502_SHEPD_HSM_24_UIST-ERISKAY

SOUTH UIST – ERISKAY ENGINEERING JUSTIFICATION PAPER

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1 Executive Summary

1.1 Summary

Background

This Engineering Justification Paper (EJP) for Scottish Hydro Electric Power Distribution (SHEPD) sets out the investment required for the South Uist – Eriskay 11kV subsea cable and associated evidence and justification to support Ofgem's assessment of this investment. As this re-opener submission seeks funding for the South Uist – Eriskay cable replacement, this EJP reflects on currently available data where appropriate and builds upon the initial submission which was made to Ofgem as part of SHEPD's draft RIIO-ED2 business plan submission, prior to the cable being removed from SHEPD's baseline and moved to the HOWSUM.

The South Uist – Eriskay subsea cable provides one of the main connections between South Uist in the Outer Hebrides to the islands of Eriskay. It also provides strategic back up under outage contingencies for Barra and Vatersay. This subsea cable works in conjunction with subsequent subsea cables feeding the smaller islands and a second land-based connection between Pollachar and Eriskay. The South Uist – Eriskay cable was installed in 1987, previous subsea cable installations in this area are recorded and have previously failed and been abandoned.

Drivers for change

SHEPD have been assessing whole system solutions for the Outer Hebrides, looking at the larger Islands of Lewis, Harris, North Uist, Benbecula and South Uist. These islands are currently supplied via SHEPD's 33kV network from Ardmore on Skye. Wider network reconfiguration and reinforcement is proposed for these parts of the network and further details can be found in the associated core narrative document and associated EJPs. Whilst conducting wider whole system analysis, no major network changes were highlighted or proposed for the 11kV network supplied from Pollachar. i.e. no alternative source or credible network route was identified to supply the wider islands by connecting through Barra/Eriskay and hence the islands will remain supplied on the 11kV network from Pollachar. The islands on Eriskay, Barra and Vatersay are connected to Pollachar on South Uist via 11kV network made up of OHL, underground cable and subsea cables. One of the 11kV cables, which is the first subsea cable section between Pollachar (South Uist) and the subsequent islands is the South Uist – Eriskay cable.

Through network assessment this cable has been found to have a high network risk and associated impact costs should the cable fail in service, and although currently only a Health Index (HI)3 cable, has been deemed in need of replacement to reduce the associated probability of failure and risk associated with the wider network.

The South Uist – Eriskay cable is mainly buried across its route and therefore it is challenging to gain an end to end visual inspection of the cable, with mainly nearshore areas periodically becoming exposed. Previous shore-end remedial works have taken place on this cable to re-bury and protect the shore ends.

As part of securing this section of network and improving future cable resilience, alongside additional investments on the downstream Eriskay – Barra subsea cable, which is proposed to be augmented with a second cable. Additional details on proposals for the Eriskay – Barra subsea cable can be found in Appendix 5A – Eriskay-Barra EJP.

It is therefore proposed by SHEPD to replace the existing South Uist – Eriskay cable base on the cable age and associated network risk with the asset which is reaching the end of its operational life. In its place will be installing a new, land-based solution in its place, securing this section of network.

Options analysis

SHEPD have assessed seven different options for the replacement of the existing submarine cable. An eighth option has also been considered but this is a sensitivity on the investment timing of option seven. The first six options explore traditional subsea cable installations of varying numbers and sizes. Options seven and eight then explored land-based alternatives.

Option seven, the replacement of the existing subsea cable with an alternative land-based solution through the South Uist – Eriskay causeway was determined as the best technical and financial long term network solution. This conclusion was further supported by outputs of the CBA which confirmed, based on option NPVs that it is better to invest now in RIIO-ED2 rather than defer expenditure to later in RIIO-ED3.

CBA and overall cost

A detailed CBA has been conducted at all key stages of the project. This CBA considered all eight options from the options analysis. An overview of the results has been provided in Table 1.

Option	10 year NPV	45 year NPV
1. Do Nothing - Fix on Failure	(£1.96m)	(£4.85m)
2. Replace - Similar Sized Cable	(£1.77m)	(£4.20m)
3. Replace - Larger Cable	(£1.85m)	(£4.40m)
4. Augment - Similar Sized Cable	(£1.78m)	(£4.22m)
5. Augment - Larger Cable	(£1.86m)	(£4.42m)
6. Reinforcement - two new cables	(£3.26m)	(£7.82m)
7. Replace - Land based solution - 2026/27	(£0.05m)	£0.15m
8. Replace - Land based solution - Deferred to 2031/32	(£0.08m)	£0.01m

Table 1: South Uist – Eriskay cable replacement CBA

The current forecast cost for the optimal solution is [redacted] (2020/21 prices) including risk of [redacted], shown in Table 2. This has utilised SHEPD unit rates for the associated network assets. SHEPD propose to include this scope of work alongside other baseline projects being delivered on the islands to drive cost efficiencies and reduce network outages.

2020/21 prices	Class 2 Estimate, January 2024
Project costs	[redacted]
Project risk cost	[redacted]
Total:	[redacted]

Table 2: South Uist – Eriskay cost estimate 2024

Solution delivery

The aspects of the proposed solution are business as usual activities for SHEPD. There are challenges associated with the installation of the new onshore cable surrounding the design deviations but these are manageable, especially given the long term benefits of the solution. SHEPD also has a precedence and confirmation that this type of solution can be installed in this location, as a similar circuit route is already installed in the West side of the causeway crossing. There will be challenges on installation due to the geographical location and topography of the area associated with the project but these are more around the rate of progress rather than the deliverability of the solution. SHEPD has high confidence in being able to deliver the proposed investment.

Conclusion

SHEPD has conducted options assessment and CBA to support the replacement of the existing South Uist – Eriskay subsea cable. This analysis suggests that the existing cable should be replaced with a land based solution within the RIIO-ED2 price control period.

SHEPD was provided development funding for HOWSUM projects under RIIO-ED2 Final Determinations. We have estimated that development costs for the South Uist – Eriskay subsea cable replacement are circa [redacted]. The final proposed solution for this cable is estimated to cost [redacted]. SHEPD is therefore seeking to recover [redacted] of additional funding relating to this project at this time under the HOWSUM reopener mechanism, provided for in Special Condition 3.2 Part O. SHEPD is seeking full approval from Ofgem to proceed with the preferred long term technical solution for this cable replacement.

The benefits associated with delivery of this project are significant and include improved asset health and reliability, contribution to security of supply and meeting demand and generation needs as part of a whole system solution out to 2050 and beyond.

Further detail on all key areas is included in the following sections. This EJP should be read in conjunction with the Hebrides and Orkney Whole System UM Core Narrative, Appendix 4B – Uist-Eriskay CBA, and the wider submission documents.

