RIIO ED2 Engineering Justification Paper (EJP)

Skye - South Uist (North) – Strategic Investment

Investment Reference No: 328_SHEPD_SUBSEA_SKYS_UIST_NORTH

Contents

Definitions and Abbreviations

Acronym	Definition
EJP	Engineering Justification Paper
CBA	Cost Benefit Analysis
CBRM	Condition Based Risk Management
IDP	Investment Decision Pack
EfW	Energy from Waste
ESA	Electricity Supply Area
EV	Electric Vehicle
FES	Future Energy Scenarios
GIS	Geographic Information System
GW	Gigawatt
kW(h)	kilowatt (hour)
MW	Megawatt
OHL	Overhead Line
PEV	Pure Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photovoltaics
BSP	Bulk Supply Point
GSP	Grid Supply Point
LRE	Load Related Expenditure
LCT	Low Carbon Technology
SSEN	Scottish and Southern Electricity Network
UG	Underground Cable

1 Executive Summary

This Engineering Justification Paper (EJP) for Scottish Hydro Electric Power Distribution (SHEPD) covers the investment required to manage the performance of the 46.2 km Skye - South Uist - 33 kV subsea cable which provides supplies to 4,404 customers on South Uist, Benbecula and North Uist with a single circuit.

A number of subsea cable circuits have failed during RIIO-ED1, causing significant impact on customer interruptions and constrained generation, and have resulted in impact costs for temporary generation and CO_2 emissions. There has been a review of the approach taken to attempt to identify and pre-empt the impact of subsea cable failure by using a ‘monetised risk-based approach’ alongside a traditional CBRM approach, which was not viewed as identifying the critical circuits for the strategic programme effectivly on its own.

Following optioneering and detailed analysis, as set out in this paper, the proposed scope of works for the existing Skye - South Uist circuit is as follows:

- Install 2 new 33 kV cables from Skye to North and South Uist to replace the existing Skye – South Uist 33 kV subsea cable*
- One subsea cable will run from Ardmore Grid to Lochmaddy on North Uist with a requirement to build a 33kV land connection, via overheadline and underground cable, between Lochmaddy and Clachan.
- The second route will be from Dunvegan Grid to Loch Carnan with on overland section on Skye and a subsea connection from Skye to South Uist.
- There will need to be an extension of the 33 kV Busbar at Dunvegan grid

*This EJP will cover the North Route only from Ardmore to Clachan, with a separate EJP produced for the Dunvegan to Loch Carnan route.

The anticipated cost to deliver the preferred solution of both cables is £[redacted], with £[redacted]m associated with the North route only. The delivery programme for all subsea cables in ED2 will be determined through detailed planning and engagement with marine installation contractors and cable procurement opportunities. For simplicity, where required, the delivery year is assumed as 2027/28 in this EJP and this will be refined as our programme develops. Given the size and scale of this project there is a possibility the routes may be delivered as independent installation campaigns and hence the EJP has been broken into two, one for the north route and one for the south route. There is also the opportunity to continue operating the existing cable in parallel until the second route is installed later in ED2. Savings would still be anticipated for combined cable procurement, route survey synergies, engineering etc even if the installations are delivered seperatley.

This scheme delivers the following outputs and benefits:

- Enhanced security of supply for 4,404 customers with 2 - 33 kV cables supplying North and South Uist.
- Improves reliability and reduces the potential for customer interruptions due to a subsea cable fault.
- Reduces the risk of incurring impact costs, constrained generation, temporary generation and CO_2 impacts.
- Increases import and export capacity of the submarine cables, future proofing the network.
- Reduces the monetised risk on the Skye – South Uist cable, forecast to be £45.07m by the end of ED2 with no intervention, to zero whilst both cables are in commission.

All subsea cable EJPs should be read in conjunction with the ***Scottish Islands (Annex 8.1)*** of our RIIO-ED2 Business Plan. Further information is contained in the Annex regarding the proposed Whole System approach for the Hebrides and Orkney Whole System Uncertainty Mechanism (HOWS), that specifically relates to this EJP.

2 Investment Summary Table

Table 1 below provides a high level summary of the key information relevant to this Engineering Justification Paper (EJP).

Table 1: Investment Summary

Name of Programme	Skye - South Uist (North Route) Strateigc Investment			
Primary Investment Driver	The Primary Investment Driver described within this EJP is the requirement to reduce the overall monetised risk associated with the loss of the existing subsea cable from Skye - South Uist			
Investment reference/mechanism or category	Cost Benefit Analysis reference: 328_SHEPD_SUBSEA_SKYS_UIST* *Combined CBA for the proposed North and South cable routes demonstrating the value offered.			
Output reference/type	As above			
Cost (£m)	£[redacted] (North route only) (Total programme cost of £[redacted])			
Delivery year	ED2 (2027/28)			
Reporting Table	CV25: High Value Project			
Outputs included in RIIO ED1 Business Plan	No			
CV25 High Value Project	**Asset Category**	**North Route ED2 (£m)**	**South Route ED2 (£m)**	**Total (£m)**
	33 kV Subsea Cable	[redacted]	[redacted]	[redacted]

3 Introduction

This Engineering Justification Paper (EJP) covers the investment required to manage the performance of the Skye – South Uist 33 kV subsea cable which provides supplies to Loch Carnan, Drimore and Pollachar on South Uist, and Aird and Clachan on Benbecula and North Uist. The 95 mm² PILC 33 kV cable is 46.17 km long from Ardmore Grid Station on Skye, to Loch Carnan.

The Primary Investment Driver described within this EJP is based on reducing the overall monetised risk associated with this circuit which has been determined from the "Strategic Subsea Cable CBA Model" developed to determine the overall replacement / augmentaiton strategy for all subsea cables by mitigating the monetised risk associated with the subsea cable assets. The model evaluates the probabilty of failure, the cost of intervention and the impact cost and used this assesment across the asset population to determine the initial investment method to be considered. Further detail on the Strategic Subsea Cable CBA Model is provided in the ***Scottish Islands (Annex 8.1).***

There exisiting Skye – South Uist 33 kV cable is 31 years old, supplies 4,404 customers with a demand of 8.43MW, and has 7.5 MW of generation connected. Generation would be constrained should the cable fail. The cable is HI5 and C2 criticality, and under the monetised risk criteria it ranks 1st out of the subsea cable population for intervention. Recent stakeholder feedback also fully supports the strategic investment and emphasises the importance of a reliable network connection.

