure enough feedback was received to ensure our proposals were responsive to stakeholder requirements, a webinar was held for statutory consultees and elected members to encourage feedback sharing. At this event questions regarding the proposals were posed directly to the project team for consideration ahead of refinement.

3.4 Key Stakeholder Feedback and Actions Taken Based on Stakeholder Views (2020-Present)

In the following table, we have summarised the key themes identified during our extensive stakeholder engagement and the actions we have undertaken to address these. Appendix B Argyll and Kintyre Reinforcement Stakeholder Engagement Activity 2020 _Present contains further details on these activities, demonstrating the lengthy timeline of these efforts and the fundamental influence stakeholders have had on our final proposals.

[22] https://www.ssen-transmission.co.uk/projects/argyll-and-kintyre-275kv-substations/

Key theme	*Actions undertaken*
Design & Build an Enduring Whole System Solution Which Recognises Developer Needs This feedback was predominantly derived from: • Developers • Network Operators Developers requested we develop an enduring solution which would provide sufficient capacity for significant additional renewable generation and mitigate risk of connection delays. Contracted customers noted the critical importance of the proposed reinforcement strategy for the development of renewable energy in the region. They told us timely delivery of this reinforcement is critical to meeting connection dates, recognising the upgrade required to connect wider contracted generation background beyond their own schemes. Following the fourth CfD allocation round opening in December 2021 and the recent UK government announcement that CfD auctions will be held annually. Our generation customers told us that this could potentially help to reduce uncertainty for developers to support net zero goals and create a more even spread of resources for supporting players such as supply chain. Network Operators have told us they also want to ensure a whole system approach is adopted to guarantee that enduring, coordinated network solutions are identified for proposals. To this end, concentrated discussion has occurred regarding the connection point to SPT's network and the Port Ann GSP owned and operated by Scottish Hydro Electric Power Distribution (SHEPD).	• The ask for an enduring solution required a clear understanding of what additional generation will seek to connect in coming years, so the project could be designed to accommodate this. To supplement our view of the generation potential in Argyll, we undertook a stakeholder engagement exercise consisting of an online questionnaire and webinar event in early 2021, which alongside direct engagement with developers and the local authority identified 1815MW of scoping generation. • Following completion of the CBA, and subsequent review and discussion with both Ofgem and the ESO, we re-contacted developers who had shared their generation ambitions requesting statements of commitment to deliver their generation project and their preferred route to market to support Ofgem's review of the certainty of the generation background driving the scheme. This allowed us, Ofgem and the ESO to attain a deeper understanding of local developer needs to make the CBA and INC robust and to provide more certainty and visibility of the determining factors for the progression of these projects. • Initial proposals for the Preferred Alternative Option for Creag Dhubh – Dalmally 275kV Connection included a new Glen Lochy Switching Station connecting to SPT's. We coordinated a monthly meeting with SPT, where initial discussions confirmed this was not an optimum solution from a whole energy system perspective, due factors including the timescale of development and delivery and the costs of this option. In response to this, we began workshopping alternative appropriate means for connecting to the network, working closely with our fellow TO. This concluded with an agreed 'tie in' connection point on SPT's existing 275kV OHL, responding to their concerns regarding timescales whilst also ensuring a reduction in local infrastructure required– thus also responding to community concerns regarding disruption and visual impact. • Extensive discussion and workshopping commenced with SHEPD as the Distribution Network Operator (DNO) in this region from late 2021 to ensure a coordinated approach to connections involving the local distribution network, including a whole system CBA regarding the solution for Port Ann GSP. In working closely with SHEPD, we identified a mutually agreeable solution which would allow the new Creag Murrail 275kV substation to absorb the majority of the existin Port Ann GSP equipment, which would then be operated by the DNO. To support the DNO in this transition, we are currently working on the initial design development on their behalf. This solution also responds to historical requests from the Port Ann community, to ensure additional infrastructure is not constructed at the existing GSP, and where possible, that it should be scaled back.

Key theme	*Actions undertaken*
Design & Build a Solution That is Sensitive to the Environment and Fully Environmentally Assessed This feedback was predominantly derived from: • Statutory and Non-Statutory Consultees including Scottish Forestry, Argyll and Bute Council, SEPA and NatureScot amongst many others Statutory consultees confirmed their optimum solution for the strategy is aligned to our proposed reinforcement option. This is predominantly due to avoidance of National Scenic Areas and Loch Lomond and the Trossachs National Park (LLTNP), alongside the utilisation of existing infrastructure reducing further environmental impact. During recent consultation, feedback was provided regarding ensuring avoidance of black grouse lek habitats and scheduled monuments near Dalmally. For the Creag Dhubh – Inveraray OHL, consultees concerns included loss of ancient woodland; requesting a peat landslide hazard and risk assessment be undertaken as part of the EIA, that construction avoids proximity to local rivers, that private water supplies are further investigated, and consultee involvement is undertaken to determine proposals to protect water quality.	• Our preferred option was developed to meet the expectations of statutory consultees captured in earlier engagements and through their policy positions. • In Spring 2021, we held workshops with statutory consultees to seek their views regarding option scoring for the strategy from an environmental and consents perspective. Their feedback was that our preferred option was the most favourable solution for meeting their requirements, so with the support of statutory stakeholders, we confirmed our proposed reinforcement as Option 7 (see Chapter 7, Proposed Reinforcement Option). • In considering alternative options for the Creag Dhubh – Dalmally 275kV Connection project based on community feedback, we reengaged LLTNP Authority regarding their position on citing works within the National Park. Upon receiving written confirmation that the LLTNP Authority would object to any proposal to build new infrastructure through the National Park we communicated to the local community the material risks this objection would have on planning consent and confirmed alternative options would require avoidance of this environmental designation. • Where consultees have requested further in-depth environmental survey works and assessments, all these requirements will be addressed during project refinement. Many have already been built into the project programme to be captured within the EIA process for the Creag Dhubh – Dalmally 275kV Connection and the Creag Dhubh – Inveraray 275KV OHL. Environmental Assessment (EA) is also undertaken as part of the planning process for the 275kV Substations. These robust assessments include the likes of ecology, forestry, ornithology, landscape and visual, peat and hydrology and cultural heritage. • Throughout the project refinement process, environmental consultees will be kept updated and informed as to progress of assessments at each stage for each element and invited to make further comment on outcomes.
Increase Transparency and Continue to Review and Improve Stakeholder Engagement Methods This feedback predominantly derived from: • Local Communities • Landowners • Local Elected Members Throughout early development of the Creag Dhubh – Dalmally 275kV Connection project,	• The project team engaged with stakeholders as soon as certainty regarding the requirement for the wider strategy was obtained. This was vital in ensuring the communities ask of visibility regarding the full strategy was shared as soon as it was confirmed. The March 2021 Information Sharing Webinar provided an effective way to communicate this update and introduce additional project elements whilst affording stakeholders the opportunity to direct questions to the project team during the webinar. • Where specific engagement is required on individual project elements, our project team have made efforts to set each element within the wider context – ensuing we are

Key theme	*Actions undertaken*
local stakeholders questioned plans for the 'missing link' between the proposed 275kv OHL in this area and the 275kV Inveraray – Crossaig replacement OHL in the South. We were asked to increase transparency by sharing the full remit of anticipated future infrastructure projects in Argyll. Following the consultation events in September 2020, suggestions for improvement were received and an eagerness to return to face-to-face engagement expressed from community stakeholders. Planning authorities and elected members have encouraged us to continue to exceed minimum statutory engagement requirements, particularly due to the impact COVD 19 has had on face to face engagement.	transparent about the extent of work required in communication materials, 'joining the dots' whilst also taking opportunities to amalgamate consultation activities to avoid engagement fatigue. • We recommenced face-to-face engagement from October 2021, with a town hall meeting • COVID 19 restrictions in Winter 21/22 impacted planned further face-to-face engagement so we created an online portal allowing stakeholders to view 3D visualisations of the Creag Dhubh - Dalmally 275kV Connection project in the local area. • Due to Winter 21/22 restrictions, we supplemented our Argyll 275kV Substation's consultations with a stakeholder webinar aimed at local elected members and statutory consultees • We are in the process of creating supplementary project videos which will include 3D visualisations, animations, interviews and maps, subsequently making detailed information more accessible. • In recognition of the community's preference for face to face engagement, we have committed to recommence this, with upcoming consultation events and an information sharing session currently being planned for in person. •
Design and Build an Economic Solution which Provides the Best Value to GB Consumers This feedback was provided by: • Ofgem; in their role to role to protect consumers now and in the future by working to deliver a greener, fairer energy system. As the independent energy regulator for GB, Ofgem have a responsibility to deliver a net zero economy at the lowest cost to consumers.	• As further outlined in Chapter 6 Reinforcement Options Assessment, the ESO has a requirement to create an independent CBA to determine which option would create the highest overall benefit to the GB consumer with the lowest risk of deviation. • The CBA does not however make judgement on the suitability of options based on other considerations such as system operability, environmental benefits and government legislation. • We worked closely with the ESO to support their CBA, and in communicating concerns regarding limitations, the ESO acknowledged our position, agreeing to make adaptions to its national CBA methodology. However, there are significant challenges in modifying a CBA methodology intended for large-scale strategic investment appraisal to the local and connection-related options assessment. • The initial CBA results from the ESO indicate avoided constraint costs are similar for all onshore investment options. If all options realise the same constraint cost benefit, then the ESO concludes that the lowest capital and operational cost option should be preferred. • These results contradict local system modelling under the planning standards and are counter-intuitive in that options with greater system capability are not resulting a reduction in constraint costs

Key theme	*Actions undertaken*
	• Given these challenges and the questions arising from the initial CBA results, both we and the ESO are committed to further economic appraisal in advance of the FNC. This will incorporate the detailed local economic appraisal undertaken by us, including for social, environmental and GHG emissions. • In further engaging with the ESO and adopting the additional work outlined, we hope to evidence that the preferred solution provides best overall value to both consumers and wider society.
Minimise the Effect of Additional Infrastructure on the Village of Dalmally This feedback predominantly derived from: • Local Communities • Landowners • Local Elected Members Local stakeholders have consistently provided feedback citing concerns regarding the effect additional infrastructure in the vicinity of Dalmally may have on local residents. Despite positive feedback received in 2020 in regard to the alternative option developed and taken forward in response to concerns, feedback received during the Summer 2021 consultation cited 'a complete objection to and rejection of the proposed unnecessary link and increased infrastructure', with fears the development will affect the local livelihood and economy and is situated within an Area of Panoramic Quality.	• By responding to initial feedback and changing the alignment of the OHL to ensure it was located South of the village, the number of properties located within 500 metres of the OHL has reduced from 33 to 5 when compared to our original preferred route from 2018 – a reduction of 85%. Further engagement with SPT has also resulted in the Glen Lochy Switching Station proposed to be located east of Dalmally no longer being required, further reducing visual impact. • Due to stakeholder feedback following this confirmed change conflicting with comments received from 2020, further engagement was undertaken to gain understanding as to why the alternative solution was not deemed acceptable • Engagement took place in the form of the (MSP) Roundtable Session and Town Hall Meeting as described in Key Activities. It also included targeted landowner discussions stakeholder emails and engagement with the local MSP. • The primary source of continued contention was identified as being due to alternative options proposed by community members which would see the OHL cited further away from the village not progressed due to the requirement to avoid Loch Lomond and Trossachs National Park and a local Special Protected Area for Eagles. • It was acknowledged that further efforts were required to describe the trade-off undertaken, to build trust that community comments had not merely been disregarded. Therefore, through discussions and an FAQ document we evidenced to the community that statutory consultees confirmed objections would be submitted had alternative routes through the National Park be taken forward, explaining the material impact this would have on planning applications. • We also recognise the importance of transparency and setting appropriate expectations and have been clear that the imminent planning application will be based on the preferred route. • Further engagement activities due to take place in March 2022 are being planned with a focus on sharing the stakeholder trade off process and resultant decisions.

Key theme	***Actions undertaken***
Keep Expectations Regarding Timescales Realistic This feedback was provided by: • Statutory Consultees Our consenting body stakeholders want to ensure that our expectations are realistic in terms of planning timescales and that we are mindful of their workload and staffing constraints.	• By setting up quarterly meetings, we have been able to provide both the ECU and Argyll and Bute Council with advance notice of our pipeline of work. • By liaising closely with relevant planning authorities, we have been able to work towards achievable timescales and ensure our intentions match the capabilities of the consenting bodies. • Through ongoing dialogue, we have also been able to identify windows of opportunity in which to best utilise their time and have been mindful of this when updating our project programme, including increasing the timescale for planning approval within the programme.

3.5 Next steps

There is important stakeholder engagement still to be delivered to progress this project, in order to finalise proposals and achieve necessary planning consents. We also recognise further engagement is required the area to help stakeholders understand the wider need for the project and we plan to address this at our next Argyll Regional Stakeholder Webinar late March 2022. In responding to community members asks for increased visualisations and planning authority feedback regarding the effectiveness of 3D modelling, we are also focussing on the creation of additional media communication materials such as information videos, interactive maps, and 3D models to aid transparency and improve understanding.

A summary of our planned engagement is outlined below:

Stakeholder	Upcoming/Ongoing Engagement Activity	Anticipated Date
All	Argyll Regional Stakeholder Webinar – including Argyll and Kintyre Reinforcement Strategy Video	**Q2 2022**
All	Creag Dhubh – Dalmally Section 37 and Town and Country Planning application submissions	**Q2 2022**
All	Creag Dhubh – Inveraray Preferred Alignment Public Consultations	**Q2 2022**
All	Argyll and Kintyre 275kV Substations Town and Country Planning Applications	**Q2 2022**
All	Creag Dhubh – Inveraray Section 37 Consent Application	**Q3 2022**
Ofgem	Interface and update meetings	**Ongoing**
Planning Authorities	Interface and update meetings	**Ongoing**
Elected Members	Project briefing notes and follow up meetings	**Ongoing**
SPT	Interface and update meetings	**Ongoing**
Communities	Community Council, Community Liaison Group and Community Forum Meetings	**Ongoing**
Customers	Programme dependent interface meetings with primary developers	**Ongoing**

All	Submit FNC – Once the FNC is submitted to Ofgem, this will be communicated to stakeholders, with meetings to discuss next steps offered.	**Q3 2022**

Our engagement thus far has allowed us to conclude that:

1. Stakeholders want to understand the overarching solution for providing the infrastructure required to deliver Net Zero. Engaging on projects in silos and piecemeal development risks a lack of transparency regarding the full remit of works required in this context
2. The need for growth is certain, the trend of generators seeking connection to the grid from 2025 onwards will continue, as electricity demand is forecast to increase as the economy becomes greener
3. Stakeholders are eager to ensure that the proposed solution provides sufficient capacity for this future generation without requiring additional works

4. The Need

4.1 Introduction

The need for reinforcement of the Argyll and Kintyre network is driven by the requirement to provide efficient capacity to accommodate renewable generation which will connect in the area. In this chapter, we provide robust evidence of the drivers for undertaking the proposed works.

In our paper, Enabling Whole Energy System Outcomes Policy[23], we recognise the importance of a whole system approach. We have applied these principles in developing the Argyll and Kintyre network response. In this chapter, we outline how we assess system needs from a whole system point of view, and in chapter 5 and 6 we consider a wide range of potential solutions to meet network needs.

To meet future generation and demand capacity requirements and maintain security of supply, our development of the Argyll and Kintyre reinforcement considers both the generation and demand (load requirements) and the risk associated with the asset condition of the existing OHL (non-load requirements) as well as system operability requirements. We take a long-term view of the network capacity required for the connection of renewable generation beyond the current connected and contracted generation.

We conclude that the renewable generation driven need for increased capacity on the Argyll – Kintyre network has been established.

- **Current consented generation, 281MW, exceeds the available network capacity, 108MW**
- **Contracted generation, 670MW, far exceeds that level**
- **Both the ESO FES and our local Local-FES scenarios all point to generation growth at levels which are significantly higher.**

We see compelling evidence that further reinforcement will be required to meet the continued generation growth. To this end, our incremental investment strategy is ideally suited, avoiding unnecessary investment and ensuring we remain on a Net Zero pathway.

4.2 Non-Load Need

The network assets in the Argyll and Kintyre area were built in the 1950s and 1960s as described in Section 2 (Project Background), with a number of asset interventions taking place on both load and non-load basis:

- The double circuit OHL from Crossaig to Carradale was completed in 2015 as part of the load driven Kintyre – Hunterston project,
- the rebuild of the Inveraray to Port Ann section was completed in RIIO-T1 primarily driven on an asset condition basis but the capacity of the line was increased for load reasons, and
- the Port Ann – Crossaig section is currently being rebuilt in the RIIO-T2 price control, primarily on an asset condition basis, with a scheduled completion date of 2023.

[23] 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/

The asset condition of the remaining assets in the Argyll and Kintyre area was assessed to consider any non-load intervention requirements in the near future. The following circuits were assessed:

- Inveraray – Ardkinglas – Inverarnan/Sloy 132kV single circuit
- Inveraray – Sloy 132kV double circuit OHL
- Sloy – Inverarnan 132kV double circuit OHL
- Taynuilt – Inveraray 132kV double circuit OHL

From the assessments undertaken and reviewing historical information, intervention on a condition basis is recommended only on the Taynuilt – Inveraray double circuit OHL. Refurbishment work is required to replace insulators and associated fittings on the towers by 2031. No other work is required on this line at this point.

Assessments were also undertaken on two substations potentially impacted by a requirement to reinforce the network, Clachan GSP and Port Ann GSP. The assessments have concluded there are no non-load works anticipated at this point in time.

The conclusion of the non-load need assessment is that intervention is required to replace the insulators and associated fittings on the Taynuilt – Inveraray double circuit OHL within the RIIO-T3 period.

4.3 Load Need

There are two key load related consideration for the Argyll and Kintyre reinforcement project. These are:

(i) the need to maintain security of supply at the GSPs in the area, and

(ii) to increase the capacity of the network to accommodate additional renewable generation seeking connection.

Part of the network in this area forms part of the Main Interconnected Transmission System (MITS) therefore, the network needs are assessed against the NETS SQSS design criteria for the MITS, in addition to the design criteria for generation and demand connection. Section 1 of the SQSS acknowledges that there are parts of the system where multiple design criteria apply, and in such cases the most onerous criteria shall be applied.

4.3.1. Security of supply

The security of supply for the Argyll and Kintyre area is mainly dependent on the two network corridors connecting this area to the wider network as well as the generation connections in this area. The Inveraray to Sloy corridor consists of three 132kV circuits while the Kintyre to Hunterston route consists of the two 220kV cables. Any network intervention must not reduce the security of supply. Table 1 shows the maximum and minimum demand at each GSP in the Argyll and Kintyre area. The maximum coincident peak demand in this area is 64MW.

Table 1: Maximum and Minimum demand of each GSP in Argyll and Kintyre

GSP	Maximum Demand (MW)	Minimum Demand (MW)	Demand Group Classification*
Taynuilt	26.2	6.3	Class C (12-60MW)
Clachan	3.1	0.0	Class B (1-12MW)
Port Ann	15.6	3.2	Class C (12-60MW)
Carradale	18.6	4.7	Class C (12-60MW)

** Demand group classification according to NETS SQSS Table 3.1 which defines the minimum planning supply capacity following secured events*

With a current total installed generation capacity of 582MW against a peak demand of approximately 64MW, this area is a net exporter of renewable generation. It is important to note that the renewable generation exports from this area contribute to the wider GB security of supply. It is therefore equally important that the load intervention to provide additional generation connection capacity does not unduly restrict regional generation in this area from contributing to GB security of supply, in line with the network design principles of the NETS SQSS.

4.3.2. Need for network capacity to connect generation

There is significant interest from renewable generation developers to connect to the network in the Argyll and Kintyre area. Connections at either transmission or distribution level ultimately impact on the power flows on the transmission system. The base network described in Chapter 2 can accommodate up to 108MW of contracted generation in the queue, beyond which reinforcement will be required. The 108MW of available capacity on the existing network is over and above the 582MW connected generation as of February 2022 and indicates the potential additional generation connections that could be made prior to reinforcement being required to maintain compliance under existing derogation. It is important to quantify the need for network capacity based on currently known information and a view of potential development consistent with the net zero pathways. Further details on potential future generation developments are provided in sub-sections 4.5.1.2 -4.5.1.8 below.

4.4 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), total group demand supplied by the Argyll and Kintyre network is classified as Class D (60 - 300MW). Starting with an intact system and following a secured event, the security standard requires that the group demand minus 20MW should remain connected[24] with the full group demand restored within 3 hours. For an initial background with a single planned outage, loss of supply is permitted for a secured event, with the smaller of (group demand minus 100MW) and two thirds of the group demand to be restored within 3 hours, and the total group demand restored within the time to restore the planned outage.

Individually three of the GSPs (Carradale, Port Ann and Taynuilt) are classified as Class C (12 – 60MW). Starting with an intact system and following a secured event, the security standard requires that within 15 minutes the smaller of (group demand minus 12MW) and two-thirds of group demand be restored, with full demand restored within 3 hours. For an initial background with a single planned outage, loss of supply is permitted for a secured event. The fourth GSP (Clachan) is classified as Class B (1 – 12MW). Starting with an intact system and following a

[24] The group demand may be lost for up to 60 seconds if this leads to significant economies

secured event, the security standard requires that within 3 hours group demand minus 1MW should be restored, with full demand restored in the time to repair the secured event. For an initial background with a single planned outage, loss of supply is permitted for a secured event.

The existing demand security compliance is met for the following criteria:

i) NETS SQSS Section 3 – Demand Connection Criteria Applicable to the Onshore Transmission System

ii) Engineering Recommendation ER P2/7

4.4.1. 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[25]. 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 Argyll and Kintyre 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 Argyll and Kintyre) not connected to the mains gas network[26], 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 we undertook with 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[27].

Demand growth for Argyll and Kintyre is considered in the context of NGESO's four Future Energy Scenarios[28] 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, electric district heating, high energy efficiency, uptake in electric vehicles and demand side flexibility. Under this scenario, peak demand in the area could increase by up to 51% by 2050. This included electric vehicles demand and it would still be much lower than the currently installed generation capacity.

4.5 Compliance with generation connection criteria

There is 363MW of large onshore wind generation (>= 10MW) connected to the Argyll and Kintyre network as well as 80MW of large hydro generation. A total of 139MW of small embedded generation (< 10MW) is connected into the distribution network served by the transmission network in this area, giving a total generation capacity of 582MW. As described in section 4.3.1, with a peak demand of just 64MW, this results in this area being a net exporter of renewable energy.

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[25] Draft Heat Buildings Strategy. Available at: https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings-consultation/pages/2/

[26] SSEN DFES 2020. Available at: https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=20282

[27] 4D Heat. Available at: https://www.ssen.co.uk/WorkArea/DownloadAsset.aspx?id=19929

[28] Future Energy Scenarios: Available at: https://www.nationalgrideso.com/document/174541/download

The generation connection design criteria are contained in Section 2 of the NETS SQSS. The criteria are divided into two main categories:

(i) criteria to limit the loss of power infeed to ensure that the system frequency can be maintained within the statutory limits, and

(ii) sufficient transmission capacity to allow local generation to access the market, enable it to contribute to meeting the national demand security, as well as to ensure that the system can be operated safely and securely both in the short term and long term.

Variation to connection design criteria is permitted under customer choice providing there is no wider system impact or impact on other network users.

For all secured events in this area, which include the loss of transmission lines, transformers, and busbar sections, the loss of power infeed is within the 1,800MW loss of power infeed limit, therefore the transmission network is compliant against the loss of power infeed criteria. As stated in Chapter 2, the Argyll and Kintyre network has a derogation from the connection capacity criteria relating to the loss of both subsea cables as well as the loss of one circuit on the double circuit radial line from Inveraray to Taynuilt.

For the fault outage of one of the Kintyre – Hunterston cables while the other cable is on planned outage, overloading would result on the circuits north of Crossaig leading to Sloy switching station. Generation connecting into the Kintyre and Argyll area requires an operational intertrip to manage this condition. This is a category 2 intertripping scheme which as defined in the Grid Code[29], is a system to generator operational intertrip scheme which alleviates a circuit overload on the NETS and is installed in accordance with the requirements of the planning criteria of the SQSS in order that measures can be taken to permit maintenance access for each transmission circuit and for such measures to be economically justified. On the other hand, for the loss of one of the circuits between Inveraray and Taynuilt, overloads are observed on the remaining circuit on that route. Details of the derogation are contained in the derogation update report submitted to Ofgem following the completion of the Kintyre – Hunterston project[30].

4.5.1. 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, strengthening national policy objectives associated with achieving net zero GHG emissions by 2045 in Scotland indicate continued growth in renewable generation.

The ScotWind leasing announcement in January 2022 indicated that Zone W1, to the west of the Argyll and Kintyre network area, has a 2GW offshore wind developer successful in securing a lease option for that seabed area. The connection options for the offshore wind generation in this area are being assessed as part of the Holistic Network Design[31] (HND) project being undertaken by the ESO. This ScotWind generation could potentially add to the generation need in this area subject to the outcome of the HND work due to be published in June 2022 [redacted]

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[29] The Grid Code available at; https://www.nationalgrideso.com/uk/electricity-transmission/document/162271/download

[30] Argyll and Kintyre Derogation Update Report Rev1.0

[31] ESO led Holistic Network Design (HND) for a coordinated onshore and offshore network as part of the BEIS led Offshore Transmission Network Review (OTNR)

4.5.1.1. Contracted generation

A significant and sustained increase in renewable generators are seeking to connect to the Argyll and Kintyre transmission network since late 2019. As shown in Figure 6, over 1,000MW of generation has applied for a connection to this network. 612MW of onshore wind has signed connection offers in the past two years, bringing the total contracted generation level to 670MW. The 582MW of connected generation includes two onshore wind farms, Blary Hill (35MW) and BAT III (50MW), which connected in September 2021. This is represented in Figure 6 by the drop shown between Jul 21 and Oct 21 on the 'Contracted' line. The 'Contracted & Connected' line represents the contracted generation as well as those two generators that connected in September 2021.

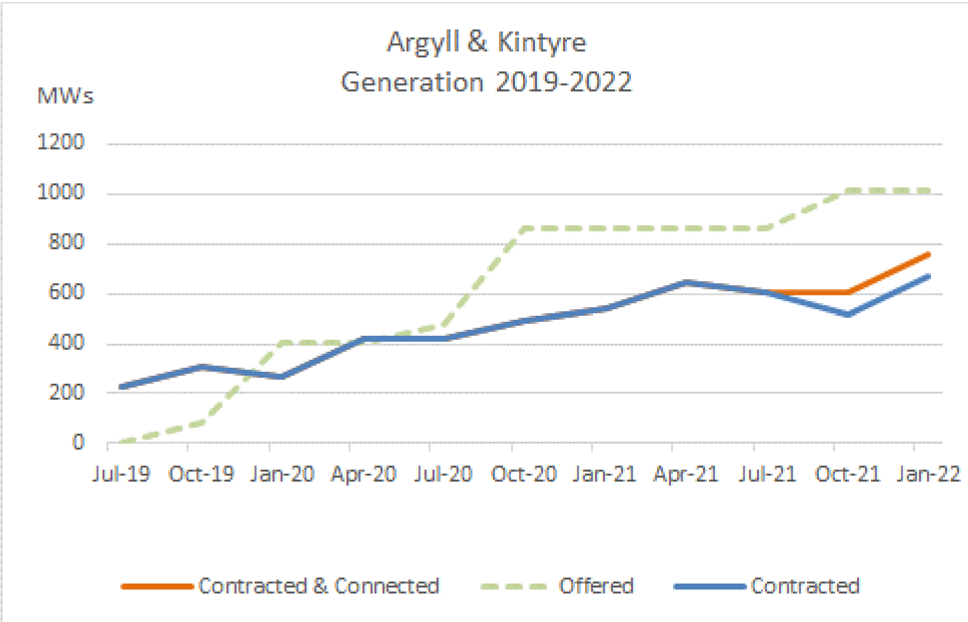

Figure 6 Level of generation that has been issued an offer, and generation that has contracted

Table 2**.** shows details of the generation contracted to connect to the Argyll and Kintyre network, as well as generators currently in the application process. There has been a significant and continued upward trend in the contracted generation since 2019. This upward trend is continuing, as per the inclusion of [redacted] currently progressing through the connection application process, as well as continued pre-application discussions with developers interested in connection opportunities in this area.

Table 2 Contracted and offered generation schemes in the Argyll and Kintyre area as of February 2022

[redacted]

281MW of the contracted generation is consented. The contracted developers in Argyll and Kintyre are predominantly experienced large developers. These developers have significant portfolios of generation across the UK and are experienced in developing onshore wind farms within our network area. The contracted generators that do not have planning consents are currently in the consent application process or are in scoping. We have engaged with each of the contracted developers and have received statements of commitments to their respective projects, as well as supporting the proposed reinforcement of the transmission network in Argyll and Kintyre.

Connection studies undertaken in accordance with the NETS SQSS and the Connect and Manage criteria of the Connection and Use of System Code[32] (CUSC), pursuant to the Transmission Standard Licence Condition D3 indicate that network augmentation is needed to provide the necessary efficient capacity to connect the contracted generation. The proposed transmission reinforcement works are set out in the connection agreements with developers. Any minimum enabling works required to connect generation are required to be completed before the generation requiring them can connect.

The proximity of our network to the SPT network in the Argyll and Kintyre area results in our transmission network being classified as an Affected TO for connections applications made to SPTs network. This requires us to undertake connection studies on those applications to consider any potential network reinforcements to enable the connection to the SPT network. The same is true of SPT for connection applications to our network. We work closely with SPT to undertake connection studies, understand the impact of the connection on each network, and coordinate any identified network reinforcement requirements. There are currently two large, pumped storage, hydro applications in progress, one in each TO area, that we are actively engaged on with SPT.

The contracted generation background provides a short-term view of system capacity requirements. In making a long-term investment decision, it is important to draw on energy insights on potential future connections in the area. We acknowledge that the level of uncertainty increases in the mid- to long-term and below we describe the approach we took to deal with the uncertainty based on a review of the ESO's FES in light of renewable developer aspirations in the Argyll and Kintyre area.

[32] Describe CUSC

4.5.1.2. 2021 FES

FES 2021 for Kintyre and Argyll identified up to 1,104MW of new renewable generation that could emerge over the period to 2050, adding to 497MW of generation already connected as of July 2021. Since then, two more wind farms have connected, adding a total capacity of 85MW and resulting in 582MW of connected generation as of February 2022. Figure 7 shows the FES 2021 new generation for the Argyll and Kintyre area over the period to 2050.