2 Investment Summary Table

Within this paper all price bases are in 2020/21 prices. As part of any CBA a capitalisation rate of 85% and a pre-tax WACC of 4.12% have been utilised.

Name of Scheme/Programme	South Uist – Eriskay 11kV Subsea Cable Replacement	
Primary Investment Driver	CV7a Asset Replacement & Associated monetised risk	
Scheme reference/ mechanism or category	502_SHEPD_HSM_24_UIST-ERISKAY	
Output reference/type	2.75km HV Sub Cable Disposal 2.3km HV U/G Non Pressurised Addition 19 HV Pole Additions 1.3km HV Conductor Addition	
Cost	TOTAL: HOWSUM DEVELOPMENT FUNDING: **NET FUNDING SOUGHT:**	[redacted] [redacted] [redacted]
Delivery Year	2026/27	
Reporting Table(s)	CV7a Asset Replacement; R3	
Outputs in RIIO ED2 Business Plan?	No - project sits under the HOWSUM. HOWSUM Development Funding (HDF) has been provided as part of SHEPD's RIIO-ED2 settlement for HOWSUM project development costs. Uist-Eriskay development costs in RIIO-ED2 are estimated at [redacted] (see also Hebrides and Orkney Whole System Core Narrative, Table 5).	
Spend Apportionment	**RIIO-ED2**	**RIIO-ED3+**
	[redacted]	N/A
MVA released	N/A	N/A

Table 3 South Uist – Eriskay investment summary table

3 Appendices Summary

Table 4 summarises the appendices.

Appendix	Summary of content
Appendix 4B – Uist-Eriskay CBA	Full details of project cost benefit analysis

Table 4 Summary of appendices

4 Introduction

The South Uist – Eriskay submarine cable was identified as a cable qualifying for intervention as part of SHEPD's RIIO-ED2 business plan submission. The cable has been selected for intervention due to the monetised risk it currently contributes to the network. The replacement cable will reduce this risk by removing the asset from the marine environment and by installing new onshore assets providing longer asset life.

This project forms part of a whole system approach taken on the Outer Hebrides. Over the course of RIIO-ED2 there are potentially 5 subsea cable investments proposed relating to the overall electricity network on the Outer Hebrides. This cable forms an integral part of a whole system approach ensuring the network is fit for purpose for the long-term and supports a transition to net zero.

Several subsea cable circuits have failed during RIIO-ED1, causing significant impact on customer interruptions, constrained generation, and have resulted in impact costs for temporary generation and CO2 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 effectively on its own.

This paper recommends the existing subsea cable is replaced with a land-based solution, including a causeway crossing. This will improve circuit reliability, asset life and result in a more efficient project delivery. This solution is estimated at around 10% of the cost of a subsea cable replacement whilst delivering a longer life asset and associated benefits.

5 Background Information

5.1 Existing Network Arrangements

The South Uist - Eriskay subsea cable is supplied from Pollachar 33/11 kV Primary S/S on South Uist and provides supplies to 1,052 customers on Eriskay and Barra, as well as some other smaller islands. This cable has been identified as requiring intervention during the RIIO-ED2 price control period to ensure an acceptable level of risk is maintained on the SHEPD network.

The existing subsea cable is a 95 mm² PILC 'H' SWA 11 kV cable and is 2.75 km long. The cable is rated at 4.7MVA. The cable is currently connected between East Kilbride on South Uist and Rhuban on Eriskay as shown in Figure 1. The cable routes and subsea cable and network arrangements are shown in Figure 2.