The monetised risk currently £13.87m which would increase to £45.07m by the end of ED2. This is by far the biggest monetised risk of all subsea cables and represents 70% of the total monetised risk of all SSE subsea cables.

Planned intervention is therefore required to reduce this risk, and the options considered range from Do Minimum and take action following a failure, to avoiding the failure by intervening before failure and ensuring much greater reliability of the supply.

Having identified the need for intervention, 7 options were considered as shown;

- Option 1: Do Minimum – replace on failure
- Option 2: Replace the cable with the same size cable
- Option 3: Replace with a larger cable
- Option 4: Augment the existing cable with new cable same size as the existing
- Option 5: Augment the existing cable with new cable larger cable
- Option 6: Two new cables along the same route
- Option 7: Two new cables on alternative routes

The preferred option has been identified as Option 7: Two new cables on alternative routes. This EJP covers one of the repalcement routes (North) and a separate EJP has been provided for the Southern route.

The benefit of providing two new subsea cables on shorter routes effectively reduces the risk of the impact cost and constrained generation to a very low level with N-1 security against a cable fault. This option provides N-1 security on the distribution network but would still be at risk to an upstream transmission network outage. Based on demand forecasting, two circuits will be required to support the Uists regardless of demand security requirements. This is mainly driven through load growth forecast at Clachan Primary S/S. The total cost of £ [redacted] million will be incurred within the ED2 period, with £[redacted] m assocaiated with the northern route. The final installation year has yet to be determined and will be subject to detailed project planning and engagement with marine contractors, cable manufaturers, environmental and consenting considerations and to align project management resource in line with delivery of all other subamrine cable portfolio works for ED2.

Figure 1 and 2 below provide an indication of the exisiting cable route and the proposed cable routes assocaited with Option 7. Detailed route proving will still be required during the project development and refinement phase.

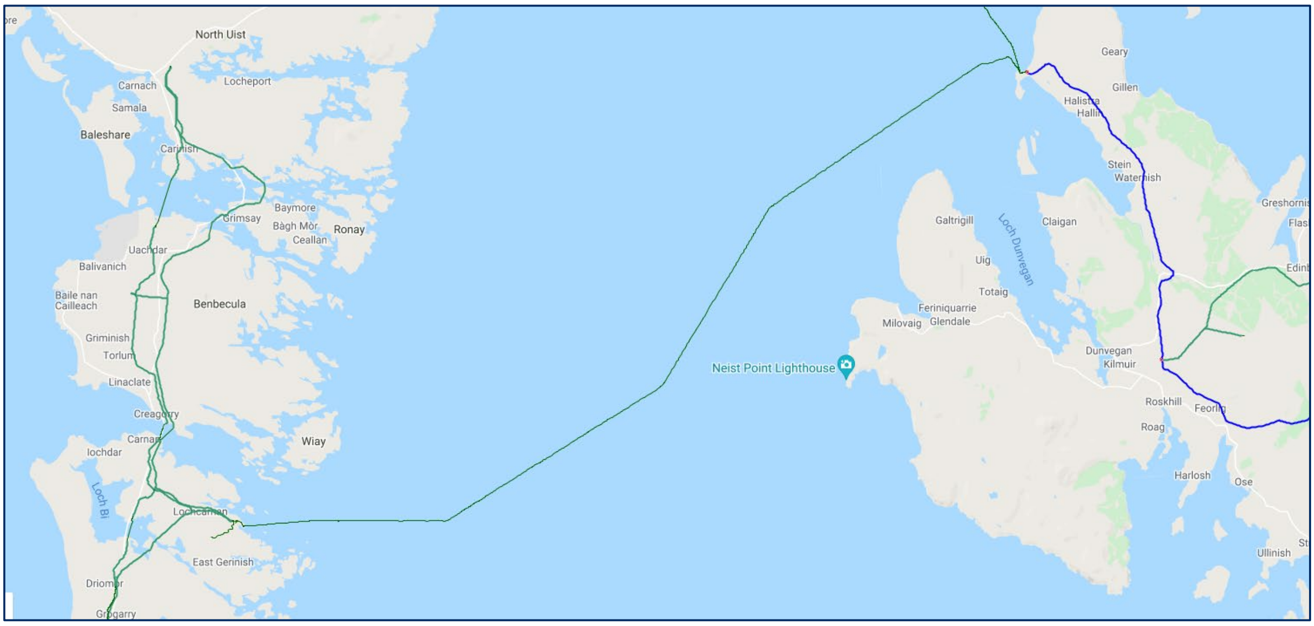

Figure 1: Existing Ardmore grid - Loch Carnan 33kV subsea cable route.

Figure 2: Proposed option 7 diverse routes North (Blue) & South (Green)

4 Background Information and Analysis

4.1 How Do We Determine Our Intervention Priorities

We introduced our Condition Based Risk Management (CBRM) system in 2014 following the RIIO-ED1 Business Plan submission. However, since August 2017, we switched over fully to maximise utilisation of the Common Network Assets Indices Methodology (CNAIM) modelling for all asset classifications applicable for the RIIO-ED1 requirements with the data inputs outlined in the Information Gathering Plan (IGP).

The RIIO-ED2 Business Plan submission has been based on the latest version of the industry standard CNAIM v2.1 which was approved for use in RIIO-ED2 by Ofgem in April 2021. The supporting data used in the modelling of this submission is based on the reported position of our asset condition for RIIO-ED1 Year 6 at the end of August 2021.

The full details of the Energy Network Association's NARMs Electricity Distribution Working Group (NEDWG) publication on CNAIM v2.1 is available on Ofgem's website. For further detail on our RIIO-ED2 NARMS strategy please see ***Safe and Resilient (Annex 7.1).***

Our proposed investment programme in ED2 is asset data led; refined and iterated by overlaying the industry standard risk management methodology with enhanced risk modelling and cable specific cost benefit analysis. We are proposing planned replacement of cables where the certainty of need is highest driven by high probability and impact of failure in ED2.