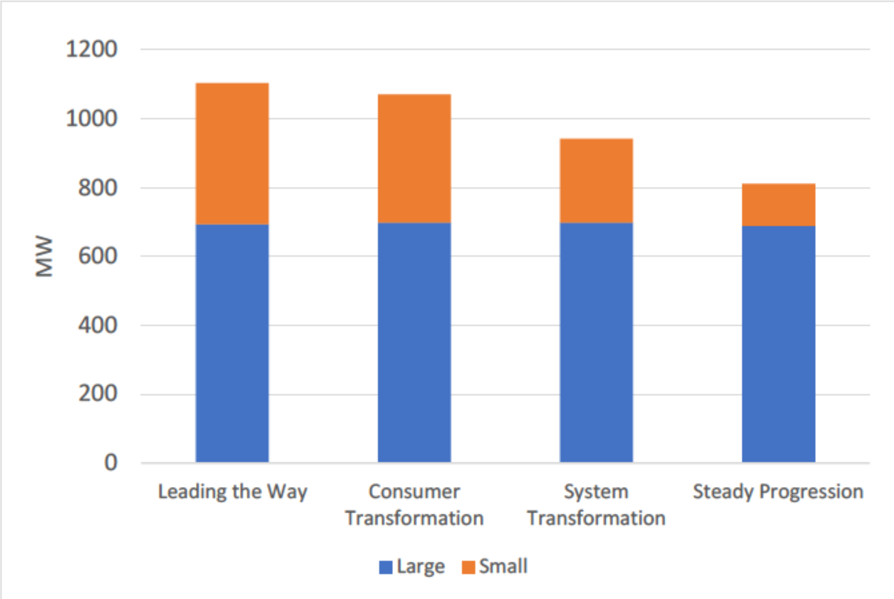

Figure 7 FES 2021 new large (>10MW) and small generation development in Argyll and Kintyre by 2050

New generation in LtW (Leading the Way) and CT (Consumer Transformation) is around 1,100MW whereas growth in ST (System Transformation) and SP (Steady Progression) is lower at 941MW and 810MW 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[33].

The ESO FES are macro in nature, focusing largely on contracted generation and are not intended to capture more granular detail of generation development on a smaller network such as Argyll and Kintyre. In the north of Scotland, our published Energy Trends papers[34] have identified developments that have not always matched the prevailing GB trends. Therefore, additional granularity provided through localised FES for the north of Scotland better represent local stakeholder needs. 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.

[33] https://www.gov.scot/publications/securing-green-recovery-path-net-zero-update-climate-change-plan-20182032/pages/7/
[34] Future Energy Scenarios (ssen-transmission.co.uk)

It is worth noting that onshore wind generation in the north of Scotland FES has been upwardly evolving on an annual basis over the past six years as the UK moves towards net zero aspirations and policies and technologies evolve. Lately, there has also been an increased interest in large pumped hydro storage schemes which are seen as necessary complementary technologies to mitigate the intermittency of renewable generation as well as provide ancillary services for the secure operation of the grid. Figure 8 shows the total installed onshore wind and pumped hydro capacity by 2040 as assumed in the ESO's FES from 2016 to 2021 for the north of Scotland area. The graph does not reflect the connections activity since the 2021 FES data freeze in March 2021.

It is clear from the graph that the generation growth trends within the Argyll and Kintyre area is in line with trends for similar technologies in our network area.

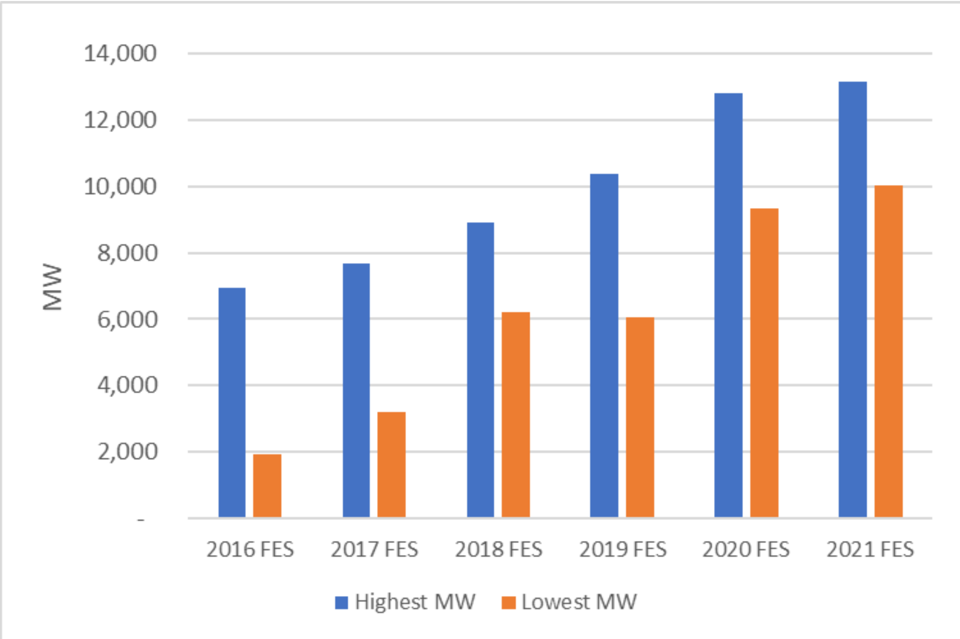

Figure 8 2016 – 2021 FES total installed onshore wind and pumped hydro generation by 2040 for the north of Scotland

Alongside developers that have signed contracts for a connection to the local transmission network, there is further significant interest in the area from scoping generators. We routinely undertake direct engagement with stakeholders from which we gain detailed insights on individual projects in the area, including projects not yet in the application process which are not fully captured in the FES, to develop plausible local scenarios for the generation growth in the Argyll and Kintyre area.

In order to address uncertainties in future generation growth, a multi-scenario approach consistent with the ESO Future Energy Scenarios (FES) was adopted. We developed four local generation scenarios for the Argyll and Kintyre area with a yearly resolution to 2050. The scenarios were developed through a combined approach of stakeholder engagement and the use of an internal Scenario Assessment Tool (SAT). In order to align the local scenarios with the most up-to-date FES, they were compared to the FES 2021 for this area, with differences identified and justified. Further details on the development of the Argyll and Kintyre local generation scenarios are available in the Appendix E Argyll and Kintyre Local FES report (provided in the list of supporting documents).

4.5.1.3. Stakeholder input

To supplement our view of the generation potential on Argyll and Kintyre, we undertook a stakeholder engagement exercise via an online questionnaire and webinar event in April 2021 to gather intelligence on scoping generation with an interest in developing renewable generation projects in the Argyll and Kintyre area. Table 3 lists the relevant developers that submitted questionnaire responses following the webinar.

A total of 1815 MW of potential new generation in addition to the current contracted generation capacity of 520MW was identified through this exercise, giving a total of 2335MW of potential new generation in this area. This is higher than the 2021 FES generation for the area by 2050 and also more than three times the currently contracted generation. [redacted] appear in both the scoping table (Table 3), and the contracted and offered table (Table 2). Both these generators were identified through the developer webinar session in April 2021 and they subsequently submitted connection applications. In assessments undertaken utilising the local scenarios, these two generators have been considered at their scoping TEC, as per Table 3.

Table 3 Scoping generation in the Argyll and Kintyre area

[redacted]

** Identified through developer webinar from April 2021, they indicated they did not want their details shared publicly.*

The substantial potential generation background identified projects at a range of development stages and is consistent with the recent growth in contracted generation capacity. The projects identified include credible developers and we consider the level of interest high, consistent with interests elsewhere on our network.

The online questionnaire formed the basis of an objective view of generation development on Argyll and Kintyre 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. Figure 9 shows the build-up of capacity looking to connect into the Argyll and Kintyre area categorised into connected, contracted, offered and scoping generation. Some of the generation identified as scoping in the April 2021 developer engagement seminar has progressed to apply, with connection offers now offered. This accounts for the difference between the scoping generation capacity in Figure 9 and in Table 3.

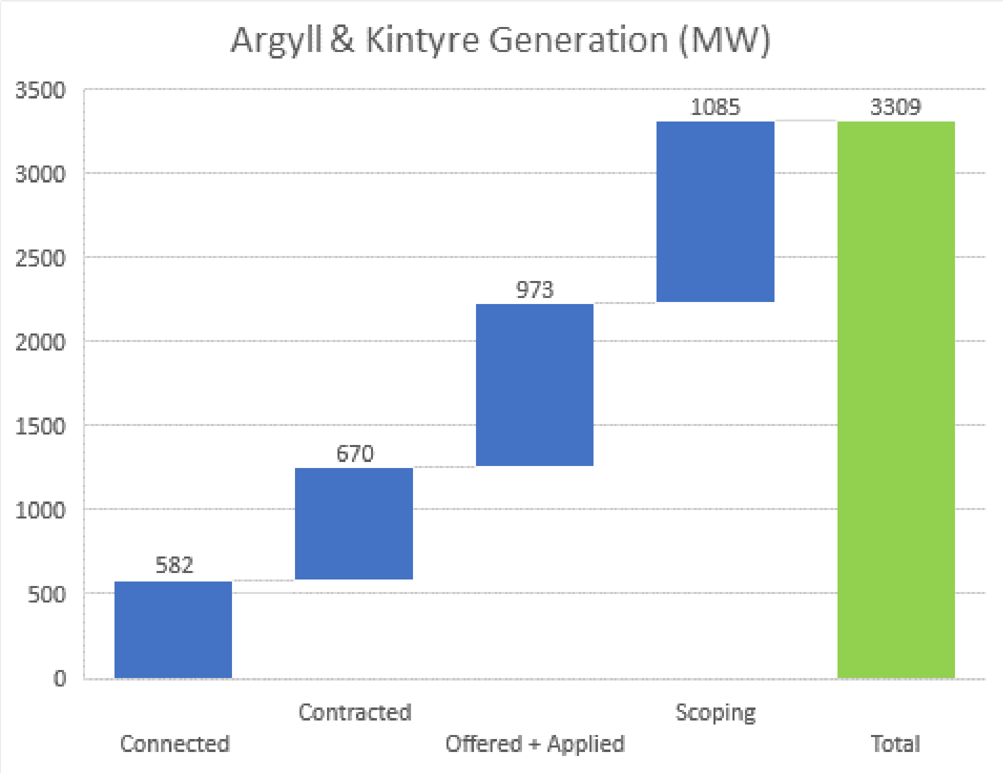

Figure 9: Capacity looking to connect into the Argyll and Kintyre area categorised into connected, contracted, offered and scoping generation

It is important to note that 281MW of the contracted generation is consented. With the base network described in Chapter 2 only capable of accommodating up to 108MW of additional contracted generation in the queue, Figure 9 clearly shows that network reinforcement will be required to accommodate even the consented generation.

To determine the full extent of required reinforcement, the development of scenarios was undertaken in order to address the inherent uncertainties with future generation capacity.

4.5.1.4. Scenario Assessment Tool

We developed the Scenario Assessment Tool to assess the probability of generation connecting to the network. This shares some similarities to the Probability of Generation Assessment Tool (PGAT), a tool developed by GHD[35] which was used for the local FES development for the Western Isles and Skye INC.

The SAT scores projects against a range of criteria identified as primary indicators of project development potential. The criteria are seen as key project drivers in helping to assess the likelihood of future generation proceeding with a proposed connection to the transmission network. The project drivers and their respective weightings in the project scoring system are outlined in Table 4. Further description of each Project Driver is available in the Appendix E Argyll and Kintyre Local FES report.

[35] GHD Consulting Services, employed by SSEN Transmission on the Skye LOTI project

Table 4 SAT criteria and weightings

Project Drivers	Weighting (%)
Network Contractual Status	12.5
Project Planning Status	32.5
Ownership / Financial Considerations	10
Distribution or Transmission	10
Economies of scale	10
Distance to Connection	15
Location favourability	10

4.5.1.5. Development of Local FES for Argyll and Kintyre

The SAT process provides an overall 'score' for each project. The SAT 'score' achieved by a project is used to identify which local scenario the project falls within, or if it is omitted all together. Those scoring in excess of 65 out of 100 are assumed to progress in Scenario 1 (S1) – with the '65' score and resulting scenario generation sitting lower than the lowest FES 2021 scenario. At the other end of the scale, projects scoring above '50' go ahead in Scenario 4 (S4) – where around 70% of the 2,335 MW of potential generation identified progresses. This is approximately double the highest FES 2021 scenario (Leading the Way)

Projects at an early planning stage (notice of interest stage) have had their proposed capacity adjusted to reflect uncertainty around planning and the capacity that their proposed scheme would be built to. The adjusted MW value was calculated by applying an 18.02% capacity decrease to all projects with the Project Planning Status of 'notice of interest.' This average capacity decrease of 18.02% was calculated by taking the average decrease from historic schemes that applied for a higher capacity but out turned with less capacity when finally commissioned.

Additionally, the FES 2021 datasets for small embedded generation (<10MW) have been utilised for each corresponding scenario to incorporate potential increases in small embedded generation out to 2050.

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 Argyll area. The outcome provides a suitable scenario 'snapshot' of potential long-term generation outcomes for the local Argyll and Kintyre region – albeit based only on projects that are 'known' at this current time. The resulting scenarios are shown in Figure 10. Also shown on the figure are the 2021 ESO FES for the Argyll and Kintyre region.

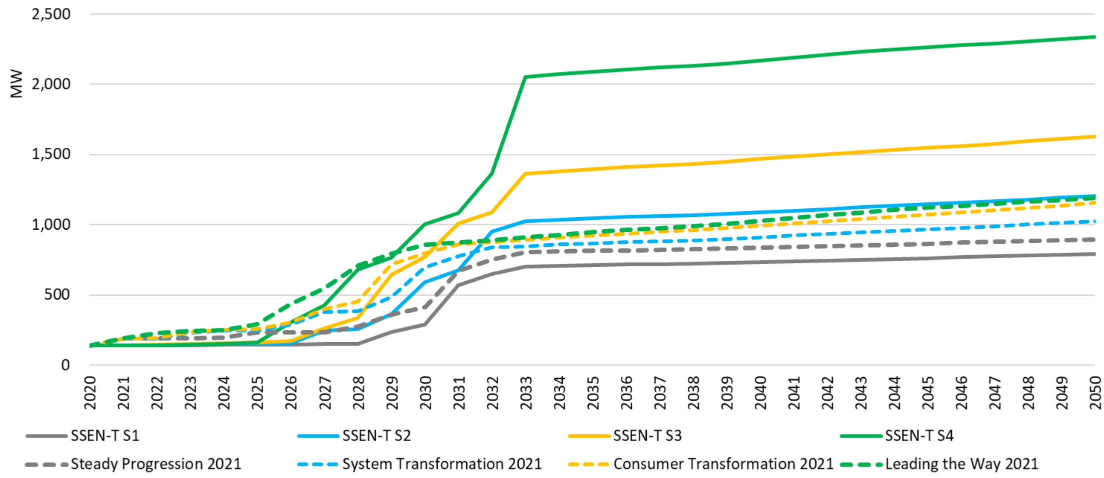

Figure 10 Argyll and Kintyre Local Scenarios – New generation by scenario

The majority of the increase in generator connections across all scenarios is prior to 2035. However, the recent UK Government announcement of a target date of 2035 for a decarbonised power system will likely accelerate renewables growth in the next decade.

4.5.1.6. Local FES alignment with the ESO FES

The aim of SAT and the stakeholder engagement exercise is to objectively develop a range of plausible long-term scenarios for use within the assessment of network needs and also for CBA. The scenarios developed are intended to build upon the ESO's FES. Therefore, while the SAT scores inform scenario development by determining the relative 'proceedability' ranking of each project identified, there is also a more subjective user input that determines the scoring thresholds defining each scenario. The outcome is an objective evaluation of the projects identified, with project scores determining both overall scenario capacities and which projects are developed in which scenarios.

The low S1 results in the development of less than a quarter of the potential capacity identified in our stakeholder engagement out to 2050 and sits lower than the lowest FES 2021 scenario. S1 is a very pessimistic outcome that could potentially emerge in a world where: the planning environment is significantly more hostile than the current one; market conditions worsen due to lower long term electricity prices, higher technology costs and/or cost of capital and; there is a more moderate commitment to long term climate goals. It should be noted that S1 does not align with meeting the UK and Scottish government net zero targets.

The highest scenario (S4) allows around 70% of the capacity currently identified to be successfully delivered. The SAT scenario development also limits the potential installed capacity of projects with the Project Planning Status of 'notice of interest.' This is supported by empirical evidence of historic projects that applied for a higher capacity but out turned with less capacity when finally commissioned.

We believe S4 is a plausible, high scenario in a world where the planning environment is more amenable (e.g. due to the increasing acceptance of the climate emergency) or market conditions improve, facilitating projects with more expensive grid connections and heightening interest from developers.

The mid scenarios S2 and S3 show additional scenario ranges. S2 allows around 30% of the identified capacity to be developed, with some 40% developed in S3.

4.5.1.7. ESO and Ofgem feedback

The scenarios and SAT approach was shared with the ESO's Future Energy (FES) team. [redacted]. This was presented to the ESO who noted that the approach was the correct action to take.

Additionally, as there were a number of projects identified through the stakeholder engagement questionnaire exercise, these were not present within the FES 2021 dataset so connection dates for those schemes needed to be created. Utilising the ESO's methodology that it applies for 'scoping' schemes, those projects who have indicated a 'notice of interest', connection dates for the projects were developed. The ESO's methodology is shown in Table 5

Table 5 ESO methodology for assessing generator connection dates for scenarios

Onshore Wind	Battery Storage	Pumped Storage
LW – Requested date + 5yrs	LW – Requested date + 6yrs	LW – Requested date + 5yrs
CT – Requested date + 6yrs	CT – Requested date + 8yrs	CT – Requested date + 9yrs
ST – Requested date + 7yrs	ST – Requested date + 10yrs	ST – Requested date + 14yrs
SP – Requested date + 8yrs	SP – Requested date + 11yrs	SP – Not included in scenario

Overall, the ESO's FES team indicated that the approach taken to develop the Argyll scenarios followed a similar process to that followed by the ESO and the methodology to determine the connection dates for notice of interest projects was correct.

The results of the SAT and the underlying model were shared with Ofgem to facilitate Ofgem's understanding of how each scenario was developed and the information/data used in the scenario creation. Ofgem were broadly content with the SAT approach and transparency of the workings used to create each scenario. There were some suggested changes to the criteria weightings in the model to align with those considered for the Skye CBA. Table 6 shows the proposed adjustments to SAT's criteria weightings.

Table 6 Ofgem's proposed adjustments to SAT's criteria weightings

Project Drivers	Original Weighting (%)	New Weighting (%)
Network Contractual Status	12.5	10
Project Planning Status	32.5	40
Ownership / Financial Considerations	10.0	10
Distribution or Transmission	10.0	5
Economies of scale	10.0	10
Distance to Connection	15.0	15
Location favourability	10.0	10

Table 7 shows the resulting scenarios after changing the SAT criteria weightings based on the feedback and applying the proposed adjusted weightings, while **Error! Reference source not found.** shows the visual impact on the scenarios in graph format.

Table 7 Impact of proposed adjusted weighting to SAT's criteria

	S1	S2	S3	S4
Original Weighting	531 MW	822 MW	1,117 MW	1,787 MW
Ofgem Weighting	510 MW	664 MW	904 MW	1,609 MW

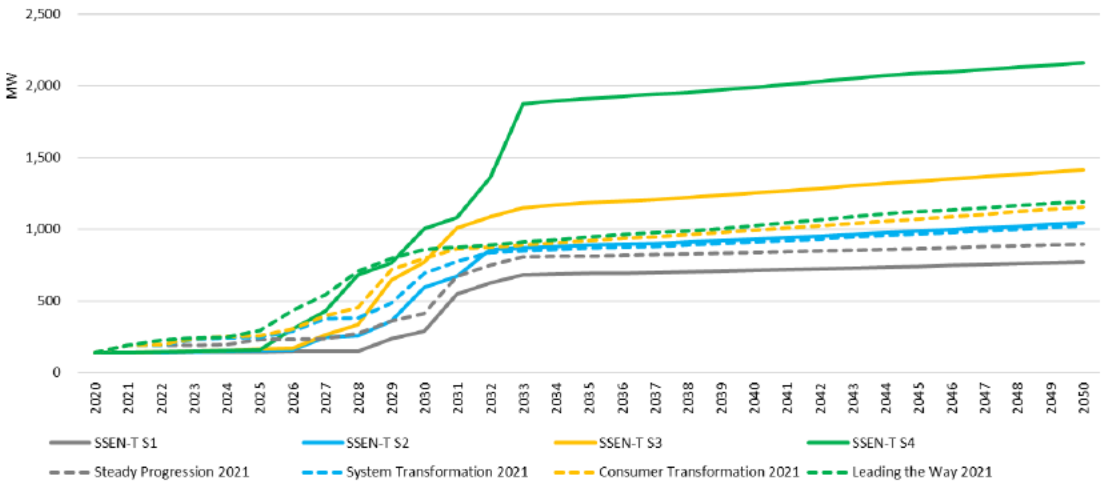

Figure 11 Impact of proposed adjusted weighting to SAT's criteria on scenarios – New generation by scenario

4.5.1.8. Generation Sensitivity

Near the closing stages of the scenario development, [redacted] Both of the schemes were included within a sensitivity (S4+). The capacity for each scheme follows the same logic that has been applied to each notice of interest scheme as well as the connection date being calculated based on the ESO's methodology. This ensures consistency across all scenarios. Figure 12 shows the generation scenarios with this additional sensitivity added.

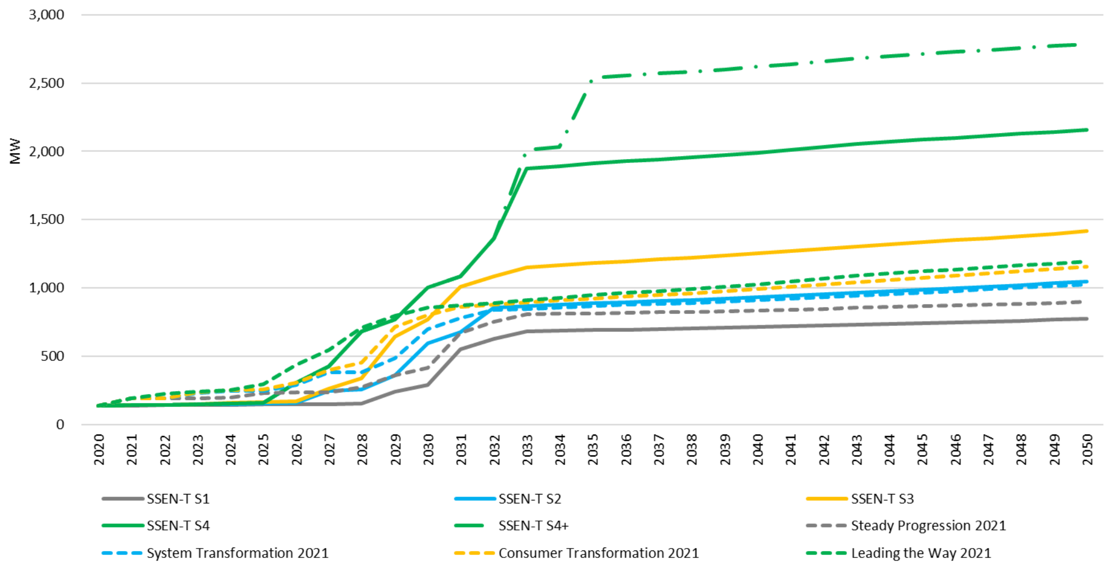

Figure 12 Argyll and Kintyre Local Generation Scenarios with S4+ sensitivity – New generation by scenario

The scenario development for the Argyll 275kV Strategy has built upon the previous approach and lessons learned from the Skye LOTI. The stakeholder engagement undertaken has provided additional clarity to scenario assumptions and highlighted the significant renewable generation potential in the Argyll area.

The stakeholder engagement undertaken forms the basis of an objective view of generation development on Argyll by better understanding the developer perspective. The results allowed us to outline the total MW of project potential, along with project timescales and project location. In addition, we gained a better understanding of projects at earlier stages of development. The approach incorporated real objectivity into scenario development – with projects evaluated against a set of criteria considered pertinent indicators of a project's likelihood of progression. The SAT allows transparent evaluation of each project and rationale for inclusion in any scenario.

The approach we have developed provides a balanced view of how generation could develop in the area – engaging with local developers to explore the depth and possibility of future renewable growth, but also objectively analysing each project's development potential. 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 Argyll area.

4.6 MITS capacity requirement

The network in the Kintyre and Argyll area forms part of the MITS and its capacity is also assessed in accordance with the MITS criteria in Section 4 of the NETS SQSS based on MITS boundary B3b. A MITS boundary divides the transmission system into two contiguous parts and is normally drawn across critical circuits which present limitations to power flows. The required power transfer capability across B3b is a function of the generation and demand on either side of the boundary. Figure 13, an extract from the 2021 Electricity Ten Year Statement (ETYS)[36] shows the geographic map of the network in and around Kintyre and Argyll, showing the B3b

[36] Electricity Ten Year Statement (ETYS) 2021 | National Grid ESO

boundary. This boundary cuts across the Inveraray – Sloy group of three 132kV circuits as well as the two Kintyre – Hunterston 220kV subsea cables. These circuits often present limitations to the capacity of the network in this area to export power to the rest of the GB network.

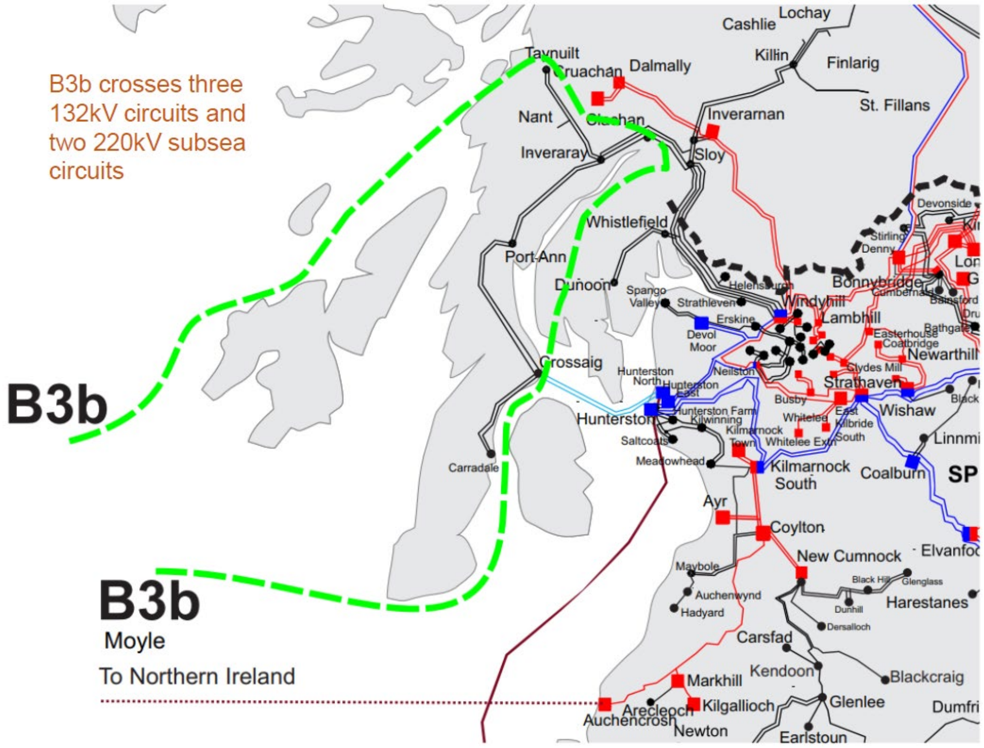

Figure 13 Map of the Central belt of Scotland, showing boundary B3b (source: ETYS 2021)

The 2021 ETYS provides the required transfer capability of the B3b boundary in accordance with the NETS SQSS MITS criteria based on the 2021 FES. Figure 14 shows the required transfers for boundary B3b across a range of 2021 FES and 2020 FES up to 2040 as well as the current capability of the boundary. This shows that the current B3b boundary capability of 450MW is lower than the required transfer capability across all scenarios, indicating the need for more capacity. The capacity requirement on this boundary is driven by power export requirements to enable efficient operation of the GB electricity market as well as to ensure local generation in the Argyll and Kintyre region can contributing to meeting GB security of supply.

Figure 14 also shows that from around 2033, the required transfer begins to drop but remains well above the current network capability. This is due to the assumptions in the NETS SQSS which see the scaling factor for hydro generation dropping as more generation connects onto the wider GB network, while the scaling factor for wind is kept constant. Effectively, this represents a reducing capacity factor for hydro generation (and other conventional power stations) as more wind connects to the wider GB system. It is worth noting that the NETS SQSS is planned to be reviewed in the coming year and the MITS scaling factors are in scope for that review.

