# RIIO ED2 Engineering Justification Paper (EJP)

## *Barvas & Coll Primary Substations*

## *Worst Served Customer Proposal*

*Investment Reference No: 342_SHEPD_REGIONAL_WSC_BARVAS*

# Contents

# Definitions and Abbreviations

| Acronym | Definition |
|---|---|
| EJP | Engineering Justification Paper |
| CBA | Cost Benefit Analysis |
| IDP | Investment Decision Pack |
| WSC | Worst Served Customer |
| NoSR | North of Scotland Resilience |
| SSEN | Scottish and Southern Electricity Network |
| NRN | Network Reference Number |
| EHV | Extra High Voltage (33kV) |
| CBRM | Condition Based Risk Management |
| CI | Customer Interruptions |
| CML | Customer Minutes Lost |
| PSR | Priority Service Register |

## 1 Executive Summary


This Engineering Justification Paper (EJP) covers the strategic investment required within our Scottish Hydro Electric Power Distribution (SHEPD) network to address the high volume of interruptions at Barvas and Coll network which serves the north of the Isle of Lewis. The two sites are currently positioned at the top rank of SHEPD's Worst Served Customer (WSC) list. Barvas and Coll supply in total 2,476 customers of which 1,895 are WSCs. Customers have experienced up to 23 interruptions over the three consecutive years between 2017 and 2019 with average interruption length of around two hours.

Following optioneering and detailed analysis, as set out in this EJP, the proposed scope of works to address the WSC issue at Barvas and Coll are as follows:

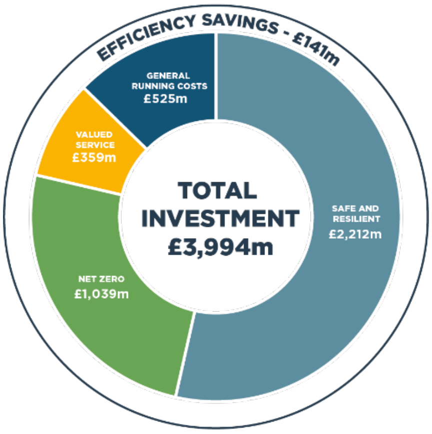
- Install a new 18.7km 33kV overhead line with 38mm$^2$ hard-drawn copper (HDC) conductor between Stornoway and Barvas;
- Install a new 7.5km 33kV overhead line with 38mm$^2$ HDC conductor between P79 and Coll;
- Install a 33kV bus section breaker at Barvas;
- Install two 33kV CB at Coll to enable the auto-changeover arrangement;
- Install a new 12 panel 33 kV switchboard at Stornoway to facilitate the new Barvas/Coll connection;
- Install approximately 11.4 km of 150mm$^2$ XLPE cable circuit as a new feeder from Barvas to interconnect with Barvas Feeder 011;
- Install 1.2km overhead line with covered conductor on Battery Point 652-050 Steinish B spur;

The anticipated cost to deliver the proposed solution is £7.42m. As a result of the remoteness of both sites (North of the Isle of Lewis) the investment priority is high and both sites have high vulnerability. The scheme is therefore prioritised for delivery in the first two years in ED2 with the refinement phase commencing in the final year in ED1.

The scheme delivers following outputs and benefits:

- Improved network performance for the 1,895 WSCs at Barvas and Coll by providing the second 33kV connection, removing the operational issues associated with teeing off the existing circuit and 11kV reinforcement works; this is expected to take all 1,895 WSC out of this classification.
- Improved CI/CML performance as a result of the works expected volume reductions of 13,021 CI and 307,615 CMLs in the SHEPD area per year;
- Achieving P2 security of supply compliance requirement for Barvas and Coll;
- Improved network operation and reliability by separating the Voltage Regulation and Reactive Compensation from the Battery Point Power Station circuit breaker connection;
- Removal of the partial discharge issue at Stornoway Grid switchboard and reduce the reliance on the diesel generation during maintenance of the switchboard. A shutdown would otherwise be required to perform the necessary maintenance which is prohibitively expensive.
- Reduced losses by 77.2MWh per annum in this part of the network as result of the additional circuit supplying both sites.

Non-Load investment sits within the Safe and Resilient Totex.



## 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*

<table>
<tr><td>Name of Scheme/Programme</td><td colspan="6">Barvas & Coll Substations WSC Proposal</td></tr>
<tr><td>Primary Investment Driver</td><td colspan="6">North of Scotland Resilience</td></tr>
<tr><td>Scheme reference/mechanism or category</td><td colspan="6">342/SHEPD/REGIONAL/WSC/BARVAS</td></tr>
<tr><td>Output reference/type</td><td colspan="6">As above</td></tr>
<tr><td>Cost</td><td colspan="6">Cost for the selected Investment is £7.42m.</td></tr>
<tr><td>Delivery year</td><td colspan="6">2023/24</td></tr>
<tr><td>Reporting Table</td><td colspan="6">• CV15 North of Scotland Resilience (SHEPD)</td></tr>
<tr><td>Outputs included in RIIO ED1 Business Plan</td><td colspan="6">No</td></tr>
<tr><td rowspan="2">Spend Apportionment (£m)</td><td>2023</td><td>2024</td><td>2025</td><td>2026</td><td>2027</td><td>Total</td></tr>
<tr><td>3.66</td><td>3.75</td><td>0</td><td>0</td><td>0</td><td>7.42</td></tr>
</table>

## 3 Introduction

This EJP provides high-level background information for this proposed WSC scheme. It explains the data and analysis undertaken, the existing network arrangement, the proposed works and improvements to the network, the expected outcomes from these works and justifications for the proposal.

In order to establish the most economic and efficient solution, the EJP provides an exhaustive list of the options considered through the optioneering process. This is based on the background information and fault data analysis detailed in section 4. Each option is described in detail in section 6, with the justification set out for those options which are deemed unviable solutions, and therefore not taken forward to the Cost Benefit Analysis. The Cost Benefit Analysis (CBA) Summary in section 7 provides the comparative results of all the options considered within the CBA and sets out the rationale and justification for the preferred solution.

The Primary Investment Driver described within this EJP is CV15 – North of Scotland Resilience and the proposed investment will improve the Barvas and Coll 33kV network. Post improvement works, due to lower numbers of faults impacting the Barvas and Coll customers, all customers will be removed from WSC classification.

The high number of WSCs on the Barvas 11kV has varied throughout ED1, ranging from 1,174 to 1,742 customers. In year 2019, it had in total 1,174 WSCs that indicated high volumes of interruptions to their supply. It is clear from the data that this is not acceptable, therefore it is clear that investment within this network is required.

# 4 Background Information and Analysis

## 4.1 Existing Network

Both Coll and Barvas are supplied from Stornoway Grid (645-303). They are located in the northern end of the Isle of Lewis. Each site has two HV feeders with total customer numbers of 1,755 at Barvas and 1,365 at Coll. The existing 33kV circuit from Stornoway 33kV 3L5 to Barvas is made up of the following sections:

- 18.8 km 0.05 sq inch Cu (BS1320) overhead line conductor.
- 0.3 km 300 mm2 Al (XLPE single core).

The supply to Coll is via another 7km overhead line circuit that is connected to this Stornoway – Barvas circuit at pole number 79A9. The three sites are shown on the map below.