We have adopted a four-step funnel approach, as shown in figure 3, to determine the interventions required on the network. This approach allows us to filter from an initial examination of the complete list of subsea cables we operate to a credible and deliverable list of interventions which are supported by robust analysis. Steps 1 to 3 are set out in detail within our ***Scottish Islands (Annex 8.1).***

This EJP covers Step 4 for the Skye – South Uist cable which has qualified as requiring intervention. We set out here our approach to clearly justify why the circuit design approach is being proposed and associated costs are the most economic and efficient and what work would be required to deliver on these investments.

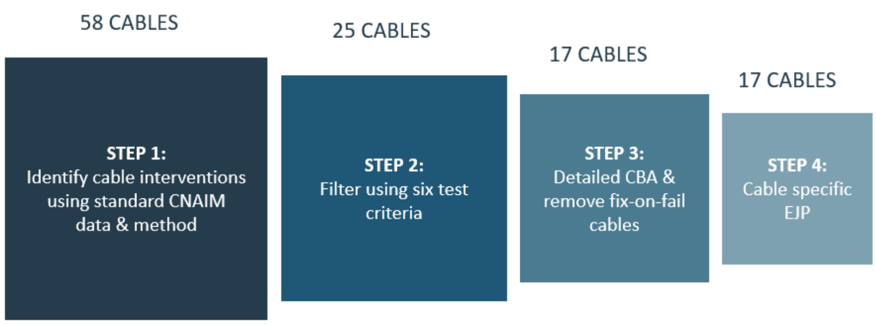

Figure 3: Cable filter selection process

4.2 Demand and Generation Forecast for Primaries on North and South Uist

The exisiting 33 kV subsea cable from Ardmore grid to Loch Carnan primary is a 95 mm² PILC 'HSL'DWA AEI rated at 16 MVA. The current demand on the Ardmore - Loch Carnan cable is 8.43 MVA (52.7% of the cable rating). The demand projections for this island group, are as shown for the primary substations on North and South Uist and Benbecula in Figure 4.

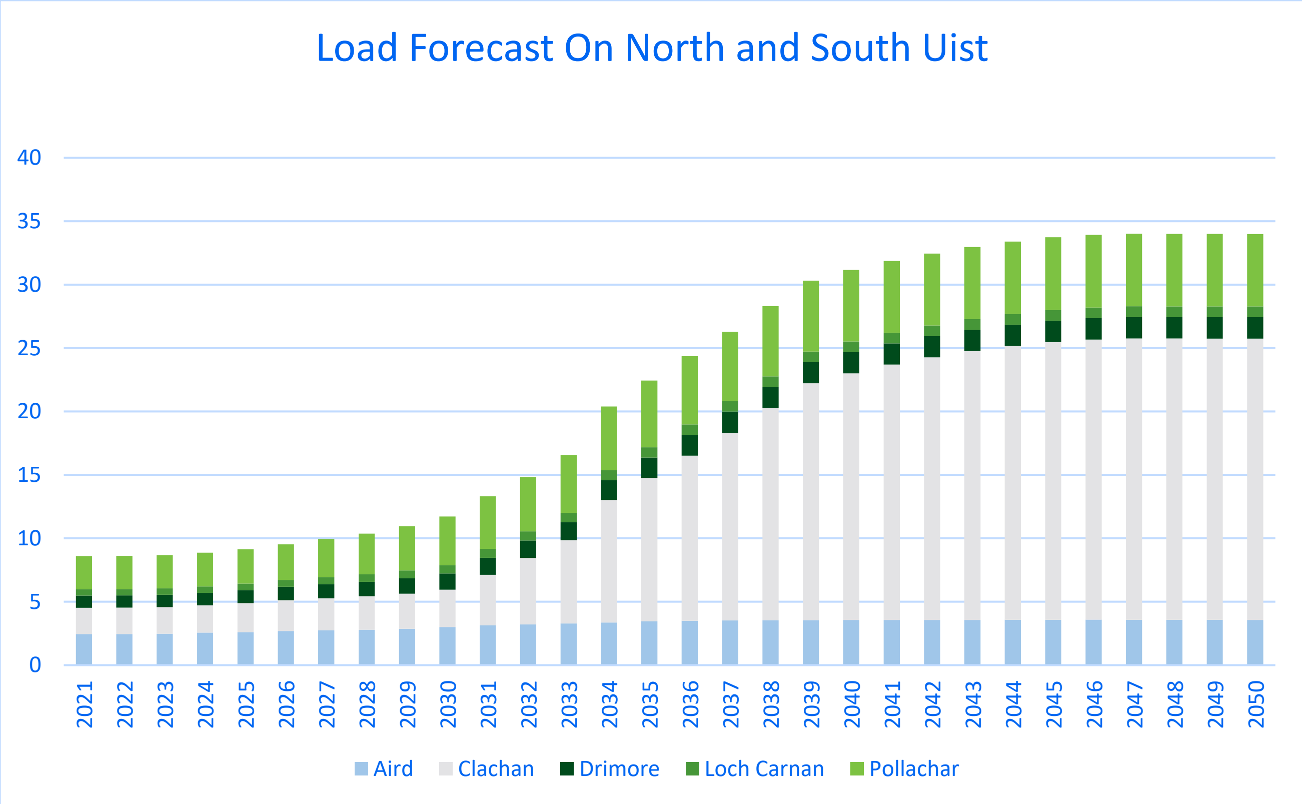

Figure 4: Load Forecast on North and South Uist

The load forecast for the 5 primary substations are shown in figure 4 and forecast demand at the end of ED2 is expected to be 10.8 MVA (67% of the cable rating). Beyond ED2 the demand forecast is being driven largely by the rise in non-domestic load at Clachan Primary shifting the major demand to North Uist. This will have a significant impact on the optimal solution with the current demand centre in the south of the islands shifting to the North, within 10 years. Based on these Consumer Transformation (CT) DFES forecasts the demand on the islands will exceed the current cable rating by 2033. Following this the existing cable would either need to be replaced with a larger cable or an alternative solution developed to support demand and remain compliant with ER P2, which is currently being met through standby generation at Loch Carnan Power station.