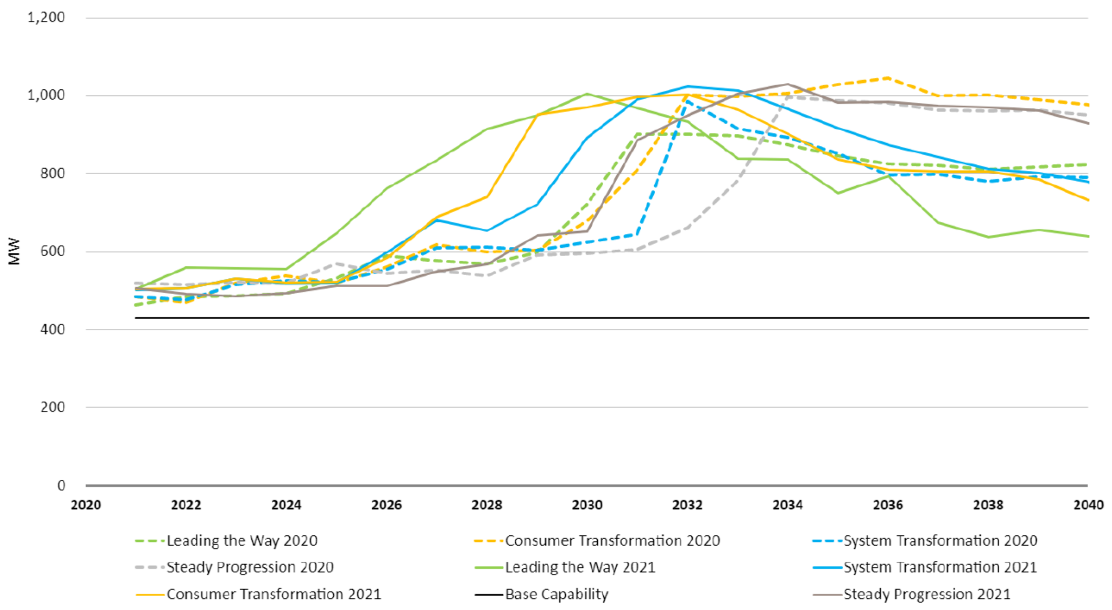

Figure 14 B3b required transfers from ETYS 2021 against the B3b base capability

Due to the shallow nature of the interconnected network in this area, and the volume of generation seeking to connect, the minimum enabling works reach into the MITS. Reinforcement of the network is required to ensure compliance with the MITS criteria. While on the wider interconnected transmission system, the reinforcements required are assessed via the Network Options Assessment process, this is not the case for boundary B3b and the Argyll and Kintyre network. The NOA methodology was developed for assessing wider system reinforcements and therefore is not well suited to assessing minimum enabling works for connections as required under the generation connection criteria of the NETS SQSS (Section 2) and the CUSC Connect and Manage criteria. Minimum enabling works are required to be completed before the generation that requires them can connect.

4.7 Summary of Need

A comprehensive review of need has shown that there is a strong and increasing need to reinforce the Argyll and Kintyre network in order to enable renewable generation to connect. At least the minimum enabling works are required to be completed in accordance with the planning standard (SQSS) and the CUSC Connect and Manage criteria. There is no imminent non-load need, however intervention is required on insulators and associated fittings on the Inveraray to Taynuilt double circuit OHL during RIIO-T3 period.

5. Reinforcement Options

5.1 Note on Earliest In Service Dates Presented

Earliest In Service Dates (EISDs) for options presented in this report were initially based on the position in Summer 2021 when the ESO CBA was undertaken. However, because of subsequent requirements to undertake additional studies to robustly justify the proposed solution, the EISDs presented in the CBA are no longer achievable. This is due to the INC being delayed while these studies were undertaken. The revised EISDs for all options, other than the preferred reinforcement option, are now based on development works starting in the fourth quarter of 2022. Only the preferred reinforcement option continues to be worked upon at this time however it is noted the EISD for this has also been affected by the INC delays.

Through the document it is made clear when EISDs are presented if they refer to those from the CBA or current dates.

5.2 Option Development Background

We identified the need for reinforcement of the Argyll and Kintyre network in Chapter 4. In order to address this need, we considered a wide range of reinforcement options ranging from 'non-build' to 'build' options and we considered potential development pathways for the network in Argyll. We considered the following factors in the development of the options:

- the asset condition of the existing infrastructure and potential interventions;
- known and potential future generation capacity requirements;
- security of supply for the Argyll network;
- operability of the network;
- costs and benefits to customers and consumers of today, and in the future;
- 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 Argyll network. In our paper, Enabling Whole Energy System Outcomes Policy[37], 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 DNO 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 Chapter 4 and in the development of options in this Chapter to meet the need.

[37] 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/

5.3 Options assessment methodology

In working to identify the proposed reinforcement option we have considered all potential solutions and applied a two-stage assessment to determine if an option should be progressed for further detailed analysis through System Operability assessments and Cost Benefit Analysis.

5.4 Initial Options

Prior to undertaking the two-stage assessment we developed an initial list of potentially feasible schemes which can enable the connection of additional generation onto the transmission network. Where appropriate, we also consider the 'Do Nothing' option which we normally consider as the counterfactual.

We apply a whole system approach to asset intervention in the Argyll and Kintyre area, carefully considering the load and non-load drivers as discussed in Chapter 4.

5.4.1. Consideration of 'Do Nothing' (operational options)

In practice, a "Do Nothing" option or non-asset option still requires some level of intervention to the operation of the network. This does not create any additional capacity on the existing network.

As set out in Chapter 4 - Need, connection assessments of contracted generation and network requirements to enable the connection of the generation volumes in the local FES have demonstrated a clear need to undertake reinforcement of the network. While the "Do Nothing" option is not credible, we consider it in the initial list of options only to provide a reference point for the reinforcement options, i.e. we consider it as a counterfactual.

5.4.2. Reviewing the Non-Load Need

As set out in Chapter 4, the analysis undertaken shows that there is minimal non-load intervention requirement in the short-term (before 2031) on the current OHL assets between Taynuilt and Inveraray. This intervention involves replacement of the insulators and associated fittings on this line by 2031. No other work is required on this line at this point.

While the asset condition is not the dominant driver for the Argyll and Kintyre reinforcement project, the timing of the replacement of insulators and associated fittings and load intervention is coordinated to realise efficiency benefits for customers through coordination. Where the future asset replacement date is closer to the proposed reinforcement the benefit to customers increases. At this stage, these benefits do not alter the clear underlying need to undertake network reinforcement to enable the connection of new renewable generation in the area.

5.4.3. Intervention Options for Renewable Generation Capacity

A review was undertaken on the viable routes out of the network that could be developed in order to consider options for increasing the export capacity for generation of the Argyll and Kintyre network. These viable routes were informed by considering the existing network infrastructure in the area, as well as the geographical and topology constraints of the local area. We also engaged extensively with SPT due to the proximity of their network to our Argyll and

Kintyre network, and the requirement that any reinforcement to increase export capacity will directly connect to SPT's network and require coordinated reinforcement on their side. We worked through the viable export options, to understand the impacts at the interface point and on the SPT network beyond.

The result of this exercise was four identified export routes from Argyll and Kintyre to the wider GB network that could be built upon to increase the capacity of the local network. Two of these routes are to the north of the peninsula, and two of these routes to the south. These routes are described in more detail below and shown in Figure 15.

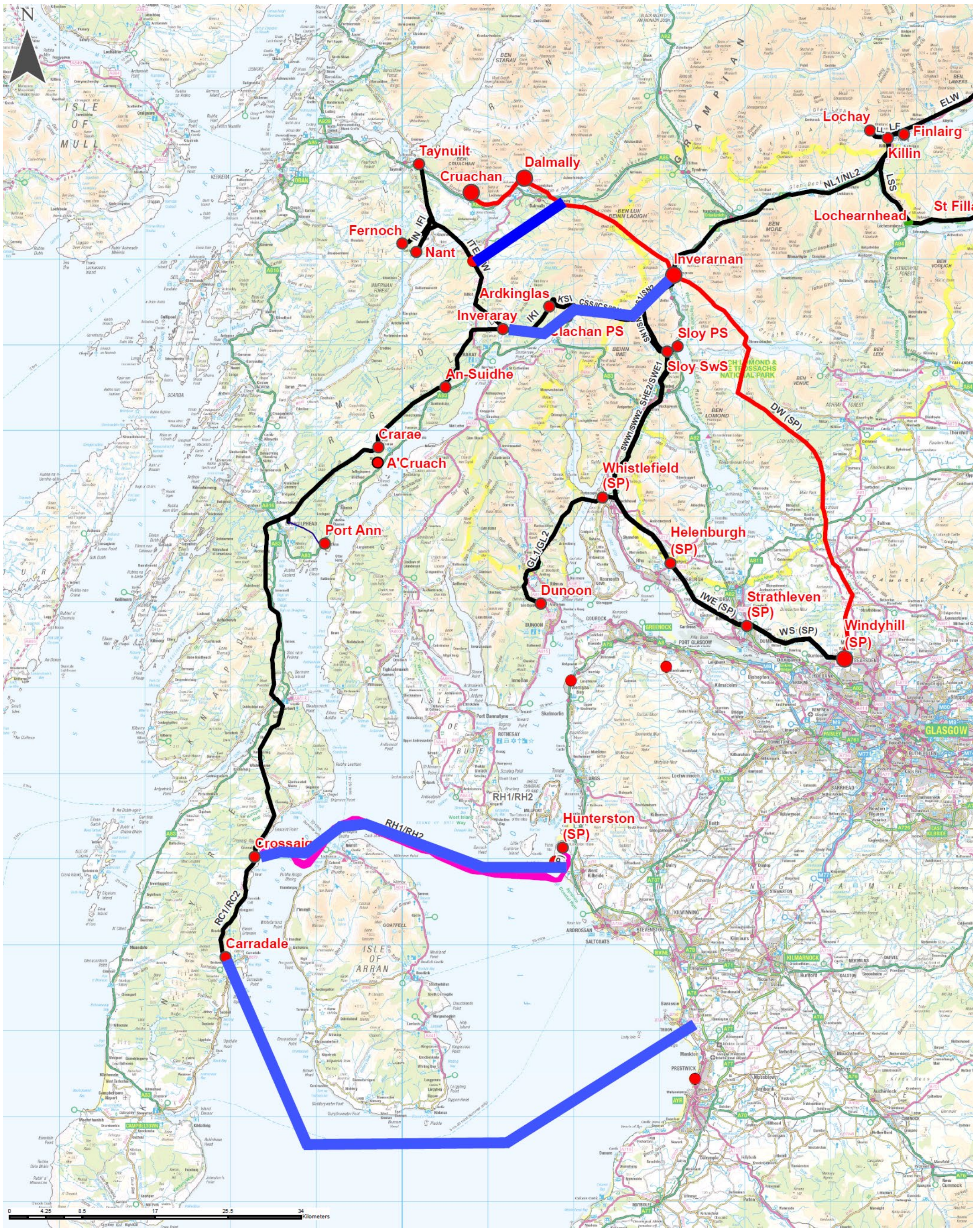

Figure 15 map showing the existing network, and the four potential export routes marked in blue

- Export via Dalmally – Windyhill 275kV OHL - A new proposed export route to the north of the peninsula with a new circuit route being established to connect to the SPT 275kV circuit from Dalmally – Windyhill.

- Export via Sloy-Inverarnan - An existing export route to the north of the peninsula with the existing circuits between Inveraray – Sloy – Inverarnan being upgraded. This would ultimately connect to the SPT 275kV circuit from Dalmally – Windyhill.
- Export via subsea cable from Crossaig to Hunterston - An existing export route to the south of the peninsula with an additional subsea circuit being established between Crossaig substation and Hunterston substation (SPT).
- Export via subsea cable from Carradale to Kilmarnock South - A new proposed export route to the south of the peninsula with a new subsea circuit route being established to connect to the SPT network at Kilmarnock South substation.

A fifth export route was considered as part of strategic reinforcement options considered in 2016. This route was from Port Ann through to Devol Moor in SPTs network. Based upon previous consideration of the option this was ruled out based upon engagement with stakeholders and consideration of the engineering challenges with laying subsea cable in this area. [redacted] Additionally, from an engineering perspective there are numerous existing cables, wrecks, and shallow depths that would make justification difficult when there are viable alternatives available.

Taking into account the background network changes, the viable export routes set out here, and the reinforcement need set out in Chapter 4 - Need, a list of options was assessed as part of this option assessment, as listed in **Error! Reference source not found.**.

Table 8 Initial list of reinforcement options

Option	EISD*	Title
Initial Option 1	2028	3rd Crossaig – Hunterston Subsea Cable 220kV + North Argyll
Initial Option 2	2028	3rd Crossaig – Hunterston Subsea Cable 220kV Higher Capacity + North Argyll
Initial Option 3	2028	3rd Crossaig – Hunterston Subsea Cable 400kV + North Argyll
Initial Option 4	2029	3rd Crossaig – Hunterston Subsea Cable HVDC + North Argyll
Initial Option 5	2028	Twin Carradale – Kilmarnock South Subsea Cable 220kV + North Argyll
Initial Option 6	2027	275kV Radial Crossaig – North Argyll
Initial Option 7	2027	275kV Radial Carradale – North Argyll
Initial Option 8	2028	275kV Radial Crossaig – Inverarnan (via Sloy)
Initial Option 9	2028	275kV Radial Crossaig – Inverarnan

**Earliest In Service Dates (EISDs) reflect the date each option would be delivered should a decision to progress them be taken following the review of this Initial Needs Case in Q4 2022.*

We further assessed this list to identify those schemes which should be put forward for further detailed analysis in Chapter 6. A description of the full scope associated with each initial option is set out in Appendix 3: Scheme Options for Stage 2 Assessment.

5.5 Criteria for Option Assessment

5.5.1. First Stage Assessment Criteria

Following identification of the initial options in Table 8, the first stage undertakes an assessment system requirement based on connection studies and on contracted customer dates. The assessment criteria are set out below:

1. To what extent does the option provide required network capacity in full or in part considering all current known generation and demand scenarios.

2. To what extent does the option meet customers connection dates. Where the scope of works involves third parties, e.g. SPT, SHEPD or other Users, coordination is required. It is noted that only some options will meet this criteria in full.

The scheme must meet with the commitments made under our RIIO-T2 Business Plan unless there are allowable mitigating circumstances. For example, the use of SF_6 based Gas Insulated Switchgear where there is no appropriate alternative technology.

5.5.2. Second Stage Assessment Criteria

The second stage assessment considers each option against the following key areas.

- **Engineering** – This considers an assessment of the technology being proposed for each option to determine the risk the technology introduces to the electricity transmission network, its customers or our ability to deliver Business Plan objectives. This assessment includes consideration to whether or not the proposed technology is new and unproven to our System, the GB Electricity Transmission System or completely new to the electricity transmission industry. Any previous performance issues with proposed technology will also form part of this assessment and potential issues with supply will be considered.
- **Environmental and Consenting** – This considers whether there are environmental and consenting constraint challenges for the option, whether the option will compromise ecology and landscape features and whether it will compromise visual amenity or people's use/enjoyment of an area. Finally, it considers whether the option is likely or otherwise to be contrary to planning policy/other proposals.
- **Cost** – Each scheme will be assigned an initial Class 0 Cost Estimate (accuracy range of -50/+100%) with costs determined through utilising benchmarked rates from similar completed projects and high level assessments made of items such as cable and OHL route lengths and substations built up on the basis of the number of bays. Costs are then assessed against the lowest scheme cost calculated to assign the RAG status. It is noted the costs utilised are regularly updated to reflect the current costs being incurred across our construction portfolio.

The assessment against the criteria listed above requires us to determine if the constraints or issues are of a significant magnitude to prevent the project from progressing e.g. this is "black flagged" or it is allowable to continue to progress the project. For example, if a project proposes to develop infrastructure within a designated area, initial consultation would be undertaken with the relevant authority for the area to determine their view on the proposals. In the case of the Argyll and Kintyre Reinforcement Scheme there were Options proposed which saw significant development within the Loch Lomond and Trossachs National Park. Early consultation noted this development would be objected to by the Park Authority and would undermine positive work undertaken in the area under the VISTA Scheme. As such, we determined this was a "Black Flag" and did not progress the option.

It should be noted the two-stage assessment serves an additional secondary purpose, should the detailed analysis show marginal differences between two options. The assessment can highlight where an option may have more significant anticipated environmental impacts or engineering challenges which can assist with differentiating the preferred option should there be marginal economic gains demonstrated.

In terms of limitations of the two stage optioneering assessment, it is acknowledged that due to the phase of the project at which this work is undertaken that the level of detail available to assess the projects upon is limited. As a result there may be schemes which are taken forward which may transpire to have significant issues or limitations which could not have been foreseen at the time.

Whilst targeted consultation is undertaken with key stakeholders, wider consultation on the various options is not undertaken. This can result in future stakeholder opposition to a particular option being progressed however it is not considered feasible given the limitations in information available to consult on a wider basis at this stage.

5.6 Assessment of Initial options

In terms of the output of the detailed option assessment, these are set out below for each. Each option was assessed under the two stages. Any options that did not pass at least one stage of the assessment were not progressed further to detailed analysis.

It should be noted that in terms of the initial options listed here, all of these options met the LOTI Criteria in being wholly load related via the contract generation drivers and through all having an associated Capital Expenditure of greater than £100m.

5.6.1. Initial Option 1 – 3rd Crossaig – Hunterston Subsea Cable 220kV + North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Does not provide enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Viable cable route identified from Crossaig – Hunterston project • 220kV subsea cable is considered a known technology • Onshore elements at North Argyll did not raise any significant constraining factors	**Progressed** to further options assessment

Overall, the environmental, engineering and cost data did not identify any significant concerns for this option. However, it does not accommodate the full contracted generation and does not meet the contracted dates. This option was progressed.

5.6.2. Initial Option 2 – 3rd Crossaig – Hunterston Subsea Cable 220kV Higher Capacity + North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Does not provide enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Viable cable route identified from Crossaig – Hunterston project • 220kV subsea cable is considered a known technology • Confirmed that higher capacity 220kV cables are available on the market	**Not Progressed** to further options assessment

	• Onshore elements at North Argyll did not raise any significant constraining factors • Higher cost without matching increase in network capacity	

Overall, the environmental and engineering data did not identify any significant concerns for this option. However, it does not accommodate the full contracted generation and does not meet the contracted dates. The higher capacity cable has an additional cost compared to Initial Option 1, however it does not give additional firm capability compared to Initial Option 1. As a result, this option was not progressed.

5.6.3. Initial Option 3 – 3rd Crossaig – Hunterston Subsea Cable 400kV + North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Does not provide enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Viable cable route identified from Crossaig – Hunterston project • 400kV subsea cable has not been employed on our network to date • Limited use of 400kV subsea cables on GB network, which are less than 1 mile in length • Onshore elements at North Argyll did not raise any significant constraining factors	**Not Progressed** to further options assessment

Overall, the environmental and cost data did not identify any significant concerns for this option. However, it does not accommodate the full contracted generation and does not meet the contracted dates. Also, there were engineering concerns over the availability of this technology and evidence of its successful deployment in a subsea environment within the GB transmission network. This option was not progressed.

5.6.4. Initial Option 4 - 3rd Crossaig – Hunterston Subsea Cable HVDC + North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Does not provide enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Viable cable route identified from Crossaig – Hunterston project • HVDC considered a mature technology on our network • Footprint required for convertor station would be significant	**Not Progressed** to further options assessment

	• HVDC technology is expensive and deemed uneconomic for distances under 50-60km • Onshore elements at North Argyll did not raise any significant constraining factors	

Overall, the environmental and engineering data did not identify any significant concerns for this option. However, it does not accommodate the full contracted generation due to limitations of the surrounding network and does not meet the contracted dates. The cost of the option was highlighted under the assessment as the technology is deemed uneconomic for distances under the range of 50-60km and for low capacities. This option was not progressed.

5.6.5. Initial Option 5 - Twin Carradale – Kilmarnock South Subsea Cable 220kV + North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Provides enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Cable route to south of Arran would traverse a significant trench and need to avoid a marine protected area • 220kV subsea cable is considered a known technology • Onshore elements at North Argyll did not raise any significant constraining factors	**Progressed** to further options assessment

Overall, the environmental, and engineering data did not identify any significant concerns for this option. However, it does not accommodate the full contracted generation and does not meet the contracted dates. The cost of the option is significant but is an alternative route to the proposed additional subsea cable from Crossaig. This option was progressed.

5.6.6. Initial Option 6 - 275kV Radial Crossaig – North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Provides enough capacity to accommodate contracted generation. • Meets generator connection dates	• Onshore elements at North Argyll, Craig Murrail, and Crossaig did not raise any significant constraining factors	**Progressed** to further options assessment

Overall the Environmental, Engineering, and Cost data did not identify any significant concerns for this option. It does accommodate the full contracted generation and does meet the contracted dates. This option was progressed.

5.6.7. Initial Option 7 - 275kV Radial Carradale – North Argyll

Stage 1 Assessment	Stage 2 Assessment	Outcome

• Provides enough capacity to accommodate contracted generation. • Meets generator connection dates	• Onshore elements at North Argyll, Craig Murrail, Crossaig, and Carradale did not raise any significant constraining factors • Similar to option 6 above but has additional scope not currently required	**Not Progressed** to further options assessment

Overall, the environmental, engineering, and cost data did not identify any significant concerns for this option. It does accommodate the full contracted generation and does meet the contracted dates. This option is similar to Initial Option 6 but extends the 275kV OHL beyond Crossaig to Carradale. This extension is currently not required based on the contracted background. This option was not progressed.

5.6.8. Initial Option 8 - 275kV Radial Crossaig – Inverarnan (via Sloy)

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Provides enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Onshore elements at Craig Murrail, and Crossaig did not raise any constraining factors • Significant environmental and consenting concerns associated with the National Park on section between Inveraray – Sloy - Inverarnan	**Not Progressed** to further options assessment

Overall, the engineering, and cost data did not identify any significant concerns for this option. It does accommodate the full contracted generation but does not meet the contracted dates. The identified scope would require significant development in the Loch Lomond and Trossachs National Park. Recent works to reduce the transmission infrastructure within the National Park leads to a significant risk of objection from the Park Authority under this option, which was confirmed via consultation undertaken with the Park Authority and written confirmation of their position received. Progressing this option could result in loss of visual amenity in the National Park and associated significant reputational damage. This option was not progressed.

5.6.9. Initial Option 9 - 275kV Radial Crossaig – Inverarnan

Stage 1 Assessment	Stage 2 Assessment	Outcome
• Provides enough capacity to accommodate contracted generation. • Does not meet generator connection dates	• Onshore elements at Craig Murrail, and Crossaig did not raise any constraining factors • Significant environmental and consenting concerns associated with the National Park on section between Inveraray – Sloy - Inverarnan	**Not Progressed** to further options assessment

Overall, the engineering, and cost data, did not identify any significant concerns for this option. It does accommodate the full contracted generation but does not meet the contracted dates. The identified scope would require significant development in the Loch Lomond and Trossachs National Park. Recent works to reduce the transmission infrastructure within the National Park leads to a significant risk of objection from the Park Authority under this option, which was confirmed via consultation undertaken with the Park Authority and written confirmation of their position received. Progressing this option could result in loss of visual amenity in the National Park and associated significant reputational damage. This option was not progressed.

5.7 Options for Detailed Analysis

Based upon the outcome of the two-stage options assessment exercise, three initial options were to be progressed to detailed assessment: options 1, 5 and 6. Each of these options are formed of individual project components that could be constructed independently of the other components. It is recognised that some of these individual components can increase the export capacity of the Argyll and Kintyre network, and thus enable the connection of a portion of the contracted renewable generation and there could be benefits associated with delivering different combinations of individual components.

The individual components that make up the three progressed initial options are listed in Table 9, along with a high-level description of the works. Each individual component was assigned an option code.

Table 9 Individual Option Components for network reinforcement

Code	Description	EISD*
Base	Base Network (Counterfactual)	N/A
DDNC1	Creag Dhubh substation and new 275kV line (with normally open circuit)	2026
DDNC2	Creag Dhubh substation and new 275kV line	2026
CKNC	Two subsea cables Carradale - Kilmarnock South	2028
KHNC	3rd Subsea Cable (Crossaig - Hunterston)	2028
DINC	New 275kV line Creag Dhubh – Inveraray	2027
DCUP1	Uprate Creag Dhubh - Crossaig Line to 275kV (Crossaig radialised)	2027
DCUP2	Uprate Creag Dhubh - Crossaig Line to 275kV (Crossaig interconnected)	2027

**EISD reflects current deliverable date of each option.*

As a result, the individual components that provide an increase in export capacity, and their combinations, are assessed in the detailed analysis along with the three initial options that were progressed from the two-stage options assessment exercise. These options are listed in Table 10. Included in the table is both the capital costs and the calculated operation and maintenance costs. The CAPEX costs are for our works only, and do not include the costs for work required on SPT's network. The OPEX costs are based on an assumed asset life of 40 years. The total costs including SPT share are included in Table 16 (Summary of reinforcement options CBA input data) The EISDs for each component is also listed. It should be noted that the options in Table 10 are named by the codes assigned to each component.

Table 10 Options progressed for detailed analysis

ESO Option #	Code	Short Description and ***EISD****	[redacted]	[redacted]	[redacted]
01	Base	Base Network (Counterfactual)			
02	DDNC2	Creag Dhubh substation and new 275kV line (***2026***)	[redacted]	[redacted]	[redacted]
03	DDNC1+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (***2026***) 3rd Subsea Cable at Crossaig (***2028***)	[redacted]	[redacted]	[redacted]
04	DDNC2+ KHNC	Creag Dhubh substation and new 275kV line (***2026***) 3rd Subsea Cable at Crossaig (***2028***)	[redacted]	[redacted]	[redacted]

ESO Option #	Code	Short Description and ***EISD****	[redacted]	[redacted]	[redacted]
05	DDNC1+ DINC+ DCUP2	Creag Dhubh substation and new 275kV line (N/O) (***2026***) New 275kV line Creag Dhubh - Inveraray (***2027***) Uprate Creag Dhubh - Crossaig Line to 275kV (I) (***2027***)	[redacted]	[redacted]	[redacted]
06	DDNC1+ DINC+ DCUP1	Creag Dhubh substation and new 275kV line (N/O) (***2026***) New 275kV line Creag Dhubh - Inveraray (***2027***) Uprate Creag Dhubh - Crossaig Line to 275kV (R) (***2027***)	[redacted]	[redacted]	[redacted]
07	DDNC1+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (***2026***) Two subsea cables Carradale - Kilmarnock South (***2028***)	[redacted]	[redacted]	[redacted]
08	DDNC2+ CKNC	Creag Dhubh substation and new 275kV line (***2026***) Two subsea cables Carradale - Kilmarnock South (***2028***)	[redacted]	[redacted]	[redacted]
09	DDNC1+ DINC+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (***2026***) New 275kV line Creag Dhubh - Inveraray (***2027***) Two subsea cables Carradale - Kilmarnock South (***2028***)	[redacted]	[redacted]	[redacted]
10	DDNC1+ DINC+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (***2026***) New 275kV line Creag Dhubh - Inveraray (***2027***) 3rd Subsea Cable at Crossaig (***2028***)	[redacted]	[redacted]	[redacted]
11	CKNC	Two subsea cables Carradale - Kilmarnock South (***2028***)	[redacted]	[redacted]	[redacted]
12	KHNC	3rd Subsea Cable (Crossaig - Hunterston) (***2028***)	[redacted]	[redacted]	[redacted]
13	DDNC1	Creag Dhubh substation and new 275kV line (N/O) (***2026***)	[redacted]	[redacted]	[redacted]
14	DDNC2+ CPFC	Creag Dhubh substation and new 275kV line (***2026***) Power flow control devices in line with Crossaig SGTs (***2026***)	[redacted]	[redacted]	[redacted]

**EISD reflects current deliverable date of each option.*

***N/O – Normally Open Point, I – Interconnected network, R – Radial network*

A detailed description for each individual component can be found in Appendix 4 - Detailed list of option components.

For each of the options described in Table 10, there are corresponding SPT works to reinforce their network and accommodate the proposed reinforcements. We worked extensively with SPT to help develop options, and to consider the potential connection points on their network. It was through these discussions that substations were identified on the SPT network to connect in the subsea cables in the south. In the north, we worked with SPT to develop a "loop in loop out" connection onto one side of the Dalmally – Windyhill double circuit OHL that is owned by SPT.

We also worked with SHEPD to consider whole system solutions to reduce required works where possible. In the options where the Inveraray – Crossaig line is uprated to 275kV, a solution was identified to maintain connection to the existing Port Ann GSP that reduced the works, reduced the environmental impact, and reduced the cost of the option.

6. Reinforcement Options Assessment

6.1 Introduction

In this chapter we explain how we identify the shortlist of deliverable options (chapter 5) which meet all, or part, of the identified need (chapter 4). The process of refining options to produce our recommended solution is in two stages.

- **Testing option operability:** by probabilistic system studies we test whether the potential solutions will be operable in real life scenarios (as required by NETS SQSS). Through this test we can identify our 'do minimum' option.
- **Testing economic benefits case:** by evaluating some of the economic costs and benefits across the remaining viable, operable, scenarios we can rank options in terms of consumer benefit. Through this we produce our recommended solution to meet the system need identified in chapter 4.

The assessment stages in chapter 5 started this process of reconciling options that meet the demonstrated need for network capacity for bulk power transfer out of the area, with the technical codes and standards, e.g. NETS SQSS, and the objective of securing value for consumers. We continue to rely on stakeholder engagement to inform our option development. Stakeholder input is critical in order to get buy-in from all those affected by the infrastructure developments, from local communities, landowners and consumers to businesses. The cumulative societal, environmental and economic impacts continue to be carefully considered in the planning and development of infrastructure projects. Evidence of this has been included in preceding chapters.

Testing Option Operability - The next stage of our refinement process is to identify the short list of options which can be taken forward to economic assessment without undermining the technical integrity of the system.

As the required reinforcement works are categorised as minimum enabling works according to the CUSC Connect and Manage criteria, and are therefore required to be complete in order to connect at least a proportion of contracted and consented generation, we have completed additional, more detailed, technical connections analysis based on probabilistic power system studies to ensure that the key operability criteria mandated by the NETS SQSS can be met (to ensure that the proposed design is technically competent).

We engaged the ESO in carrying out this analysis and interpreting the results to ensure the ESO can efficiently operate the resulting network in accordance with Section 5 of the NETS SQSS, in accordance with their licence obligations. While for the ESO this is over and above their required input into the LOTI process, engagement with the TO in matters of this nature is commonplace and covered as part of the STC[38] Investment Process. We provide a separate

[38] System Operator Transmission Owner Code (STC) defines the relationship between the transmission system owners and the system operator

detailed operability assessment report which is included in the document list in Appendix F Argyll & Kintyre Local Operability Study Technical Report.

The output of this assessment is summarised in section 6.2.5 which follows. This analysis was carried out against the standards set by the Connect and Manage arrangements. For system stability and safety, it is essential to recognise that the Connect and Manage arrangements represent a subset of the criteria required for NETS SQSS compliance. This allows a lower minimum amount of works to enable timely connection of generation with the balance of works to meet NETS SQSS compliance to be delivered after the generation connection. There is therefore no remaining scope to adopt lower standards. These results establish a firm minimum requirement within which we must develop system investment solutions.

The analysis concludes that the partial reinforcement options will not lead to a technically operable network under multiple generation scenarios and over the short and medium term (2027 to 2035). We use the technically operable options within the Cost Benefit assessment which then follows.

Testing economic benefits case - In addition to the technical assessment ordinarily undertaken by the TO to determine the necessary connection works in accordance with the relevant criteria of the NETS SQSS and Section 13 of the CUSC (Connect and Manage criteria), the LOTI guidance requires the ESO to undertake an independent cost benefit analysis[39].