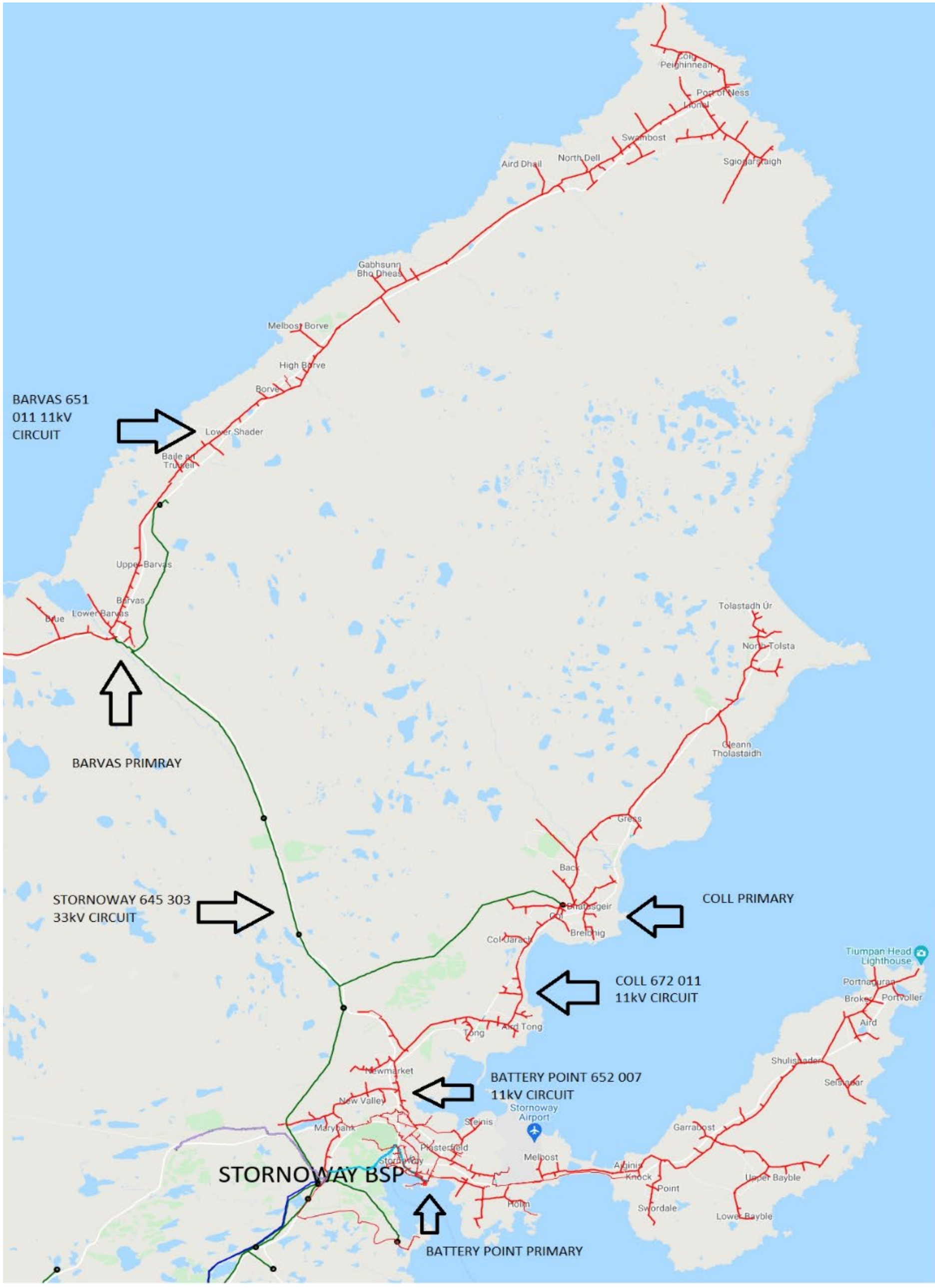



*Figure 1: The geographic locations of Stornoway, Barvas and Coll substations*

Barvas feeder 011 presently has no interconnection with any other 11kV circuits, and therefore is not secure for an outage condition on the feeder. As the feeder extends to the remote North End of Lewis there is no practical option for interconnection with existing feeders.

There is an existing reinforcement scheme underway to be completed in ED1 to provide interconnection on the remote end of feeder 011. The details are presented in a diagram in Appendix 4 and outlined below.

i. New 13.1 km 11kV 150mm$^2$ cable interconnector from Borve regulator to Campar Mor.
ii. New 465m 11kV 150mm$^2$ cable circuit from Lionel Gen Site to Ness F.C.
iii. Existing circuit from Knockaird water tower to Ness FC is being upgraded to 38mm$^2$ HDCU 3 phase.

Barvas presently does not comply with the P2 security of supply requirements. This is due to the load disconnection being more than 1MW, thus resulting in an N-1 condition. Lack of redundancy and back feeding arrangements means restoration of power can only be completed in repair time. Barvas currently has a P2 derogation which this EJP would seek to resolve.

At Coll primary substation, all 721 customers on feeder 011 are WSCs. This feeder is interconnected with Battery Point feeder 050 where there are also 46 WSCs. The details are summarised in table 2 below. Other HV feeders of these sites are not shown as there are no WSCs in 2019/20.

*Table 2: Barvas, Coll and Battery Point WSCs HV Feeders*

| | HV Feeder | Number of connected customers | Number of PSR customers | Length of OHL (km) | Length of UG cable (km) |
|---|---|---|---|---|---|
| **Barvas** | **651-011** | 1393 | 284 | 55.68 | 0.92 |
| **Barvas** | **651-012** | 362 | 65 | 18.53 | 0.21 |
| **Coll** | **672-011** | 721 | 147 | 13.63 | 0.44 |
| **Battery Point** | **652-050** | 1380 | 308 | 9.31 | 5.57 |

### 4.2 WSC Network Performance

Barvas has continuously had amongst the highest number of WSCs over the ED1 years. On HV feeder 011, 1,174 out of all 1,393 customers are in the WSC category with the highest interruption number being 23 over the 3-year period. The feeder also has a high proportion of customers whom are PSR customers, as a result the area has a high network investment priority score of 4.7 out of 8. The priority investment score would indicate that work needs to take place in early years in ED2.

At Coll primary substation, all 721 customers on feeder 011 are WSCs, experiencing 12-14 interruptions over the 3-year period. The average interruption length is 1 hour and 40 minutes as staff have to travel from Stornoway as the nearest depot shown on figure 1 to respond to a fault. Out of this group of customers, 147 are PSR registered.

Battery Point feeder 652-050 has 46 customers as WSC and they are on the Steinish B spur.

Based on the stakeholder feedback, the interruption length and the vulnerability of customers are also considered. The average interruption length in minutes is shown here, using the faults data from the first five years in ED1. The network investment priority score, on a scale of 1 -8, relating to the areas supplied by each feeder is included in the table below.

This is extracted from the Customer Mapping Tool and this parameter is closely relating to the customer vulnerability. The list of indicators of vulnerable characteristics and weighting system applied when producing combined indexes of vulnerability is included in Appendix A. It is used to prioritise the investment against other investments in ED2 years.

Table 3 below shows the WSC network performance on each feeder. It shows the WSC number and the range of interruption numbers over the 3-year period from the reporting year 2019/20 against each feeder.

*Table 3: WSC Network Performance*

| | HV Feeder | WSC No. | Range of interruption No. over 3-year | Average interruption length (mins) | Network Investment Priority score (high score = more vulnerable) |
|---|---|---|---|---|---|
| **Barvas** | **651-011** | 1146 | 12-23 | 116 | 4.7 |
| **Barvas** | **651-012** | 28 | 13 | 138 | |
| **Coll** | **672-011** | 721 | 12-14 | 100 | 4.1 |
| **Battery Point** | **652-050** | 46 | 12 | 102 | 3.9 |

## 4.3 Demand Forecast

Under the Consumer Transformation scenario, the demand forecast for Barvas and Coll are shown in the table below between 2021 and 2033. The average annual growth rates for Barvas and Coll are 5.50% and 4.57% respectively. This indicates more needs to reinforce this part of the network to ensure the compliance to the security of supply standard.

*Table 4: Demand Forecast*

| Year | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BARVAS (MW) | 2.50 | 2.51 | 2.55 | 2.69 | 2.88 | 3.10 | 3.29 | 3.48 | 3.76 | 4.11 | 4.42 | 4.58 | 4.74 |
| COLL (MW) | 2.47 | 2.47 | 2.50 | 2.60 | 2.74 | 2.92 | 3.09 | 3.26 | 3.45 | 3.70 | 3.92 | 4.06 | 4.21 |

## 4.4 Fault Data Analysis

The figure below highlights the fault history on the circuits associated with both Barvas and Coll between 2017 and 2019.