4.3 Existing Network Arrangement

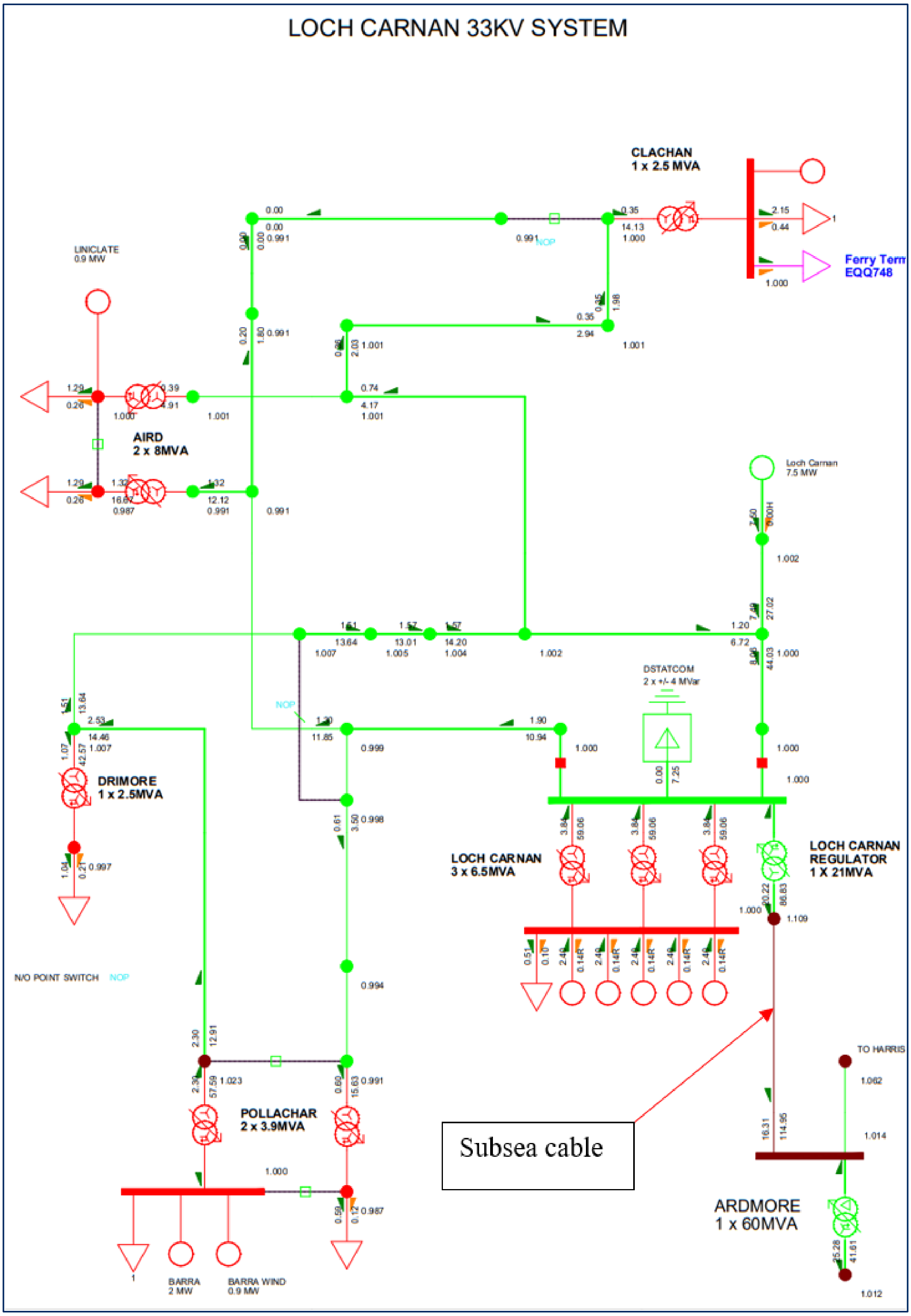

Figure 5: Loch Carnan 33kV Network Arrangement SLD.

The existing 33kV network configuration is shown in Figure 5 above, with the 5 primaries supplied via the subsea cable from Ardmore grid to Loch Carnan.

The existing Skye - South Uist 33 kV subsea cable is 46.17km in length and has been in service for 31 years. The probability of Failure is 1.8858 in 2023/24 rising to 6.1268 by the end of ED2, 2028. For reference the Skye - Harris 33 kV subsea cable which runs from Ardmore Grid north to Harris as shown in Figure 5 had a Probability of Failure of 1.3126 and failed in October 2020. This provides a reference of the potential for failure of this critical cable.

During the recent failure of the Skye - Harris subsea cable, a detailed assessment was carried out on the ability to conduct a repair on the cable in this location and water depth. Cable Consulting International Ltd (CCI) was approached to provide an independent engineering assessment of a repair option. A copy of this report was shared with Ofgem along with additional SHEPD narrative at the time. There were several concerns raised within the independent report. CCI gave a Low Confidence rating on a successful repair, with the possibility of increasing to Low / Medium if several potential mitigations could be put in place. Even then, it was their opinion that should a repair be successful, they would not anticipate it lasting any more than 3 years.

Therefore, the likelihood of a successful repair was Low. As a result, a repair option was rejected on that project. The cost of attempting the repair was estimated at around £[redacted] without any certainty of success. If the repair was unsuccessful then the cost of the standby generation would continue to be incurred while the replacement was programmed and delivered.

The Skye - Harris cable had been in service for 30 years at the time and would now be 31 years old, the same as the Skye - South Uist cable. The Skye – South Uist cable is also laid in the same area and is of the same type of cable (PILC 'HSL' DWA AEI) and manufacturer, therefore the potential for failure of the Skye – South Uist cable is considered to be significant. It is not certain that a repair would be a viable option on this cable in the event of a failure but would be subject to the fault specifics, mainly around the potential location and water depth of the fault. Therefore, under the fault replacement option in this paper it is considered an end-to-end replacement would be required.