To this end, we worked with the ESO from early 2021 to prepare the necessary inputs required by the ESO to perform its CBA. Summary details of the ESO's CBA including methodology, input data, assumptions, results and our analysis of the results are covered in section 6.3. The parallel development of the operability assessment and CBA output results in some options being included within the CBA modelling that are identified as technically inoperable. This is captured within the summary tables which follow. However, the relative ranking of options produced by the analysis remains useful in identifying the preferred option that will meet customer requirements.

The ESO has provided a separate detailed CBA report which is included in the document list in Appendix G - Argyll CBA Report V5 Final, hereafter CBA Report.

This work concludes that the best value, operable, reinforcement options is also the minimum investment option – Establishment of a new 275/132kV substation in North Argyll tied to the SPT 275kV network and uprating the North Argyll to Crossaig 132kV line and associated substations to operate at 275kV.

Option	Code	Short Description and EISD*
05	DDNC1+ DINC+ DCUP2	Creag Dhubh substation and new 275kV line (***2025***) New 275kV line Creag Dhubh - Inveraray (***2026***) Uprate Creag Dhubh - Crossaig line to 275kV maintaining interconnection at Crossaig (***2026***)

**EISD reflects those used in the CBA.*

6.2 Testing system operability

[39] Paragraph 4.6, https://www.ofgem.gov.uk/publications/large-onshore-transmission-investments-loti-re-opener-guidance

In chapter 5 we identified the list of investment components which, in various combinations deliver a range of system outputs. We have subjected the common combinations to additional system operability analysis. Table 11 shows an update of the options in Table 10 indicating options on which operability studies were undertaken. The rationale for the selections of options and grouping them is given in Table 11.

Table 11 Options refined by system operability studies

Option	Code	Short Description and ***EISD****	Options refinement Operability test undertaken
01	Base	Base Network (Counterfactual)	No – initial analysis confirms system inoperability
02	DDNC2	Creag Dhubh substation and new 275kV line (***2025***)	✓ Studied
03	DDNC1+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (***2025***) 3rd Subsea Cable at Crossaig (***2027***)	✓ Studied (See opt 04)
04	DDNC2+ KHNC	Creag Dhubh substation and new 275kV line (***2025***) 3rd Subsea Cable at Crossaig (***2027***)	✓ Studied
05	DDNC1+ DINC+ DCUP2	Creag Dhubh substation and new 275kV line (N/O) (***2025***) New 275kV line Creag Dhubh - Inveraray (***2026***) Uprate Creag Dhubh - Crossaig Line to 275kV (I) (***2026***)	✓ Studied
06	DDNC1+ DINC+ DCUP1	Creag Dhubh substation and new 275kV line (N/O) (***2025***) New 275kV line Creag Dhubh - Inveraray (***2026***) Uprate Creag Dhubh - Crossaig Line to 275kV (R) (***2026***)	✓ Studied (See opt 05)
07	DDNC1+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (***2025***) Two subsea cables Carradale - Kilmarnock South (***2027***)	Not studied Meets minimum capacity requirements at significant cost
08	DDNC2+ CKNC	Creag Dhubh substation and new 275kV line (***2025***) Two subsea cables Carradale - Kilmarnock South (***2027***)	Not studied Meets minimum capacity requirements at significant cost
09	DDNC1+ DINC+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (***2025***) New 275kV line Creag Dhubh - Inveraray (***2027***) Two subsea cables Carradale - Kilmarnock South (***2027***)	Not studied Meets minimum capacity requirements at significant cost
10	DDNC1+ DINC+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (***2025***) New 275kV line Creag Dhubh - Inveraray (***2027***) 3rd Subsea Cable at Crossaig (***2027***)	✓ Studied (See opt 04)
11	CKNC	Two subsea cables Carradale - Kilmarnock South (***2027***)	Not studied Capacity does not meet contracted generation, plus significant cost
12	KHNC	3rd Subsea Cable (Crossaig - Hunterston) (***2027***)	Not studied Capacity does not meet contracted generation, plus significant cost
13	DDNC1	Creag Dhubh substation and new 275kV line (N/O) (***2025***)	✓ Studied (See opt 02)
14	DDNC2+ CPFC	Creag Dhubh substation and new 275kV line (***2025***) Power flow control devices in line with Crossaig SGTs (***2025***)	✓ Studied (See opt 02)

**EISDs reflects those used in the CBA.*

This section details the engineering studies undertaken. The minimum connection works included in customer connection agreements are a subset of the full set of options developed and taken forward to detailed assessment as shown in Table 10. We summarise the methodology used for connection studies and the more detailed probabilistic study work below.

6.2.1. Connection studies

The standard generator connection studies are based on the engineering design criteria stipulated in the NETS SQSS Section 2 – Criteria for onshore generation connections. As stated in section 4.5, two sets of criteria are applicable:

(i) loss of infeed criteria (NETS SQSS Section 2.5 – 2.7) and
(ii) generation connection capacity criteria (NETS SQSS Section 2.8 – 2.13).

Loss of infeed is permitted for individual generation connection where the developer has opted for variation to standard design under customer choice criteria in Section 2.15 – 2.18 of the NETS SQSS. With the total volume of connected and contracted generation at 1,251MW[40], the infrequent infeed loss risk does not constrain the engineering design of the Argyll and Kintyre network at this point.

The connection capacity criteria cover the remainder of the engineering considerations to ensure the network can be operated safely, securely and efficiently. This includes fault levels, thermal capacity, system stability, voltage performance and supply capacity requirements. Within the standard connection application assessment timescale of 90 days, we undertake system analysis to address the key operability elements, with more detailed studies such as stability studies undertaken at a later stage in the connection process where necessary following connection offer acceptance.

In order not to unduly delay renewable generation connections, we apply the C&M criteria[41] to determine which of the reinforcement works required to meet compliance under the generation connection criteria of the NETS SQSS must be completed as minimum enabling works before the generators requiring them can connect. CUCS 13.2.4 defines the minimum that enabling works will include as the works required to:

i) comply with pre-fault criteria of onshore generation connection criteria of the SQSS
ii) achieve compliance with loss of power infeed criteria of the SQSS on the onshore transmission system
iii) enable the ESO to operate the NETS in a safe manner
iv) resolve any fault level issues associated with C&M Power Station
v) comply with minimum technical, design and operational criteria and performance requirements under the grid code
vi) meet other statutory obligations including but not limited to obligations under any Nuclear Site Licence Provisions Agreement and
vii) avoid any adverse impact on other Users.

[40] Total connected and contracted generation total is identified in the Need Chapter
[41] Connect and Manage criteria utilised to define Enabling Works and Wider Works for a generator connection application; https://www.nationalgrid.com/sites/default/files/documents/5639-Connect%20and%20Manage%20-%20Updated%20Guidance.pdf

This forms the basis on which the options set out in customer contracts are determined and therefore the basis of the reinforcement options in this INC. As explained in section 5, the optioneering exercise is based on all reinforcement option elements considered during the connections process to ensure that the network design to accommodate the cumulative generation capacity remains robust.

The remainder of the transmission works required to achieve compliance with the generation connection criteria are designated as derogated wider works.

6.2.2. Approach to operability assessment

The connection studies we undertake within the licenced timescales for making connection offers are based on the deterministic criteria of the NETS SQSS. This involves setting up a very limited set of representative network conditions against which system studies are undertaken. These conditions include the generation output for the generator being studied and other generators already in the background, the reactive power output of generators and the level of demand. We apply contingencies defined as secured events in the NETS SQSS. Examples of secured events include fault outages (such as for the loss of a line, transformer or cable circuit) or planned outages to allow for system access for maintenance. We identify solutions to resolve any violations observed for any of the secured events, e.g. to resolve any thermal overloading or voltages outside the planning voltage limits.

Our system studies indicate that due to the number of generator schemes and their position on the on the network, the circuit-level power flows are sensitive to the network configuration, generation dispatch and specific contingencies.

For this reason, system operability is a critical factor in identifying viable solutions and identify the correct minimum enabling works. Pre-fault system loading is a critical operability consideration for the safe, secure and economic operation of the Argyll and Kintyre network.

Given the wide range of operational conditions during a typical year of operation we undertook probabilistic power system analysis studies to capture realistic circuit-based impacts of different dispatch patterns considering secured events. This improves the robustness of the analysis underpinning the determination of minimum enabling works.

6.2.3. Selection of options to study

We started with the 14 options identified for detailed analysis (Table 12). Recognising the computational burden of probabilistic studies, we selected cases for detailed operability studies tactically. This allows us to identify common network components and avoid multiple unnecessary runs, as well as reduce the computational burden and the time taken to undertake each study. Table 12 shows a summary of the rationale for selecting options for detailed operability studies in the form of probabilistic analysis.

Table 12 Selection of network options for probabilistic studies

Option grouping	Consideration for probabilistic study	Outcome
01 **Do nothing**	Not a realistic proposition to meet contracted generation or the minimum generation scenario	Not studied
02 **(DDNC2),** 13 **(DDNC1)**	These options do not meet the minimum requirements but individually represent a distinct step in the reinforcement strategy	Studied DDNC2*
04 **(DDNC2 + KHNC),** 03 **(DDNC1 + KHNC)** 10 **(DDNC1+ DINC+ KHNC)**	Exploring the 3rd Kintyre –Hunterston cable option in addition to DDNC1/2 instead of the 275kV upgrade (DCUP1/2). Limited capacity and late delivery date of 2028	Studied (DDNC2 + KHNC)* for information
05 **(DDNC1+ DINC+ DCUP2)** 06 **(DDNC1+ DINC+ DCUP1)**	05 is the proposed Argyll strategy as per the connection contracts. Meets the minimum capacity requirements	Studied option 05**
14 **(DDNC1 + CPFC)**	This option is very sensitive to generation dispatch north vs south and not meet the minimum requirements	Not studied
11 **(CKNC),** 12 **(KHNC)**	These provide lower capacity compared to DDNC2 but more expensive and do not meet the minimum requirements	Not studied
07 **(DDNC1+ CKNC)** 08 **(DDNC2+ CKNC)** 09 **(DDNC1+ DINC+ CKNC)**	Higher capacity options with Carradale – Kilmarnock South cables (CKNC) in addition to DDNC1/2. More expensive and beyond minimum capacity requirements for contracted generation but provide pathways for future growth	Not studied

** DDNC1 and DDNC2 have the same scope, only differing in operational network configuration. DDNC2 maintains interconnectivity and performs better, hence it is studied. Similarly (DDNC2 + KHNC) is studied as it performs better than (DDNC1 + KHNC). DINC without the 275kV upgrade (DCUP1/2) is not effective.*

*** DCUP1 and DCUP2 have the same scope, only differing in operational network configuration. DCUP2 maintains interconnectivity at Crossaig and performs better, hence it is studied. Note that DDNC1 and DDNC2 are the same when considered with the Creag Dhubh to Inveraray OHL rebuild (DINC) and the 275kV upgrade (DCUP1/2).*

In summary, the options taken forward to probabilistic assessment are as follows:

i) **Option 02 – DDNC2**: Creag Dhubh 275/132kV substation and new 275kV OHL tie in to the SPT owned Dalmally – Windyhill OHL. The Inveraray – Taynuilt line is turned in to the new 132kV busbar at the new Creag Dhubh busbar.

ii) **Option 05 – DDNC1+ DINC+ DCUP2**: Creag Dhubh 275/132kV substation and new 275kV OHL tie in to the SPT owned Dalmally – Windyhill OHL. The Inveraray – Taynuilt line is turned into the new 132kV busbar at the new Creag Dhubh busbar. New 275kV OHL between Creag Dhubh and Inveraray (initially operated at 132kV), and the conversion of the Creag Dhubh to Crossaig OHL to operate at 275kV.

iii) **Option 04 – DDNC2 + KHNC**: DDNC2 as described above plus a third Kintyre – Hunterston subsea cable

6.2.4. Methodology

The probabilistic power flow study models the actual Argyll and Kintyre network as it will be following completion of the current, inflight, network investment. This study applies greater granularity to the system model and input data to determine if, and to what extent, the network would be non-compliant with the NETS SQSS during a typical year of operation while respecting the electrical and topological characteristics of the network and the location of generators.

System input data and criteria: The typical year is split into hourly periods, in which a full contingency study is undertaken for each hourly study period. For each study period, generation is dispatched according to time series data as described below and the network model is set up to run the power flow. Contingency criteria are applied to the power flow case and equipment loadings are assessed against the appropriate seasonal ratings. Any violations in terms of overloads are noted. Where violations are observed either pre-secured event or after, an optimisation algorithm is employed to redispatch generation in this area in order to bring the power flows within the ratings of the equipment for safe and secure operation of the network. The volume of generation curtailed to secure the system is also noted.

Model time periods: Different generation backgrounds and scenarios present different forecasts of installed generation capacity in future years. To manage computational burden, three years (2027, 2031 and 2035) were selected for assessing the reinforcement options under different generation capacity scenarios described in chapter 4. These years represent the most up-to-date delivery for the minimum enabling works (2027), the year around which the capacity flattens out in terms of new large generation connecting (2035) and a year in between these two dates (2031).

Model generation scenarios: In addition, two contracted scenarios have been considered, (CNTRCA and CNTRCB) which are based on the contracted generation (February 2022). Whilst the [redacted] is not a contracted scheme as of February 2022, it has been issued a connection offer and has the potential for significant impact due to its size. It has therefore been included in a modified version of the contracted generation background. The generation backgrounds which have been used to inform the various probabilistic studies undertaken are listed in Table 13, with their capacities shown in Figure 16. Not every generation background has been used for all the three study years. Note the contracted generation has been studied as a single year, with an assumption of all contracted generation being connected under that scenario (hence the capacity represented in Figure 16 remains flat).

Table 13 Generation background scenarios

Generation Background Name	Description
CNTRCA	Connected and contracted generation background
CNTRCB	CNTRCA plus [redacted] (in application process)
CT	Local Scenario – Consumer Transformation
ST	Local Scenario – System Transformation
LW	Local Scenario – Leading the Way
SP	Local Scenario – Steady Progression

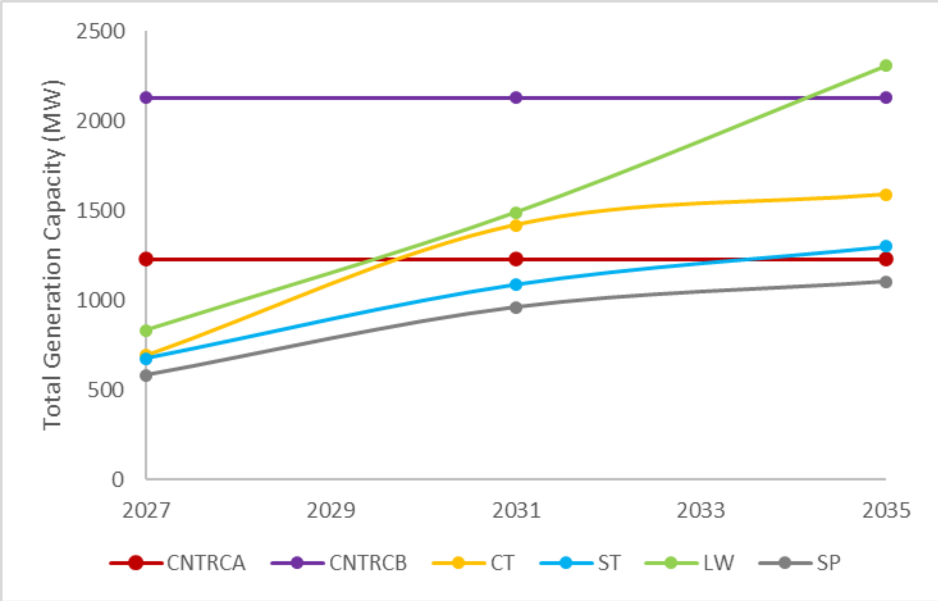

Figure 16 Generation capacities for the different scenarios in 2027, 2031 and 2035

The probabilistic studies are based on modelling hourly time series historic data for generation and demand across the course of a single year. The modelling is based on the year 2013 as this is consistent with the ESO's GB model set up for constraint estimation and CBA. Generation is scaled on an hourly basis in line with historical generation profiles which are modulated by the connected and contracted generation capacities in the area.

Model dispatch assumptions: The sources and derivation of the dispatch data used is explained in the following paragraphs.

Wind power modelling

Working with SPT, we jointly commissioned joint work with the University of Strathclyde to undertake weather reanalysis to create normalised wind generation profiles specific to the location of windfarms on the network. We utilised this output for connected generation and for contracted and scoping wind generation.

Hydro and Pumped Hydro generation

Hydro and Pumped Hydro generation was modelled using generator profiles from historical Final Physical Notification (FPN) data from the Elexon Balancing Mechanism Reporting Service (BMRS) website[42].

Other generation are less significant in the overall profile. However, these have still been modelled as part of the assessment. Solar has been profiled based on a solar irradiance calculation tool on the European Commission Photovoltaic Geographic Information System[43], while generic scaling assumptions were used for battery storage, consistent with assumptions used in the Electricity Ten Year Statement (ETYS).

Transmission circuits and equipment are modelled in accordance with their seasonal ratings throughout the course of the study year. Given the low value of the demand, as explained in chapter 4, it is scaled to a singular value for each season.

[42] https://www.bmreports.com/bmrs/?q=help/about-us
[43] https://re.jrc.ec.europa.eu/pvg_tools/en

The studies model power flows to respect the electrical characteristics of the network including the network topology and connectivity for operational conditions like planned outages considering contingencies in accordance with the criteria of Section 2 of the NETS SQSS. In line with the Connect and Manage criteria, the studies focus on pre-fault and post-fault criteria for the background condition of no local system outage, so only single contingencies are considered. All single circuit fault outages on the Argyll and Kintyre network are considered, covering all the export circuits from this area and internal circuits. Any thermal pre-fault (i.e. intact system) and post-fault loading violations are noted for review at the end of the study.

Control actions - An optimal power flow algorithm was developed to minimise the weighted sum of control actions to bring the power flows to secure levels subject to pre-fault and post-fault network constraints. Before adjusting generator outputs for managing network violations, the algorithm first adjusts network settings to mitigate violations as much as possible. This is because network equipment adjustments are not market options and therefore carry a very low cost since the network assets are regulated and owned by the TO. Overall, the optimisation algorithm uses the following priority order for controls:

1. Phase shifting transformer angle adjustment for active power control
2. Generator active power dispatch
3. Load curtailment (pumped storage is modelled as load when pumping)

Modelling assumptions - Given the locality of Cruachan power station to the local area of study, that specific generator's historic output profile was utilised to model new pumped storage developments that are in the local future energy scenarios. It is noted that the scaling factor for pumped storage hydro schemes is influenced by market behaviour due to the nature of storage associated with this generator type, and future dispatches may differ from historic outputs. For this assessment the historical data has been utilised.

We engaged with the ESO Economics team on the proposed probabilistic power flow analysis, including the scaling of generation. We took on board the ESO's comments on the dispatch of generation as well as the priority order of generation curtailment in resolving thermal constraints subject to specific network characteristics.

The ranking order of generation was discussed with the ESO Economics team. The relative cost of constraining different types of generation is not considered directly within this analysis, with the assessment seeking to minimise the weighted sum of control actions subject to network constraints. We considered how different generation technologies and their relative location on the network could impact the level of constraints. The ESO's feedback led to the consideration of a number of dispatch groups in priority of the ranking order of the generation advised by the ESO. The assessment was undertaken for a set of dispatch groups indicated in Table 14.

Table 14 Dispatch groups for assessment

Dispatch Group	Description
0	None (Unconstrained)
1	Pumped Storage
2	Pumped Storage, Hydro
3	Pumped Storage, Hydro, Onshore Wind

We consider six generation backgrounds for assessment against the options we studied over 3 different years. Not all generation backgrounds were used for all study years. For each year there are 8760 hourly calculations, required for all of the dispatch groups listed in Table 14. This is a significant volume of calculations. Clustering of time periods has been utilised by identifying groups of periods that are similar according to net power injections at locations around the Argyll and Kintyre network. The use of clustering cuts down the number of assessment periods. **This improves the efficiency of studies, reducing the study time for a single option, scenario and year from approximately 24 hours to 4 hours, with a minimal loss of accuracy (~1%).**

We are in the process of registering an NIA[44] innovation project to further develop the probabilistic study approach and tools to help bring this valuable but computationally onerous and time-consuming application into business as usual for connection studies. The key benefit targeted is to enhance the robustness of connection projects, particularly high value connection works where the engineering considerations must be carefully considered. This will complement the information provided by the ESO CBA which is not designed to capture or answer the question of system operability.

The assessment focusses on the local generator connection capacity on the Argyll and Kintyre network, the constraints on the local network and the ability to facilitate competition in the generation and supply of electricity by enabling the connection of local generation. It does not consider assumptions regarding wider system constraints. The ESO's indicated in their feedback that the probabilistic assessment methodology is credible for the study.

6.2.5. Results of the Operability Analysis

The key output of the analysis for each study undertaken (option, scenario, year) was:

- the number of constrained periods during the course of a single operational year, and
- the critical overload observed on a particular circuit prior to undertaking constraint management action.

The analysis also provides the level of constraint management to be taken on the local network to maintain compliance with single fault criteria of the NETS SQSS. By undertaking the local probabilistic analysis through the consideration of a ranking order and differing dispatch groups, the minimum constraint action to relieve the overload in a particular period can be determined.

The full set of results is presented in the "Argyll & Kintyre Local Operability Study Technical Report" which is included in the document list in Appendix F.

As is evident from Figure 16, the contracted generation background falls mainly within the local generation scenario envelope bounded by the Steady Progression and Leading the Way local scenarios. The results for these scenarios are presented in this report for the two key options of interest:

- Option 02 (DDNC2) - the **Creag Dhubh** reinforcement, and

[44] In the RIIO-2 price control, NIA provides limited funding to RIIO network licensees to enable them to take forward innovation projects that have the potential to address consumer vulnerability and/or deliver longer–term financial and environmental benefits for consumers, which they would not otherwise undertake within the price control.

- Option 05 (DDNC1 + DINC + DCUP2), the **Argyll 275kV Strategy**.
- For results of the 03, 04 and 10 configurations which include a third Kintyre – Hunterston cable and why this is not a viable reinforcement option see section 6.2.5.3 below.

6.2.5.1. Results for Steady Progression local scenario

Figure 17 shows the study results for the **Steady Progression local scenario** for the Creag Dhubh reinforcement and the Argyll 275kV Strategy for years 2027, 2031 and 2035 and by month during the year. The top row shows the likelihood of overloads with option 02 (Creag Dhubh) only, measured as average number of hours in a day for each month of the modelled year. The error lines are the 95th percent confidence interval. The bottom row shows the equivalent results for option 05 (Argyll 275kV Strategy).

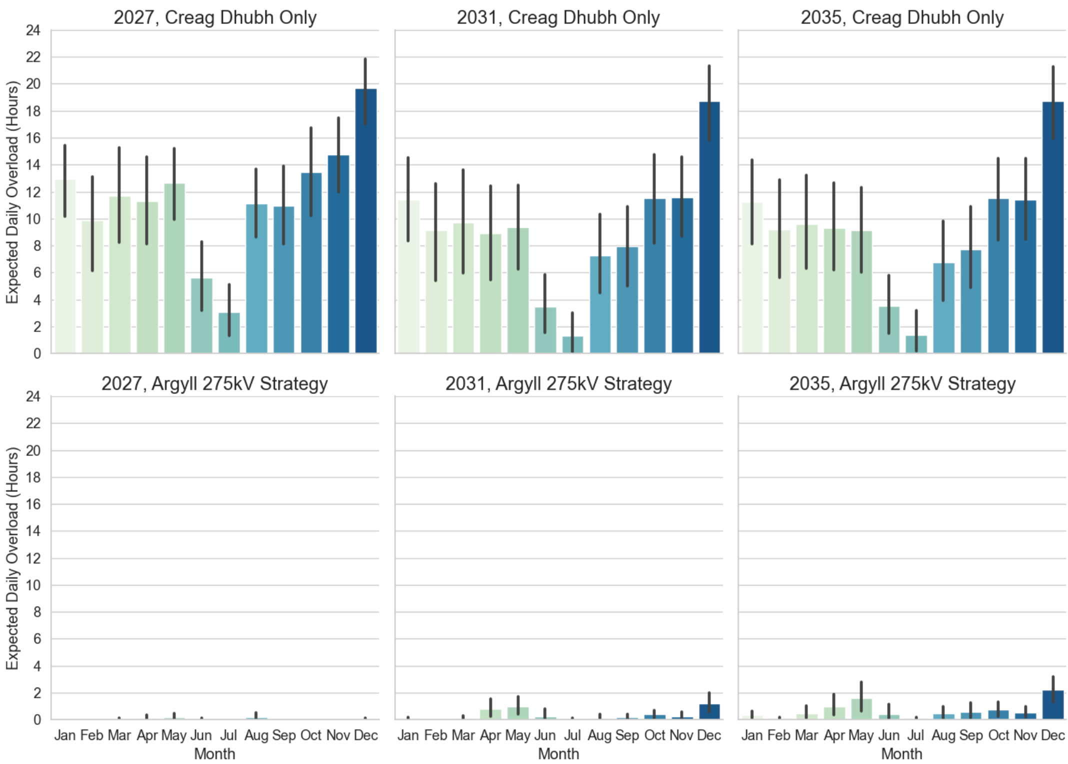

Figure 17 Expected daily hours with overloads under intact and contingency network for Steady Progression (SP)

The results show that, during winter periods, most of the day will require constraint actions under option 02 (Creag Dhubh). Constraint actions remain significant in all months other than the peak summer (June and July). Constraint actions are significantly reduced under option 05 (Argyll 275kV Strategy) in each of the three time periods studied (but particularly pronounced in 2027).

This first output identifies significant results which inform which reinforcement options results in an operable system.

- **The network is constrained for an average of 18 hours per day during winter (December) for the Creag Dhubh option across all years.**

- **The Argyll and Kintyre 275kV Strategy has very few constrained periods in 2027, but that starts to slowly increase in later years particularly in December. This points to the continued need for future network reinforcement.**

- **These results indicate an inoperable network with only the Creag Dhubh reinforcement under the low generation scenario. The network remains operable under the Argyll 275kV Strategy.**

In addition to the likelihood of network violations (the number of hours on average per day per month), we also monitor the severity of loading violations. Figure 18 shows the severity of loading violations for specific circuits over the course of the year both in the intact network and following single fault outages for the same study arrangements as in Figure 17 above.

The results show that there is an increase in loading between 2027, 2031 and 2035.

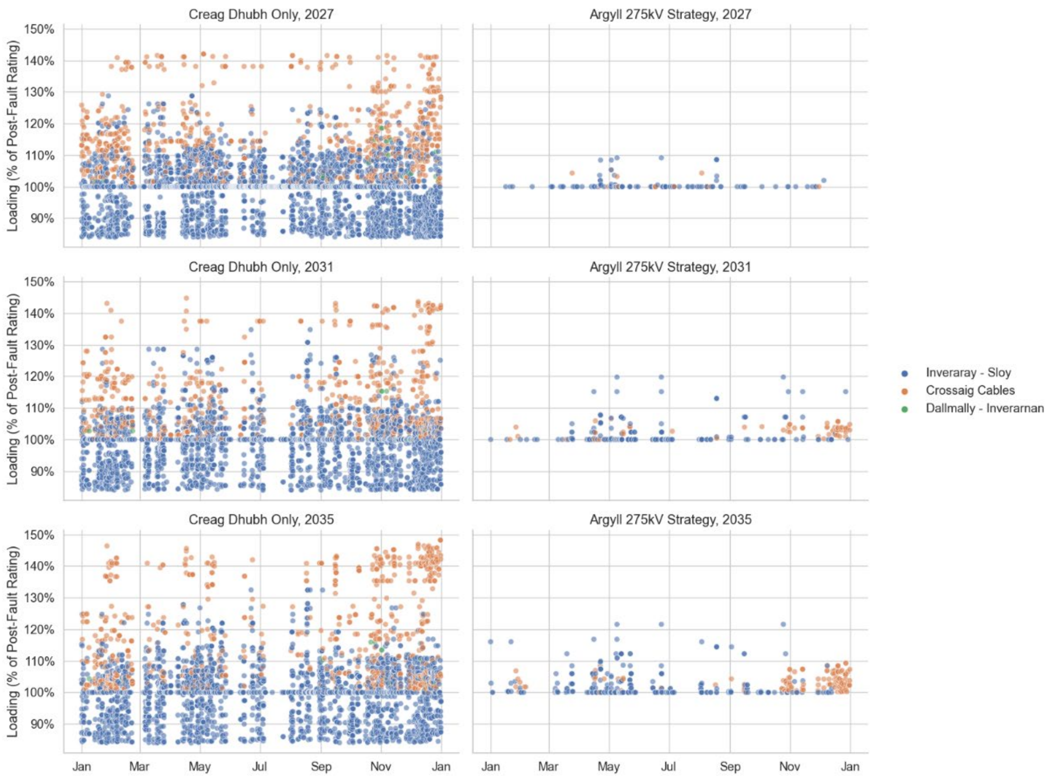

Figure 18 Intact and contingency network violations for Steady Progression (SP)

This second study output identifies significant results which inform which reinforcement options results in an operable system.

- **The results show that with year 1 (2027) generation and only the Creag Dhubh reinforcement, the result is a frequently constrained network and therefore, the growth in generation in later years will mainly increase the energy constrained.**

- **For the Creag Dhubh option, there is continued increase in overloading into future years under both pre- and post-fault conditions due to the growth in onshore wind. Overloads observed with the Argyll 275kV Strategy are significantly infrequent and less severe.**

- **The key limiting circuits where overloads are observed are the Inveraray – Sloy circuits, and the Crossaig – Hunterston subsea cables. This can be as high as 150% loading on the Creagh Dhubh only network in 2035. These levels of overloading are considered to be very high. Significant network management actions would need to be undertaken by the ESO.**

- **These identified levels of overloading will also significantly limit our ability to gain access to the transmission network for asset maintenance purposes.**

- **These results indicate an inoperable network with only the Creag Dhubh reinforcement under the low generation scenario. The network remains operable under the Argyll 275kV Strategy.**

6.2.5.2. Results for Leading the Way local scenario

Figure 19 shows the study results for the **Leading the Way local scenario** for the Creag Dhubh reinforcement and the Argyll 275kV Strategy for years 2027, 2031 and 2035 and by month during the year. The top row shows the likelihood of overloads with option 02 (Creag Dhubh) only, measured as average number of hours in a day for each month of the modelled year. The error lines are the 95th Percent confidence interval. The bottom row shows the equivalent results for option 05 (Argyll 275kV Strategy).