There has been five 33kV faults which have caused significant volumes of customer interruptions. There were also 16 11kV faults on Barvas circuit 011 and 7 on Coll circuit 011 during the 2017 and 2019 period.

Barvas 11kV circuit 011, Melbost Borve section (the north half of the circuit), has experienced very high number of interruptions, ranging from 19 to 23 over the last 3-year period. This involves 81 secondary sites and 861 customers. The current reinforcement scheme to the northern end of the feeder will provide localised ring connection as shown in Appendix 4. However, due to a pattern of wider interruptions across the network, the faults upstream on this 11kV circuit and on the 33kV network need to be addressed. If no action is taken to address the 33kV circuit from Stornoway and the first section of the Barvas circuit 011, the customers will remain in the WSC classification.

There were further 9 EHV faults in the first two years in ED1 and 12 such faults between 2010 and 2014 as shown in Appendix 5. The causes of these interruptions are a mixture of bird strikes, lightning and transient on various sections on the 33kV circuit. Therefore, the Stornoway 645 - 303 33kV radial circuit has had a consistently high number of interruptions affecting high customer volumes.

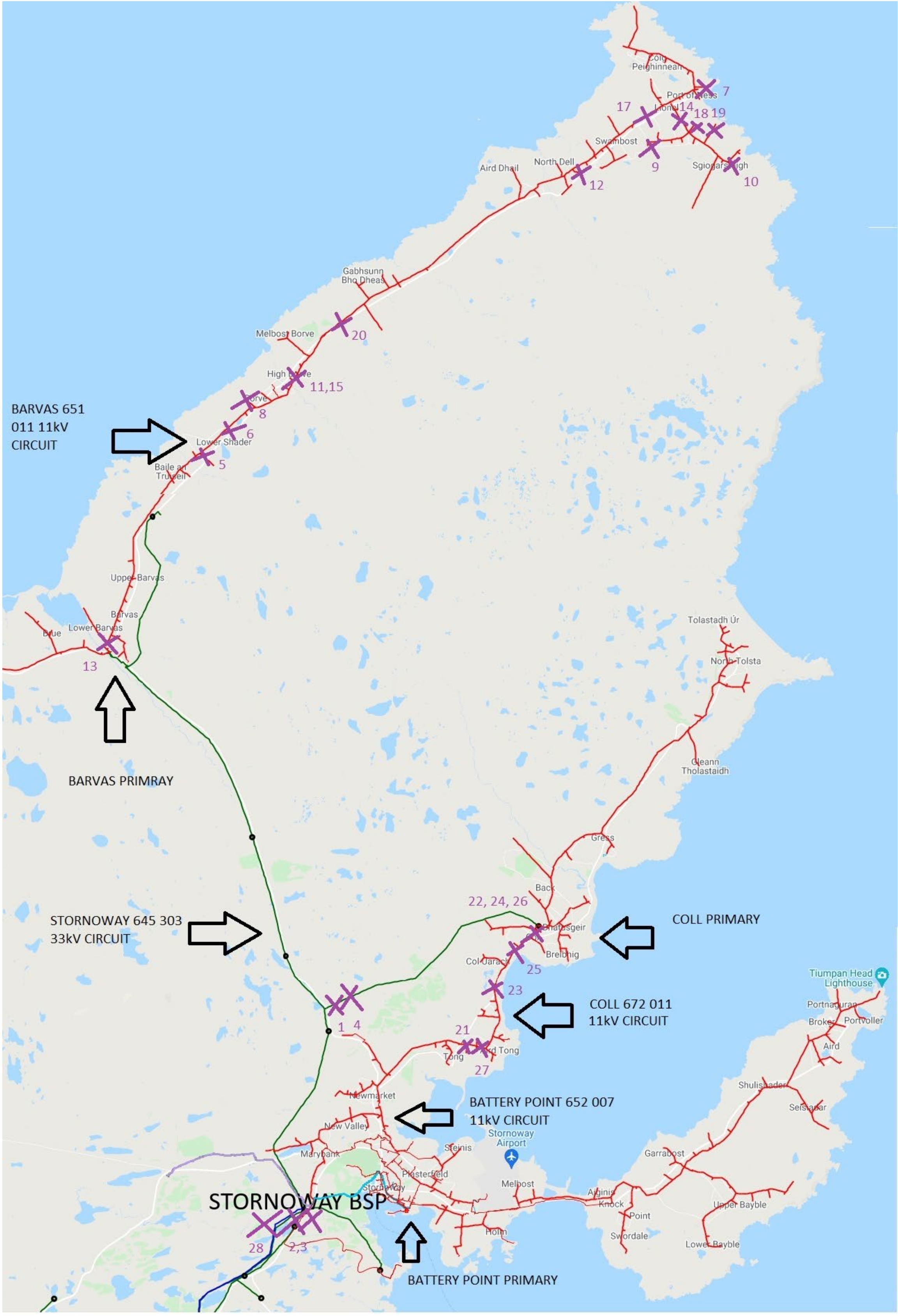



*Figure 2: Locations of faults in across the Stornoway, Barvas and Coll area.*

The list below reflects where faults have affected higher customer numbers across the proposed area for investment, there are other lower customer number faults that have occurred during the identified WSC time period which have not been listed.

*Table 5: Fault Data Analysis*

| Date | Fault Description | No. Customers Impacted |
|---|---|---|
| 2017 | 33kV fault: Birds, Grid CB Trip no auto reclose – no damage | 2752 |
| 2017 | 33kV fault: Lightning, Grid CB Trip – no damage | 2742 |
| 2017 | Barvas 011 11kV fault: Lightning, Faulty Surge Arresters | 180 |
| 2017 | Barvas 011 11kV fault: Birds, Birds Nest removed | 995 |
| 2017 | Barvas 011 11kV fault: Faulty manufacturing, PMT failure | 850 |
| 2017 | Barvas 011 11kV fault: Wind and Gale, Arcing OHL - no damage | 181 |
| 2017 | Barvas 011 11kV fault: Extension of fault zone, PMCB operated from Control | 112 |
| 2017 | Barvas 011 11kV fault: Faulty manufacturing, PMT failure | 1384 |
| 2017 | Barvas 011 11kV fault: Birds, Birds Nest removed | 856 |
| 2017 | Coll 011 11kV fault: Deterioration, 11kV Cable box failure | 708 |
| 2017 | Coll 011 11kV fault: Deterioration, PMT LV bushing failure | 162 |
| 2017 | 33kV fault: Transient, Grid CB Operation – no auto reclose | 3039 |
| 2018 | Barvas 011 11kV fault: Deterioration, Broken OHL binder | 1385 |
| 2018 | Barvas 011 11kV fault: Deterioration, Faulty relay in Primary CB | 1385 |
| 2018 | Barvas 011 11kV fault: Birds, Birds Nest removed | 239 |
| 2018 | 33kV fault: Transient, PMCB Operation | 852 |
| 2018 | Barvas 011 11kV fault: Windborne Materials, Wire debris caught on OHL | 852 |
| 2018 | Barvas 011 11kV fault: Safety Restriction, Removal of dead birds from PMT | 239 |
| 2018 | Barvas 011 11kV fault: Birds, Removal of Dead Birds | 240 |
| 2018 | Barvas 011 11kV fault: Deterioration, PMT failure | 856 |
| 2018 | Coll 011 11kV fault: Deterioration, Broken OHL insulator leading to damage | 709 |
| 2018 | Coll 011 11kV fault: 3rd Party Contact, Road accident cause broken OHL pole | 336 |
| 2018 | Coll 011 11kV fault: Safety Restriction, Outage to repair broken LV stay at PMT pole | 202 |
| 2018 | Coll 011 11kV fault: 3rd Party Contact, Road accident cause broken OHL pole | 709 |
| 2019 | 33kV fault: Transient, PMCB Operation | 1369 |
| 2019 | 33kV fault: Transient, PMCB Operation | 1354 |
| 2019 | Barvas 011 11kV fault: Deterioration, broken OHL conductors | 1392 |
| 2019 | Coll 011 11kV fault: 3rd Party Contact, LV conductors brought down | 377 |

# 5 Optioneering

This section of the report sets out the investment options that are considered when resolving the WSC issues. As described below a holistic approach is taken to ensure investment options represent best value for money for network customers.