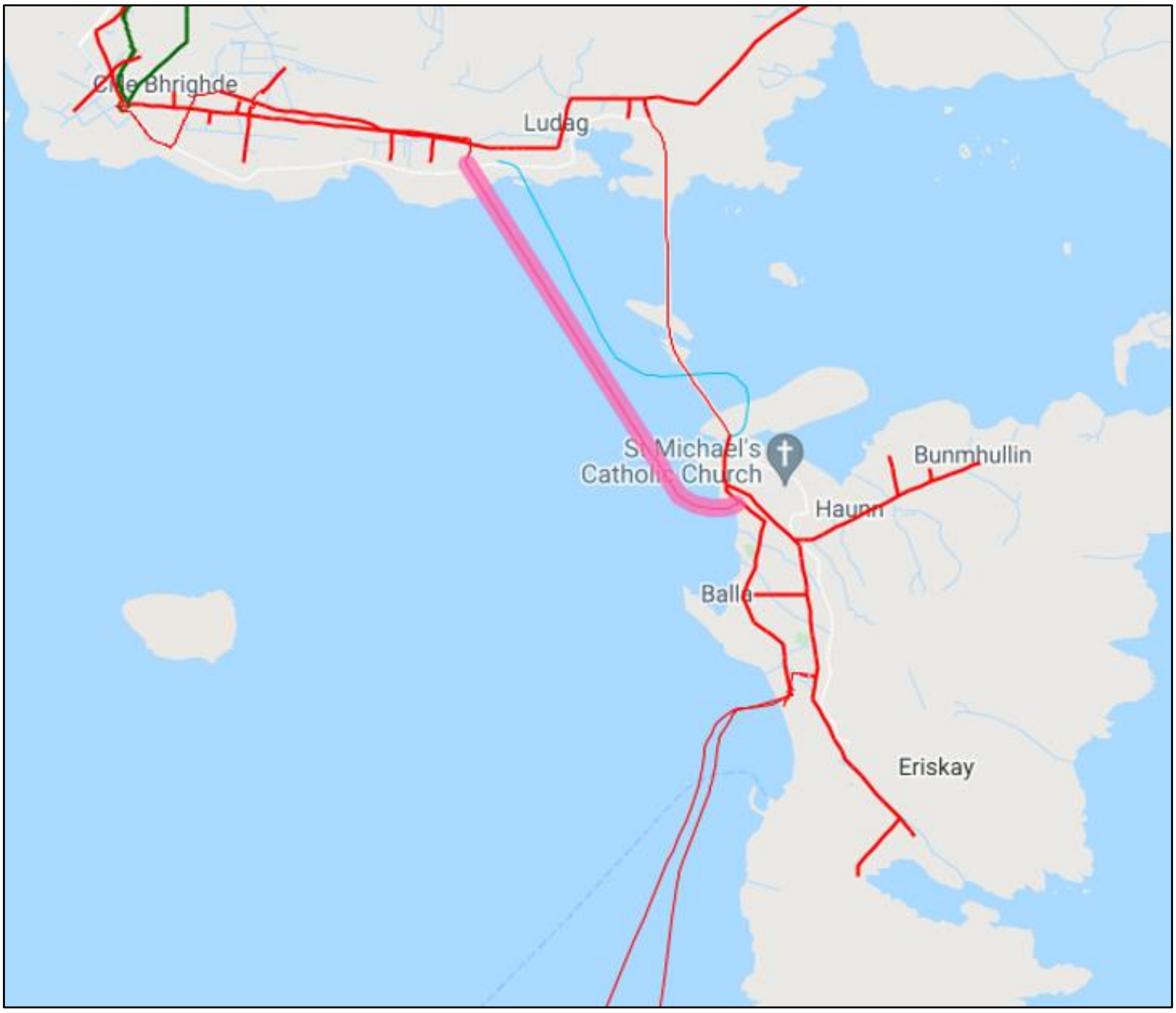

Figure 1: South Uist - Eriskay Subsea Cable Route

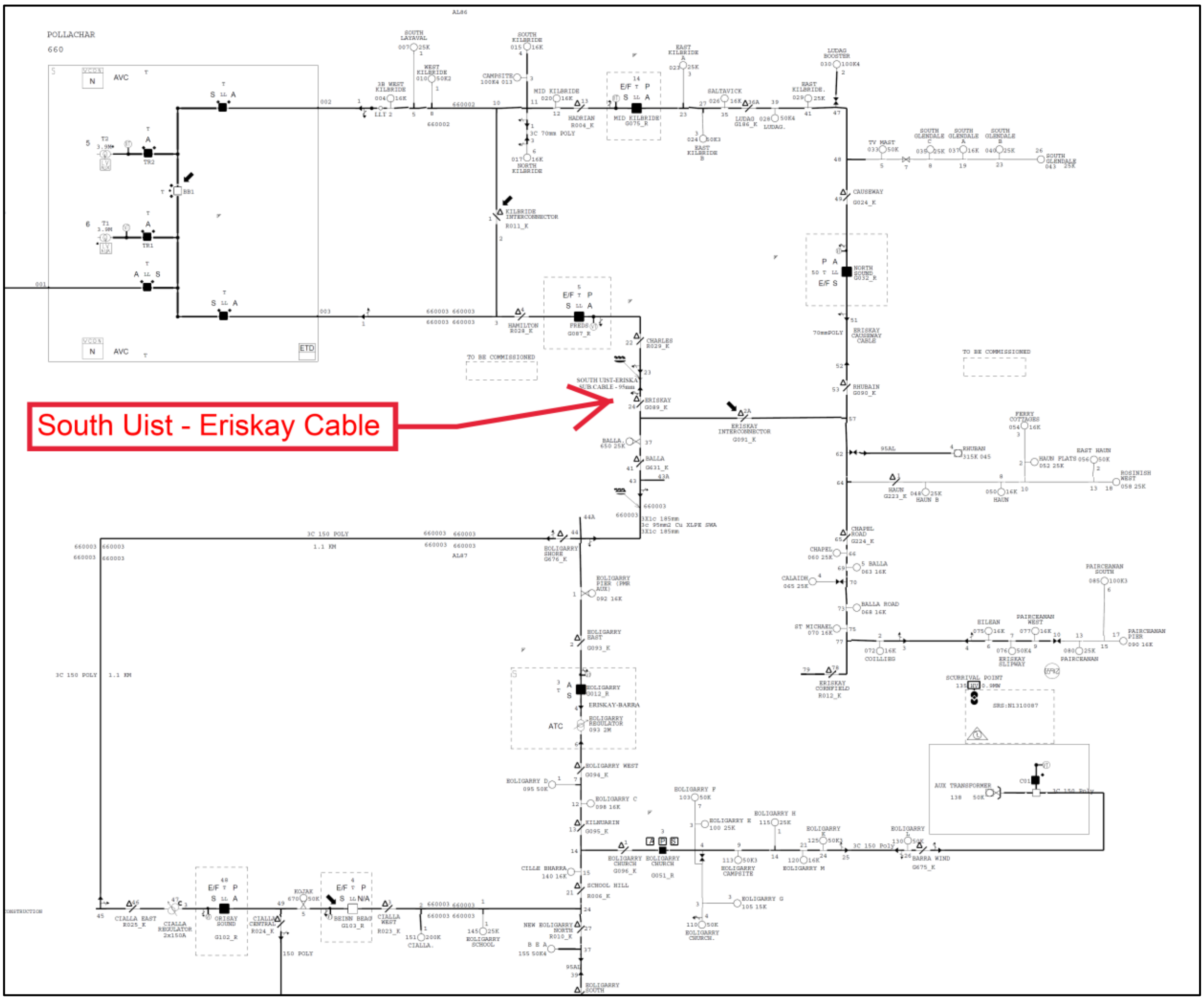

Figure 2: South Uist – Eriskay 11 kV subsea cable and network arrangement

5.2 Load Forecast for South Uist - Eriskay

The current maximum demand on the South Uist - Eriskay cable is 1.79MVA (38.1% of the cable rating). Based upon the 2022 CT Winter Maximum DFES from Pollachar substation it is anticipated that, on average, the 11kV feeder which the South Uist – Eriskay cable is on will experience an average load growth per year of 1.98% between 2023 and 2050. Therefore, forecast demand by 2050 is expected to be 3.1 MVA. The forecast demand projection anticipated to be seen by the circuit is shown in Figure 3 below. This also highlights than demand is not forecast to continually grow significantly, and tails off. This provides reassurance that the new proposed asset will be sufficient to provide for network needs over the asset life.