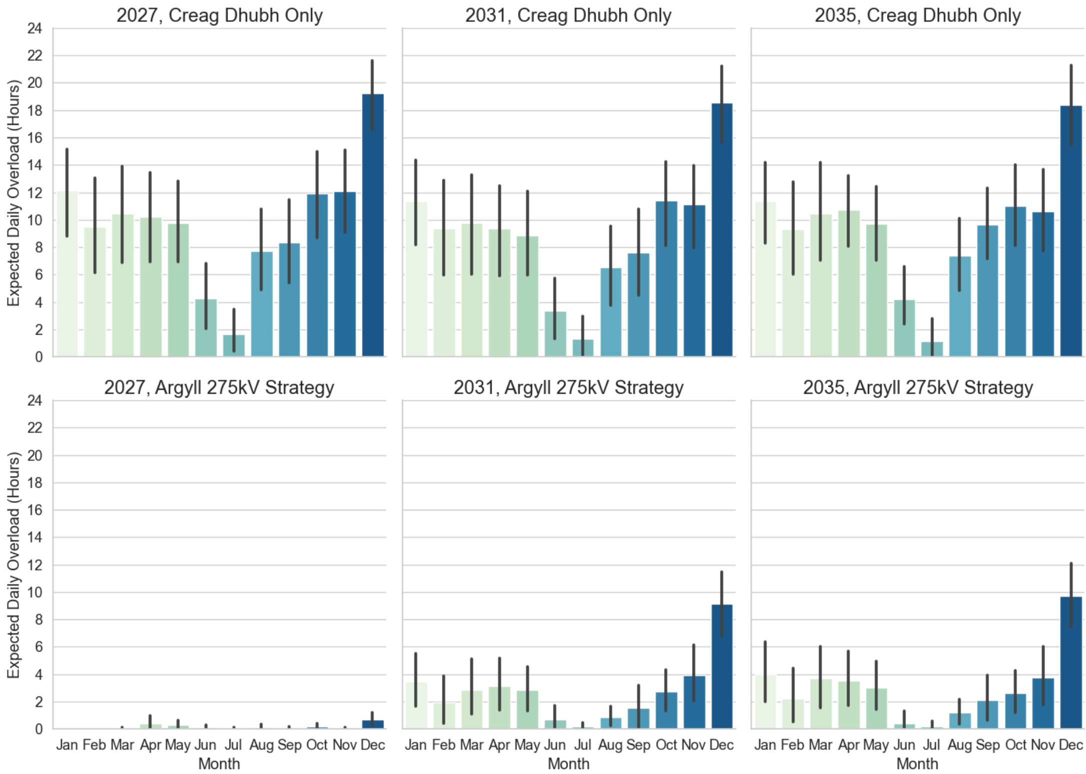

Figure 19 Expected daily hours with overloads under intact and contingency network for the Leading the Way local scenario

As we witnessed in the Steady Progression results, the analysis shows that, during winter periods, most of the day will require constraint actions under option 02 (Creag Dhubh). Constraint actions remain significant in all months other than the peak summer (June and July). Constraint actions are significantly reduced under option 05 (Argyll 275kV Strategy) in each of the three time periods studied (but particularly pronounced in 2027).

This first output under the Leading the Way scenario, identifies significant results which inform which reinforcement options results in an operable system.

- **The network is constrained for an average of 18 hours per day during winter (December) for the Creag Dhubh option across all years. Consistent with the SP scenario.**

- **The Argyll 275kV Strategy has very few constrained periods in 2027, but that starts to increase in later years particularly in winter months. This points to the continued need for future network reinforcement and is consistent with the trend we saw in the SP results.**

- **These results indicate an inoperable network with only the Creag Dhubh reinforcement under the low generation scenario. The network remains operable under the Argyll 275kV Strategy.**

In addition to the likelihood of network violations (the number of hours on average per day per month), we also monitor the severity of loading violations. Figure 20 shows the severity of loading violations for specific circuits over the course of the year both in the intact network and following single fault outages for the same study arrangements as in Figure 19 above.

The results show that there is an increase in loading between 2027, 2031 and 2035.

Figure 20 Intact and contingency network loading violations for the Leading the Way local scenario

This second study output under the Leading the Way scenario identifies significant results which inform which reinforcement options results in an operable system.

- **The results show that there is enough generation in 2027 to result in a frequently constrained network with Creag Dhubh only, and the growth in generation in later years will mainly increase the energy constrained.**

- **For the Creag Dhubh option, there is uniform but significant increase in overloading between the years. For the Argyll 275kV Strategy, there is a step change in the loading between 2027 and 2031 which is due to the growth in onshore wind during in that period.**

- **The key limiting circuits where overloads are observed are the Inveraray – Sloy circuits, and the Crossaig – Hunterston subsea cables. This can be as high as 180% loading on the Creagh Dhubh only network in 2035. These levels of overloading are considered to be very high. Significant management actions would need to be undertaken by the ESO.**

- **These identified levels of overloading will also significantly limit our ability to gain access to the transmission network for asset maintenance purposes.**

- **These results indicate an inoperable network with only the Creag Dhubh reinforcement under the low generation scenario. The network remains operable under the Argyll 275kV Strategy.**

Figure 17, Figure 18, Figure 19 and Figure 20 have shown the likelihood and intensity of network loading violations where they occur under the Steady Progression and Leading the Way generation backgrounds. To give a more complete picture of the violations, Figure 21 shows an estimation of annual constraints for the two main options studied in the Argyll and Kintyre area across the local FES backgrounds for each of the three study years.

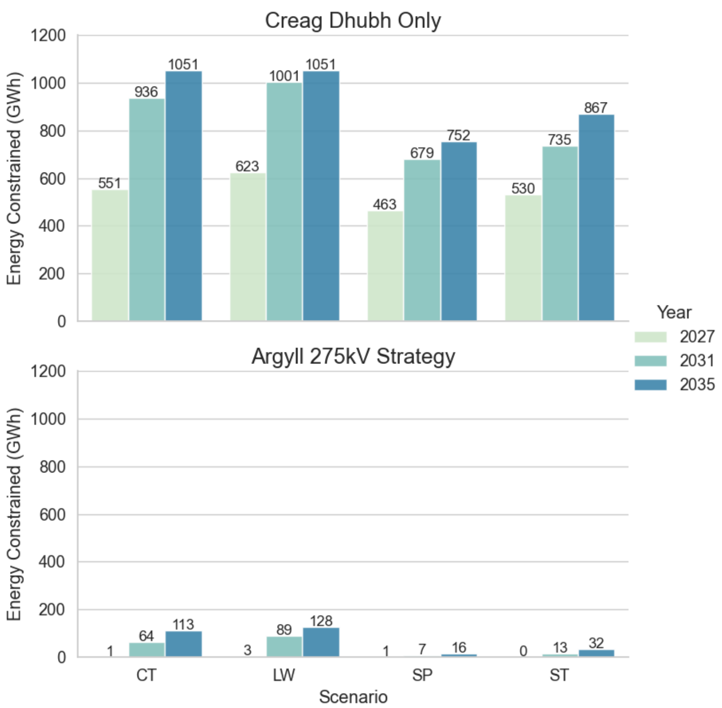

Figure 21 Local constrained energy estimates for Creag Dhubh and Argyll 275kV Strategy options by scenario by study year

These results show:

- **That even in year 1 (2027) progressing with the Creag Dhubh option only will lead to very high constraint volumes. This increases materially by 2031 and 2035.**

- **The bottom graph shows that the minimum enabling works consisting of the Argyll 275kV strategy are effective at reducing the constraints across all the generation backgrounds across all years.**

As shown in Figure 16, the contracted generation capacity sits within the envelope of the Steady Progression and Leading the Way local scenarios between 2031 and 2035.

We have considered system operability (frequency and intensity of overloads) at both the lower and upper generation scenarios and over multiple years. From this we can conclude that the Creag Dhubh only option will not provide sufficient capacity for the contracted background while the Argyll 275kV Strategy will provide sufficient capacity and permit a safe and secure system.

6.2.5.3. Results for the Creag Dhubh + third Kintyre – Hunterston Subsea Cable option

Option 04 – DDNC2 + KHNC (Creag Dhubh + third Kintyre – Hunterston Subsea Cable) was also studied to gain insights into how it performs relative to Option 02 (Creag Dhubh) and 05 (Argyll 275kV strategy).

It is important to note that this option **does not provide enough capacity to meet the contracted generation** but provides more capacity compared to Creag Dhubh only. Limited studies were therefore undertaken for this option.

This option was assessed for Steady Progression in 2031 and Leading the Way in 2035, which bound the local generation scenario envelope. With an EISD of the subsea cable of 2028, this option was not studied in 2027. Figure 22 shows the study results for the Steady Progression 2031 scenario (top row) and for the Leading the Way 2035 scenario (bottom row).

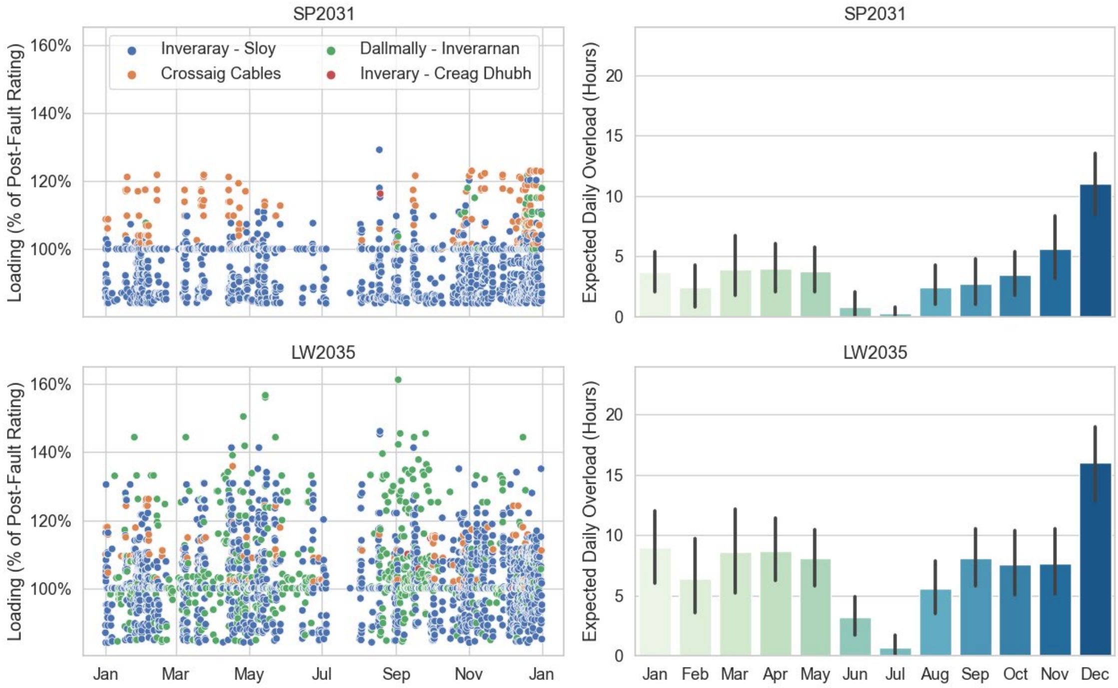

Figure 22 Expected daily hours with overloads, and loading violations under intact and contingency network for the Steady Progression 2031 and Leading the Way 2035 local scenarios

The results show that under the Steady Progression scenario in 2031 there is a significant number of hours of constraint actions daily throughout the year, increasing during winter periods. These are significantly increased across the full year when under the Leading the Way 2035 scenario, particularly in the winter periods.

The results highlight a number of important conclusions which eliminate this option from further consideration.

- **The network is constrained throughout the year, increasing during winter for Steady Progression 2031 with over 10 constrained hours a day on average in December. Constraints are even more prominent across the year for Leading the Way 2035 with over 15 constrained hours a day on average in December.**
- **The scenarios studied for this option sit at both ends of the scenario envelope from 2031 to 2035. Therefore, the other years for these two scenarios studied, and the other two scenarios not studied here, the expected daily hours with overloads would sit between the values shown in Figure 22. This would continue to represent material system overload frequency and intensity.**
- **The key limiting circuits where overloads are observed within the Argyll and Kintyre area are the Inveraray – Sloy circuits and the Crossaig – Hunterston subsea cables. This can reach as high as 120% loading under Steady Progression 2031. The levels of overloading increases under Leading the Way 2035 to over 140% and even up to 160%. A number of overloads are also observed on the Dalmally – Inverarnan circuits under this scenario.**

- **Significant management actions would need to be undertaken by the ESO. These levels of overloading will also make it significantly difficult to us to gain access to the transmission network for asset maintenance purposes.**

- **These results indicate an inoperable network in the near term with only the Creag Dhubh + 220kV Kintyre – Hunterston subsea cable reinforcement under the low generation scenario. The network remains operable under the Argyll 275kV Strategy.**

Overall, this option does not perform well as it does not provide enough capacity to accommodate contracted generation and it also has a late delivery date.

While this option demonstrates system operability issues it also introduces asset stranding under future generation growth and network reinforcement scenarios.

Future need

- As we have seen above, contracted generation and local FES point to the need for continued network investment.

Strategic network development

- It fails to build upon the ongoing strategic network development of the Inveraray to Crossaig OHL which is being constructed at 275kV for initial operation at 132kV.
- Progressing the third Kintyre – Hunterston cable ahead of the 275kV upgrade will not provide the minimum capacity required by current contracted generation.
- Placing subsea reinforcement ahead of onshore will lead to all new contracted generation between north Argyll and Crossaig connecting to the existing 132kV Inveraray to Crossaig OHL. This triggers the need for significant accumulated conversion works and costs in future for 275kV operation. This will not produce any increased network benefit, capacity, but will lead to lost value, wastage and delay through upgrading existing connections.

6.2.6. ESO Review of system operability

The analysis summarised above and contained in the accompanying technical report[45], represents necessary analysis to complement the wider assessment of reinforcement options. We shared all generation background data with the ESO as part of the project along with our methodology, assumptions and study results for their review. The ESO undertook desktop analysis of the generation data and also reviewed our operability results from the probabilistic analysis.

The outcome of the ESO's review covered the following key points:

a) Do Nothing option – not valid option
The ESO confirmed from its analysis that Do Nothing is not a valid option due to the severe level of overloading.

  - With the network intact, there is only enough thermal capacity to export 55% of the generation. Almost half the total generation capacity would need to be managed to ensure no pre-fault overloads.

[45] Argyll & Kintyre Local Operability Study Technical Report – Appendix F

- Further capacity would need to be restricted to manage a single circuit fault or to prevent an overload during a planned outage.

- Following a second outage, the capacity available **would only allow 16% of the generation to run**.

b) Creag Dhubh only option (DDNC1) – significant and material network issues
The ESO's analysis assumed an open point on the Creag Dhubh to Inveraray 132kV line (DDNC1 rather than DDNC2).

- With the network intact, there would only be enough thermal capacity to export 60% of the generation. Almost 40% of the generation capacity would need to be managed to ensure no pre-fault overloads with an intact system.

- Further capacity would need to be restricted to manage a single circuit fault or to prevent an overload during a planned outage.

- Following a second outage, the capacity available **would only allow 28% of the generation to run**.

- The ESO indicated that although there is sufficient volume of generation in the Balancing Mechanism to manage overloads, it would not support this approach as the practicalities of doing so would be concerning, particularly under an intact network.

c) Argyll 275kV Strategy

The ESO supports the Argyll 275kV strategy in the INC. A letter of support from the ESO is provided in the list of documents in Appendix H – "ESO Support Letter Argyll LOTI project.pdf".

ESO has the responsibility to ensure that the network remains operable under all prevailing conditions and is secure for the next event, the worst case from a thermal perspective typically being the next double circuit fault.

- It recognised that the Argyll 275kV strategy reinforcement works are enabling works for multiple connection offers, which from a connect and manage perspective, are necessary works to be delivered prior to a generation connection to ensure the network remains operable.

- Without the delivery of enabling works (Argyll 275kV strategy), the ESO's ability to operate the network in an efficient and co-ordinated way could be jeopardised.

- With further interest from developers in this area, making a higher generation scenario feasible, there is a risk that not proceeding with the works already identified would push back the connection dates for further renewable generation connections.

The ESO acknowledged that the probabilistic assessment we have undertaken is a step further than the traditional deterministic approach adopted as part of the connections study, and has welcomed the additional analysis. The ESO recognises that its high level operability assessment did not provide any insights on how often the worst-case scenarios are likely to occur and what volume of constraint actions could be required.

The ESO's high level assessment and our probabilistic assessment indicate the high possibility of pre-fault overloads which would be challenging for the ESO to manually manage in real time should these be occurring on a frequent basis. Our additional analysis shows that under conservative assumptions pre-fault overloads will be a frequent occurrence. Without the delivery of enabling works, the ESO's ability to operate the network in an efficient and co-ordinated way would be jeopardised

6.2.7. Operability Conclusion

The additional system operability analysis produces a number of key conclusions which are central to the next stage of economic assessment.

- **Do nothing -** As confirmed by the ESO, 'Do nothing' fails to meet design requirements and will result in an inoperable network.

- **Minimum cost option** (02 and 13) **-** The Creag Dhubh reinforcement (02 and 10) fails to provide sufficient capacity for connected and contracted generation and will result in very frequent and increasingly intense system overloads. The practical implications of trying to manage this frequency and volume of constraint action renders this reinforcement option undeliverable.

- **The Creag Dhubh + third 220kV Kintyre – Hunterston subsea link** (03, 04, 10) **-** also displays increasing frequency and volume of network overloads, rendering the solution impractical for system operation. Furthermore, the sequence of reinforcement – 132kV subsea first and a future 275kV Argyll OHL upgrade creates stranded assets of currently contracted, new generator connections and associated infrastructure. As this reinforcement option also does not provide the minimum capacity requirements of the contracted generation future reinforcement is expected.

- **Argyll 275kV strategy** (05 and 06) - the operability analysis confirms that, with small levels of system overloads in later years as generation continues to grow, this solution is technically feasible. **This becomes our 'Do Minimum' option.**

- **Reinforcement options > Argyll 275kV strategy** – all options which provide enhanced system reinforcement over and above the Argyll 275kV are considered operable.

Only reinforcement options which can result in an operable network are considered in detail in the subsequent CBA results.

Scottish & Southern Electricity Networks
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Table 15 Summary of reinforcement options CBA input data

Option	Code	Short Description and *EISD**	System Operability Assessment?	Operability Result
01	Base	Base Network (Counterfactual)	No	Does not meet system requirements
02	DDNC2	Creag Dhubh substation and new 275kV line (*2025*)	Yes – study complete	Failed on frequency and intensity of overload
03	DDNC1+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	Yes – see option 04	Failed on frequency and intensity of overload
04	DDNC2+ KHNC	Creag Dhubh substation and new 275kV line (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	Yes – study complete	Failed on frequency and intensity of overload
05	DDNC1+ DINC+ DCUP2	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh – Inveraray (*2026*) Uprate Creag Dhubh – Crossaig Line to 275kV (I) (*2026*)	Yes – study complete	Viable - consider CBA ranking **Do Minimum option**
06	DDNC1+ DINC+ DCUP1	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh – Inveraray (*2026*) Uprate Creag Dhubh – Crossaig Line to 275kV (R) (*2026*)	Yes – see option 05	Viable - consider CBA ranking **Do Minimum option**
07	DDNC1+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) Two subsea cables Carradale – Kilmarnock South (*2027*)	No – see table 13	
08	DDNC2+ CKNC	Creag Dhubh substation and new 275kV line (*2025*) Two subsea cables Carradale – Kilmarnock South (*2027*)	No – see table 13	
09	DDNC1+ DINC+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh – Inveraray (*2027*) Two subsea cables Carradale – Kilmarnock South (*2027*)	No – see table 13	
10	DDNC1+ DINC+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh – Inveraray (*2027*) 3rd Subsea Cable at Crossaig (*2027*)	Yes – see option 03	Failed on frequency and intensity of overload
11	CKNC	Two subsea cables Carradale – Kilmarnock South (*2027*)	No – see table 13	
12	KHNC	3rd Subsea Cable (Crossaig – Hunterston) (*2027*)	No – see table 13	
13	DDNC1	Creag Dhubh substation and new 275kV line (N/O) (*2025*)	Yes – see option 02	Failed on frequency and intensity of overload
14	DDNC2+ CPFC	Creag Dhubh substation and new 275kV line (*2025*) Power flow control devices in line with Crossaig 220/132kV SGTs (*2025*)	No – see table 13	Fails minimum assessment

**EISD reflects those used in the CBA.*

Key:

- EISD is the earliest in-service date the option could be delivered
- (N/O) on the 'Creag Dhubh substation and new 275kV line' option means that the new Creag Dhubh 132kV busbar is not interconnected to Inveraray
- (I) on the 'Uprate Creag Dhubh - Crossaig Line to 275kV' option means that the network is interconnected at Crossaig, (R) means it is radialised (not interconnected)
- The EISDs for each option have been delayed since the CBA was undertaken. The EISDs in this table reflect the EISDs at the time of undertaking the CBA.

6.3 Testing economic benefits case

Complementing the system operability assessment, and in line with the requirements of the LOTI reopener guidance, we have worked with the ESO to undertake an independent cost benefit analysis[46]. The results of this analysis point to the 'do minimum', the Argyll 275kV Strategy, as the best value, technically operable, reinforcement option. The ESO acknowledges the limitations of the CBA assessment, and that it should not be the main factor in deciding upon the optimal investment option, as noted in Appendix H ESO Support Letter Argyll LOTI project.

We worked with the ESO from early 2021 to prepare the necessary inputs it required to perform its CBA. Summary details of the ESO's CBA including methodology, input data, assumptions, results and our analysis of the results are covered in the following section.

Our system operability results confirm that the 'Do Minimum' option is the Argyll 275kV strategy – all other lower cost or reduced network infrastructure options fail the requirements of NETS SQSS and will not produce an operable, manageable system for the ESO. We have opted to continue to include all original options identified in chapter 5 within the inputs for the CBA and therefore they also appear in the ESO's report. However, inoperable solutions are discounted from further consideration and are shown as such within this section.

The CBA results determine which of the options, discussed in Section 5, produces the highest overall net benefit for the GB energy consumer, but without any calibration for technical viability. Its desktop method involves assessing the potential benefits, in the form of reduced constraint costs, of reinforcement options and compares these against the cost to build and operate these assets. Recognising the limitations created by the parallel technical system studies, the CBA does still provide a ranking of options which can be used to determine an optimum network development pathway, thereby informing the long-term network development strategy.

The ESO undertakes the necessary modelling for the CBA using its electricity market model BID3[47], which it uses to derive constraint costs based upon a given generation scenario and network background. Constraint costs arise where network capacity is insufficient to accommodate power flows arising from market determined generation and demand dispatch. This results in the generation behind the network constraint being curtailed (bid-off) and replacement generation being sourced elsewhere (offer-on) in order to maintain the generation/demand balance. Constraint costs arise from the bid-off and offer-on market balancing actions.

6.3.1. CBA Methodology

[46] Paragraph 4.6, https://www.ofgem.gov.uk/publications/large-onshore-transmission-investments-loti-re-opener-guidance

[47] 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

6.3.1.1. Local Generation Scenarios (Local FES)

These local generation scenarios are based on the most up to date information (as per LOTI guidance) and are built from the FES 2021 scenarios. In order to remain consistent with the wider network capabilities background from the relevant Network Options Assessment, NOA 2020/21, the background for the rest of the network is FES 2020. These scenarios formed the basis for power flow modelling for the Argyll network.

6.3.1.2. Setting up local FES and additional boundaries

The CBA used by the ESO to consider the economic merits of reinforcement option on the GB system has limitations in how it is able to represent the local network. Some of these limitations can be removed through reconfiguration which we have supported the ESO in doing for Argyll. There remain limitations, identified by the ESO, which cannot be accommodated and for which additional analysis – such as the system operability testing – are required.

The ESO employs BID3 for assessing network reinforcements options on the MITS within the Network Options Assessment (NOA) process where it is well proven. Boundary B3b (see Figure 23) is a MITS boundary within the Argyll and Kintyre area. Due to the topological characteristics of this network which require the boundaries to be redrawn for different network reinforcements, the small size of the area relative to the whole GB and all the proposed works being required to facilitate generation connections as minimum enabling works, this boundary has not been assessed by the ESO in the NOA since its inception in 2015.

The CBA approach for this area therefore required a review of the standard NOA methodology to address the reinforcement option dependent boundaries, specific generation capacity forecasts in line with the local FES developed in Section 4 (Need) and how the generation is grouped into new zones to enable the different boundaries to be drawn. As depicted in Figure 23, the area of study for the Argyll sits mainly behind the B3b boundary, with the two Kintyre – Hunterston subsea cables and two circuits at Inverarnan crossing boundary B4[48]. The range of options requires different boundaries to be considered based on how the network is altered by each option, and as such the level of detail needed does not fit within the GB-wide NOA CBA setup.

[48] The B4 boundary is the network ownership boundary between SPT and SSEN Transmission. It is also a MITS boundary which is assessed as part of the annual NOA process.

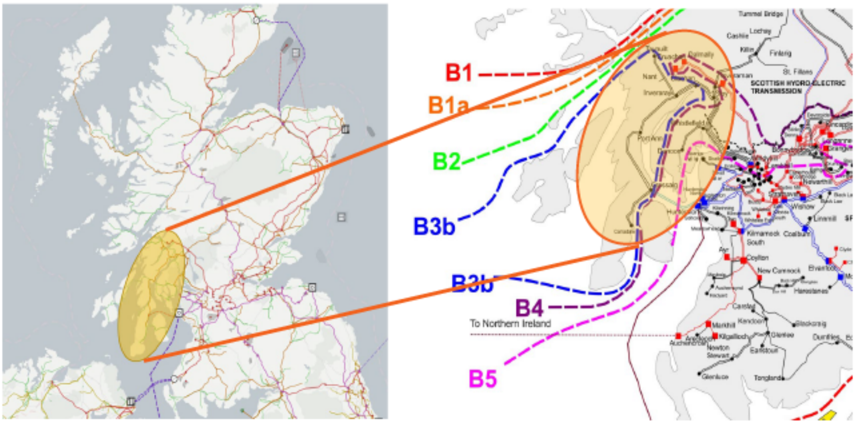

Figure 23 Geographic location of Argyll and Kintyre within Scotland showing MITS boundaries near this area

We supported the ESO in its adaptation of the standard NOA CBA tool to address these specific requirements for the Argyll and Kintyre area. In particular, we supported the ESO to adopt the local generation scenarios, generation rezoning and creation of network boundaries to align with the updated BID3 modelling zones.

Figure 24 shows how BID3 generation Zone X was split into 4 zones (X1, X2, X3 and X4), while Zone O was split to introduce Zone O1. The incorporation of local FES into the local area involved allocating the scenario generation into the updated zones as well as making necessary adjustments in the wider system zone W which sits between MITS boundaries B2 and B4.

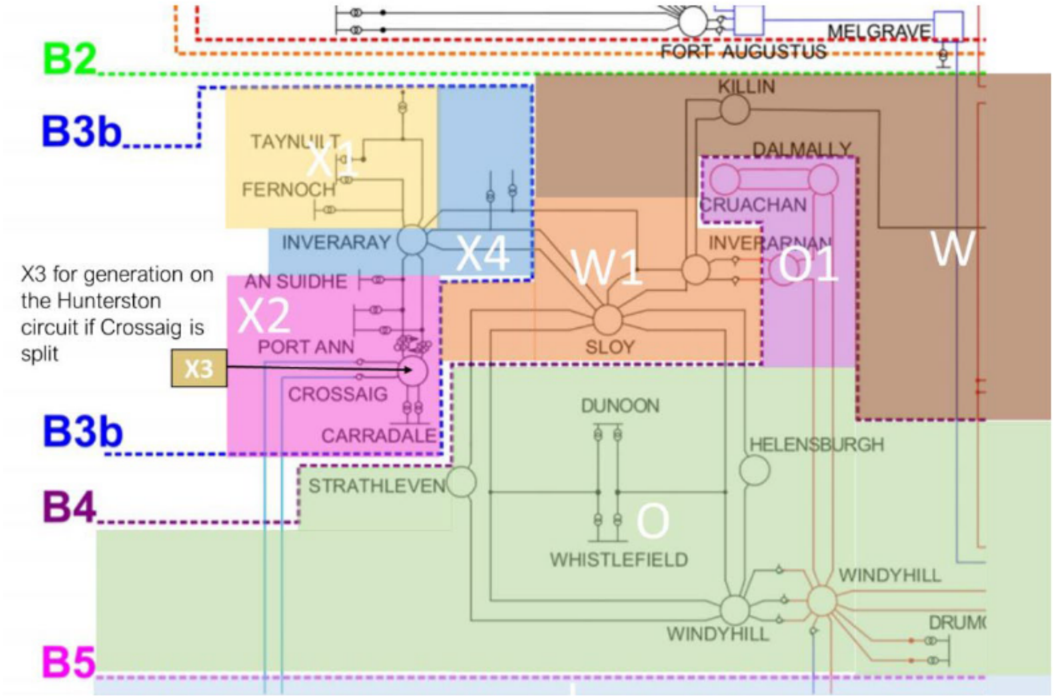

Figure 24 Generation zone splits to allow modelling of the local area in BID3

Splitting the Zones O, W, and X within BID3 enabled the local generation to be mapped correctly and all new boundaries to be set up within the model such that all of the options could be assessed within a single BID3 model setup.

One of the key points acknowledged by the ESO at the outset of the analysis was that the pre-existing network boundaries were not accurate to study local generation variations. This is rooted in the approach used in the BID3 model which requires changes in generation totals in the Argyll and Kintyre area (compared to existing FES20) to be balanced within the wider Zone W capacity. As BID3 is used to model the NOA process at GB level, this macro level consideration must be adapted when considering a smaller local network. While the area studied is largely located in zone X, both zone W and X are essentially treated as one zone in the NOA model since the boundary B3b is not included. By adjusting generation within zone W to maintain overall total generation capacity within Zones W and X, overall generation capacity above the B4 boundary has been kept at a similar level to the FES 2020 background, and hence NOA 2020/21 optimal paths are considered a valid boundary background.