5 Summary of Options Considered

Table below provides a high-level summary of the 7 investment options under consideration along with the advantages and disadvantages associated with each and a conclusion. All 7 options had a CBA carried out to evaluate the long-term benefits of each intervention strategy. A more detailed description of each option is then provided within the proceeding sub-sections.

Table 2: Summary of Investment Options

Option	Description	Advantages	Disadvantages	Conclusion
1. Do Minimum	Replace on failure	No immediate capital investment	Availability of material and resource when required. Higher cost of replacement and would need to be existing route with emergency replacement increasing cost by [redacted]%. Significant impact cost and constrained generation will be incurred.	Rejected
2. Replace – like for like	Replace the cable with the same size cable on the existing route.	Improves HI. Provides new life cycle and allows greater protection of cable to be installed.	Remains single circuit security of supply. Improves the reliability with the new circuit, but due to the length of the subsea cable still has a probability of failure of 0.34. Retaining a risk of incurring high costs due to failure of the new cable. Will provide an improvement for the short to medium term, However, future reinforcement for load growth will be required.	Rejected
3. Replace with larger cable	Replace the cable with a larger cable on the same route	Improves HI. Provides new life cycle and allows for greater protection of the cable to be installed. Provides for future load and generation growth.	Remains single circuit security of supply. Improves the reliability with the new circuit, but due to the length of the subsea cable, still has a probability of failure of 0.34. Retaining a risk of incurring high costs due to outages. Will provide an improvement for the short to medium term and enable load growth and generation growth.	Rejected

4. Augmentation	Lay a new cable and retain the old cable with additional switchgear at Ardmore and Loch Carnan	Similar cost to replacement. Provides N-1 for the remainder of the existing cable life. Would require future reinforcement for forecast load growth.	Improves the reliability with two cables in service. However, would fall back to single circuit following the failure of the existing circuit. This would then revert to option 2. Provides enhanced security for the remaining life of the existing cable but at greater cost than option 2. The benefits of this are dependent on the life of the existing circuit, which is thought to be limited.	Rejected
5. Augmentation larger cable	Lay a new cable and retain the old cable with additional switchgear at Ardmore and Loch Carnan with greater capacity for future growth in generation and load.	Similar cost to replacement. Provides N-1 for the remainder of the existing cable life. Provides for future load and generation growth.	Improves the reliability with two cables in commission. However, would fall back to single circuit following the failure of the existing circuit. This would then revert to option 3. The benefits of this are dependent on the life of the existing circuit, which is thought to be limited.	Rejected
6. Two new cables existing route	Lay two new cables along the known route of the existing cable and provide a firm connection.	Provides N-1 security and removes the impact of a failure for a single circuit increasing reliability.	Higher cost and maintains the length of the existing route, which is a critical component of the probability of failure. Higher cost than other options.	Rejected
7. Two new cables on alternative routes	This provides for a single 33 kV circuit from Ardmore grid to Clachan and a second from Dunvegan grid to Loch Carnan	As option 6 but shorter subsea route. Further improving security and reliability of the subsea cables. Provides independent routes from different grid stations and	Unknown subsea route condition. New over land routes required with unknown access and consents.	Recommended option

		to different primaries. Much greater security. Potential to reduce the subsea cable length and reduce cost. Allows for the reinforcement of the area in North Uist where higher growth is anticipated.		

6 Analysis and Cost

6.1.1 Option 1: Do-Minimum replace on failure

The total impact cost incurred would be £7.35m plus £[redacted]m for the replacement of the cable.

The total cost with this option is based on a planned replacement cost uplifted by 10% for a 500mm² cable due to future load growth requirements and a further increase of [redacted] % to reflect the premium paid in a fault situation. This gives a total cost of replacement in an emergency scenario of £[redacted]. This is estimated to be the cost when the replacement is done under emergency conditions without sufficient time to plan and procure the replacement cable in an efficient manner. The route would be the existing route between Ardmore grid and Loch Carnan. This provides for a larger cable able to provide capacity of 30 MVA, which is below the 2040 demand forecast of 34MVA. This option would incur the impact costs and would remain a single circuit security of supply once replaced with a risk of future failure, however, there would also be a requirement for further investment in the future to secure the group demand post 2040.
Additional costs incurred would be the following:

Constrained generation	£1.10 million
Impact costs	£6.25 million
Capital cost	£[redacted] million

This option was rejected, as it would incur impact cost and constrained generation cost and reputational damage. In addition, the replacement in an emergency would increase costs.

6.1.2 Option 2: Replace the cable with the same size cable 95 mm²

Replacing the cable with a new 95mm² subsea cable would be the lowest capital cost solution and will impact the Health Index and Probability of Failure resulting in a change to the characteristics set by the age and condition. The new cable would be connected to the existing network points at Ardmore Grid and Loch Carnan, and the old cable disconnected. The demand on the cable is 8.43 MVA with a load growth forecasting a rise to 16.6 MVA by 2033. The current cable capacity is 16MVA and would need to be replaced by that time in order to fully support demand. It would therefore be necessary to replace the cable with a 300 mm² (30MVA) cable or larger, which would have capacity to 2039 and beyond that would require a 500mm² cable. Therefore, this option assumes replacement in 2033 with a 500mm² cable to satisfy future demand.

The initial capital cost would be £[redacted]m, with an additional cost of £[redacted]m by 2033. This was rejected as the initial lower capital cost is far outweighed by the need to reinforce by 2033.

6.1.3 Option 3: Replace with a larger 500 mm² cable

This option involves laying a 500 mm² (35 MVA) subsea cable rather than the like for like replacement in option 2. This cable has a higher initial cost but lower overall costs as it avoids the need to reinforce in 2033. Although preferable to option 2, it retains a single circuit security of supply and potential risk of an interruption and the impact costs.

The cost of this option would be £[redacted] m. Although preferable to option 2 this was rejected due to the lower security of supply level and a lower NPV value.