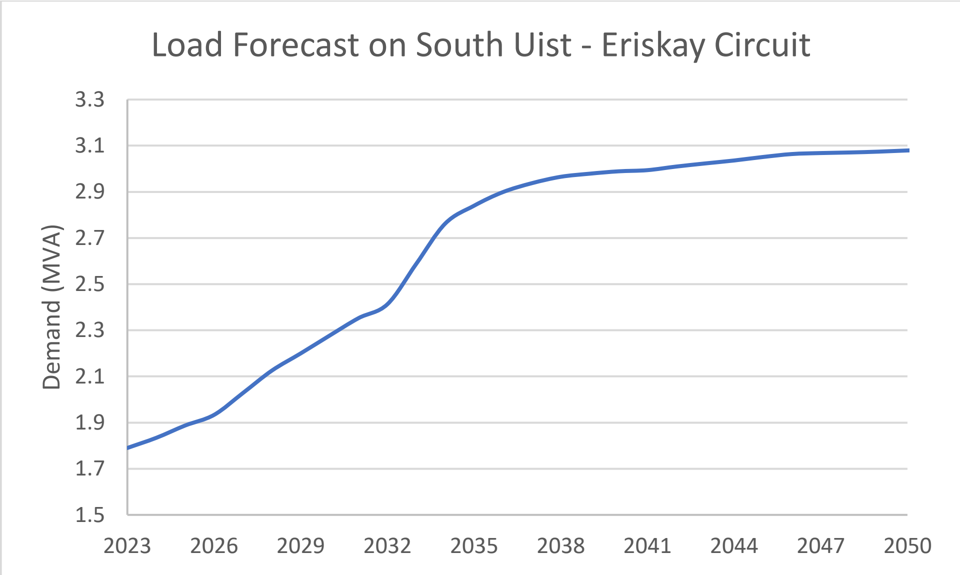

Figure 3: Load Forecast South Uist - Eriskay - 11 kV Feeder

5.3 Existing Asset Conditions

The SHEPD_52 South Uist – Eriskay 11kV subsea cable was installed in 1987 and as such has been in service for 37 years with a current Heath Index of HI3 and Criticality Index of CI2 and is anticipated to become an HI4 CI2 by the end of RIIO-ED2, with no intervention. The cable is forecast to become an HI5 asset in 2032/33. It is very difficult, in this location, to perform a full visual inspection of the subsea cable. This is due to the shallow water depth and the shifting nature of the marine environment sediment offshore. This means the cable is covered/buried for the majority of the route most of the time. Shore ends do become exposed on a semi-regular basis and have had maintenance to re-protect and bury in the intertidal zone. Given it is difficult to see the subsea cable it is hard to determine the physical external condition to derive an definitive condition score. The cable could therefore be in a much poorer condition than the INVEST input data would suggest, given the cable is 37 years old and has significantly exceeded the design life of a cable of this type.

The terminal poles associated with the existing asset are noted as being in good condition with some as expected deterioration.

5.4 Existing Operational Issues

There are not currently any operational issues with this specific circuit, however access to the existing Eriskay subsea landing location is challenging.

Voltage regulators are in place on this network to support maintaining network voltages within acceptable limits. These are normal network assets and network parameters are assessed through standard planning studies and new connections to ensure the statutory limits are managed effectively.

Further along the network there is only a single subsea cable feeding to Barra and onward islands. In the event of an outage of this cable, Barra Power Station is required to support the 11kV network. SHEPD is submitting a separate investment request through the HOWSUM to install a second operational subsea cable between Eriskay and Barra which will alleviate this issue if accepted.

5.5 Network Analysis Summary

Network studies have considered demand growth on the circuits out to 2050 in line with the CT DFES scenarios. These studies highlight no thermal or voltage issues associated with the new proposed onshore solution.

The studies also confirmed that the new overland route can support the 11kV network onto Barra and surrounding islands, under worst case N-1 contingencies.

There are no concerns with fault levels.

5.6 Regional Stakeholder Engagement and Whole systems analysis Summary

Through SHEPD's work with Regen on the DFES scenarios, multiple island stakeholder groups are engaged to allow a better understanding of future demand and generation requirements on the islands. A wide range of stakeholders have been consulted by REGEN as part of the works to develop the 2021and 2022 DFES scenarios and will be further engaged in the development of subsequent versions of the prediction models. This includes details of future connections activities, industrial electrification, local development plans and independent stakeholder ambitions.

SHEPD is continuing to directly engage with key stakeholders in relation to the wider whole system analysis and solution for the Outer Hebrides. This has included recent HOWSUM webinars and bilaterals, with further engagement planned throughout 2024.

Please refer to the HOWSUM Core Narrative document for more information on recent and planned stakeholder engagement activities.

5.7 Flexible Market Viability

This investment decision is not being driven through anticipated load growth or new connections, but from an asset health associated network risk and security of supply perspective as part of SHEPD's whole system planning, SHEPD is committed to considering flexible alternatives to traditional engineering solutions on our networks. SHEPD require to maintain this connection as part of the wider 11kV network supplying Eriskay, Barra and Vatersay. This element of network infrastructure is also key to any future reduction of use in, future planned repurposing, mothballing or removal of Barra Power Station. Flexibility calls to date have identified no services available in this area; however we will continue to monitor this as future calls are progressed. Our Distributed Embedded Generation (DEG) strategy, taking account of Barra Power Station, will be included in more detail in our January 2025 HOWSUM application.

5.8 Confidence Table

Table 5 provides an indication of our confidence levels in each of the sections which have been analysed/utilised as part of the solution assessment.

Confidence Factor	Certainty (High, Medium, Low)	Comments
Load forecast	Medium	Data is not collected/recorded for the 11kV level as part of the DFES. Data associated with 33kV primary and similar load growth profile applied to the existing 11kV load. This is thought to be representative of potential growth on the 11kV network in this area.
Existing asset condition	Medium/High	The existing subsea cable is mainly buried between landing locations. There could be instances of cable damage along the route which are not visible. Additionally, no electrical testing is performed on SHEPD subsea cables. Therefore, the subsea cable could be in a worse condition than assumed and confidence is Medium. The remaining onshore assets are much more visible and easily accessible and SHEPD has high confidence in their condition assessment.
Existing operational issues	High	This is a long-established network.
Connections activity	Medium	Connections are regularly changing, and new applications can be received at any time. However, we had reasonable certainty based on DFES analysis and research and connections pipeline at time of [redacted].
Regional stakeholder engagement	Medium	Outer Hebrides whole system webinars have been held also with the offer of bilaterals. Further engagement undertaken through DFES and wider community engagement sessions.
Flexible market viability	Low/Medium	There are a number of emerging technologies which may be possible considerations for flexibility as part of a long-term solution. The islands of Eriskay, Barra and Vatersay have limited flexible generation installed at the moment which could make this challenging.
Funding position	Medium	We have agreement to use the HOWSUM, and the outcome of the submission is subject to Ofgem's assessment. Based on our analysis of island needs we believe we have identified the correct solution for implementation at the correct time.

Table 5: Confidence table

6 Summary of Options Considered

6.1 Summary of Options

This section indicated the list of options which were considered as part of the overall investment solution for the South Uist – Eriskay subsea cable intervention.

- Option 1: Do-Minimum – Replace on failure.
- Option 2: Planned replacement during RIIO-ED2.
- Option 3: Replace with a larger 185 mm² cable.
- Option 4: Augmentation with a similar sized cable.
- Option 5: Augmentation with a larger cable.
- Option 6: Installation of two new cables on the existing route.
- Option 7: Installation of an underground cable following a land route through the Eriskay causeway
- Option 8: Installation of an underground cable following a land route through the Eriskay causeway, but with installation deferred to end of RIIO-ED3.