## 5.1 Summary of Options

Table below provides a high-level summary of the 5 investment options under consideration along with the advantages and disadvantages associated with each. A more detailed description of each option is then provided within the proceeding sub-sections.

*Table 6: Summary of WSC Investment Options*

| Option | Description | Advantages | Disadvantages | Result |
|---|---|---|---|---|
| **1. Do Nothing (Baseline)** | No upfront action taken to improve the network performance.<br>Maintenance and Inspection activities continue as normal. | No additional cost | WSCs will continue experiencing high number of interruptions. | Rejected |
| **2. Enhanced Maintenance and/or Inspection (Refurbishment)** | Enhanced inspection and maintenance to improve asset condition or slow the rate of ageing. | Cost effective over short time period<br>No large upfront CAPEX | Additional maintenance resource required<br>Significant proportion of customers remain as WSCs<br>Increase in OPEX<br>No new fault resilience added | Taken forward to CBA |
| **3. Re-build existing lines (Replacement)** | Rebuilding the existing network where the WSCs are to reduce the probability of failure on components. | Improve the network performance over short term<br>No further maintenance or inspection required | Increase in CAPEX<br>Lower utilisation of existing assets<br>WSCs will fall back in this category over a period of time.<br>No new fault resilience added<br>P2 compliance will not be addressed | Taken forward to CBA |
| **4. Reinforcing existing network (Reinforcement)** | Installation of additional assets to mitigate the risk of interruptions due to single circuit supply arrangement | WSCs unlikely to return to this category as new fault resilience added to the networks<br>P2 compliance and addressing the switchboard partial discharge issue.<br>Wider benefits to network users | Often costly when compared with other options<br>Longer delivery time due to the likely requirement of additional consent | Taken forward to CBA/ Preferred option |

| | | | | |
|---|---|---|---|---|
| | | including Net Zero targets | | |
| **5. Flexible solutions** | Use battery storage or other alternative mean to support the network and mitigate interruptions | Reduced requirement of reinforcing the network<br><br>Competitive cost comparing to the reinforcement option | Technology and mechanism are yet to be proven<br><br>Limited sites that can utilise such arrangement to improve WSC performance | Option rejected |

# 6 Analysis and Cost

## 6.1 Option 1: Do Nothing

**Estimated Cost: £0k**

Due to the remoteness of the Barvas site, particularly its HV feeder 011, it is supplied through a long radial feed circuit from Stornoway Grid and has no interconnection at 33kV and 11kV for its feeder 011. Without any intervention, the WSCs will experience similar level of interruptions into ED2 and beyond. Therefore, this option is not considered viable.

## 6.2 Option 2: Enhanced Maintenance and/or Inspection (Refurbishment)

**Estimated Cost: £221k**

This option is to carry out enhanced maintenance on the EHV feeder and network improvement schemes on the worst performing HV feeders at both Barvas and Coll. This will target the asset with poor health condition such as pole replacement and refurbishment. This is likely to improve the network performance for a small portion of the WSCs. However, given that most faults are due to external factors, such as wind and gale, lightning and transient events, then this option will not resolve these potential faults. This measure alone will not provide the improved performance required to take customers out of the WSC category.

The expected outcome is that the Option 4 proposal would have to be applied in the ED3 period and therefore the costed option in the CBA allows for refurbishment in ED2 followed by reinforcement in ED3. Under this option, the Barvas/Coll customers could experience WSC equivalent performance during the full ED2 period.

## 6.3 Option 3: Re-build existing lines (Replacement)

**Estimated Cost: £2,311k**

Under this option, the following worst performing section of the overhead line will be re-built:

- 12km of the 33kV overhead line between Stornoway, Barvas and Coll
- 12km of the 11kV overhead line network on Barvas feeder 011

It is expected that the network performance will result in reasonable improvements. The network performance however would deteriorate over time. It is likely that significant number of customers would remain as WSCs as no fault resilience is added to the circuit in the form of circuit interconnection or splitting the circuit. The entire site would remain exposed to faults arising from external factors.

In terms of CBA assessment, it is assumed that 20 years post carrying out the Option 3 works, due to deteriorating performance of the circuit, that the Option 4 reinforcement proposal would have to be implemented at that point in the future. Therefore, the costed option in the CBA allows for re-building of the circuit in ED2 followed by reinforcement in a future price control price.

During the proposed Option 3 works, it is likely that the proposals would be built as an 'online' build. This will require circuit outages which enviably would impact the respective WSC and potentially wider area customers. Also, it would lead to an increase in diesel usage and $CO_2$ emissions due to usage of mobile generation to ensure customers were not off supply for excessive periods of time during the works.

### 6.4 Option 4: Reinforcing existing network (Reinforcement)

**Estimated Cost: £7,418k**

This option involves 5 individual components which are described below:

<u>33kV Circuit Reinforcement – Barvas/Coll</u>

Due to the high number of EHV faults on the existing network, it is proposed to install approximately 18.7km of 33kV 38mm$^2$ HDC overhead line circuit and 320 m 300mm$^2$ Al cable circuit between Stornoway and Barvas. On this second circuit at pole 79, a second connection to Coll should be made and an installation of approximately 7.5km of 33kV 38mm$^2$ HDC overhead line circuit is also proposed. A 33kV bus section breaker at Barvas and two 33kV CB at Coll to enable the auto-changeover arrangement is also required.

<u>Replacement of Stornoway Grid 33kV switchboard</u>

To facilitate this second connection, the 33kV switchboard at Stornoway will also be replaced due to its condition. Firstly, there are no spare breaker bays to accommodate the proposed new circuit. The alternative solution would be a 19 km tee off from an existing circuit. This could cause more nuisance trips on the wider network as it would not be possible to install protection to discriminate faults on the network.

Secondly, the current arrangement with the Reactive Compensation connected directly into the same CB as the Battery Point power station CB restricts flexibility on the network. Under specific outage conditions this can cause issues with system voltage support if the single circuit to Battery Point is out of service. Moving the Reactive Compensation to a separate CB would improve network operation and reliability.

Thirdly, and as a secondary deliverable, there is an ongoing need to address partial discharge on one half of the Stornoway grid board. Replacement of the existing board would resolve this problem. As a note, if SHEPD were to maintain the existing board instead, this would cost approximately £1.2 million for half the board. The cost is predominantly due to the need for diesel generation to support the network. This cost is also comparable to a full board replacement.

The new 33 kV switchboard is required to have 12 circuit breakers, this will comprise of the following:

(i) 9no. circuit breakers as replacement for the existing breakers (inclusive of bus section and transformer breaker).
(ii) 2no. circuit breakers to provide a dedicated feed for DVAR units, which presently are connected of the Battery Point feeders.
(iii) 1no. circuit breaker for new 33 kV feeder to Barvas/Coll.
(iv) A new building to accommodate this new switchboard.