Given that the local FES are higher than ESO 2020 FES for Argyll and Kintyre, this approach ensures that local constraints are assessed without additional wider constraints (to those present in the NOA background) masking the effect of releasing local capability and leading to an underestimate of constraint savings from the options studied. If this adjustment were not made, the total capacity above B4 would be higher compared to what was studied in NOA, the wider boundaries to the south would be more constrained, and this would limit the benefit of releasing Argyll capacity as there would be limited capacity to transfer the power further south without further reinforcements (which this CBA is not considering).

Section 3 of the ESO's CBA report provides details of the CBA model setup, including generation zones as well as the associated new boundaries. We discussed the development of the modified CBA methodology with NGESO and Ofgem, and this was accepted as reasonable, as part of the pre-CBA engagement for this LOTI project.

Limitations of boundary modelling: It is important to highlight the limitations of this revised model. While the more detailed local boundaries have been used in the CBA model, the model does not attempt to capture actual system behaviours based on specific type and location of generators in this area. Nor will it accurately capture the electrical characteristics of the network specific to its connectivity and the combined effect of different dispatch patterns which mean that the location of constraints is dynamic. To more accurately represent these, the more detailed system studies in the preceding section are required.

6.3.1.3. Cost Benefit Analysis Approach

CBA is, in itself, a comparative analysis which is driven by relative values. It looks at which option, out of a selection of options, is the highest performing relative to others; it makes no judgements on the impact of that option implemented in its own right in isolation. While all options have been included in the analysis, not all options can be considered as viable.

The reference point therefore for any CBA must be understood as it acts as a standard against which all other options shall be judged and ultimately ranked. This is referred as the baseline, or 'counterfactual', the network configuration against which options are compared. Depending on the nature of this baseline, the performance of the proposed options may vary and comparatively improve or reduce the economic performance of the network.

For the purposes of this CBA, the counterfactual was taken as the 'do nothing' option, using the current capabilities of the Argyll network, in order to set a baseline to compare the proposed reinforcement options against. However, 'do nothing' as an option may have other impacts and costs not assessed in this analysis, for example the impact on generation connections which are dependent on enabling reinforcements, or system operability implications.

While 'do nothing' has been considered as an option for this CBA, with zero cost and zero improvement to boundary capabilities, we have identified that some level of reinforcement, e.g. for active network management or operational intertrips, to the current network is required to enable renewable generator connections. This would have an associated cost and therefore must be considered when interpreting the results.

The 'do nothing' is therefore an invalid option within the results and only serves to provide a common reference point for other options.

The CBA must be understood therefore as a method by which a set of options are judged relative to the baseline. The tool emphasises the variation, or distance travelled, away from the baseline to the option in question, rather than focusing on the inherent value which each option creates in its own right. Whilst the marginal position of the option is not a trivial matter, its elevation to the dominant consideration in the CBA results in a restricted view of what is happening.

6.3.2. CBA Inputs

6.3.2.1. Local FES

The local FES for the Argyll area as described in Section 4 were used for modelling the local network power flows to allow the calculation of constraint volumes for the different network reinforcement options based on the local network boundary capacities. Scenario data is provided Appendix E Argyll and Kintyre Local FES Report. The local FES are considered up to 2050 and then assumed to flatline until the end of the simulation CBA assessment period which assumes an asset life of 40 years for all the build options considered.

6.3.2.2. Reinforcement options and associated boundary capacity uplifts

The reinforcement options form an input into the CBA as they provide the network capacity uplift based on network boundaries. For each option, the EISD, capital cost (CAPEX) profile, operation and maintenance cost (OPEX) profile, relevant boundary and associated capacity uplift were provided to the ESO. All costs were provided in 2020/21 price base. The scope and costs of the options included SPT elements of the reinforcements in line with our licence obligations to plan and develop a coordinated GB transmission system.

We undertook the studies to determine the boundary capabilities for the different network states representing the different reinforcement options. These studies were based on the assessment criteria of the NETS SQSS Section 4 (MITS criteria). Table 16 shows summary data of the theoretical network options. The cost figures are discounted at the Social Time Preference Rate (STPR) of 3.5% for the first 30 years and 3% thereafter based on the HM Treasury's Green Book.

This table of CBA options is highlighted to capture the results of the system operability testing summarised in the start of this chapter. The CBA results for invalid, inoperable solutions are included for completeness (grey highlight).

Table 16 Summary of reinforcement options CBA input data

Option	Code	Short Description and *EISD**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
01	Base	Base Network (Counterfactual)				[redacted]	[redacted]
02	DDNC2	Creag Dhubh substation and new 275kV line (*2025*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
03	DDNC1+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
04	DDNC2+ KHNC	Creag Dhubh substation and new 275kV line (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
05	DDNC1+ DINC+ DCUP2	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh - Inveraray (*2026*) Uprate Creag Dhubh - Crossaig Line to 275kV (I) (*2026*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
06	DDNC1+ DINC+ DCUP1	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh - Inveraray (*2026*) Uprate Creag Dhubh - Crossaig Line to 275kV (R) (*2026*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
07	DDNC1+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) Two subsea cables Carradale - Kilmarnock South (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
08	DDNC2+ CKNC	Creag Dhubh substation and new 275kV line (*2025*) Two subsea cables Carradale - Kilmarnock South (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
09	DDNC1+ DINC+ CKNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh - Inveraray (*2027*) Two subsea cables Carradale - Kilmarnock South (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
10	DDNC1+ DINC+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh - Inveraray (*2027*) 3rd Subsea Cable at Crossaig (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
11	CKNC	Two subsea cables Carradale - Kilmarnock South (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
12	KHNC	3rd Subsea Cable (Crossaig - Hunterston) (*2027*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
13	DDNC1	Creag Dhubh substation and new 275kV line (N/O) (*2025*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
14	DDNC2+ CPFC	Creag Dhubh substation and new 275kV line (*2025*) Power flow control devices in line with Crossaig 220/132kV SGTs (*2025*)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

*EISDs reflects those used in the CBA.

Key:

- EISD is the earliest in-service date the option could be delivered
- (N/O) on the 'Creag Dhubh substation and new 275kV line' option means that the new Creag Dhubh 132kV busbar is not interconnected to Inveraray
- (I) on the 'Uprate Creag Dhubh - Crossaig Line to 275kV' option means that the network is interconnected at Crossaig, (R) means it is radialised (not interconnected)
- The EISDs for each option have been delayed since the CBA was undertaken. The EISDs in this table reflect the EISDs at the time of undertaking the CBA.

6.3.3. Key Assumptions

6.3.3.1. Network capability

Constraint volumes estimation in BID3 assumes that the seasonal boundary capabilities are a reasonable representation of the network capability over a wide range of generation and demand dispatch conditions. It also assumes that within any area enclosed by a boundary within the Argyll and Kintyre region, there are no internal constraints such as those due to circuit overloading.

While the boundary concept is better at representing network capability on the wider transmission system 'deep' in the MITS, it may not always reliably represent local network characteristics. It was assumed that the introduction of additional local boundaries, at an increased computational burden in BID3, would help mitigate this potential issue.

6.3.3.2. Treatment of subsidies for wind generation

[redacted]

[redacted]

[redacted]

6.3.3.3. Costs and benefits

Costs are defined as reinforcement CAPEX annualised at a weighted average cost of capital (WACC) of 2.82% for SSEN Transmission and 3.22% for SPT plus annual OPEX. Benefits are defined as the constraints relieved relative to the counterfactual (do-minimum investment option in this case). Non-MW constraint based benefits such as the direct carbon reduction from the connection of renewable generation enabled by the reinforcement options, or other operability requirements such as those relating to the ability of connected generation to comply with its licence obligations under the Grid Code are not considered. STPR is applied to both costs and benefits at 3.5% for the first 30 years and 3% thereafter based on the HM Treasury's Green Book.

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[49] The number of hours for which the wholesale price must be negative before the generator ceases to obtain CfD payments for that period of negative pricing

[50] The CfD register is available online at: https://www.lowcarboncontracts.uk/cfds

[51] https://www.gov.uk/government/consultations/contracts-for-difference-cfd-proposed-amendments-to-the-scheme-2020#history

A 40-year asset life was assumed for the reinforcement options assessed in the CBA, with generation scenarios (hence constraint volumes) assumed to flatline beyond the 2040 horizon modelled within BID3.

6.3.4. CBA Results

6.3.4.1. Constraint savings

As noted in the preceding section, system operability, the limitation of the CBA methodology is that it does not have visibility of the local network to model how it would behave under specific loading patters and how it would respond under different outage conditions, as well as the network dependent constraint management actions necessary to operate the system safely. By grouping activity within a boundary, it is underestimating the frequency and volume of system actions required. This is demonstrated by the differential in System Operability constraint volumes and CBA constraint volumes – summarised below in Table 17.

Table 17 System Operability constraint volumes and CBA constraint volumes

		Constraint volumes (MWh in year)			
Year	Analysis	[redacted]	[redacted]	[redacted]	[redacted]
2027	System Operability *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]
	CBA model *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]
2031	System Operability *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]
	CBA model *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]
2035	System Operability *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]
	CBA model *(Creag Dhubh option)*	[redacted]	[redacted]	[redacted]	[redacted]

It is important to note that the CBA model's constraint volumes also assume a level of local generation constraints to manage wider system constraints which means its constraints estimations would be lower compared to a local only equivalent analysis. Notwithstanding this fact, it can be seen from the table above that there is a significant difference between the constraint volume estimates between the CBA and operability calculations. One key finding from our operability analysis is that the assumption that all generation behind a boundary can be treated equally irrespective of its location on the network is not robust for this network due to its topology.

Recognising the CBA limitations, it remains valid to consider that the CBA modelling can tell us about relative option value. BID3 derives future constraint costs in a two-step process. First, it models the future market dispatch based upon whichever plants are most economical to meet demand. Next, it tests the resultant power flows implied by the first step against the capabilities of the system boundary limits. If it finds flows are excessive across any boundary, it finds the lowest cost solution to rebalance the network such that no boundary capabilities are being exceeded. This simulates the actions which would be taken by the ESO using trades in the balancing mechanism to keep boundary flows within their limits.

The sum of these costs is called the Total Balancing Mechanism (TBM) or Total Constraint Cost (TCC) for that run. The difference in TCC as network capabilities are altered (for instance, through the addition of the options in this CBA) allows the ESO to infer the value of constraint alleviation associated with network development options.

Similar to the reinforcement options, the total constraint values are discounted into PV using the STPR approach. The values for the constraint costs are not fixed across generation scenarios; they change depending on the level of generation. The ESO's approach is to find the baseline constraint value and then compare the variation of constraint values from this across the different options. The constraint savings values presented in Table 18 for the four studied generation scenarios. Further analysis and a discussion of the relative values contained in this table can be found in the CBA report, section 5.4 & 5.5.

Table 18 Constraint Savings using BID3 model

		Constraint Savings (£m, 40 Year PV)			
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]
14	DDNC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]

6.3.4.2. Cost Benefit Analysis

The CBA compares the PV of the various reinforcement options CAPEX and OPEX 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). A negative NPV, that is where investment costs exceed the constraint cost savings, implies a net cost to the consumer while a positive NPV implies a net benefit to the consumer based only on the costs and benefits modelled. 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 CBA Report.

To calculate the NPV, the combined CAPEX and OPEX costs (Table 17) are subtracted from the constraint savings (Table 18), all in PV terms. The results are shown below in Table 19.

Table 19 Net Present Value associated with each option under the four scenarios

		Total NPV, Savings (£m)			
Option	Code	[redacted]	[redacted]	[redacted]	[redacted]
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]
14	DDNC2 + CFPC	[redacted]	[redacted]	[redacted]	[redacted]

The values generated from the CBA are then taken to a Least Worst Regret (LWR) analysis. Regrets are calculated as the difference between the NPV of an option and the NPV of the option with the highest NPV in that scenario; a marginal analysis between the 'best' possible option and the option in question. This is a form of risk calculation to understand the relative deviation of an option to the highest performing option in that scenario, in order to find the option which has the 'least worst' regret. This is presented in Table 20 below:

Table 20 Least Worst Regret Analysis

		[redacted]					
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

		[redacted]				[redacted]	
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDNC2 + CFPC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Without the system operability analysis, Option 02 (DDNC2) could be viewed as the least worst regret option. However, as we have demonstrated at the start of this chapter, a range of options would lead to an inoperable network in either the lower or higher generation scenarios (SP or LW). These options are therefore not valid for further development. The revised 'Least Worst' regret table is as follows.

Table 21 Least Worst Regret Analysis – Operability Solutions

		[redacted]				[redacted]	
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5

As we noted above, the significantly higher CAPEX cost of the Crossaig – Kilmarnock subsea link drives the differential in regret compared to the core Argyll 275kV Strategy options (05 and alternative 06).

Regrets are driven largely by the CAPEX values for scenarios CT, SP and ST as these scenarios see similar constraint savings across all options. This is due to options with higher capabilities not being useful in relieving constraints due to the lower generation capacities in these scenarios as determined by the BID3 tool.

6.3.4.3. Sensitivity Analysis

In order to test the robustness of the CBA results, a range of sensitivities were performed. A full discussion of these are given in the ESO's CBA report and a summary of the findings of these tests are provided below. The sensitivities assessed in this section include:

i) Increased generation background

ii) Impact of wider system constraints

iii) +/-20% change in capital costs

iv) +/-40% change in constraint costs

The results of these sensitivities are provided in the form of LWR tables with the most optimal performing option ranked highest.

Increased Generation Sensitivity

The generation data used in the analysis is the core driver of the study as it dictates the necessary network capacity which is required and the resulting constraints which will be produced. The analysis is based on the FES21 generation scenarios as the most up to date information which was to hand. Scenarios however are built on future projections, and these will evolve given the drive towards net zero and a decarbonised electricity system by 2035. Given this reality, it is likely that we will continue to see annual increases in the levels of generation across Scotland given the rich renewable resources, particularly onshore and offshore wind[52]. Therefore, when looking to make an investment decision for the long-term, we are required stress test the upper bound of generation which may connect to the network.

[redacted]

Testing the LW+ scenario changes the performance of the options in the CBA analysis. Increasing the generation causes greater levels of constraints on the boundaries and therefore any reinforcements to relieve this become more valuable. This effect is seen even without considering the expected materially higher local constraints demonstrated in the system operability studies. Table 22 presents the changes in the LWR analysis under this LW+ scenario.

Table 22: LWR Analysis, including the LW+ sensitivity

		[redacted]					[redacted]	
Option	**Code**	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		**Rank**
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDNC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Under the LW+ scenario, the most economic and least worst regret option remains 05, DDNC1+DINC+DCUP2. These also remain aligned to the minimum enabling works required to connect the identified generation in the Argyll network.

[52] Particularly reinforced by recent announcements of seabed leasing from Crown Estates Scotland in January 2022.

Reduced Wider Constraints Sensitivity

Power flow modelling is a complex exercise and is dependent on the ability to understand how to balance power requirements across the GB network. Given the interconnected nature of the network, increased power flows from one region can impact the performance of other areas on the system. To manage this situation, network boundaries are established and set at capacity limits to ensure the safe flow of power across regions and to prevent system overload. The levels of power under consideration in the Argyll region can therefore have impacts well beyond the boundaries in the immediate vicinity.

The modelling undertaken by BID3 optimises the entire GB network and in doing so takes actions to reduce power flows across multiple boundaries at once. A bid action taken in Argyll and Kintyre for instance could reduce flows on the local boundaries studied in this CBA as well as B4, B5, B6, and further south, depending on where the corresponding offer action was taken. In this way one action can solve constraints in multiple places.

An issue that was therefore discussed in approaching the analysis was the nested boundary effect. If the wider network beyond the Argyll boundaries remains heavily constrained, the savings realised by relieving constraints in Argyll may be countered by higher constraints appearing elsewhere on the network. The ESO’s method of modelling the network is based on the NOA methodology, considering reinforcements for the wider network and the respective future boundary capabilities. The NOA approach however only considers future boundary capacities until 2031, a fraction of the period over which the Argyll assets will be operational for. With this, it is possible that in future years beyond 2031, the wider network beyond Argyll will be less constrained due to reinforcements and hence significantly reduce the nested boundary issue.

To investigate the issue of nested boundaries, 1,000MW was added to the boundaries B4, B5, B6, B7a and B8 to simulate a much lower constrained network. Given that the direction of power flow is predominately north to south, these boundaries were selected as the network can experience constraints on boundaries as it travels south. Increasing this capacity therefore reduces the wider network constraints and tests if the issue of nested boundaries has a material effect on the results. This sensitivity was only applied to the options 02, 03, 04 and 05.

[redacted]

Capital Cost Sensitivity

The impact of changes to the CAPEX of each option was also tested to assess the robustness of the results. In order to represents reasonable levels of cost risks during the project, CAPEX was modelled at both an increase and decrease of 20%. With the testing of both an increase and decrease in capital costs, there is no change in the option of LWR; both of these tests indicate the option 05 as the option ranked highest. The results are presented in Table 23 and Table 24 below.

Table 23 LWR Results for -20% CAPEX Sensitivity

			[redacted]			[redacted]	
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDNC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Under the -20% sensitivity, option 05 remains to the highest performing option.

Table 24 LWR Results for +20% CAPEX sensitivity

			[redacted]			[redacted]	
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDNC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Under this sensitivity, option 05 remains to the highest performing option.

Constraint Cost Sensitivity

In the analysis, constrained energy avoided is deemed as the benefit created by reinforcement. This is a core driver of the model and the volumes of constrained energy, and the respective costs associated, represent costs which the consumer bears. To define benefit in the CBA, the volumes of constrained energy must be converted into constraint costs and these are built up from the various costs of 'bidding off' and 'offering on' different generation sources. This sensitivity varies the overall assumption of these costs, increasing/decreasing them by 40% in order to reflect the volatile nature of wholesale electricity prices. With the testing of both an increase and decrease in constraint costs, there is no change in the option of LWR; both of these tests indicate the option 05 as the option ranked highest. The results are presented in Table 25 and Table 26 below.

Table 25 LWR analysis for the -40% constraint savings scenario

		[redacted]				[redacted]	
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]		Rank
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDN CONC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Under this sensitivity, option 05 remains to the highest performing option.

Table 26 LWR analysis for the +40% constraint savings scenario

		[redacted]					
Option No.	Code	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Rank
01	(Do Nothing)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
02	DDNC2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
03	DDNC1+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
04	DDNC2+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
05	DDNC1+DINC+DCUP2	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1
06	DDNC1+DINC+DCUP1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	2
07	DDNC1+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	4
08	DDNC2+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	3
09	DDNC1+DINC+CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	5
10	DDNC1+DINC+KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
11	CKNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
12	KHNC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
13	DDNC1	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
14	DDNC2 + CPFC	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Under this sensitivity, option 05 remains to the highest performing option.

6.4 Options analysis conclusion

CBA is a tool which is designed to assess the relative performance of a selection of possible options. A CBA starts by taking the respective costs and benefits of these options and predicts them over the lifetime of the project. Ultimately, it is possible to represent relative risk of regret through the least worst regret methodology, a quasi-risk calculation which looks at option performance against the best-case scenario.

The conclusion of these steps is a recommendation as to the option which will create the highest overall benefit to the GB consumer with the lowest risk of deviation. This is an important step to help decision makers understand the relative performance of possible investment options, with the purpose of recommending an option to take forward into full development and implementation.

This conclusion however is selected on the basis of least cost to the GB consumer, from the perspective of network constraint relief versus CAPEX. These are undoubtedly very important considerations in any transmission investment case, but of course do not represent the totality of costs and benefits experience by the GB consumer.

The ESO cites that whilst the recommendation of the CBA provides the economic case for investment in terms of constraint cost relief; “there may be other drivers outside the scope of this analysis that when considered together with this analysis support different conclusions”. Examples of such being net zero enabling, carbon displacement, SQSS compliance and system operability, and local community preferences. These issues carry a great deal of significance in decision making and the exclusion of these distorts the true picture of what is required for the long term in the Argyll region. The analysis performed above draws conclusions which should be respected for the purpose for which it has been intended; to identify the solution which provides the greatest constraint relief for the lowest cost.

It is these additional drivers which are outside the scope of the CBA analysis which we have included in this chapter. We summarised the results of our system operability analysis at the start of this chapter. This considers the ability of the network to operate under different generation scenarios and over time. This has produced clear minimum investment requirements, identifying that the 'do minimum' option is the Argyll 275kV Strategy (option 05). It is with this knowledge that we are then able to consider the results of the ESO's CBA on a relative ranking basis.

Options rejected at the operability test stage are as follows.

Option	Code	Short Description and *EISD**	Operability Result
01	Base	Base Network (Counterfactual)	Does not meet system requirements
02	DDNC2	Creag Dhubh substation and new 275kV line (*2025*)	Failed on frequency and intensity of overload
03	DDNC1+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	Failed on frequency and intensity of overload
04	DDNC2+ KHNC	Creag Dhubh substation and new 275kV line (*2025*) 3rd Subsea Cable at Crossaig (*2027*)	Failed on frequency and intensity of overload
10	DDNC1+ DINC+ KHNC	Creag Dhubh substation and new 275kV line (N/O) (*2025*) New 275kV line Creag Dhubh – Inveraray (*2027*) 3rd Subsea Cable at Crossaig (*2027*)	Failed on frequency and intensity of overload
11	CKNC	Two subsea cables Carradale - Kilmarnock South (*2027*)	Failed on frequency and intensity of overload
12	KHNC	3rd Subsea Cable (Crossaig – Hunterston) (*2027*)	Failed on frequency and intensity of overload
13	DDNC1	Creag Dhubh substation and new 275kV line (N/O) (*2025*)	Failed on frequency and intensity of overload
14	DDNC2+ CPFC	Creag Dhubh substation and new 275kV line (*2025*) Power flow control devices in line with Crossaig 220/132kV SGTs (*2025*)	Failed on frequency and intensity of overload

*EISD reflects those used in the CBA.

The 'do minimum' and therefore, preferred option, becomes option 05, DDNC1+DINC+DCUP2. This option recommends the creation of the assets as described in Option 02, as well as a new 275kV OHL between Creag Dhubh and Inveraray, an uprating of the existing OHL between Creag Dhubh and Crossaig to 275kV to interconnect the circuits, and carrying out necessary works across the associated substations to enable this (full details provide in chapter 7).

7. Proposed Reinforcement Option

7.1 Overview of proposed option

7.1.1. Scope

Following a review of the outputs of the ESO's CBA, the local probabilistic studies, consideration of the identified generation activity, pathway to Net Zero and our obligations to maintain a safe and secure network, our preferred solution for the Strategy consists of the upgrade of the existing network to 275kV operation from Crossaig in the South to a connection point located to the east of the village of Dalmally on the SPT Dalmally – Windyhill 275kV OHL. This will form a reinforced transmission network in Argyll, providing significant benefits to the GB consumer, supporting the transition to a low-carbon economy by enabling the connection of low carbon generation and provide benefits to the local economy. It consists of five key elements:

- Establishing a new 275/132kV substation at Creag Dhubh to enable connection to SPT's Dalmally-Windyhill 275kV OHL circuits. These are to be connected by c. 14km of new 275kV Double Circuit OHL. This element is to be delivered for April 2026.
- c.10km of new 275kV Double Circuit OHL between Creag Dhubh and a tee point on the existing Inveraray-Crossaig circuits to enable 275kV operation of this section. This element is to be delivered for April 2027.
- Construction of replacement An Suidhe and Crarae substations to enable them to maintain connection to the new 275kV network. This element is to be delivered for April 2027*.
- Establishing a new 275kV substation at Craig Murrail and relocation of the Port Ann GSP to this site. This element is to be delivered for April 2027*.
- Establishing a new 275/132kV substation in the vicinity of the existing Crossaig Substation. This element is to be delivered for April 2027*.

The above scheme has a number of staged energisation dates commencing in April 2026 with the final output achieved in April 2027. The dates for energisation have been determined utilising our extensive experience in the development and delivery of transmission infrastructure, with timescales benchmarked against those actually incurred on comparable projects.

We energised the new OHL between Inveraray and Port Ann in July 2021. The Port Ann – Crossaig OHL rebuild is currently in construction and will energise in Summer 2023 Therefore project information from the immediate vicinity is available and allows the application of local knowledge to the programme. The energisation dates are also influenced by looking to deliver to, or as close to, the requested dates from the Developers whose generation triggers the requirement for the reinforcement.

It should be noted the above dates provided for energisation differ from those provided in the CBA undertaken in 2021. This is due to the requirement for extensive additional studies to be undertaken to understand the outputs of the CBA which have ultimately delayed the submission of this INC. As a result the April 2025 completion previously noted for the Creag Dhubh Substation and the OHL to SPT's Dalmally-Windyhill 275kV OHL has been delayed to April 2026. The October 2026 date for completion of the wider scheme has now been delayed until April 2027. Due to the Creag Dhubh Substation not being available until April 2026 to commence the energisation sequence this does not allow the required time to achieve 275kV operation based on an October 2026 date.

In addition to the our works, SPT are to undertake works to reinforce their network in line with the relevant Transmission Owner Reinforcement Instruction to allow connection of the above works. These comprise of the following:

- Construction of a new tower on the existing Dalmally-Windyhill 275kV OHL to allow the connection of the new 275kV OHL from Creag Dhubh in a hard tee arrangement for April 2026.

SSEN and SPT have put in place monthly meetings to manage the works required on both their networks and to discuss key interfaces relating to planning, construction, outages and commissioning to ensure these are effectively managed.

The DNO, SHEPD, are currently connected to the existing 132kV network in Argyll to feed the Port Ann GSP. The proposed upgrade to 275kV on the transmission network drives the need for a solution to maintain connectivity to the distribution network in this area. We have engaged with SHEPD to discuss a number of potential options to address this need. These options considered works to reinforce the transmission network from Craig Murrail to Port Ann GSP, or to consider the relocation of the GSP to the new Craig Murrail substation. By working together, we have been able to identify the most cost effective and environmentally beneficial option from a whole system perspective. The result of the work is that the following works are required on the Distribution Network:

- Relocation of the 33kV board and equipment to our new Craig Murrail Substation.
- Construction of a new 33kV underground cable circuit between Craig Murrail and Port Ann to maintain existing connections at this location.

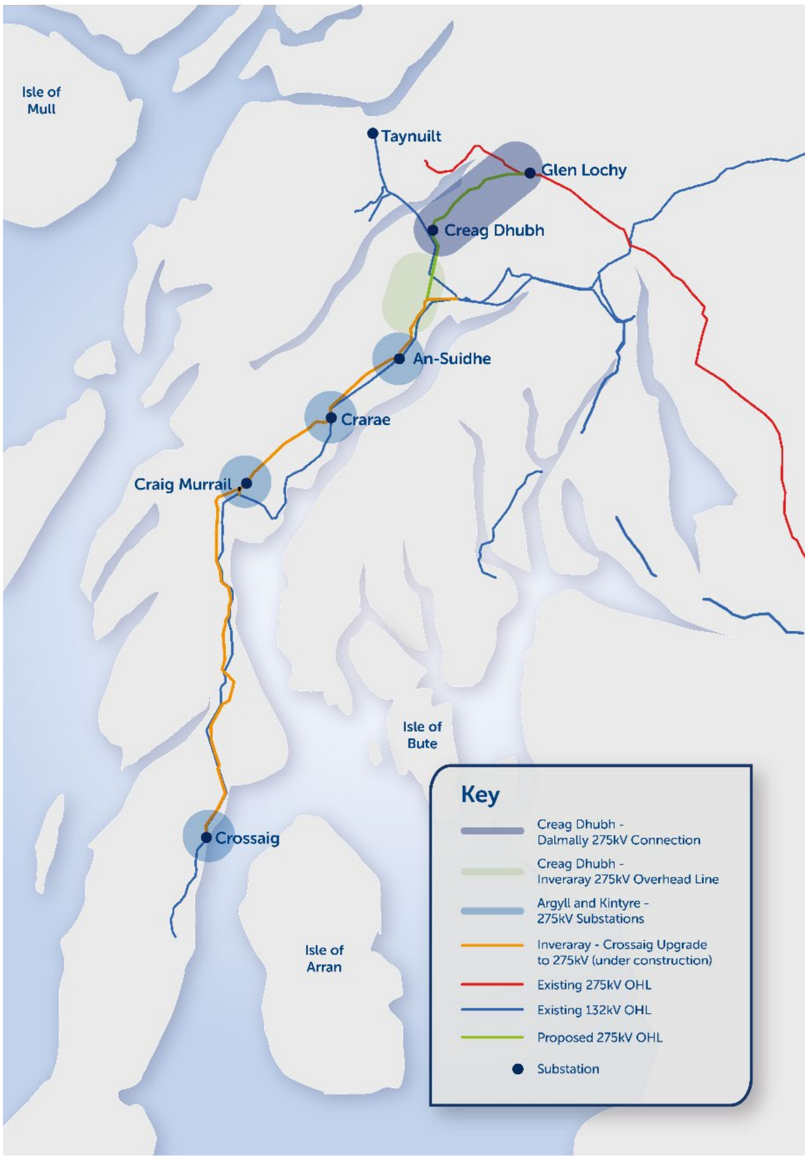


Figure 25 High Level Map of Preferred Option

The above option will form a reinforced transmission network in Argyll, considering the whole system, delivering significant benefits to the GB consumer, supporting both the transition to a low-carbon economy and the local economy. The proposed option also aligns with the feedback we have received through consultation and 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.

7.1.2. Addressing the Needs Case

The preferred option addresses the need set out in Chapter 4 by enabling the connection of low-carbon generation contracted to connect to the Argyll and Kintyre transmission network. This option is compliant with the generation connection criteria of the NETS SQSS for the contracted generation and provides capacity for future generation which has been identified as scoping. The additional analysis undertaken as part of the local probabilistic analysis has demonstrated a clear need for the reinforcement, in order to ensure that the network can be operated safely and securely. We have engaged with the ESO on the additional analysis, who have supported the work we have undertaken.

7.1.3. Strengthening of the transmission network

The preferred reinforcement increases the capacity of the existing transmission network in Argyll and Kintyre by uprating the operating voltage to 275kV and connecting onto the SPT 275kV Dalmally – Windyhill circuit. The rebuild between Inveraray and Creag Dhubh substation replaces an existing 132kV low capacity OHL asset that is 60 years old and provides a more robust network in the area. The proposed reinforcement works between the SHEPD and SSEN Transmission networks at Port Ann and Craig Murrail will also replace an ageing OHL asset, thus providing a strengthening of that local network.