6.2 Options Comparison Table

Options	Description	Advantages	Disadvantages	Total cost
1. Do-Minimum – Replace on failure.	Continue to operate the existing cable until it fails, at which time the cable would be replaced.	Maximises existing asset life and may defer expenditure beyond RIIO-ED2.	Would be out of SHEPDs control as to when replacement occurs. Costs would be greater than planned replacement. Would incur impact costs and network outage. Would place strain on internal resource at time of fault. Restoration time would be unknown and subject to cable stock and consents.	[redacted]
2. Planned replacement during RIIO-ED2.	Replace the existing subsea cable with a new 95mm² cable.	Improves HI and provides new life cycle. Reduced probability of failure.	Remains single subsea cable in the marine environment.	[redacted]
3. Replace with a larger 185 mm² cable.	Replace the existing subsea cable with a new larger 185mm² cable.	Improves HI and provides new life cycle and allows greater protection of cable. Provides for future load and generation growth	Remains single subsea cable in the marine environment.	[redacted]

Options	Description	Advantages	Disadvantages	Total cost
4. Augmentation with a similar sized cable.	Install a new 95mm^2 cable but maintain the existing cable in service.	Similar cost to replacement. Provides a second subsea cable for the remaining cable life.	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 the equivalent of option 2. Requires additional onshore infrastructure and switching, which could be a challenge at available landing sites.	[redacted]
5. Augmentation with a larger cable.	Install a new larger capacity cable but maintain the existing cable in service.	Provides N-1 on the subsea cable for the remainder of the existing cable life	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. Requires additional onshore infrastructure and switching, which could be a challenge at available landing sites.	[redacted]
6. Installation of two new cables on the existing route.	Replace the existing subsea cable with two new subsea cables.	Provides two new circuits with additional back up contingency.	Highest cost. Requires additional onshore infrastructure and switching, which could be a challenge at available landing sites.	[redacted]
7. Installation of under-ground cable following a land route through the Eriskay causeway	Replace the existing subsea cable with new OHL and under-ground cable assets utilising a causeway crossing.	Assets would have longer anticipated life than subsea cable. Significantly cheaper than any of the subsea cable options. Removes new infrastructure from marine environment. Easier to access and repair in the future. Reduce future inspection costs	Require SHEPD to request design deviations from internal policy documents. Increases amount of OHL in the area.	[redacted]

Options	Description	Advantages	Disadvantages	Total cost
8. Installation of under-ground cable following a land route through the Eriskay causeway, but with installation deferred to end of ED3.	Replace the existing subsea cable with new OHL and Under-ground cable assets utilising a causeway crossing. Carry out the works at the end of ED3.	As option 7 but would defer expenditure until end of next price control	As option 7 but also the benefits of replacing the existing cable will also be delayed. Increase risk of cable failing between now and installation. Could result in increase costs to rectify under fault conditions.	[redacted]

Table 6: Summary of investment options

7 Detailed Option Analysis

This section contains datils of the options analysis that was undertake for each of the technically feasible solutions. Option 7 has been determined as the preferred solution.

7.1 Option 1: Do Nothing – replace on failure

The "Do Minimum" Option is for the repair or replacement of the cable to be performed on failure. Based on the age, health index and length of the cable, repair would be by replacement of the entire subsea section of the cable following a similar route to that of the existing cable shown previously.

In the event of a cable failure, supplies to 1,052 customers would be interrupted and 0.9 MW of generation constrained off until re-routing of the network is complete. All customers can be supplied by an alternative source. However, the generation will be constrained until the fault is repaired. The generic model has assumed this will be for a period of six months to allow for mobilisation of resources to replace the cable.

The constrained generation costs during the outage are estimated at [redacted]

The emergency replacement of 2.75 km of subsea cable, following a similar route to the existing cable, has been estimated based on the planned replacement cost of [redacted]. This provides for an equivalent size cable (95 mm²) to provide capacity of 4.7 MVA which would satisfy the demand forecast until at least 2050.

This gives an estimated total cost of failure of [redacted]

This option avoids any initial cost of intervention and, should the cable not fault over the price control, will defer expenditure beyond RIIO-ED2. However, the cost of an emergency replacement would be higher than a planned replacement if the cable fails and it incurs the impact and environmental cost. The NPV over 45 years for this option is -£4,850,000, based on the CBA.

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

7.2 Option 2: Planned replacement during RIIO-ED2

Replacing the cable with a new 95 mm² XLPE Cu DWA subsea cable will impact the Health Index and Probability of Failure, resulting in a change to the characteristics set by the age and condition of the cable. The new cable will be connected to the existing network points and the old cable disconnected. This option is the planned replacement of the cable during RIIO-ED2 with a new 95 mm2 cable. This will avoid the costs incurred in the event of a failure. This option would keep the asset in the marine environment.

The replacement 2.75 km of subsea cable would be following a similar route to the existing cable and has been estimated at a cost of [redacted].

The NPV benefits calculation for this option outturns a value of -£4,200,000 within the CBA.

This option was identified as the preferred option at the time of the RIIO-ED2 draft business plan submission as it provided the lowest cost option and the best NPV of the subsea options considered. This option is now considered the fall-back option should the preferred option not be able to progress.

7.3 Option 3: Replace with a larger 185 mm² cable

This option is similar to option 2 but laying a new 185 mm² (8 MVA) subsea cable rather than the like for like replacement in option 2. The advantage this has over option 2 is that it would cater for additional or unforeseen growth up to and beyond 2050, but at higher initial cost. This option retains a single subsea cable and potential risk of an interruption and the impact costs. At present it is considered over engineered to proceed with this option given there would be additional cost for unused capacity. Additionally, SHEPD would have to procure new cable or use 33kV 185mm² stock cable which is earmarked for other projects and stored for emergency fault replacements.

The cost of this option is estimated at [redacted].

The NPV benefits calculation for this option outturns a value of -£4,400,000 within the CBA.

This option was rejected as the higher cost does not provide any material additional benefits above the preferred option 7 and option 2 the fallback subsea option.

7.4 Option 4: Augmentation with a similar sized cable.

This option is broadly similar to option 2, with the installation of an 11kV 95 mm² XLPE Cu DWA subsea cable but retaining the existing cable until it becomes faulty. This option would incur additional costs for connection into the 11 kV network on South Uist and Eriskay and would also result in increased maintenance and inspection costs.

This would provide enhanced security with two subsea 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 estimated at [redacted].

The NPV benefits calculation for this option outturns a value of -£4,220,000 within the CBA.

This option was rejected as it is at a higher cost and does not provide any significant additional benefit to justify the additional expenditure.

7.5 Option 5: Augmentation with a larger cable.

This option is similar to option 4 but utilising a 185 mm² cable instead of the 95 mm². This would cater for any additional potential growth, however on existing growth prediction levels this would not be necessary.