<u>Barvas 11kV Circuit Reinforcement</u>

To further address the performance issue at feeder 011, it is proposed to install approximately 11.4 km of 150mm$^2$ XLPE cable circuit as a new feeder from Barvas to interconnect with Barvas Feeder 011. The point of interconnection is proposed to be the cable immediately preceding the Borve regulator via RMU connection. Under the new normal running arrangement, it is envisaged that feeder 011 will be split with existing feeder 011 supplying as far as Borve and the new feeder supplying the remote end of the circuit. A new open point will be established on the ring switch of the new RMU. The proposed arrangement is included in the diagram below:

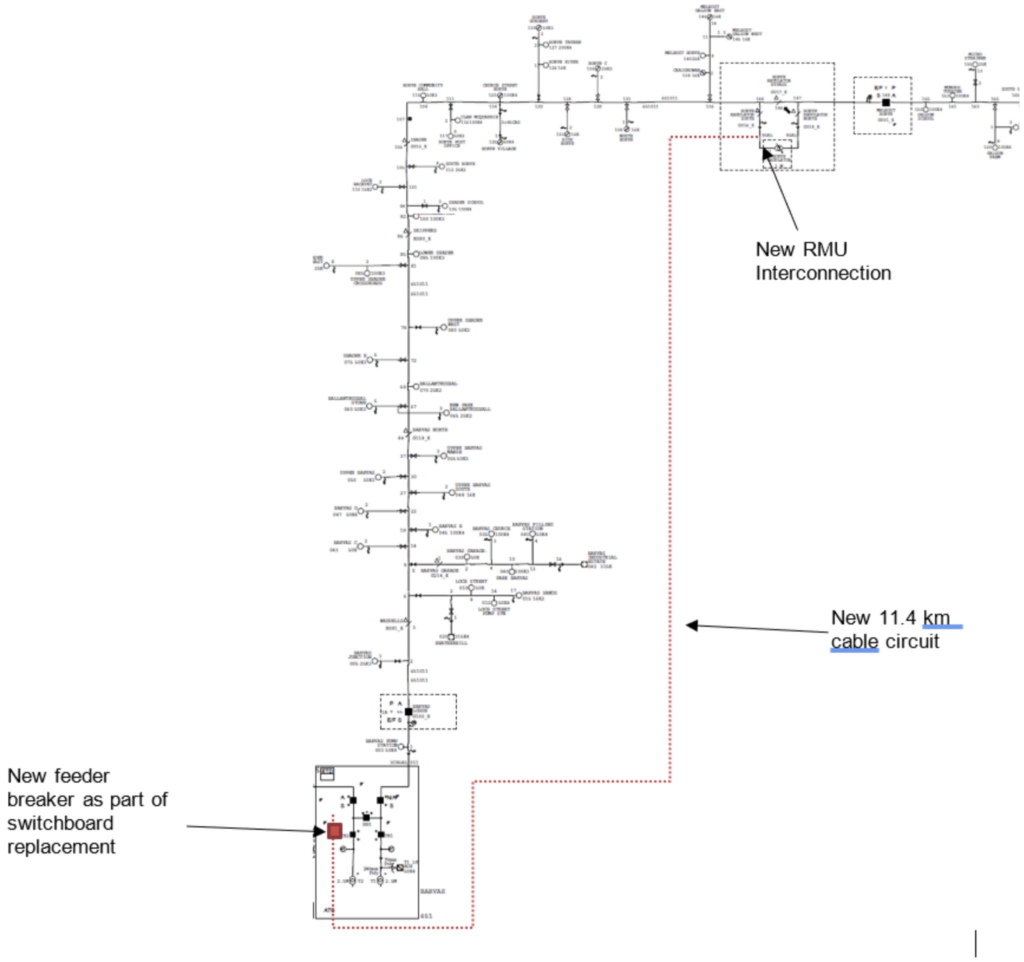



*Figure 3: The proposed new 11kV circuit at Barvas*

<u>Barvas 11kV Switchboard Replacement</u>

The existing 11 kV switchboard at Barvas does not have space to accommodate an additional circuit breaker which is required for the new feeder. In addition, it is not possible to extend the existing switchboard via a jogglebox. Therefore, the existing board must be replaced with a new six-panel 11 kV switchboard arrangement that can accommodate the existing and new circuit breakers.

<u>Battery Point 652-050</u>

Battery Point HV feeder 652-050 Steinish B spur has 46 customers under WSC category. This small section has experienced multiple transient faults and bird strikes. It is therefore proposed to replace this section (1.2km) with covered conductor to improve the network performance.

During the proposed Option 4 works, as the proposal is to build new infrastructure, the majority of new equipment can be constructed as ‘offline’ build. This would minimise the requirement for circuit outages that would impact the respective WSC and potentially wider area customers. As there would be less requirement for outages, this would result in lower amounts of diesel usage and $CO^2$ emissions due to usage of mobile generation as compared to Option 3.

Therefore, taking account of these factors, this is the preferred option.

### 6.3 Option 5: Flexible Solution

**Estimated Cost: £3,127k**

Flexibility services could be used to support the Barvas feeder 011 and Coll network in the fault scenario. However due to nature of faults, the flexible solution needs to be made available throughout the year, as well as supporting the network over the period to allow restoration. This period can be up to 5 hours for the remote Borve 11kV feeder.

The estimated cost is based on the energy storage service to support 3MW load at Barvas feeder 011 and Coll 4MW, in line with the demand forecast in ED2 period, with maximum utilisation of 30 days per annum in the five years of ED2. The technology is still unproven for a solution that can support the network of this size for this duration and would only be deployed on the 33kV network. Therefore, this solution has limited impact to the overall network performance. It has not been considered viable and has been rejected.

# 7 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. In total, three categories of CBAs have been produced as described below. The figures presented below represent the expected percentage improvement of the Ofgem CI & CML methodology ratio figures for SHEPD area per year and the expected actual volume reductions of CI and CMLs in the SHEPD area per year.

## 7.1 Cost Benefit Analysis Comparisons

The table below demonstrates that the reinforcement option is the preferred option as the other options are either rejected as non-viable for WSC or have a poorer NPV. The impact of continuing poor CI/CML resulting from other options has demonstrable lower NPV, whereas the preferred option allows the customers to benefit from investment in ED2 and improve network performance. Option 2 incorporates the works in Option 4 with reinforcement in the ED3 period which leads to the improved performance evident in the NPV figure below. However, it is apparent that delaying the investment and leaving the customers in the WSC category is not acceptable, reinforcing the case for Option 4.

The preferred option will bring wider benefits of improved network performance for these two WSC sites in the north of the Isle of Lewis whilst ensuring P2 compliance and preparing for the demand growth in future years. The table below demonstrates that despite the significantly lower upfront cost for the refurbishment option, the benefits of the reinforcement option is significant and returns more desirable NPV. This is due to the significantly higher CI & CML benefits and reduced losses that the reinforcement option will achieve.

*Table 7: Cost Benefit Analysis*

| Options | NPV After 45 Years (£k) |
|---|---|
| **Option 1 – Do Nothing** | N/A |
| **Option 2 – Enhanced Maintenance and Inspection** | 910 |
| **Option 3 – Asset Replacement** | -980 |
| **Option 4 – Circuit Reinforcement** | 1,260 |
| **Option 5 – Flexible Solution – Not in CBA as solution not viable** | N/A |

From the table above it is clear that reinforcement now, against refurbishment in ED2 followed by a reinforcement in ED3, is the best value for money option for ED2 and realises a positive return over the asset's full life cycle.

## 7.2 Benefit analysis of refurbishing the existing line (Option 2)

It is expected that following Customer Interruption (CI) and Customer Minutes Lost (CML) improvements will be achieved under this option. These figures are too low to improve the number of WSC and will make no discernible impact on the quality of supply and network performance. These benefits will diminish over a period of five years, by when the reinforcement option would be necessary to address the WSC issue.

*Table 8: Benefit Analysis for Option 2*

| | CI Improvement % (Actual Volume) | CML Improvement % (Actual volume) |
|---|---|---|

| | | |
|---|---|---|
| Coll (672-011) | 0.02 (143) | 0.02 (13314) |
| Barvas (651-011) | 0.14 (1093) | 0.14 (113323) |

### 7.3 Benefit analysis of re-building the existing line (Option 3)

It is expected that the CI & CML improvements for the re-build option would be higher than the refurbishment option but remain low CI & CML values due to the same network arrangement being retained. The assumption is that these benefits will diminish over a period of twenty years and at this future point the reinforcement option would be necessary to address the WSC issue.