7.2 Contribution to Net Zero Ambitions

The UK and Scottish Governments are committed to transitioning to a low carbon economy and the realisation of these strategies depends on the immediate deployment of new renewable generation assets. This commitment also considers the need to for large transmission infrastructure projects, such as the Argyll and Kintyre Reinforcement Scheme, to be designed with the construction of current and future renewable generation projects in mind. For the Argyll and Kintyre Reinforcement Scheme this approach will facilitate current and future developers gaining access to the transmission network, increasing the chances of progression of renewable energy schemes in the area.

7.3 Supply Chain

As part of project planning at SSEN Transmission, resourcing is continually reviewed to ensure internal resourcing is at a sufficient level to deliver programmes to the expected timescales. Additionally, SSEN Transmission regularly brief the supply chain on the pipeline of expected projects to allow adequate resourcing to be in place to support our works in conjunction with the other commitments of our Supply Chain. SSEN Transmission has a diverse supply chain with multiple approved suppliers to provide support, meaning SSEN Transmission is not solely reliant on one supplier and can accommodate having elements of the supply chain being resourced on other projects. With regards to the Supply Chain, in terms of the Proposed Reinforcement Option there are no significant concerns over delivery of this work at this stage.

SSEN Transmission is currently monitoring the ongoing situation regarding the supply of materials to construction sites and considering how to mitigate this if required. At this stage SSEN Transmission has not identified exact material requirements but as this develops consideration will be given to addressing this risk if still prevalent.

7.4 Wider Benefits of the Scheme

In terms of wider benefits this option brings forward it is considered it will have a positive effect on the local economy of Argyll and Kintyre. Whilst this is yet to be quantified the proposed works will require materials to be sourced for its construction and where possible local quarries and borrow pits, construction material merchants and sub-contractors will be utilised, bringing income to local suppliers.

Additionally, the works will require operatives to be sourced both locally and externally to Argyll, both during the construction and operational phases. The construction phase workforce will be transient and in place for the period in which the works are being built but will provide direct employment for those in Argyll. Operatives who are external to Argyll will bring income to local accommodation, dining and shopping businesses, as well as out of hours activities such as gyms and sporting facilities. During the operational phase there are less positions required but these will be on a permanent basis, with opportunities for those living in Argyll.

Delivering the works also supports wider employment opportunities within Argyll by facilitating the connection of both the contracted renewable generation schemes currently providing the main driver for the works and for those schemes currently scoping and looking to build out within the coming years. Engagement with the wider Developer community has indicated there is potential for significant further increases in the generation background in Argyll. Having the capacity within the network to support these connections facilitates their construction and operation, creating the potential for job creation in Argyll and in wider areas again through the Construction and Operational phases.

As part of our RIIO-T2 Business Plan commitments, we aim to achieve no net loss of biodiversity on all of our projects consented from 2020 and net gain on projects consented from 2025. For the Argyll and Kintyre Reinforcement Scheme we will deliver, as a minimum, no net loss biodiversity with an ambition where possible to deliver a net gain. In addition, we will ensure there is no net woodland loss as a result of our works and will look to maximise replacement planting with native species where possible. For example, we are currently developing a collaboration with the Argyll and Isles Coast and Countryside Trust to support the rejuvenation of the native Argyll rainforest.

Considering wider socio-economic benefits, the works will support the connection of renewable energy to the Transmission Network and contribute towards Net Zero and Scottish and UK Government Carbon Reduction targets. The works will help address decarbonisation throughout the UK, benefitting all consumers. Additionally, providing the Argyll and Kintyre Reinforcement Scheme will assist with resolving constraints on the network in this area which would otherwise have to be paid for ultimately by the end consumer, further benefitting consumers in Argyll.

7.5 Stakeholder Engagement

The Stakeholder Engagement undertaken on this scheme to date is set out in Chapter 3 with the manner in which it has taken into account the feedback of key stakeholders and how this option ultimately balances the requirements of all stakeholders as much as is practicable presented.

7.6 Configuration and Design of the proposed option

As noted above, the proposed option will allow 275kV operation from a connection to SPT's Dalmally-Windyhill 275kV OHL southwards to Crossaig. To facilitate the upgrade to 275kV and to manage the required Customer Connections, a series of new substations and sections of OHL are being established along the route.

7.6.1. Creag Dhubh 275/132kV Substation and new 275kV OHLs

Creag Dhubh is a new 275/132kV Gas Insulated Switchgear (GIS) substation required to connect onto the existing 132kV OHL between Inveraray and Taynuilt.

It will also connect to the existing Dalmally to Inverarnan 275kV OHL owned and operated by SPT through a new 13.5 km OHL consisting of 48no. L8 towers via a hard tee arrangement, in which the new OHL will connect directly into the existing OHL via a new junction tower. The OHL has been consulted upon during its development, including the proposed alignment. The alignment has been developed to avoid impacts on designated areas where practicable and to reduce the visual impact on the surrounding area which had been highlighted in initial consultations on this element.

The junction tower will be the responsibility of SPT to consent and construct, with this being installed prior to the commissioning and energisation works of the OHL from Creag Dhubh. This arrangement has been arrived at through engagement between SSEN Transmission and SPT and is underpinned by the Transmission Owner Reinforcement Instruction setting out the works to be completed by either party. Engagement with SPT will continue through the detailed design and construction phase to agree the exact sequence of outages required to install the new OHL and to manage the interfaces between the two parties and their Contractors.

Creag Dhubh Substation will consist of a double 275kV GIS busbar including two OHL bays, a double 132kV busbar GIS including up to four OHL bays, and a super grid transformer (SGT) bay. Solutions for the GIS will utilise alternative insulating gases to Sulphur Hexafluoride (SF_6) where technology permits this.

In addition, from Creag Dhubh a new 275kV OHL of 8km length using L8 Towers will be constructed down to a tee point on the Inveraray – Crossaig OHL. This will result in the removal of the existing 132kV OHL between Taynuilt and Inveraray from this tee point back to the Creag Dhubh Substation.

A summary of Consultation undertaken on this element of the project is set out in Chapter 3, with engagement with Statutory and wider Consultees undertaken.

7.6.2. Craig Murrail 275kV Substation

Craig Murrail is a 275kV Substation to be constructed on the alignment of the existing Inveraray – Crossaig OHL. It will consist of a 275kV GIS double busbar with provision for 4 no. OHL connections. Solutions for the GIS will utilise alternative insulating gases to SF_6 where technology permits this. 275/33kV grid transformers to facilitate the connection to Port Ann GSP will be provided. As part of the recent works to construct the Inveraray – Crossaig OHL, space provision has been made between two towers, with appropriate terminal towers installed, to accommodate the Craig Murrail site.

To date, the project has consulted upon the proposed site location with no significant feedback or concerns raised on this.

7.6.3. An Suidhe 275/33kV Substation

The existing An Suidhe Substation is currently connected to the Inveraray-Crossaig OHL at 132kV. Due to the increase in operational voltage to 275kV, a new An Suidhe Substation is to be constructed consisting of a single 275kV GIS busbar with a 275/33kV grid transformer to maintain connection to the existing wind farm. Solutions for the GIS will utilise alternative insulating gases to SF_6 where technology permits this.

The existing Inveraray – Crossaig OHL will be amended to allow connection into this site as it is not immediately adjacent to the existing OHL.

To date, the project has consulted upon the proposed site location with no significant feedback or concerns raised on this.

7.6.4. Crarae 275/33kV Substation

The existing Crarae Substation is currently connected to the Inveraray-Crossaig OHL at 132kV. Due to the increase in operational voltage to 275kV, a new Crarae Substation is to be constructed consisting of a single 275kV GIS busbar with a 275/33kV grid transformer to maintain connection to the existing wind farm. Solutions for the GIS will utilise alternative insulating gases to SF_6 where technology permits this.

The existing Inveraray – Crossaig OHL, will be amended to allow connection into this site as it is not immediately adjacent to the existing OHL.

To date, the project has consulted upon the proposed site location with no significant feedback or concerns raised on this.

7.6.5. Crossaig 275/132kV Substation

A new 275/132kV Substation is to be constructed in the vicinity of the existing Crossaig Substation. This will consist of a 132kV GIS double busbar with two 275/132kV SGTs. Connections to the existing Crossaig 132kV Substation will be maintained, with this site allowing

275kV operation in full between Crossaig and the connection onto the SPT Dalmally-Windyhill 275kV OHL. Solutions for the GIS will utilise alternative insulating gases to SF_6 where technology permits this.

The existing Inveraray – Crossaig OHL will be amended to allow connection into this site.

To date, the project has consulted upon the proposed site location with no significant feedback or concerns raised on this.

7.7 Costs

The costs associated with the Argyll and Kintyre Reinforcement Scheme at this stage in the project are determined utilising the SSEN Transmission Estimating Templates, a document which is continually refined to reflect known costs incurred on our various Transmission Projects. These are Class 1 cost estimates which were also included in the Eligibility to Apply submission to Ofgem for this project. The costs provided align with those included in the CBA and are classed as having an accuracy of -30%/+40% in line with SSEN Transmission Governance requirements. As the project progresses the Cost Estimates will continue to be refined as the project progresses and further details and increased levels of design are established.

The costs associated with the Proposed Reinforcement Option are as per the below:

Table 27 High Level cost breakdown (2018/19 Price Base)

Cost Breakdown	Cost (£million)
SSEN Project Management	13.9
Regulatory & Consents	12.3
Engineering	11.2
Principal Contractor	277.9
Commissioning	1.4
Project Risk & Insurance	35.1
Total	**351.8**

8. Project Timeline and Delivery Strategy

8.1 Overview of Project Programme and Key Dates

A Project Programme is provided in Appendix I Initial Needs Case Scheme Programme, with the current programme dates scheduled to meet the EISDs which are achievable for this scheme. The works from the current year through to energisation in 2027 are set out in the programme.

The project programme reflects current knowledge available to SSEN Transmission in terms of timescales for activities such as Planning Consents review periods. Construction timescales are based on recent relevant and comparable SSEN Transmission Projects. Activity durations are continually reviewed to ensure they reflect the most accurate programme for the works at any given point.

It should be noted that the EISDs have been reviewed since the submission of the Eligibility to Apply Letter and the CBA. This was due to the requirement for additional studies and engagement to establish the required works for the Argyll Transmission Network.

The overall completion date of October 2026 has been moved to April 2027. Additionally, the previous interim energisation date of April 2025 for the Creag Dhubh Substation and its associated OHL has been moved to April 2026.

8.2 Overview of project delivery strategy and monitoring

8.2.1. Large Capital Projects Framework and Project Lifecycle

There are a number of controls which are put in place within the SSEN Transmission business to ensure projects meet their objectives and remain on track with regards to programme, cost, quality and risk management.

Due to the value and complexity of the projects forming the Argyll 275kV Strategy, the Scheme is subject to the requirements of SSE's Large Capital Projects Governance Framework Manual which is in place to ensure projects are governed, developed, approved and executed in a safe, consistent and effective manner. The internal Framework utilises five project stages charting a project's progress from concept through to operation, with a gated system in place which needs specific requirements to be met prior to a project progressing onto the next stage. Gates are numbered from 0 to 5 and correspond with key points within the project phases where decisions are required to progress the project. The project phases and the associated Gates are set out in Figure 26.

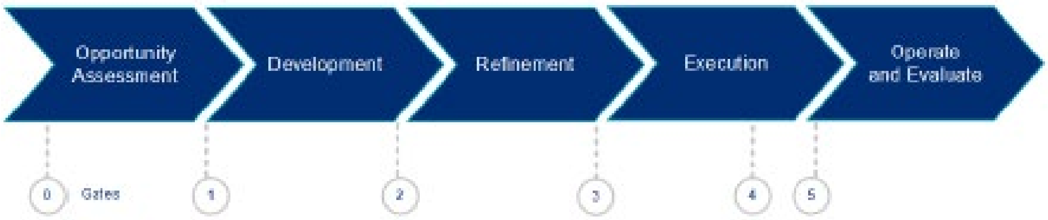


Figure 26 Large Capital Projects Gates and Stages

Opportunity Assessment, Development and Refinement are all Pre-Construction Phases, with Execution and Operate and Evaluate as Construction and Post Construction respectively. Consents must be successfully obtained to allow the project to move from Pre-Construction to Construction. The Argyll Reinforcement is currently in the Development Phase.

The key activities and control measures utilised within each phase that will be undertaken on the scheme in line with the Large Capital Projects Framework are set out in the remainder of this section.

8.2.2. Opportunity Assessment Phase

The Opportunity Phase is the first stage in the Project Lifecycle following the identification of there being a need to undertake works on the Transmission Network. The key output from this stage is to have advanced the project design from a number of potential options to having preferred site locations for substations and preferred routes for OHL's and Underground Cables.

Within the Argyll & Kintyre Reinforcement Scheme all elements have progressed through the Opportunity Assessment Phase. As part of progressing through this phase the following key project activities have been undertaken:

- Identification of suitable corridors for OHL (Tee Point to Creag Dhubh, Creag Dhubh to Inveraray Tee Point). Consultation with Statutory Stakeholders (including the Scottish Environment Protection Agency, NatureScot, Historic Environment Scotland and Argyll and Bute Council) and wider Stakeholders on these corridors.
- Identification of routes for the OHL within the Preferred Corridors and consultation with Statutory Stakeholders and wider Stakeholders on these to identify a preferred route corridor.
- Identification of suitable sites to accommodate the required Substations and consultation with Statutory Stakeholders and wider Stakeholders on these to identify a preferred site location.
- Undertaking of Environmental Surveys, both desktop and site based to inform the above works.
- Undertaking of Engineering Studies on a desktop basis to inform the above works.
- Identification of affected Landowners and initial discussions on required land acquisition.

- Engagement with Generation Developers to understand wider generation plans in the Argyll and Kintyre Region to assist with ensuring the preferred solutions meet future demand.

During this phase, the following key activities have been undertaken under the Large Capital Projects Framework:

- Project Safety Reviews – A review focussing on ensuring that any Health and Safety risks associated with the projects are identified and mitigated adequately. The review checks that where risks cannot be mitigated, these are being recorded in order that they are managed through the project lifecycle. Key items which feed into this review include Hazard Identification Workshops and outputs of internal Principal Designer (PD) works. The role of PD being undertaken by SSEN Transmission in line with the Construction (Design and Management) Regulations 2015.
- Procurement, Insurance and Legal Reviews – This review ensures that risks associated with the Procurement Strategy, Insurance and any Legal issues, such as Land Acquisition which may arise at this early project stage, have been identified and mitigation is considered.
- Design Reviews – This review focusses on the design undertaken to date and considers if it is in line with both specifications and standards as well as the required level of maturity to inform the Substation Site Selection and/or OHL Routeing.
- Gate 1 Check – A review is undertaken by SSEN Transmission Senior Management to ensure the appropriate option is being put forward for further development and to challenge the decision making process undertaken. Additionally, that all required reviews and documentation have been completed and checked by the relevant approvers prior to the projects moving onto the next phase.

8.2.3. Development Phase

The Development Phase takes the identified preferred routes or sites and develops the designs to a stage appropriate for submission of Planning Consents and issue of an Invitation to Tender. These works are supported by undertaking the required environmental studies, landowner negotiations and consultations with stakeholders. Key outputs at the end of this stage are submission of Planning Applications and issue of an Invitation to Tender.

The projects making up the Argyll and Kintyre Reinforcement Scheme are currently all within the Development Phase, within which the following key activities are to be undertaken:

- Development of the Procurement Strategy for the Scheme, for which the overall objective of this element is to deliver value to the end consumer whilst still providing a solution which meets the required uplift in capacity and all requirements of standards and specifications. The details of this are summarised further within this section.
- Development of the substation designs to a point suitable for submission into the Town and Country (Scotland) Consenting Process. During this stage, the design is progressed to a point where it is suitable to accommodate known solutions from SSEN Transmission’s Framework Suppliers, thus not precluding any supplier and maintaining the ability for competition during the Tender of the works.

- Development of the OHL Alignment from the Preferred Route selected during Opportunity Assessment. This work sees the tower positions determined within a limit of deviation for submission into the Section 37 Consenting Process of the Electricity Act (Scotland). During the Development Phase SSEN Transmission have engaged one of our Framework Contractor Partners to assist in the development of the OHL Alignments. This has consisted of developing the tower positions, requirements for angle and suspension towers and undertaking of intrusive ground investigations to confirm suitability of positions and to inform future foundation designs. This support has been undertaken to allow a suitably detailed design for consenting to be produced utilising the Contractor's knowledge of construction of OHL in the region. However, it should be noted the detailed design and construction works will still be subject to a Tender.
- Undertaking of ground investigation for substation sites.
- Undertaking of EIA for the OHL's to inform the Planning Applications. The EIA assesses the impacts of the works on a number of receptors to ensure the works and their operation do not have significant impacts on their surroundings.
- Undertaking of an EA for the substations to inform the Planning Applications.
- Consultation with Statutory and Wider Stakeholders – the developed designs for planning will be consulted upon with SSEN Transmission's wide range of stakeholders, with all comments reviewed and incorporated into the scheme plans where necessary. Each element of the project will be covered within a Consultation, with SSEN Transmission obligations under Planning Regulations for Consultation met as a minimum. Reports on the Consultation output will also be published. To date, full Consultation has been undertaken for all elements bar the OHL from Creag Dhubh to Inveraray.
- Submission of required Planning Applications for substations and OHLs will occur at the end of this Phase. The elements to be submitted to the planning authority and the type of application required are set out in Table 28 below:

Table 28 Required Planning Applications

Project Element	Planning Application Required
Creag Dhubh Substation	Town and Country (Scotland) Planning Application
Creag Dhubh – Dalmally/Windyhill 275kV OHL	Section 37 Application under the Electricity Act
Creag Dhubh – Inveraray Tee 275kV OHL	Section 37 Application under the Electricity Act
Crarae Substation	Town and Country (Scotland) Planning Application
Crarae OHL Diversion	Section 37 Application under the Electricity Act

Project Element	Planning Application Required
An Suidhe Substation	Town and Country (Scotland) Planning Application
An Suidhe OHL Diversion	Section 37 Application under the Electricity Act
Craig Murrail Switching Station	Town and Country (Scotland) Planning Application
Crossaig Substation	Town and Country (Scotland) Planning Application
Crossaig OHL Diversion	Section 37 Application under the Electricity Act

- Further negotiation with affected landowners to secure the required land purchases, wayleaves and servitudes is undertaken during this phase. Necessary Wayleaves and Compulsory Purchase Orders will be submitted where appropriate to secure the necessary rights.
- Issuing of the Invitations to Tender for the various work packages for the scheme. This process will see SSEN Transmission working with the supply chain to agree costs for the detailed design and ultimately construction of the works through competitive tender events.
- Submission of this INC

During this phase, the following key activities in addition to those set out in Opportunity Assessment are undertaken under the Large Capital Projects Framework:

- Project Assurance Review – Led by a Senior Assurance Manager and supported by SSE colleagues external to the project. The project is assessed for its readiness to pass through Gate 2 on a number of categories- including Engineering Design, Environmental and Consents, Procurement, Risk, Safety, Health and Stakeholder Engagement - through a process of interviewing the project team and its key internal stakeholders. The project is required to pass this review in order to be recommended to go forward to its Gate 2 Check.
- Gate 2 Check – A review is undertaken to ensure that all required reviews and documentation have been completed and checked by the relevant approvers prior to the projects moving onto the next phase.

8.2.4. Refinement Phase

The Refinement Phase is the final phase before commencing construction, within which Contractor partners will be appointed to deliver the works during Execution. Detailed designs will be finalised and Planning Consents will be received, with associated conditions discharged. Final agreements with Landowners will be put in place during the project phase. Within the Refinement Phase final checks will be made that the project is ready to undertake construction and is meeting the required outputs.

Within the Refinement Phase, the following key project activities will be undertaken:

- Undertake detailed design for the substation and OHL elements to prepare for construction works commencing on site.
- Once the Planning Application has been submitted, the Preparation and Submission of the FNC to Ofgem, will take place.
- Confirmation of expected detailed construction costs for the project post Gate 3
- Place orders on any long lead items of equipment
- Continue to liaise with the relevant Planning Authorities on the progress of the Planning Applications. During this period Planning Consents should be received and any Pre-Commencement Conditions will be reviewed and discharged to enable works to commence on site.
- Continue engagement with all other affected stakeholders to update on the scheme's progression towards construction.
- Finalise all negotiations with landowners and have all Heads of Term signed.
- Upon receipt of the Planning Consents, discharge the Pre-Commencement conditions required to allow construction works to commence.
- Following approval of the FNC and agreement of the final costs with the Supply Chain, the Project Assessment will be submitted to Ofgem during this period. As shown in the project programme, SSEN Transmission will undertake a competitive tender exercise for the execution phase of the project during 2022. The final design output of the works outlined above will be 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.
- Confirm award of the Construction Contracts and final costs associated with these.

During this phase, the same key activities undertaken during the Development Phase in line with the Large Capital Projects Governance Manual e.g., PAR, PIL, PSR, would be undertaken with a focus on ensuring the project had achieved all elements required to enable a successful execution phase.

8.2.5. Execution

Execution sees the project move onto site and deliver the required works. Within the Execution Phase, the following key project activities will be undertaken:

- Mobilisation of the appointed Contractors to undertake the construction of the works and establish the required infrastructure.
- Commissioning and Energisation of the Works – following construction of the new infrastructure, the SSEN Transmission Commissioning Team will work with the appointed Contractors to commission and ultimately energise the works onto the Transmission Network. This will be done in line with approved outages provided to undertake the necessary amendments to the system.

8.2.6. Lessons Learned

SSEN Transmission currently have active OHL and substation projects within the Argyll Region. The Project Team for this scheme have sought to engage with these projects to gain information on Lessons Learned. Due to the geographic proximity of these projects and the similarity of the scope they are delivering it is considered these projects provide directly relevant learning for this scheme.

In addition, the Project Team have engaged with further projects which, whilst they do not have the geographical similarities as the current works in Argyll, the type of infrastructure in their scope is relevant to this scheme.

The key areas on which Lessons Learned have been discussed include; Stakeholder Engagement, Consenting, Environmental, Engineering, Quality and Programme. A brief summary of key Lessons Learned has been included in Table 29 below:

Table 29: Lessons Learned

Lesson Learned	Learning Applied
Inveraray – Port Ann Reinforcement During the execution phases additional time has been required for the system outages required to undertake the works than originally forecast, resulting in additional requests to the ESO and amendments of programmes to accommodate this additional time.	The required durations have been fed back into the programme reviews for the current Argyll Reinforcement Scheme to ensure sufficient time is allocated into the programmes for the construction and energisation periods. Additionally, Stage by Stage diagrams have been created at an earlier stage in the project to assist with the assessment of these works.
Inveraray – Port Ann Reinforcement The use of piled foundations for the OHL construction was found to be more reliable as this could be undertaken in a wider variety of weather compared to traditional foundation solutions requiring excavations. Additionally, avoidance of digging of excavations removes a Health and Safety hazard from the works.	Foundation types Review the use of piled foundations where practicable and economic to do so for the new OHL required for the Argyll & Kintyre Reinforcement Scheme Ground Investigation to be undertaken at all tower locations to allow an informed review of the foundation design to be undertaken.
Inveraray – Port Ann Reinforcement Management of interfaces was handled via one Contractor across the scope of the OHL and Substation works under this project. This led to improved communication and management of	The scope of the Argyll Reinforcement is larger than this with additional interfaces, provision for managing multiple Contractors in the Refinement and Execution Phase will need to be made within the Argyll Reinforcement to effectively manage the project.

Lesson Learned	Learning Applied
areas including design and health and safety.	As part of the development of the Procurement Strategy and the Project Execution Plan, the interfaces between the packages of work to be tendered are to be identified. During the Refinement and Execution Phases Interface Meetings are to be established to manage all Contractors. As part of the Procurement Strategy, Contractors will be asked to demonstrate efficiencies in awarding more than one package of work to them, including demonstrating efficiencies in interface management.
East Coast 400kV OHL Upgrade Current timescales for the consent of Section 37 Applications via the Energy Consents Unit is circa 12 months.	Argyll Reinforcement Scheme programmes have been updated to reflect this duration for the receipt of the OHL Consents to ensure overall programmes are robust.
Peterhead Substation Project/Kintore Substation Project Current timescales for the construction of Substations based on contracted programmes and actual physical progress on site.	Argyll Reinforcement Scheme programmes have been updated to reflect appropriate durations for the construction of the Substations based on experience from Peterhead and Kintore.
Skye Reinforcement Project The Skye Project successfully undertook a Developer and Generator Engagement Seminar to identify scoping generation in the region to assist with developing realistic scenarios for future generation for inclusion in the Cost Benefit Analysis. This led to a fuller picture of the potential generation background in the region.	The Argyll Reinforcement Scheme undertook a similar engagement with a successful outcome for the Argyll Region, identifying a number of potential generators who were not yet in discussions with SSEN Transmission but were planning to commence these discussions in the near future.

8.3 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.

During the Refinement Phase this Procurement Strategy will be further developed to consider the synergies between each package of work as further design detail is developed, with further information on this strategy to be presented in the FNC.

The standard position will be to undertake a Tender for both Design and Construction works at the same time, with the Design Contract initially awarded and the Construction cost refined through the Design works. An option to progress the Construction Contract with the appointed Design Contractor is available, however if SSEN Transmission view that this is not offering best value there, is an option to undertake a further Tender for the Construction Contract and appoint an alternative Contractor.

The current focus for the Procurement Strategy is to drive value through requesting the Supply Chain to demonstrate value through offering savings across more than one package of work, particularly where there are similarities in the scope, for example within the OHL works.

However, the number of packages of work to be created will consider the current and future resource availability of the supply chain under SSEN Transmission's Frameworks, with a view to ensuring work packages do not result in the Scheme being placed at risk due to a lack of diversity in the Supply Chain.

8.3.1. Supply Chain Contracts

It is currently proposed to procure the required works through SSEN Transmission's Substation Frameworks for all substation works and to utilise the OHL Framework for all OHL works. These frameworks were tendered through a competitive process as part of SSEN Transmission's preparations for the RIIO-T2 Price Control to ensure value for the consumer could be delivered, as such it is considered appropriate to utilise these frameworks for the Argyll and Kintyre Reinforcement Schemes.

The key packages of work to be procured as part of the Argyll Reinforcement Scheme are set out in Table 30 below:

Table 30: Key Packages of Work

No.	Works	Contract Proposal
1	Creag Dhubh Substation Design Contract	NEC3 ECC [redacted]
2	Creag Dhubh Substation Construction Contract	NEC3 ECC [redacted]
3	OHL between Creag Dhubh and SPT Dalmally-Windyhill Design Contract	NEC3 ECC [redacted]
4	OHL between Creag Dhubh and SPT Dalmally-Windyhill Construction Contract	NEC3 ECC [redacted]

No.	Works	Contract Proposal
5	OHL between Creag Dhubh and Inveraray Tee Point Design Contract	NEC3 ECC [redacted]
6	OHL between Creag Dhubh and Inveraray Tee Point Design Contract	NEC3 ECC [redacted]
7	Craig Murrail Substation Design Contract	NEC3 ECC [redacted]
8	Craig Murrail Substation Construction Contract	NEC3 ECC [redacted]
9	An Suidhe and Crarae Substations Design Contract	NEC3 ECC [redacted]
10	An Suidhe and Crarae Substations Construction Contract	NEC3 ECC [redacted]
11	Crossaig Substation Design Contract	NEC3 ECC [redacted]
12	Crossaig Substation Design Contract	NEC3 ECC [redacted]
13	Super Grid Transformer Supply, multiple packages	NEC3 ECC [redacted]
14	Forestry Felling and Replanting Contract	NEC3 ECC [redacted]

The New Engineering Contract 3 (NEC3) suite of contracts will typically be used for all key contracts. This suite of contracts has been used successfully on other large projects delivered by SSEN Transmission. As part of the development of the Procurement Strategy, SSEN Transmission will continue to review the most appropriate form of contract under the NEC3 Engineering and Construction Contract to deliver the works. Additionally, the allocation of risk under the contract will be reviewed to determine the party with which the risk is best allocated to manage and mitigate. This approach will assist with protecting the end consumer from increased costs on the project should a risk occur.

8.3.2. Procurement Milestones

Key procurement milestones are set out in the Table 31 below:

Table 31: Key Procurement Milestones

[redacted]

8.3.3. Project Risk Management

The Argyll Reinforcement project is managing risk in accordance with the LCP Governance Manual and its 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 acts as the repository for all project risks 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 project teams 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. These sessions are also used to identify new and emerging risks (threats and opportunities).

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, the Execution risks, and the risks that cannot be transferred to the Contractor, but which should be ALARP (As Low As Reasonably Practicable) are validated. These will be 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.

Following conclusion of the multi-contract procurement process when there is a better understanding of how risks will be apportioned between SSEN Transmission and our contractors, 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. The risk allocation split will be agreed with the contractors to ensure that each risk sits with the party in the best position to own, mitigate and control that risk in order 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 Argyll 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, Kintore and Peterhead Substation projects. The 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 are organised into sub-registers for OHL, substations 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 Argyll Reinforcement Risk Management Plan, produced as part of the LCP Governance documentation for the project. The LCP Risk Team provides the Project Manager with weekly reports detailing the status of Risks and Actions to highlight which requires attention. The Top five Pre-Construction risks for the project are set out in Table 32.