This, like option 4, provides N-1 security against a subsea fault until the failure of the existing cable.

The cost of this option is estimated at [redacted].

The NPV benefits calculation for this option outturns a value of -£4,420,000 within the CBA.

This option was rejected as the higher cost does not provide any significant additional benefits over the preferred option to justify the expenditure.

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

This option 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. [redacted]. This has been costed on 95 mm² cables and would provide firm N-1 capacity against a subsea cable fault.

The cost of this option is estimated at [redacted].

The NPV benefits calculation for this option outturns a value of -£7,820,000 within the CBA.

This option was rejected as the higher cost does not provide significant additional benefits to justify the investment over the preferred solution.

7.7 Option 7: Installation of an underground cable following a land route through the Eriskay causeway

This option was identified post submission of the RIIO-ED2 business plan but does appear to be a very viable solution – see Figure 4. This option would remove the submarine cable from the marine environment and install a section of OHL and land based, ducted cable through the causeway which runs between South Uist and Eriskay. Initial discussions have been held with the Western Isles Council engineers for the roads and bridge departments and they have confirmed they would be open to the idea. SHEPD already have a cable installed in the West side of the causeway, thought to have been installed around 2001 when the causeway was constructed. This option would be significantly cheaper than any of the submarine cable solutions and is estimated at around [redacted] based on RIIO-ED2 unit rates with an additional risk allowance of [redacted].

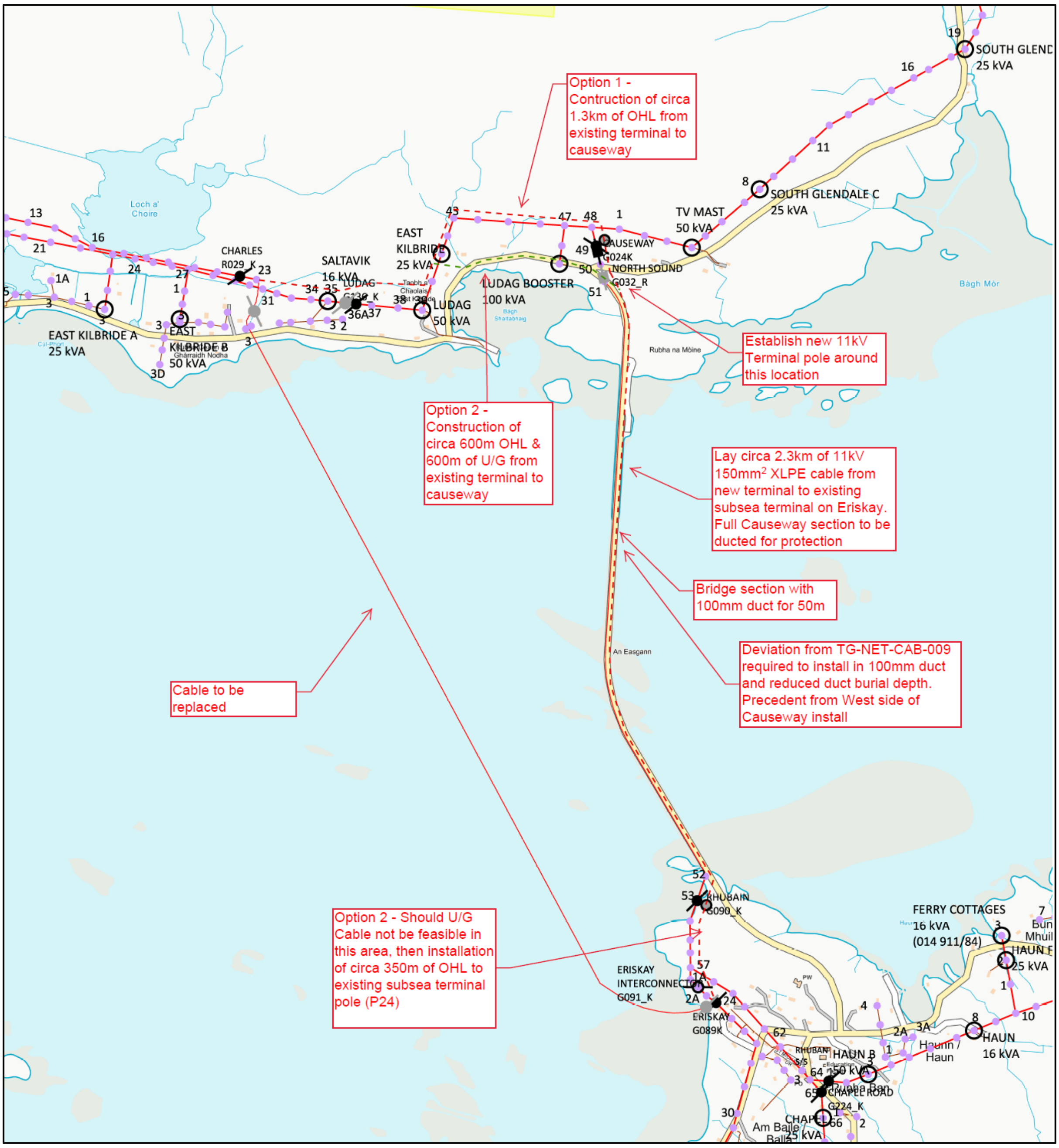

Figure 4: Proposed land-based solution for cable replacement.

The total estimated cost of this option is [redacted]. With an additional risk allowance of [redacted].

Similar to the other options, the reduction in probability of failure by removing the existing subsea cable drives the NPV benefit calculation.

The NPV benefits calculation for this option outturns a value of +£150,175 within the CBA. This NPV value is the best of all options.

This option is selected as the preferred option for progression to the development phase of this project. This option offers greater benefit at lower cost to Option 2 which was considered the preferred option at the RIIO-ED2 draft business plan submission stage. This option should remove a subsea cable from the network, increase asset life, resilience and security as well as reduce the requirement for ongoing submarine cable inspections and maintenance.

7.8 Option 8: Installation of an underground cable following a land route through the Eriskay causeway deferred to end of ED3

This is as per option 7 but with a sensitivity on deferment of the expenditure/installation until the end of the RIIO ED3 period instead of within RIIO-ED2. The NPV benefits calculation for this option outturns a value of +£12,653 within the CBA. Therefore, deferment of the option provides less benefit than delivering the works within the RIIO-ED2 period. This is not the preferred option.

7.9 Options summary table

Table 7 sets out a summary of option costs.