*Table 9: Benefit Analysis for Option 3*

| | CI Improvement % (Actual Volume) | CML Improvement % (Actual volume) |
|---|---|---|
| Coll (672-011) | 0.04 (286) | 0.04 (26628) |
| Barvas (651-011) | 0.28 (2186) | 0.29 (226646) |

### 7.4 Benefit analysis of reinforcing the existing network (Option 4)

The expected CI and CML improvements based on this option is as shown in the table below. The Table shows a significant improvement for CI/CML and network performance that will remove customers from WSC classification. There will also be the benefit of reduced losses under this option. The reduced losses based on the proposed conductor length is calculated as 77.2MWh per annum. Appendix 3 refers.

*Table 10: Benefit Analysis for Option 4*

| | CI Improvement % (Actual Volume) | CML Improvement % (Actual volume) |
|---|---|---|
| Stornoway Grid – Barvas | 0.86 (6895) | 0.22 (177869) |
| Stornoway Grid – Coll | 0.63 (5033) | 0.16 (129746) |
| Barvas (651-011) | 0.14 (1093) | 0.14 (113323) |

## 7.5 Summary of Cost

*Table 11: Summary of Cost*

| Options | Unit | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | Total |
|---|---|---|---|---|---|---|---|
| **Option 1 – Do Nothing** | £m | 0 | 0 | 0 | 0 | 0 | 0 |
| **Option 2 – Enhanced Maintenance and Inspection** | £m | 0.23 | 0 | 0 | 0 | 0 | 0.23 |
| **Option 3 – Asset Replacement** | £m | 2.41 | 0 | 0 | 0 | 0 | 2.41 |
| **Option 4 – Reinforcement** | £m | 3.66 | 3.75 | 0 | 0 | 0 | 7.42 |
| **Option 5 – Flexible Solution** | £m | 0.63 | 0.63 | 0.63 | 0.63 | 0.63 | 3.13 |

Our RIIO ED2 Business Plan costs are derived from our outturn RIIO ED1 expenditure. We have modified costs per activity, capturing and reporting those adjustments in our cost-book. By tying our costs back to reported, outturn, real life data this approach provides multiple data points on which both the Regulator and we can benchmark cost efficiency.

It provides a high level of cost confidence in our Business Plan cost forecast for RIIO ED2. Through our benchmarking analysis, we recognised that not all Non-Load related RIIO-ED1 actual unit costs sit within the upper quartile efficiency band. Where this is the case, we have applied a catch-up efficiency to those cost categories.

Further detail on our unit cost approach, cost efficiency and cost confidence for RIIO-ED2 can be found within our ***Cost Efficiency Annex (15.1)***. Following our draft Business Plan, we have continued to develop project volumes and costs, utilising valuable stakeholder feedback. We have included developments of our Commercial Strategy within the updated project scope and delivery strategy.

## 7.6 Volume on the Adopted Option

*Table 12: Volume of the Adopted Option*

| Asset Category | Unit | 2023/24 | 2024/25 | 2025/26 | 2026/27 | 2027/28 | Total |
|---|---|---|---|---|---|---|---|
| **11kV OHL (Covered Conductor)** | km | 0.0 | 2.2 | 0 | 0 | 0 | 1.2 |
| **11kV Poles** | # | 0.0 | 18.0 | 0 | 0 | 0 | 18 |
| **11kV UG Cable** | km | 0.0 | 11.4 | 0 | 0 | 0 | 11.4 |
| **11kV CB (GM) Primary** | # | 0.0 | 6.0 | 0 | 0 | 0 | 6 |
| **11kV RMU** | # | 0.0 | 1.0 | 0 | 0 | 0 | 1 |
| **33kV OHL (Pole Line) Conductor** | km | 13.1 | 13.1 | 0 | 0 | 0 | 26.3 |
| **33kV Pole** | # | 188.0 | 188.0 | 0 | 0 | 0 | 376 |
| **33kV UG Cable (Non Pressurised)** | km | 0.5 | 0.5 | 0 | 0 | 0 | 1 |
| **33kV CB (Air Insulated Busbars)(OD) (GM)** | # | 1.5 | 1.5 | 0 | 0 | 0 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **33kV CB (Gas Insulated Busbars)(ID)(GM)** | # | 12.0 | 0.0 | 0 | 0 | 0 | 12 |
| **33kV Switch (GM)** | # | 2.0 | 2.0 | 0 | 0 | 0 | 4 |
| **33kV Switch (PM)** | # | 1.0 | 1.0 | 0 | 0 | 0 | 2 |
| **11kV Pole Refurbishment** | # | 0.0 | 116.0 | 0 | 0 | 0 | 116 |

## 8 Validate investment plans and benefits with Stakeholders

This section of the EJP describes the stakeholder engagement strategy that has been implemented to inform SSEN's RIIO-ED2 submissions. This includes the engagement activities that have been undertaken, the stakeholder groups that have been approached, and the feedback that has been gathered from this stakeholder engagement.

The intention of this exercise was to identify the appetite from our stakeholders for SSEN in carry out the investment described within this document during RIIO-ED2 to improve the condition of SSEN's network assets and the quality of supply for customers in during ED2 and beyond.

We conducted audience research with stakeholders via online workshops/open forums to co-create our strategies and priorities in RIIO-ED2 for improving the network for WSCs. Following insights were derived:

- Stakeholders suggested that, based on the remote location of some Scottish islands, investment for the WSCs there should be a priority, as it will potentially take far longer to restore power there compared to mainland areas.
- There was no consensus on whether investment in worst-served circuits should be prioritised according to: number of WSCs; number of interruptions; level of customer vulnerability; or potential of low carbon technology (LCT) take-up.
- Stakeholders, however, expressed concern about the impact of power cuts on customers in vulnerable situations, and on this basis focusing investment efforts on reducing the number of worst-served vulnerable customers was supported.
- The interruption duration which is currently not considered in Ofgem's WSC definition is recognized as an important factor by our stakeholders.
- Stakeholders suggested that an annual WSC report would be welcome and raise the profile of the issue but might give the incorrect impression that these are the areas where there will be investment.
- Some stakeholders were concerned about the impact of worst-served circuits on generation as well as supply customers.

The lack of consensus from stakeholders on how to prioritise worst-served areas for improvement clearly suggests that being worst-served is a substantial detriment to all such customers, albeit playing out in different ways and therefore remedying these is extremely important. Therefore, we are committing to remove at least 75% of customers from this list in ED2; this ambitious proportion represents all circuits where cost benefit analysis warrants investment; the remaining 25% of WSCs are distributed over so many circuits that the benefit derived from each circuit investment would be limited to very few customers.

We will also ensure that we communicate effectively during power outages, particularly for remote communities where electricity is heavily relied upon, promote the PSR and the 105-power outage number, and produce an annual WSC report to be shared with wider stakeholders to embed resilience partnerships.

Based on the stakeholder feedback, the average Customer Minutes Lost (CML), Priority Service Register (PSR) and the vulnerability score from the Customer Mapping Tool are also factored in the scheme consideration.

## 9 Deliverability and Risk

Between our draft and final Business Plans we have carried out a more detailed deliverability assessment of our overall plan as a package and its component investments. Using our draft Business Plan investment and phasing as a baseline we have followed our deliverability assessment methodology. We have assessed any potential delivery constraints to our plan based on:

- In-house workforce capacity and skills constraints based on our planned recruitment and training profile and planned sourcing mix as well as the efficiencies we have built into our Business Plan (detailed in our ***Ensuring Deliverability and a Resilient Workforce (Chapter 16) and Cost Efficiency (Chapter 15***)
- Assessment of the specific lead and delivery timelines for the asset classes in our planned schemes
- We have evaluated our sourcing mix where there were known delivery constraints to assess opportunities to alleviate any constraints through outsourcing
- We have engaged our ***Supply Chain (Annex 16.2)*** to explore how the supply chain could support us to efficiently deliver greater volumes of work and how we could implement a range of alternative contracting strategies to deliver this
- We have also engaged with the supply chain on the delivery of work volumes that sit within Uncertainty Mechanisms to ensure we have plans in place to deliver this work if and when the need arises
- We have assessed the synergies between our planned load, non-load and environmental investments to most efficiently plan the scheduling of work and minimise disruption to consumers
- Based on our assessment of delivery constraints and potential solutions to resolve them, we have revised our investment phasing accordingly to ensure our Business Plan is deliverable, meets our consumers' needs and is most cost efficient for our consumers

The specific considerations for deliverability based on the scope of this EJP are detailed below:

- To install the required new 33 kV switchgear at Barvas it is highly likely that a re-arrangement of existing plant and possible extension of the substation area will be required. This will be determined as part of further refinement.
- Similarly, there is understood to be limited space for the proposed 33 kV switchboard replacement at Stornoway and due consideration will be required as part of further refinement to determine how best this may be achieved.
- The proposed new 33 kV circuit route from Stornoway → Barvas traverses the Lewis Peatland SPA/RAMSAR site and therefore would be subject to a bird survey. Further, Scottish National Heritage may object to OHL circuit and request undergrounding of this section.