6.1.4 Option 4: Augmentation with a similar sized cable.

This option is similar to option 2, laying a similar cable to the existing, but retaining the existing cable until it faults. This would incur additional costs for switchgear at both ends and short lengths of 33 kV cable to connect into the existing network.

This would provide enhanced security of supply with two circuits until the existing cable became faulty, at which time the supply would revert to a single circuit as in option 2.

The cost of this option is as option 2 plus the added cost of switchgear. When the existing cable fails the single circuit would need to be reinforced by 2033 requiring a larger cable and incur the additional cost.

The cost of this option would be £[redacted]m in 2024, with an additional cost of £[redacted]m by 2033 to cater for the demand increase. This would provide two circuits until the existing cable failed and although the security would be improved with the second cable by 2033 it would not be N-1 secure as the first circuit would not be able to supply full demand.

This option was rejected as it was overall higher cost and had a limited benefit over option 2 based on the limited life expected of the existing cable.

The cost of this is £[redacted]m in 2024 followed by a further £[redacted]m by 2033.

6.1.5 Option 5: Augmentation with a larger cable.

As option 4 but utilising a 500mm² cable immediately to avoid further costs when the existing cable becomes overloaded by 2033, should it still be in service. The benefits of augmenting are limited by the life of the existing cable which is assumed to fail in 2026.

This was rejected due to cost and the limited improvement in security of supply and reliability with a single circuit. The cost of this option would be £[redacted]m in 2024.

6.1.6 Option 6: Installation of two new cables on the existing route

The current subsea cable route from Ardmore to Loch Clachan is 46.17 km long and is along a known route and landing sites which gives high confidence in the viability of the route and reduces potential cost increases following detailed surveys.

This was considered due to the improvement in reliability and security provided by two new cables which would ensure that in the event of a subsea cable fault supplies would be maintained and avoid impact costs and constraint costs. The laying of the two cables together under the same contract is expected to allow cost savings of 15% on the second cable compared to the first.

This has been costed on 500 mm² cables and would provide firm N-1 capacity and cater for the load growth on the Uists island group until around 2050. There is a need to confirm that there is upstream network capacity on the transmission system.

The overall cost of this option was £[redacted]m. This option was rejected as although the benefits were better than options 1 to 5 there was a significantly higher initial cost due to the subsea route length.

6.1.7 Option 7: Installation of two new subsea cables on alternative routes from different GSP's

The initial cable route from Skye to South Uist installed 30 years ago was dictated by the infrastructure at that time with the grid station at Ardmore, and the load on North and South Uist requiring a connection central to the islands. At the present time, options for the supply include more direct routes from Ardmore to Loch Maddy and from Dunvegan grid further south than Ardmore on Skye. This will result in shorter subsea crossings of [redacted] km and [redacted] km respectively. This would provide a number of advantages in increased reliability with shorter subsea cables and supply coming from Dunvegan grid as well as Ardmore. The future subsea inspection costs would also be less on a shorter cable, albeit there would be the introduction of an additional cable.

It is recognised that most of the load growth forecast out to 2050 on Uist is centred on Clachan in North Uist. This option includes a [redacted] km 33kV subsea cable from Ardmore Grid to North Uist and a [redacted] km 33kV overhead line from the coast to Clachan primary substation, this can be seen as the Green dashed line in Figure 6 below and the overall route is visible in figure 2 as a blue dashed subsea route followed by the green dashed land route from Lochmaddy to Clachan primary S/S. This has driven the option of utilising the current supply point at Ardmore grid to provide a more direct subsea route to the islands at a point where the demand increase is expected to be greatest.

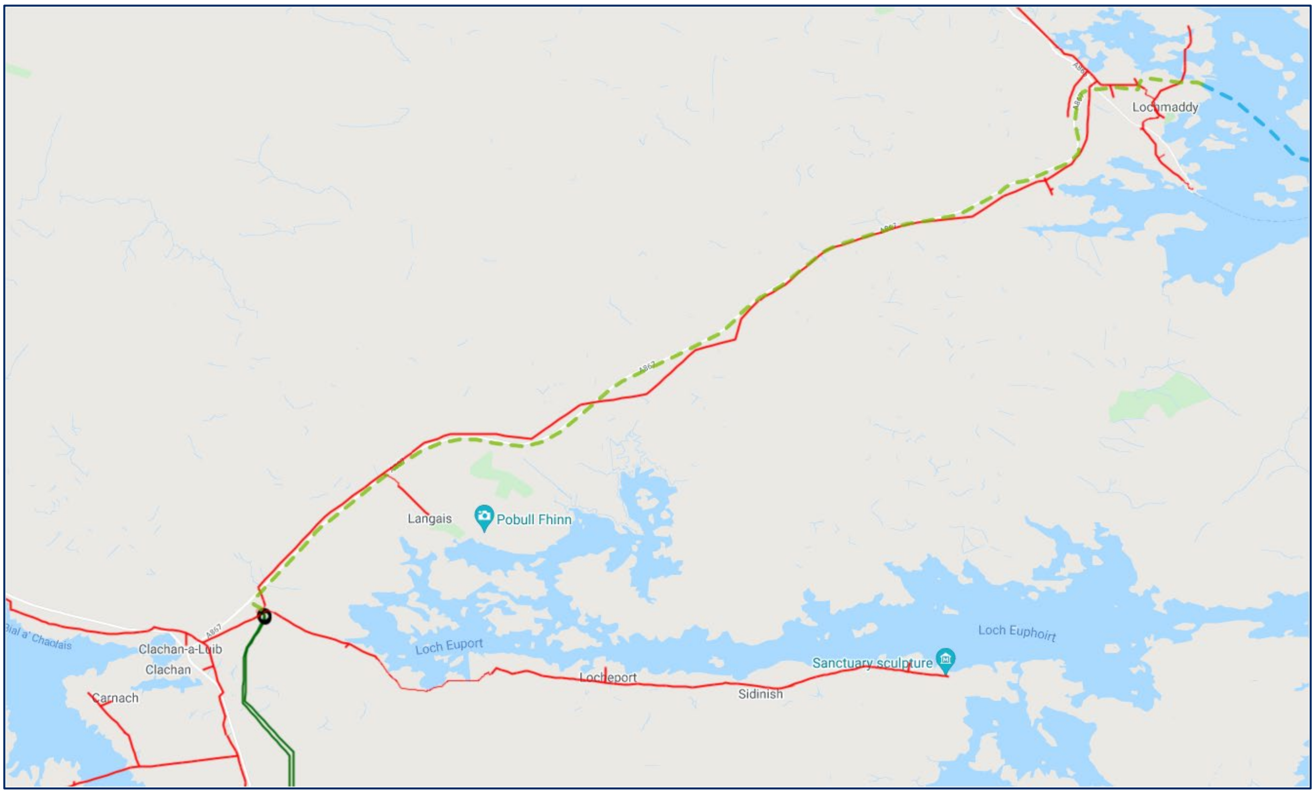

Figure 6: Ardmore grid – Clachan 33kV overhead line route.