Option		CBA whole life NPV	Forecast costs (£)					
			2024	2025	2026	2027	2028	2032
1	Do-Minimum – Replace on failure	-£4.96m					[redacted]	
2	Planned replacement during RIIO-ED2	-£4.27m				[redacted]		
3	Replace with a larger 185 mm² cable	-£4.48m				[redacted]		
4	Augmentation with a similar sized cable	-£4.29m				[redacted]		
5	Augmentation with a larger cable	-£4.49m				[redacted]		
6	Installation of two new cables on the existing route	-£7.97m				[redacted]		
7	Installation of an underground cable following	£0.19m				[redacted]		

	Option	CBA whole life NPV	Forecast costs (£)					
			2024	2025	2026	2027	2028	2032
	a land route through the Eriskay causeway							
8	Installation of an underground cable following a land route through the Eriskay causeway, but with installation deferred to end of ED3	£0.04m						[redacted]

Table 7: Summary of option costs

8 Cost Benefit Analysis (CBA)

This section of the report provides an overview of the expected costs for each option from the CBA undertaken and submitted to Ofgem. This represents the output of the detailed exercise undertaken to support the recommended investment strategy and that is now summarised within this EJP.

8.1 CBA of Investment Options

The decision to progress with the new cable is supported by CBA analysis. As part of the CBA analysis, SHEPD assessed the merits of deferring the preferred solution until the end of ED3 instead of investing in RIIO-ED2.

The CBA and wider options assessment demonstrated that replacement now, with a land-based solution, is the best option.

All eight options were viable technical solutions and were therefore progressed to the CBA stage. These options are all deemed suitable to meet the long-term CT 2022 DFES out to 2050, under both normal and N-1 conditions.

The CBA considered the eight possible options below.

- Option 1 - Do-Minimum – Replace on failure.
- Option 2 - Planned replacement during RIIO-ED2.
- Option 3 – Replace with a larger 185 mm² cable.
- Option 4 – Augmentation with a similar sized cable.
- Option 5 – Augmentation with a larger cable.
- Option 6 – Installation of two new cables on the existing route.

- Option 7 – Installation of an underground cable following a land route through the Eriskay causeway.
- Option 8 – Installation of an underground cable following a land route through the Eriskay causeway deferred to end of ED3.

Table 8 shows the total capex element associated with each of the options which was assessed within the CBA. Option 8 indicates investment beyond RIIO-ED2 at the end of RIIO-ED3.

CBA Scenario	**CAPEX Cost £m (2020/21 prices)**						**£m (2020/21)**
	2024	**2025**	**2026**	**2027**	**2028**	**2032**	**Total**
Option 1					[redacted]		[redacted]
Option 2				[redacted]			[redacted]
Option 3				[redacted]			[redacted]
Option 4				[redacted]			[redacted]
Option 5				[redacted]			[redacted]
Option 6				[redacted]			[redacted]
Option 7				[redacted]			[redacted]
Option 8						[redacted]	[redacted]

Table 8: Total CAPEX associated with each CBA scenario

8.2 CBA Results

A CBA has been produced utilising the Ofgem standard template.

The results of this analysis and the output NPVs can be seen in Table 9. This analysis has concluded that Option 7 – Replacement of the existing cable with a land-based solution, utilising the Eriskay causeway, within RIIO-ED2, is the preferred solution based upon NPVs.

This option is the cheapest option whilst delivering maximum consumer and network benefits. This solution is also anticipated to have an extended asset life over a subsea cable solution.

Options	**NPV after 10 years (£m)**	**NPV after 45 years (£m)**
1. Do-Minimum – Replace on failure	-1.96m	-4.85m

Options	NPV after 10 years (£m)	NPV after 45 years (£m)
2. Planned replacement during RIIO-ED2	(1.77m)	(4.20m)
3. Replace with a larger 185 mm² cable	(1.85m)	(4.40m)
4. Augmentation with a similar sized cable	(1.78m)	(4.22m)
5. Augmentation with a larger cable	(1.86m)	(4.42m)
6. Installation of two new cables on the existing route	(3.26m)	(7.82m)
7. Installation of an underground cable following a land route through the Eriskay causeway	(0.05m)	(0.15m)
8. Installation of an underground cable following a land route through the Eriskay causeway deferred to end of ED3	(0.08m)	(0.01m)

Table 9: Comparison of CBA results for South Uist – Eriskay

Table 10 shows forecast final cost for the recommended solution.

Recommended Option	Investment Driver	Forecast actual costs (£m)				
		2023/24	2024/25	2025/26	2026/27	2027/28
7 Installation of under-ground cable following a land route through the Eriskay causeway	CV7a – Asset Replacement	0	0	0	[redacted]	0

Table 10: Recommended option summary – forecast final cost

9 Deliverability and Risk

Option 7 has been selected as the preferred option for refinement and execution.

Proposed works:

- Installation of circa 1.3km of 11kV OHL on South Uist from pole 23 on feeder 660 003, after Charles A/B. Establishing a new 11kV terminal pole around the location of Pole 51 on feeder 660 002.
- Installation of circa 2.3km* of 11kV underground cable from the newly established terminal pole on 660 003, to Eriskay through the island causeway.

  **It is currently proposed to cable from the new terminal pole on South Uist to the existing subsea terminal pole on Eriskay, giving total length circa 2.3km. However, onsite surveys and consents may mean cabling the last 350m on Eriskay, between the causeway and existing terminal pole, may not be possible. If cabling* *is not required, then the final 350m will require the construction of new OHL, with a short cable dip due to existing 11kV lines.*

- Decommissioning of the existing South Uist – Eriskay 11kV submarine cable by cutting back from the existing terminal pole locations to the mean low water spring mark, where possible.

The new network OHL and U/G cable should be able to provide a minimum current carrying capacity of 201 Amps Winter continuous, following any deratings which are applied.

At present network studies and initial calculations in line with SHEPDs internal design installation specifications indicate a 150mm^2 XLPE cable will be suitable of providing the design requirements. This has assumed de-rating due to ducting only. SHEPD's environmental action plan states we will install 300mm^2 XLPE cable for all new 11kV installations, however, given potential challenges with duct sizing on the bridge section of the causeway, a design deviation will be required, and an exemption approved to used 150mm^2 XLPE in this case to allow the bridge crossing to be achieved, this is not thought to be a concern.

SHEPD's OHL ratings documentation indicates that 32mm^2 Cu OHL designed to 65^{o}c would be suitable to meet the design requirements. However, the existing 11kV OHL prior to Charles A/B is installed as 38mm^2 and it would be proposed that this project does not install a conductor with a rating less than the existing 38mm^2 Cu.

There will be no change to the proposed network arrangement other that the subsea section indicated will become a land-based cable. Connection will still be between R029_K Charles A/B and G089_K Eriskay A/B.