## 10 Conclusion

The purpose of this Engineering Justification Paper (EJP) has been to describe the overarching investment strategy that SSEN intends to take during RIIO ED2 for the North of Scotland Resilience (NoSR) related investment on the Barvas and Coll networks.

Five investment options have been described which could be carried out to address the WSC issue at these sites. As detailed within Section 7, a holistic approach is taken when selecting the most viable option for each investment, where the primary and secondary investment drivers are assessed together within a Cost Benefit Analysis (CBA). This includes the careful consideration of the financial, safety, and environmental implications of each investment option.

- Option 1: Do Minimum
- Option 2: Enhanced Maintenance and Inspections
- Option 3: Asset Replacement
- Option 4: Asset Reinforcement
- Option 5: Flexible Solution

A thorough stakeholder engagement exercise was undertaken to gather feedback on each of these strategies to determine which approach should be proposed within SSEN's RIIO ED2 business plans.

As a result, the following costs and volumes are proposed for delivery during RIIO ED2. The preferred investment for Barvas and Coll substations in RIIO ED2 is Option 4: Circuit reinforcement.

*Table 13: CV Table Summary*

| CV Table | Unit | 2023 | 2024 | 2025 | 2026 | 2027 | Total |
|---|---|---|---|---|---|---|---|
| **CV15 North of Scotland Resilience (SHEPD)**<br>**RIIO ED2 Spend** | £m | 3.66 | 3.75 | 0 | 0 | 0 | 7.42 |

Scottish & Southern Electricity Networks

## 11 Appendix 1 List of Indicators of Vulnerable Characteristics and Weighting System

These indicators are applied when producing combined indexes of vulnerability.

| Indicator of vulnerable characteristic | Network investment priority: score (high score = more vulnerable) |
|---|---|
| Under 5 years | 0.5 |
| Under 16 years | 0 |
| Over 65 years | 0.1 |
| Over 75 years | 0.4 |
| Over 85 years | 0.6 |
| Fuel poverty levels (Scotland; 1=low, 4=v.high) | 0 |
| Fuel poor households (England) | 0 |
| Dwellings without a mains gas connection | 0 |
| Dwellings without central heating system | 0 |
| Dwellings rated in EPC bands EFG | 0 |
| Households with no car | 0 |
| Combined distances to services (Score; high=most remote) | 0 |
| Children in low income households | 1 |
| People with low qualifications | 0 |
| People in low income employment | 1 |
| Long-term unemployment | 1 |
| Disability benefits | 1 |
| Child disability benefits | 1 |
| Mental health benefits | 1 |
| Universal credit claimants | 0 |
| People in bad or very bad health | 0.5 |
| People whose health condition limits activities a lot | 0.5 |
| Access to health services (Score; 0=best access, 100=worst access) | 0 |
| People providing over 20hrs/week of care | 0.5 |
| Number of residential care homes | 0 |
| Number of care home beds | 0 |
| Households in privated rented dwellings | 1 |
| Lone parents | 1 |
| Ethnic minorities | 1 |
| Unable to speak English well or at all | 0 |
| Lone pensioners | 1 |

## 12 Appendix 2: Relevant Policy, Standards, and Operational Restrictions

TG-NET-NPL-012.pdf

# 13 Appendix 3. CBA Assumptions

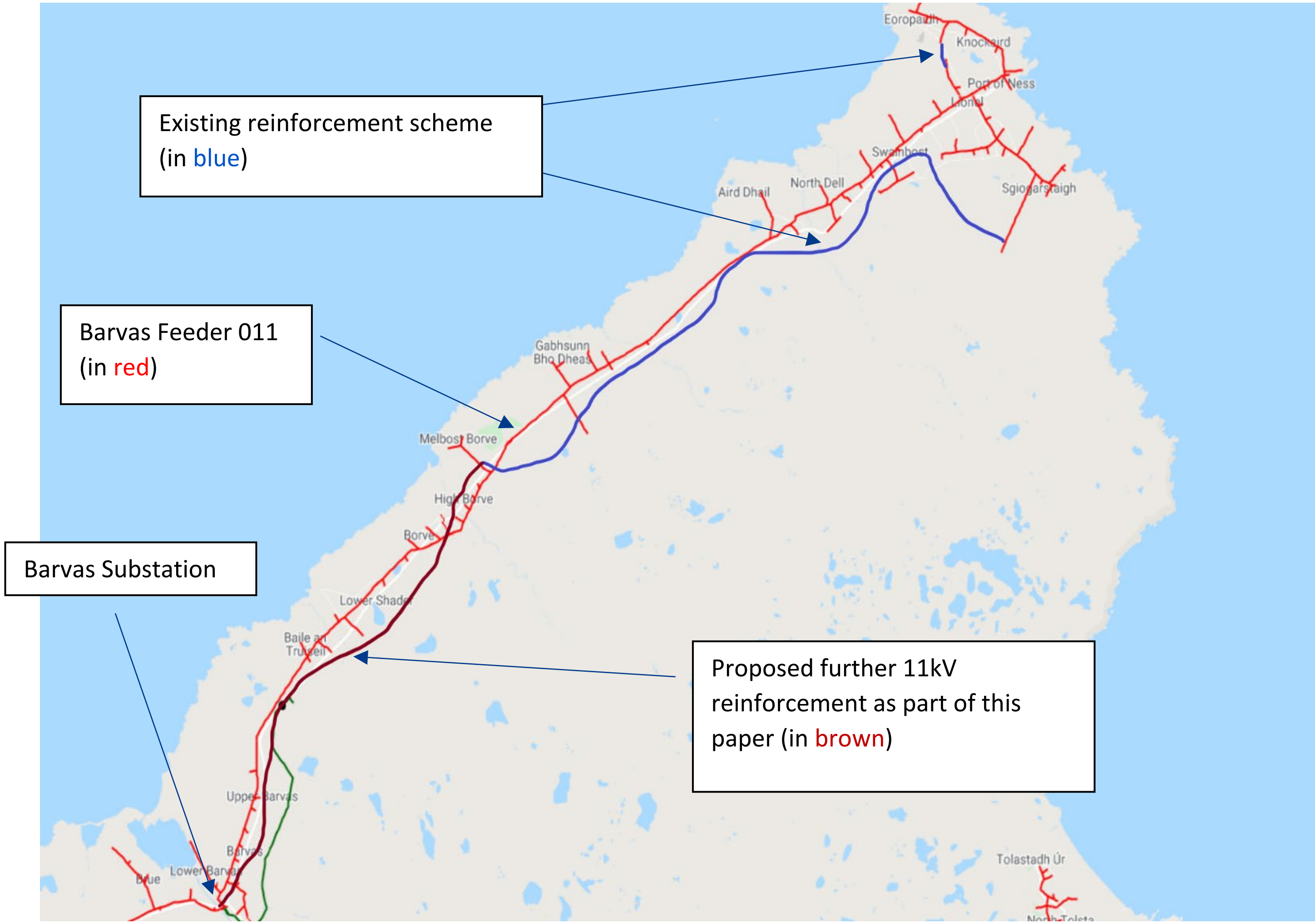
## Losses Reduction Calculation

It is expected that with the second circuit installation, the losses reduction will be achieved by the split of the load on two circuits after the reinforcement option.