This option provides for a second cable installed as the Southern cable route, which would require a circa [redacted] km 33kV overhead route from Dunvegan to the coast around Millovaig and Loch Pooltiel. The actual route would be dictated by the coastal contour and selecting the optimal landing site. This proposal for the southern route can be seen in Figure 2, highlighted by red dashed (onshore) and green dashed (Offshore) lines indicating the proposed route. This southern route has a separate EJP to reflect that this option may be delivered as two separate campaigns. The introduction of a new 33kV OHL to this part of Skye also offers potential additional benefits to customers in this area, fed from the local 11kV circuits from Dunvegan, which are on radial feeds at the moment. Potentially a future 33/11kV step down primary transformer could be installed around Millovaig to boost resilience and quality of supply for customers on Skye, although this is not currently in the planned works or scope of this project.

It has initially been intended to use 500 mm² subsea cable rated at 35 MVA per cable, but this will be assessed in the detailed design phase to confirm the cable suitability and will be subject to detailed systems studies. This will provide full N-1 capacity to the island up to 2050 based on the forecast in Figure 4. Using two independent routes from different grid stations and to different primary substations geographically separated on land and at sea to provide maximum security for this option compared to the other options. This option provides higher levels of security and best NPV of the options considered.

The total capital cost of this option is broken down as £[redacted]m for the North Route and £[redacted] m for the South Route (defined in EJP ***458_SHEPD_SKYS_UIST_SOUTH***). Giving a total option cost of £[redacted] m. This is the preferred option with the best NPV and is the most secure and reliable of the options considered. It also supports internal and external expectations to reduce our reliance on diesel driven embedded generation.

7 Summary of Cost Benefit Analysis (CBA)

This section of the report provides an overview for each option from the Cost Benefit Analysis (CBA). A detailed exercise has been undertaken to support the investment strategy that is described within this EJP for the 7 options, as described below:

7.1 Summary of Cost

Our RIIO-ED2 Business Plan costs are derived from our outturn RIIO-ED1 expenditure. For our Subsea cable projects, our Unit Costs have been derived from analysing costs pertaining to delivered projects completed during RIIO-ED1 and are therefore based on actual costs. For cable installation activities the delivered projects were competitively tendered utilising our Subsea Cable Installation Framework and cable costs have been benchmarked against recently completed tender events. By tying our costs back to reported, outturn, real life data this approach provides multiple data points and provides a high level of cost confidence in our Business Plan cost forecast for RIIO-ED2.

As our Business Plan has developed, project scopes and costs have been refined, especially with the input of valuable stakeholder feedback on our draft proposals. This final Business Plan submission cost forecast contains that refinement, and the changes are captured within our supporting plan documentation. The generic Unit Cost rates used in the draft Business Plan have now been revised following extensive analysis. This is further defined within ***Scottish Islands (Annex 8.1).***

A summary of the costs for all options is shown below in table 3.

Table 3: Summary of Investment Option Costs

Options	Unit	2023/24	2024/25	2025/26	2026/27	2027/28	Total
1. Do Minimum	£m	0	0	0	0	[redacted]	[redacted]
2. Replace	£m	0	0	0	0	[redacted]	[redacted]
3. Replace with larger cable	£m	0	0	0	0	[redacted]	[redacted]
4. Augmentation	£m	0	0	0	0	[redacted]	[redacted]
5. Augmentation larger cable	£m	0	0	0	0	[redacted]	[redacted]
6. Two new cables existing route	£m	0	0	0	0	[redacted]	[redacted]
7. Two new cables on alternative route	£m	0	0	0	0	[redacted]	[redacted]

7.2 Cost Benefit Analysis Comparisons

The NPV over 45 years demonstrates that Option 7, to replace the cable along 2 new cable routes, as the best overall option.

Table 4: Summary of Option NPVs

Options	NPV After 45 Years (£m)
Option 1 – Do Minimum	1,144.6
Option 2 – Replace	1,282.8
Option 3 – Replace Larger Cable	1,279.7
Option 4 – Augment	1,229.8
Option 5 – Augment Larger Cable	1,226.8
Option 6 – Replace Two New Cables Along Existing Route	1,301.5
Option 7 – Two New Cables Alternative Route	1,310.5

The monetised risk value for the Skye – South Uist 33kV subsea cable is £13.87m at the start of ED2 and, without intervention, will increase to £45.07m at the end of ED2. With the intervention proposed in this EJP the risk will reduce to zero with both cables in service providing an N-1 capability at distribution level.

7.3 Volume on Preferred Option

The option selected requires two new subsea cables at a total length [redacted] km to be laid along new routes and connected into the current 33 kV network. The approach taken has included the cost of additional overhead lines, circuit breakers and other associated onshore infrastructure required for connection.