Potential risks/issues/opportunities

Initial discussions have been held with the Western Isles Council engineers regarding the installation of a cable across the South Uist – Eriskay cause way including a crossing of a small bridge section. This has highlighted the below.

- The Western Isles Council engineers have no initial objections to the project proposal.
- Engineers have provided existing Bridge section drawings.
- Pre-installed ducting within the bridge section does not meet the minimum diameter requirements detailed in SSEN internal design documents.
    - Existing spare ducting is 100mm diameter and run through the East side of the bridge. Although smaller than our design requirements, the diameter is greater than a 150mm^2 XLPE Cable diameter, so a cable pull in would be possible with the use of a cable sock. A design deviation would be required.
- Pre-installed ducting [redacted].
    - SHEPD already have an 11kV cable installed in the West Side of the bridge section, [redacted].
    - Deviation required from design standards.
- Council engineers have indicated we can take up tarmac covering on the footpath and concrete on top if we wish. Given they are open to this, there may be no issue with lifting the footpath

and installing a 150mm diameter duct as per our requirements, but this would still not achieve the required burial depth.

- The causeway has protection at the side of the carriageway (large rocks and boulders) which can be washed out onto the road, during times of severe storms. Following these washouts, the protection is pushed back in place with JCB type diggers. It is therefore proposed that the cable install across the full of the causeway (circa 1500m) be protected within ducting. This may pose challenges for multiple cable duct pull ins along the route.
- The existing onshore topography on Eriskay between the end of the causeway and the network connection point may provide a challenge to install new OHL or underground cable. Should installation in this area not be possible, a longer cable route (up to 1km) may be required to navigate an alternative route.
- The geological formation of South Uist is of significant portions of hard rock. This could present challenges to the installation of further OHL infrastructure. It is likely that progress will be slow, and costs could be higher than standard unit rates. Any requirement for additional cabling sections will be challenging and slow given the rock structure of the ground.
- Due to this project crossing the marine environment, via an 80m bridge section as part of the causeway, a marine licence will be required from Marine Scotland Licensing Operations Team. This has the potential to increase project timelines. However, given the nature of the works and limited interaction with the marine environment this should not be an onerous or challenging application.

10 Outlook to 2050

Based on current analysis this solution will be fit for purpose and out to 2050 and beyond. The preferred solution will extend the circuit life and reduce the probability of failure occurring on this section of network. Additionally, should a fault occur, it should be significantly quicker to access, repair and return to service than the current subsea cable. The introduction of this overland solution in conjunction with works proposed between Eriskay and Barra to double up on the subsea cable circuits will likely reduce the running of Barra Power Station as part of SHEPD’s Outer Hebrides whole system solution.

11 Conclusion and Recommendation

It is recommended that SHEPD should be funded for the replacement of the existing South Uist – Eriskay subsea cable, with a new alternative land-based solution. This solution is presented as option 7 within this paper and will see the extension of existing OHL on South Uist, followed by the installation of new 11kV underground cable through the Uist – Eriskay causeway.

This investment will replicate a similar circuit SHEPD already have installed on the West side of the island causeway. This solution is the cheapest viable option, which will also extend asset life and reduce network risk. The option has the best NPV from all options in the cost benefit analysis and will provide a long term security of supply improvement to the network.

This option has a number of challenges relating installation, however these mainly relate to internal SHEPD design and installation policies and specifications. SHEPD has a high confidence in achieving design deviations to achieve this land based solution, as an alternative to a replacement subsea cable, which is in the best long term interest of the network and for customers.

It is proposed that this solution will be designed and consented throughout 2024/25 with installation to take place in later 2025/26. The total anticipated costs for this solution are [redacted] including allowance for risk. As noted, a portion of these costs are development costs and are covered by HOWSUM Development Funding.

12 References

The documents detailed in Table 11, Table 12 and Table 13 should be used in conjunction with this document.

Table 11 – Scottish and Southern Electricity Networks Documents

Reference	Title
N/A	Appendix 4B – Uist-Eriskay CBA
N/A	Hebrides and Orkney Whole System UM Core Narrative
N/A	Appendix 3A – Outer Hebrides 2050 Whole System Proposals EJP (Skye-Uist-Harris)

Table 12 – External Documents

Reference	Title
N/A	Distribution Future Energy Scenarios 2022 Results and Methodology Report, North of Scotland licence area, April 2023

Table 13 – Miscellaneous Documents

Title

13 Subsequent Sections

[redacted]

14 Revision History

No	Overview of Amendments	Previous Document	Revision	Authorisation
01				
02				

Scottish & Southern Electricity Networks

Appendix A Definitions and Abbreviations

Acronym	Definition
ANM	Active Network Management
BAU	Business As Usual
BPS	Barra Power Station
CAPEX	Capital expenditure
CBA	Cost Benefit Analysis
CBRM	Condition Based Risk Management
CDM	Construction Design Management
CEM	Common Evaluation Methodology
CI	Criticality Index
CIS	Cable system, Installation and Service
CMZ	Constrained Management Zone
CNAIM	Common Network Assets Indices Methodology
CPA	framework CPA value
CT	Consumer Transformation
DEG	Distributed Embedded Generation
DFES	Distribution Future Energy Scenarios
DNO	Distribution Network Operator
DSO	Distribution System Operator
DWA	Double Galvanised Steel Wire Armour cable
EHV	Extra high voltage
EJP	Engineering Justification Paper
EoL	End of Life
EPCI	Engineering, Procurement, Construction, and Installation contract
ER P2	Engineering Recommendation P2 Issue 8 2023
FES	Future Energy Scenarios
GB	Great Britain
GSP	Grid Supply Point
HI	Health Index
HOWSUM	Hebrides and Orkney Whole System Uncertainty Mechanism
HV	High Voltage
HVDC	High Voltage Direct Current
kV	kiloVolt
LW	Leading the Way DFES
MVA	Mega Volt Ampere
MW	Megawatt

Acronym	Definition
NPV	Net Present Value
OHL	Overhead Line
OPEX	Operating expenditure
PSS Sincal	Simulation and analysis software for distribution and industrial planning
RIIO-ED1, 2, 3	RIIO Electricity Distribution Price Control periods 1, 2 and 3
ROV	Remotely Operated Vehicle
SBT	Science Based Target
SEPA	Scottish Environment Protection Agency
SEPD	Southern Energy Power Distribution
SHEPD	Scottish Hydro Electric Power Distribution
SWA	Steel Wire Armoured cable
SSEN	Scottish and Southern Electricity Networks
TO	Transmission Operator
U/G	Underground
UM	Uncertainty Mechanism
UCSR	Utilities Contracts (Scotland) Regulations 2016
WACC	Weighted Average Cost of Capital
XLPE	Cross-Linked Polyethylene Cable