Table 32: Project Risks and Mitigations

Risk	Proposed Mitigation
Regulatory process The regulatory process has been confirmed with Ofgem but requires flexibility on submission dates to meet key programme deliverables, such as the energisation date	Engage with Ofgem to establish the type and level of detail required to inform a project submission relative to the estimate capital value of the project and to agree where potential concessions can be made to ensure successful delivery to ensure that developer connections can be made. Use learning from similar project submissions undertaken in T1 to inform project

Risk	Proposed Mitigation
	information needed for submissions relative to project development stage
Project Interfaces and Interdependencies Due to the complex scope comprising of multiple new substations and construction of sections of new OHL working to phased energisation dates, there will be project interfaces to manage during the Refinement and Execution phases including the completion of elements of works to allow other projects to progress. Delays to certain elements of the scheme could prevent other elements energising on time.	The Project Team are identifying all project interfaces and interdependencies within the Project Documentation. Requirements for provision of information, completion of works and access to areas are to be captured within the Contracts with associated Key Dates to manage their delivery. Interface meetings will be established throughout the Refinement and Execution Phases to manage the various projects and their works.
Consenting Timescales Due to significant development in the Electricity Generation and Transmission Sectors there are a number of Planning Applications being lodged with the Scottish Government's Energy Consents Unit and Local Councils within Scotland, leading to potentially elongated Consenting timescales which could delay the overall programmes.	The Project Team are liaising with current Development projects with Applications lodged and analysing the timescales associated with recent Consents received. Applications are being subjected to internal and external reviews prior to being submitted, to ensure they are robust and all required information is provided to reduce the risk of delays in the planning process. Project programmes are continually being reviewed to optimise the timings for submissions of Planning Applications.
Public Opposition to new Transmission Schemes A pressure group against further Transmission development has been established in Argyll which presents opposition to any works being taken forward. There is a risk public opposition results in delays to the Consenting Process through items such as a Public Local Inquiry	The Project Team continue to undertake appropriate and transparent consultation with the affected local communities throughout the Development phase to ensure the input of all stakeholders is accounted for in the proposals being put forward for planning and that it can be demonstrated the correct processes have been followed to ensure a robust application.
Presence of Unexploded Ordnance Areas in which the Argyll 275kV Strategy are to be developed were utilised as firing ranges	The Project Team are engaging a specialist Unexploded Ordnance Consultant to assist

Risk	Proposed Mitigation
by the Ministry of Defence during World War II, with numerous unexploded ordnance in the region. Removal and making safe of these areas may add additional time and costs to the Scheme.	with identifying and planning removals of the Unexploded Ordnance where required in line with the current programmes.

8.4 Applicability of Late Competition

We note Ofgem's LOTI guidance[53] states that Ofgem will assess whether a LOTI project, in whole or part, meets the criteria for competition and whether it should be delivered by a late competition model rather than by the incumbent TO. Our response below focuses on relevant project-specific factors rather than overarching policy or finance ability factors that Ofgem may also consider.

Stage 1 assessment – Assessment against criteria for 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; high value (above £100m), new and separable. In the 2020/21 NOA Report[36], the ESO assessed that the North Argyll substation and North Argyll-Craig Murrail 275kV Operation as eligible for competition. We note that it is Ofgem's decision as to whether all three of the criteria has been met.

Stage 2 assessment – Delivery model selection

We note that Ofgem has outlined three possible delivery models that it will consider within it's LOTI guidance. The models proposed by Ofgem are the CATO regime, the Special Purpose Vehicle (SPV) model and the Competition Proxy Model (CPM). We believe all three have unresolved issues that have yet to be addressed. We also note that the CATO regime is on hold due to legislation not being in place. We outline below 3 project specific factors that Ofgem should consider when making its competition assessment.

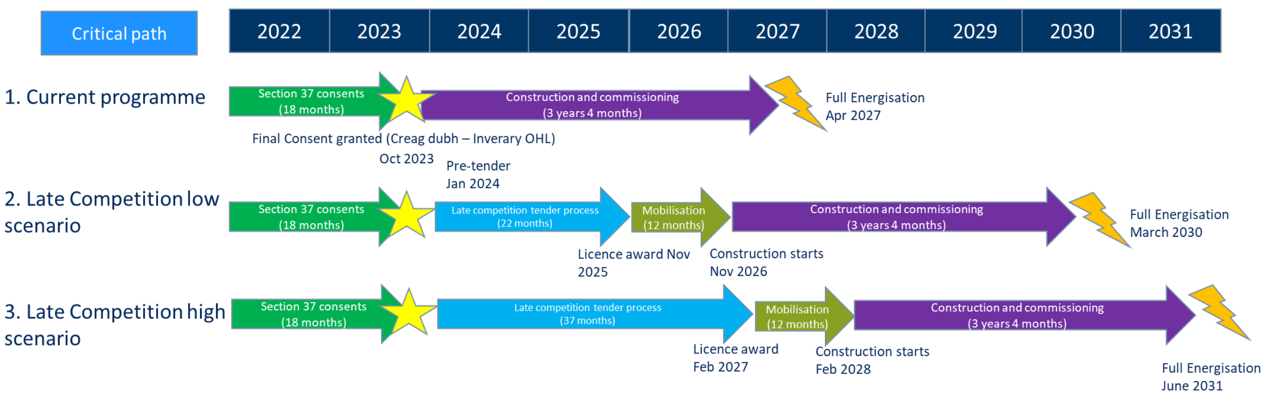
Delays to pathway to Net Zero

Due to the significant increase in generation background in 2019/2020, the Strategy programme is challenging and must be delivered at pace to meet EISDs and connection dates. Large contracted and scoping generation must be connected on time to enable the pathway to Net Zero and ensure stability and reliability of the network. Missed connection dates will have wider impacts for SSEN Transmission, for example on our stakeholder surveys, and ODIs, such as the Quality of Connections Survey, which we may incur financial penalties

53 https://www.ofgem.gov.uk/sites/default/files/docs/2021/03/large_onshore_transmission_investements_loti_re-opener_guidance_-_clean_0.pdf Page 9

We expect that necessary legislation to enable the CATO regime would not be in place until mid-2023 at the earliest. Based on the timelines presented in the BEIS consultation[54] we expect a tender to take between 22-37 months from the pre-tender to licence award stage. We also assume that the new CATO would require a 12-month mobilisation phase before it can begin construction. Overlaying these assumptions onto the Argyll programme critical path suggests that the full energisation date of April 2027 could be delayed between c3-4 years. We have mapped this timeline in Figure 27.

Figure 27 Overlay of BEIS timelines for late competition onto the current Argyll critical path



We therefore believe, based on the expected timelines outlined by BEIS, that the introduction of the CATO regime to the Argyll 275kV Strategy would cause a significant delay to the pathway to Net Zero, and therefore would not be beneficial for customers.

We also believe that the introduction of the SPV and CPM models would delay the Argyll 275kV Strategy. The SPV model would require the running of a competition, which we would expect to follow similar timelines to those presented. Both models would require significant development time as they have unresolved issues and would impact on full energisation dates.

Synergies across the Argyll programme

As a natural monopoly, we are able to apply economies of scale and scope, to implement synergies across our portfolio, and bundle works to obtain volume discounts and efficiency in development and delivery programmes, as well as find efficiencies to provide cost advantage for end costs for consumers. Through coordinating the design of the scheme, we can identify these efficiencies at an early stage and implement them.

Examples of this include utilising the same contractor on project elements with the same deliverables such as delivery of Gas Insulated Switchgear for the substations or the 275kV OHL’s, where bundling of work to one Contractor allows the use of a consistent design across the schemes and removes costs for preparing these individually. Additionally, with SSEN Transmission coordinating this can allow a bulk discount to be applied to the purchase of equipment, with this applicable to a significant number of the substation and OHL components within the scheme.

[54] Competition in Onshore Electricity Networks (publishing.service.gov.uk) page 19 and 20

Delivering the Argyll and Kintyre Reinforcement Scheme as a coordinated scheme will provide efficiencies through reduced number of contractor mobilisations, reduced welfare requirements, shared construction resources and tighter programme coordination The current programme offers opportunities to utilise our Contractor resource in an efficient and sustainable manner

Reducing risk of abortive works

Additionally, having the scheme coordinated by SSEN Transmission reduces the potential for abortive works. We are able to view the whole scheme and its wider interactions with the network to ensure that, where practicable, the design and construction of new infrastructure takes into account the long-term requirements and avoid abortive works such as having to install super grid transformers on a temporary basis to maintain network operation whilst other elements of project infrastructure are completed. We are able to consider this for the Argyll 275kV Strategy as well as its associated Customer Connection works which interface with it to provide the optimum solution for the end users.

Conclusion

Given the schedule issues due to the expected lengthy timelines for running a competition, coupled with the complexity of this project, multiple interfaces, and extensive and coordinated stakeholder engagement throughout the development cycle of the project, we do not think that the delivery of this project through any of the three late competition models is in the best interest of consumers. We would encourage Ofgem to rule out applying late competition to the Argyll 275kV Strategy based on the project specific factors presented.

9. Conclusion

The need for reinforcement of the Argyll and Kintyre network has been clearly demonstrated through the recent steady rise in contracted and applied generation activity at the end of 2019 through to 2020, in addition to the volumes of generation looking to connect to the network in the upcoming years.

There are three clear drivers which evidence the need to intervene in the Argyll and Kintyre region during the RIIO-T2 price control period. This includes:

- The increase in low carbon renewable generation is the driver for the required reinforcement works proposed in the Argyll 275kV Strategy.
- Power system studies undertaken on the existing network to assess the connection of the contracted generation has identified that network reinforcement is required to maintain compliance with the NETS SQSS and the Connection and Use of System Code (CUSC) Connect and Manage Criteria as the capability of the existing network would be exceeded with the connection of the generation.
- 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.

Whilst the increase in low carbon generation is the primary driver for the reinforcement of the Argyll and Kintyre network, it has been equally important to consider the sensitive environments and communities which surround the area. In line with our RIIO-T2 Business Plan commitment, we have adopted a stakeholder-led approach to gather key feedback which has influenced both our options and preferred solution.

Our strategic approach has allowed us to develop a long-term economic solution which enables renewable generation today, and in the future to mitigate the need for further construction work in the future. This eliminates the potential for disruption to the local environment and communities in later years and instead, enables us to future proof the network whilst facilitating wider moves to net zero.

In order to assess our potential options, we have supported the ESO in defining a methodology for its CBA of the Argyll 275kV Strategy, which considers the complexities surrounding the network. In addition, we applied lessons learned from Skye and undertook early engagement with Ofgem, presenting them with the opportunity to feed into the development of the local FES, an approach which has been welcomed.

Our preferred option for reinforcement of the Argyll and Kintyre network has been developed through an extensive assessment of the potential future generation in the area, in depth engagement with both generators and local communities. The preferred option has also been economically assessed through the CBA, as well as other economic indicators such as carbon cost and value to consumers. As a result, we are confident that the option, outlined below, is most appropriate in meeting the needs of our stakeholders as well as current and future consumers whilst facilitating the shift towards net zero by 2050 (and 2045 in Scotland).

The information and evidence provided within this submission clearly demonstrates that Ofgem should approve the INC and supporting the proposed solution which is to create a high capacity 275kV double circuit (2 x 1160MVA summer pre-fault rating) and consists of five key elements:

1. Establishing a new substation at Creag Dhubh and new switching station at Glen Lochy to enable connection to Scottish Power's Windyhill – Dalmally 275kV OHL circuits. These two new assets are to be connected by c. 14km of new OHL
2. c.10km of new OHL between Creag Dhubh and a tee point on the existing Inveraray-Crossaig Circuits to enable to 275kV operation of this section
3. Upgrade of An Suidhe, Crarae and Port Ann substations to enable them to maintain connection to the 275kV network
4. Establishing a new substation at Craig Murrail
5. Establishing a new substation in the vicinity of the existing Crossaig substation

Next Steps

Following submission of this INC, we anticipate Ofgem's response by the end of September 2022 at the latest, in line with the 6-9 month decision making timeframe specified in paragraph 4.3 of the LOTI Re-opener Guidance[55]. During this time SSEN Transmission, will continue to closely monitor generation, and progress its stakeholder engagement with increased focus on local authorities, statutory consultees, communities and landowners on project design to obtain the necessary planning consents.

Following Ofgem's decision on the INC, we will aim to submit our FNC for the full strategy in January 2023 after we have submitted our planning applications for all elements of the Strategy. This will be up to 10 months prior to when we anticipate receiving all our planning consents. As set out in our Eligibility to Apply letter, we require flexibility in the LOTI framework with regards to Ofgem's review and direction of the FNC. This includes the request that subject to confirmation of no material objections, Ofgem provide and consult on its conditional FNC decision prior to receiving planning permissions. As such we expect to receive Ofgem's response to our FNC by 30th June 2023, following which we will prepare and submit our Project Assessment within October 2023. This timeline is critical in ensuring we are able to meet our legal obligation to provide connected generation dates in 2026 through to 2027.

We welcome Ofgem's timeliness and flexibility during this process to date, particularly in relation to the development of the local scenarios which were used to inform the CBA. We will continue to engage positively closely with Ofgem throughout the process in order to ensure we are being as open and transparent as possible throughout the remainder of the LOTI assessment process for the Argyll 275kV Strategy.

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[55] https://www.ofgem.gov.uk/publications/large-onshore-transmission-investments-loti-re-opener-guidance

10. Appendices

Title	Description	Purpose
All numbered appendix items are found within this document below		
Appendix 1 Existing Network – Circuit Ratings	Table with ratings on the existing overhead line circuits	To provide information on the existing network for context of the analysis
Appendix 2 Existing Network Diagram	Diagram showing the existing transmission network	To provide information on the existing network for context of the analysis
Appendix 3: Initial options	Detailed description of the Initial reinforcement Options	To provide greater granularity and detail on the Initial options
Appendix 4 Detailed list of option components	Detailed description of individual components that make up the reinforcement options	To provide greater granularity and detail on the individual option components
Appendix 5: List of Acronyms	List of acronyms used throughout the Argyll and Kintyre Reinforcement INC	To provide guidance to the reader on acronyms used
All of the following Appendix items will be found in separate folder provided with the INC		
Appendix A Argyll and Kintyre Reinforcement Stakeholder Engagement Plan - Stakeholder Profiling Map	An example of a stakeholder profiling mapping exercise undertaken for Argyll stakeholder identification and prioritisation	To illustrate the robust planning and detailed consideration of stakeholder groups ahead of carrying out tailored engagement
Appendix B Argyll and Kintyre Reinforcement Stakeholder Engagement Activity 2020 _Present	A list of engagement activity carried out since the wider strategy was introduced	To demonstrate the full extent of engagement undertaken regarding the strategy
Appendix C Overview of Creag Dhubh - Dalmally Project History and Consultation (2016-2021)	A timeline table describing the engagement history for the Creag Dhubh – Dalmally 275kV Connection Project	To provide context regarding the history prior to the full strategy being developed
Appendix D Alternative Options Based on Stakeholder Feedback	An overview of alternative options presented to local stakeholders and their response to the subsequent consultation	Providing context regarding design changes directly in response to stakeholder views
Appendix E Argyll and Kintyre Local FES	A report of the Local FES that was used in the detailed options analysis	To clearly evidence how the Local FES was developed and the sources utilised

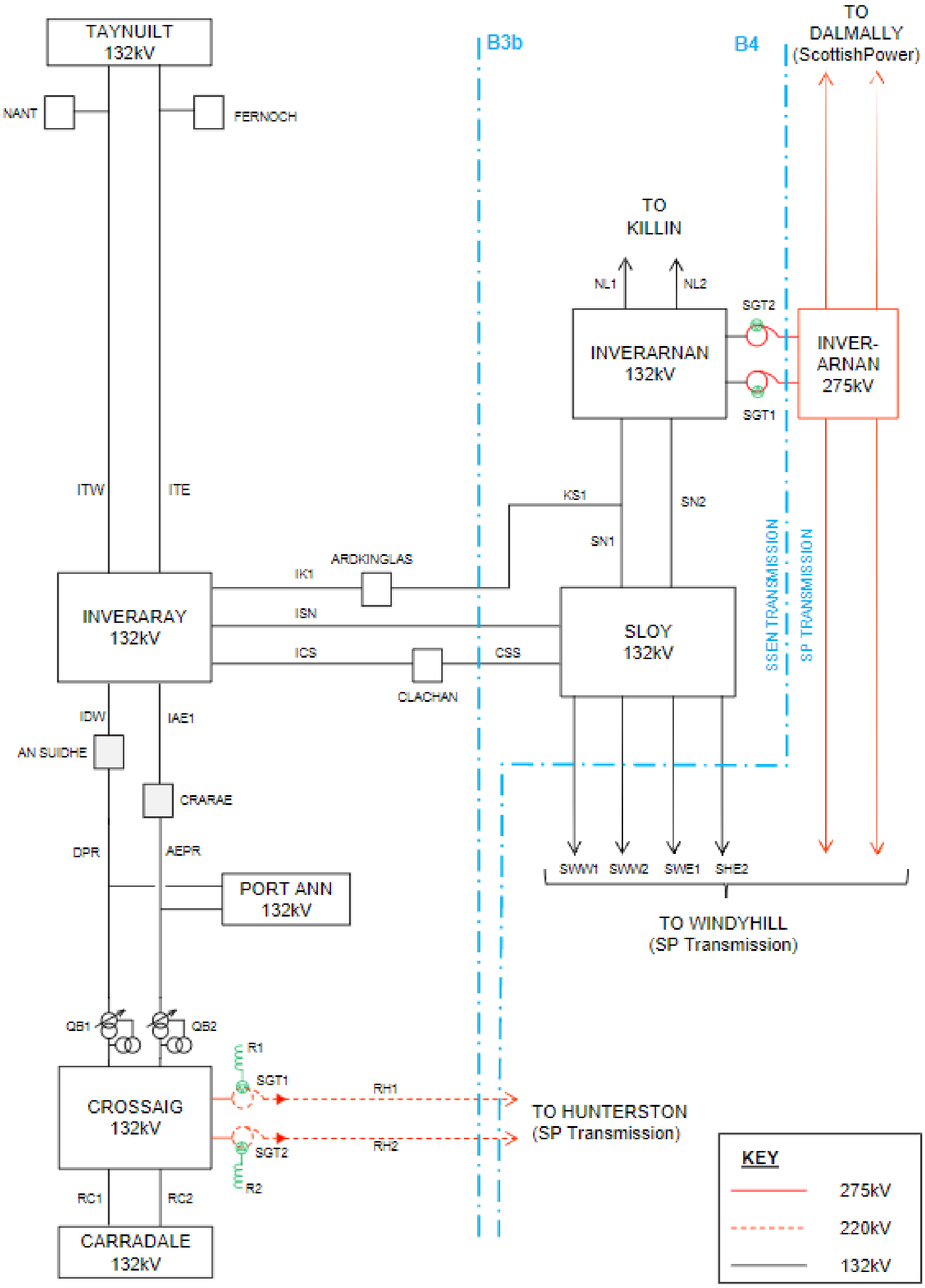
Appendix F Argyll & Kintyre Local Operability Study Technical Report	A report of the local operability studies we undertook as part of the detailed options analysis	To clearly demonstrate the study methodology, the studies undertaken and the results.
Appendix G Argyll CBA Report V5 Final	A report completed by the ESO on the CBA they undertook, as required by the LOTI guidance	To clearly demonstrate the CBA methodology applied, the studies undertaken and the CBA outputs.
Appendix H ESO Support Letter Argyll LOTI project.pdf.	A supporting letter from the ESO for the INC	Demonstrates support from the ESO on the approach we have taken to the detailed option analysis
Appendix I Initial Needs Case Scheme Programme	Current programme for the Argyll and Kintyre Reinforcement Scheme through to completion.	To provide a summary of the programmed key activities and dates associated with the Argyll 275kV Scheme.

Appendix 1: Existing Network – Circuit Ratings

	Pre-Fault Rating (MVA)			Post-Fault Rating (MVA)		
Circuits*	Summer	Spr/Aut	Winter	Summer	Spr/Aut	Winter
RH1/RH2	240	240	240	240	240	240
RC1/RC2	334	362	376	398	429	449
IDW/IAE	556	595	619	662	710	739
DPR/AEPR	556	595	619	662	710	739
ITE/ITW	67	77	83	79	92	99
IK1/KS1	89	103	111	106	123	132
ISN	89	103	111	106	123	132
ICS/CSS	89	103	111	106	123	132
SN1/SN2	89	103	111	106	123	132

** Circuit IDs shown on the schematic network diagram in Appendix 2*

Appendix 2: Existing Network Diagram



Appendix 3: Initial options

Initial Option	Full EISD	Title	Description
Initial Option 1	2028	3rd Crossaig – Hunterston Subsea Cable 220kV + North Argyll	• A new 275/132kV substation at Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Open the existing 132kV circuits between Creag Dhubh and Inveraray, • Install a 3rd 220kV subsea cable, rated at 240MVA, between Crossaig substation and Hunterston substation (SPT). • Establish a new 132kV substation at Craig Murrail
Initial Option 2	2028	3rd Crossaig – Hunterston Subsea Cable 220kV Higher Capacity + North Argyll	• A new 275/132kV substation at Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Open the existing 132kV circuits between Creag Dhubh and Inveraray, • Install a 3rd 220kV subsea cable, rated at a higher capacity than the existing cables at 240MVA, between Crossaig substation and Hunterston substation (SPT). • Establish a new 132kV substation at Craig Murrail
Initial Option 3	2028	3rd Crossaig – Hunterston Subsea Cable 400kV + North Argyll	• A new 275/132kV substation at Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Open the existing 132kV circuits between Creag Dhubh and Inveraray, • Install a 3rd subsea cable operating at 400kV between Crossaig substation and Hunterston substation (SPT). This will require a new 132kV double busbar substation at Crossaig • Establish a new 132kV substation at Craig Murrail
Initial Option 4	2029	3rd Crossaig – Hunterston Subsea Cable HVDC + North Argyll	• A new 275/132kV substation Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Open the existing circuit between Creag Dhubh and Inveraray • Install a 3rd subsea cable, HVDC, between Crossaig substation and Hunterston substation (SPT). This will require HVDC converter stations to be established at both Crossaig and Hunterston substations.

			• Establish a new 132kV substation at Craig Murrail
Initial Option 5	2028	Twin Carradale – Kilmarnock South Subsea Cable 220kV + North Argyll	• A new 275/132kV substation at Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Rebuild the circuit between Creag Dhubh and Inveraray to the same design as Inveraray – Crossaig but operate at 132kV. Bypass Inveraray Substation. • Rebuild the circuit between Crossaig and Carradale at 275kV and connect to a new 275kV substation at Carradale. • Install two 220kV subsea cables from the new Carradale substation to Kilmarnock South substation (SPT), with a rating of circa 240MVA per circuit. • Establish a new 275/132kV substation at Craig Murrail, directly on the Inveraray – Crossaig circuit.
Initial Option 6	2027	275kV Radial Crossaig – North Argyll	• A new 275/132kV substation Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Rebuild the circuit between Creag Dhubh and Inveraray to the same design as Inveraray – Crossaig. Bypass Inveraray Substation. • Establish a new substation at Crossaig substation, to enable the radialisation of the network. Carradale will connect to the Inveraray – Crossaig OHL. • Enable operation of Inveraray – Crossaig at 275kV by rebuilding An Suidhe and Crarae substations to 275kV operation. • Establish a new 275kV substation at Craig Murrail, directly on the Inveraray – Crossaig circuit
Initial Option 7	2027	275kV Radial Carradale – North Argyll	• A new 275/132kV substation Creag Dhubh and a new 275kV double circuit OHL to connect to Dalmally – Windyhill 275kV line. • Rebuild the circuit between Creag Dhubh and Inveraray to the same design as Inveraray – Crossaig. Bypass Inveraray Substation. • Establish a new 275/132kV substation at Carradale, to enable the radialisation of the network. • Enable operation of Inveraray – Crossaig at 275kV by rebuilding An Suidhe and Crarae substations to 275kV. • Establish a new 275kV substation at Craig Murrail, directly on the Inveraray – Crossaig circuit.

Initial Option 8	2028	275kV Radial Crossaig – Inverarnan (via Sloy)	• Establish a new 275/132kV substation at Inveraray, and rebuild the double circuit OHL between Inveraray and Sloy at 275kV. • Rebuild Clachan substation to maintain connection at 275kV. • Establish a new 275kV double busbar at Sloy. Transformers will be required to connect to the existing Sloy 132kV busbar. Rebuild the double circuit OHL between Sloy and Inverarnan at 275kV. • Rebuild Inverarnan substation to enable the connection of the new 275kV OHL from Sloy, and the turn in of both sides of the Dalmally – Windyhill 275kV double circuit (SPT). Connect Ardkinglas 132kV circuit to Inverarnan 132kV busbar to maintain connection. • Establish a new substation at Crossaig substation, to enable the radialisation of the network. Carradale will connect to Inveraray – Crossaig OHL. • Enable operation of Inveraray – Crossaig at 275kV by rebuilding An Suidhe and Crarae substations to 275kV. • Establish a new 275kV substation at Craig Murrail, directly on the Inveraray – Crossaig circuit.
Initial Option 9	2028	275kV Radial Crossaig – Inverarnan	• Establish a new 275/132kV substation at Inveraray and rebuild the double circuit OHL between Inveraray – Sloy and Sloy – Inverarnan at 275kV, bypassing Sloy. • Rebuild Clachan substation to maintain connection at 275kV. • Rebuild Inverarnan substation to enable the connection of the new 275kV OHL from Inveraray, and the turn in of both sides of the Dalmally – Windyhill 275kV double circuit (SPT). Connect Ardkinglas 132kV circuit to Inverarnan 132kV busbar to maintain connection. • Establish a new substation at 275/132kV Crossaig substation, to enable the radialisation of the network. Carradale will connect to Inveraray – Crossaig OHL. • Enable operation of Inveraray – Crossaig at 275kV by rebuilding An Suidhe and Crarae substations to 275kV. • Establish a new 275kV substation at Craig Murrail, directly on the Inveraray – Crossaig circuit.

Appendix 4: Detailed list of Option components

Code	Description	Detailed Description
CKNC	Twin Subsea Cable (Carradale - Kilmarnock South)	Two 220kV 240 MVA subsea cables from Carradale substation to Kilmarnock South substation (SPT). New 132kV Carradale substation, tying in the existing Carradale GSP and the 132kV OHL circuits to Crossaig. Ownership boundary will be the landing point on SPT network. Cable into Kilmarnock South substation and connection to 275kV busbar will be SPT works.
KHNC	3rd Subsea Cable (Crossaig - Hunterston)	3rd 220kV 240 MVA subsea cable from Crossaig substation to Hunterston East substation (SPT). New 132kV bay and SGT at Crossaig substation. Ownership boundary will be the landing point on SPT network. Connection onto Hunterston 400kV busbar will be SPT works.
DDNC1	Creag Dhubh Substation - Normally Open	New 275/132kV substation at Creag Dhubh in North Argyll. Turn in the existing Inveraray - Taynuilt 132kV OHL. Open the circuit between Creag Dhubh and Inveraray. A new 275kV double circuit OHL from Creag Dhubh substation to Dalmally - Windyhill circuit (SPT), looped into one side. Ownership boundary will be prior to circuit loop in. Tower works and reprofile of Dalmally - Windyhill 275kV OHL will be SPT works.
DDNC2	Creag Dhubh Substation	New 275/132kV substation at Creag Dhubh in North Argyll. Turn in the existing Inveraray - Taynuilt 132kV OHL. 132kV circuit between Creag Dhubh and Inveraray operated closed. A new 275kV double circuit OHL from Creag Dhubh substation to Dalmally - Windyhill circuit (SPT), looped into one side. Ownership boundary will be prior to circuit loop in. Tower works and reprofile of Dalmally - Windyhill 275kV OHL will be SPT works.
DINC	OHL to Inveraray	A new 275kV double circuit OHL from Creag Dhubh to Inveraray - Crossaig OHL (bypassing Inveraray Substation). Circuit will be operated at 132kV initially. Existing OHL between Creag Dhubh substation and

		Inveraray switching station to be removed. Inveraray switching station now radialised from Sloy.
DCUP1	275kV Reinforcement - Radialised Network	Operate the Creag Dhubh - Crossaig double circuit at 275kV. Construct new 275kV substations at Crarae and An Suidhe to maintain transmission connected generator connections. Construct a new 275kV substation at Craig Murrail, and install new 275/33kV GTs to maintain connection to Port Ann GSP. Construct a new 132kV Crossaig double busbar and connect OHL from Craig Murrail and OHL from Carradale onto new busbar. Install a normally open point between the two Crossaig busbars, and radialise the subsea cables from Hunterston.
DCUP2	275kV Reinforcement - Interconnected Network	Operate the Creag Dhubh - Crossaig double circuit at 275kV. Construct new 275kV substations at Crarae and An Suidhe to maintain transmission connected generator connections. Construct a new 275kV substation at Craig Murrail, and install new 275/33kV GTs to maintain connection to Port Ann GSP. Construct a new 132kV Crossaig double busbar and connect OHL from Craig Murrail onto new busbar. Install two cable circuits between the two Crossaig busbars to maintain connectivity with the existing Crossaig double busbar.
CPFC	Crossaig Power Flow Control	Installation of Power flow control devices at Crossaig substation, onto the 132kV side of the 220/132kV SGTs that connect to the 220kV subsea cables to Hunterston.

Appendix 5: List of Acronyms

Acronym	Full Name
CAPEX	Capital Expenditure
CBA	Cost Benefit Analysis
CFD	Contracts for Difference
DNO	Distribution Network Operator
EA	Environmental Assessment
EIA	Environment Impact Assessment
EISD	Earliest In Service Dates
ENSG	Electricity Networks Strategy Group
ESO	Electricity System Operator
FES	Future Energy Scenarios
FNC	Final Needs Case
GB	Great Britain
GHD	Gutteridge Haskins & Davey
GHG	Greenhouse Gas
GSP	Grid Supply Point
GT	Grid Transformers
GVA	Gross Value Added
HVDC	High Voltage Direct Current
INC	Initial Needs Case
LOTI	Large Onshore Transmission Investment
LWR	Least Worst Regret
LLTNP	Loch Lomond and the Trossachs National Park
MSIP	Medium Sized Incentive Projects
MW	Mega Watts
MVA	Megavolt Ampere
NETS	National Electricity Transmission System
NGESO	National Grid Electricity System Operator
NOA	Network Options Assessment
NOS	North of Scotland
NPV	Net Present Value
OAR	Options Assessment Report
OFGEM	Office of Gas and Electricity Markets
OHL	Overhead Line

OPEX	Operation Expenditure
PGAT	Probability of Generation Assessment Tool
PV	Present Value
RAG	Red, Amber, Green
RIIO	Revenue=Incentives + Innovation + Outputs
SAT	Scenario Assessment Tool
SEA	Socioeconomical Analysis
SHEPD	Scottish Hydro Electric Power Distribution
SPEN	Scottish Power Energy Networks
SPT	Scottish Power Transmission
SQSS	Security and Quality of Supply Standard
SSEN	Scottish & Southern Energy Network
STCP	System Operator Transmission Owner Codes Procedure
STPR	Social Time Preference Rate
SWW	Strategic Wider Works
TBC	Total Balancing Mechanism
TCC	Total Constraint Cost
TO	Transmission Operator
VISTA	Visual Impact of Scottish Transmission Assets