Table 5: Summary of Preferred Option Volumes (Northern Route)

Asset Category	Unit	2023/24	2024/25	2025/26	2026/27	2027/28	Total
33kV OHL	km	0	0	0	0	[redacted]	[redacted]
33kV Poles	No	0	0	0	0	[redacted]	[redacted]
33kV Switch (PM)	No	0	0	0	0	[redacted]	[redacted]
33kV Subsea Cable	km	0	0	0	0	[redacted]	[redacted]
33kV CB Gas Insulated Busbar) (ID) (GM)	No	0	0	0	0	[redacted]	[redacted]
33kV UG Cable	km	0	0	0	0	[redacted]	[redacted]

Table 6: Summary of Preferred Option Volumes (Southern Route)

Asset Category	Unit	2023/24	2024/25	2025/26	2026/27	2027/28	Total
33kV OHL	km	0	0	[redacted]	0	0	[redacted]
33kV Poles	No	0	0	[redacted]	0	0	[redacted]
33kV Switch (PM)	No	0	0	[redacted]	0	0	[redacted]
33kV Subsea Cable	km	0	0	[redacted]	0	0	[redacted]
33kV CB Gas Insulated Busbar) (ID) (GM)	No	0	0	[redacted]	0	0	[redacted]
33kV UG Cable	km	0	0	[redacted]	0	0	[redacted]

8 Deliverability & Risk

Our ***Deliverability Strategy (Annex 16.1)*** describes our approach to evidencing the deliverability of our overall plan as a package, and its individual components. Testing of our EJPs has prioritised assessment of efficiency and capacity, and this has ensured that we can demonstrate a credible plan to move from SSEN's RIIO-ED1 performance to our target RIIO-ED2 efficiency.

We have also demonstrated that SSEN's in house and contractor options can, or will through investment or managed change, provide the capacity and skills at the right time, in the right locations. This assessment has been part of the regular assessment of our EJPs, IDPs and BPDTs. For the investment proposed under our subsea cable related EJPs, we have been developing our RIIO-ED2 Commercial & Deliverability Strategy and engaging with our supply chain to ensure we can deliver the solutions proposed, while identifying and managing the risks presented by the complex and challenging nature of the projects.

Our deliverability testing has identified major strategic opportunities which is relevant to all subsea EJPs.

- In RIIO-ED2, SSEN will change the way Capital Expenditure is delivered, maximising synergies within the network to minimise disruptions for our customers. This is particularly relevant for a Price Control period where volumes of work are increasing across all work types.
- The principle is to develop and deliver programmes of work, manage risk and complexity at programme level and to develop strategic relationships with our suppliers and partners to enable efficiency realisation. This potentially includes refining our contracting strategies to improve our risk profiles.
- Transparency with the supplier in terms of constraints, challenges, outage planning and engineering standards will capitalise on efficiencies, supported by a robust contracting strategy.

The delivery programme for all subsea cables in RIIO-ED2 will be determined through detailed planning and engagement with marine installation contractors and cable procurement opportunities. In addition, early stakeholder engagement will significantly de-risk project schedules and deliver value.

We are already identifying opportunities for improved efficiency and improved risk management of our projects and associated programmes. As part of the planning for our final Business Plan submission, we have explored subsea cable project 'bundling' by cable type and geographic location. Our delivery year for each EJP is based on this initial assessment, which will be further explored and then refined with our supply chain in early 2022 to identify the optimal equilibrium of project deliverability and risk management.

9 Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to provide the investment justification and option selection for the 33 kV subsea cable from Skye to South Uist (North route).

Due to the subsea cable faults in RIIO-ED1 the approach has been to pre-empt failures where possible. The creation of the monetised risk CBA model allows for the circuits which are likely to have the biggest impact to be addressed.

This approach considers the subsea population within the CBA tool to identify the appropriate circuits to be replaced. This EJP is to cover the Skye to South Uist cable which is the highest scoring in the model in terms of monetised risk and will have the biggest impact on SHEPDs overall subsea cable monetised risk when replaced. This identifies the most critical circuit by a significant margin within the subsea cable population. The Probablility of Failure is increasing significantly over ED2 and the consequences of failure are £7.35 million upon failure, at which time action would be required to resolve the outage.

7 options were consdiered as shown;

- Option 1: Do Minimum – replace on failure
- Option 2: Replace the cable with the same size cable
- Option 3: Replace the cable with alarger cable
- Option 4: Augment by laying a similar sized cable and retaining the existing cable.
- Option 5: Augment by laying a larger cable and retaining the existing cable.
- Option 6: Lay two new cables along the esisting route
- Option 7: Lay two new cables along alternative shorter routes

The monetised risk value for the Skye to South Uist 33 kV subsea cable is £13.87m at the start of ED2 and without intervention will increase to £45.07m at the end of ED2. With the intevention proposed in this EJP the the PoF is significantly less for each cable individually and the two cables combined reduce the potential risk to zero with full N-1 at a distribution level.

The preferred option is option 7 - Install two new cables along alternative shorter routes with associated onshore infrustructure. The full cost of £[redacted]m will be incurred in CV25 in ED2 in relation to both the proposed North and South routes to relace the exisiting cable. Associated with the North cable alone will be an expenditure of £[redacted]m. The delivery programme for all subsea cables in ED2 will be determined through detailed planning and engagement with marine installation contractors and cable procurement opportunities.

Table 7: Summary of Spend per Asset Category (Northern Route)

CV25 High Value Project	Asset Category	ED2 (£m)
CV25 RIIO ED2 Spend	EHV Subsea Cable	[redacted]
CV25 RIIO ED2 Spend	33kV OHL	[redacted]
CV25 RIIO ED2 Spend	33kV Poles	[redacted]
CV25 RIIO ED2 Spend	33kV Switch (PM)	[redacted]
CV25 RIIO ED2 Spend	33kV CB Gas Insulated Busbar) (ID) (GM)	[redacted]
CV25 RIIO ED2 Spend	33kV UG Cable	[redacted]

Table 8: Summary of Spend per Asset Category (Southern Route)

CV25 High Value Project	Asset Category	ED2 (£m)
CV25 RIIO ED2 Spend	EHV Subsea Cable	[redacted]
CV25 RIIO ED2 Spend	33kV OHL	[redacted]
CV25 RIIO ED2 Spend	33kV Poles	[redacted]

CV25 RIIO ED2 Spend	33kV Switch (PM)	[redacted]
CV25 RIIO ED2 Spend	33kV CB Gas Insulated Busbar) (ID) (GM)	[redacted]
CV25 RIIO ED2 Spend	33kV UG Cable	[redacted]