| Description | Line Voltage (kV) | | Demand Capacity (MVA) | Load Factor | Conductor size | Line Resistance/km | Line Length/km | Actual Resistance | Losses (W) | Losses MWhrs | Losses in relation to baseline |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Before Reinforcement | 33 | | 3.50 | 0.40 | 0.05 sq inch Cu | 0.544 | 18 | 9.79 | 17,624.84 | 154.39 | |
| | | | | | | | | | | | |
| After Reinforcement | 33 | | 1.75 | 0.40 | 0.05 sq inch Cu | 0.544 | 18 | 9.79 | 4,406.21 | 38.60 | |
| | 33 | | 1.75 | 0.40 | 0.05 sq inch Cu | 0.544 | 18 | 9.79 | 4,406.21 | 38.60 | 77.20 |

Scottish & Southern
Electricity Networks

## 14 Appendix 4. Existing Network Reinforcement Schematic & The Proposed 11kV Connection



## 15 Appendix 5. 33kV Faults History on Stornoway Grid – Barvas/Coll between 2010 and 2019

| Site Name | Cost | Month | Cause |
|---|---|---|---|
| Stornoway Grid - Barvas Moor 33kV Cct. : Faulty PMR (1H0) at Coll S/S. | £61,642 | August 2010 | Faulty Manufacturing, Design, Assembly or Materials |
| Stornoway - Barvas Moor 33kV cct - Wind and gales caused broken binder pole 27 Stornoway - Barvas Moor cct. ESQC details req'd. See F11-119-2 for restoration of Coll customers. | £0 | February 2010 | Wind and Gale (excluding Windborne Material) |
| Stornoway Grid/Barvas Moor 33kV Cct. : Bird caused flashover - fuses blown at tapping to Vodafone Barvas Moor spur, P135 Barvas Moor/Barvas 33kV line. No damage - fuses replaced. | £74 | August 2011 | Birds (including Swans and Geese) |
| Stornoway Grid - Barvas Moor 33kV cct : Deliberate disconnection to allow for the safe removal of debris on pole 197 of the Barvas Moor - Barvas 33kV cct. | £19,665 | December 2011 | Windborne Materials |
| F12-2023-1. Stornoway Grid/Barvas Moor 33kV Cct. : Gale - Stornoway Grid s/s, 33kv CB 3L5 tripped when Grid supply restored. Melbost Borve PMCB found to be open as well. No | £82,286 | December 2012 | Wind and Gale (excluding Windborne Material) |
| Stornoway Grid / Barvas Moor 33kV cct. Steelwork on Pole 201 Barvas Moor / Barvas cct found to be live. Supplies interrupted to replace broken insulators. | £83,072 | February 2012 | Deterioration due to Ageing or Wear (excluding corrosion) |
| Stornoway Grid/Barvas Moor 33kV Cct. : Unknown transient - at Stornoway Grid s/s 33kV CB 3L5 tripped and auto-reclosed. Pentland Road W/F 33kV CB 1C0 tripped at the same time - | £0 | July 2013 | Cause Unknown |
| Stornoway / Barvas Moor 33kV cct. Goose hit 11kV overhead line outside Barvas S/S. No permanent damage. | £67,053 | October 2013 | Birds (including Swans and Geese) |
| Stornoway - Barvas Moor 33kV cct. Cause:- Unknown, no fault found. | £53,016 | November 2013 | Cause Unknown |
| F14-270-1. Stornoway Grid - Barvas Moor 33kV cct. Unknown cause, Barvas 1H0 / 2h0 both tripped. No trip alarm received for 1H0. Protection operation to be investigated for | £47,867 | February 2013 | Cause Unknown |
| Stornoway Grid - Barvas Moor 33kV cct. Unknown cause Barvas 2H0 and BB1 tripped for transient on the 012 cct, 012 CB failed to trip. No fault found. Protection settings to be | £9,669 | July 2014 | Cause Unknown |
| F14-1117-1. Stornoway - Barvas Moor 33kV cct. CB 3L5 tripped Cause : Unknown. Did not appear to auto-reclose. Reclosed by tele-control | £44,119 | August 2014 | Cause Unknown |
| Stornoway Grid - Barvas Moor teed 33kV cct. Cause: Bird strike. Broken conductors P83 - P84 of the Loch Dubh / Coll S/S 33kV cct.. | £70,816 | August 2014 | Birds (including Swans and Geese) |
| Stornoway Grid - Barvas Moor teed 33kV Cct. Source CB tripped for unknown transient. CB successfully closed from Control. Coll S/S backfed via automation. | £52,086 | November 2014 | Cause Unknown |
| Stornoway - Barvas Moss 33kV cct. Cause unknown. Stornoway 3L5 tripped and was successfully reclosed from control. Coll S/S backfed on the 11kV network. | £52,891 | November 2014 | Cause Unknown |
| Stornoway - Barvas Moor 33kV Cct. Cause:- Bird strike. Broken HV conductor span 57-58 of the Arnol / Bragar 11kV Cct. Deterioration of Batt Charger at Barvas s/s resulted in no tripping at Barvas, hence, Stornoway S/S CB 3L5 cleared fault (extension of fault zone) - successfully reclosed and fault repairs carried out on 11kV Cct. See also fault report 52/H000153 | £86,662 | December 2014 | Birds (including Swans and Geese) |
| Stornoway - Barvas Moor 33kV Cct. Cause:- Deterieration / Ageing. Deterioration of Battery Charger at Barvas s/s resulted in no tripping at Barvas, hence, Stornoway S/S CB 3L5 cleared fault on 11kV network (extension of fault zone) - successfully reclosed and fault repairs carried out on 11kV Cct. **See also fault report 52/H000152 for 11kV fault / customer details.** | £0 | December 2014 | Deterioration due to Ageing or Wear (excluding corrosion) |
| F14-1705/1682-1. Stornoway - Barvas Moor 33kV cct. Wind/Gale - Lightning, no fault found, network restored. | £0 | December 2014 | Wind and Gale (excluding Windborne Material) |
| Stornoway Grid - Barvas. Lightning stike, two fuses operated at pole 135 Barvas Moor - Barvas network. | £0 | December 2014 | Lightning |
| Stornoway / Barvas Moor 33kV cct. Lightning caused blown fuse controlling Ice Mast spur - replaced okay. | £0 | December 2014 | Lightning |
| Stornoway / Barvas Moor 33kV cct. Lightning caused blown fuse controlling Blackwater spur - replaced okay. | £0 | December 2014 | Lightning |
| F15-92-1 Stornoway Grid / Barvas Moor 33kV cct. Wind and gale. Broken pole P152 Barvas spur. Western Isles link was lost, see F/R 81/159 for customer numbers. | £0 | January 2014 | Wind and Gale (excluding Windborne Material) |
| F15-92-1 Stornoway Grid - Barvas Moor 33kV cct. Wind and gale. Broken binder P84 Barvas spur. Western Isles link had tripped, see F/R 81/159 for customer numbers. | £0 | January 2014 | Wind and Gale (excluding Windborne Material) |
| Stornoway - Barvas Moor 33kV cct. Unknown 2 fuses operated at pole 79A2 | £106 | January 2014 | Cause Unknown |
| Stornoway / Barvas Moor 33kV cct. Unknown transient caused Stornoway 3L5 to trip - did not appear to auto-reclose. Reclosed by tele-control. Note system abnormal at time. Need to | £0 | March 2014 | Wind and Gale (excluding Windborne Material) |
| Stornoway Grid - Bennadrove Dump 33kV Cct. Unknown transient. CB 3L5 at Stornoway Grid S/S tripped and was successfuly reclosed from COntrol. CB did not appear to carry out auto- | £56,655 | May 2015 | Cause Unknown |
| Stornoway Grid - Bennadrove Dump 33kV cct. Cause unknown. Stornoway 3L5 tripped and was closed from control. No fault found. | £53,771 | May 2015 | Cause Unknown |
| Stornoway - Bennadrove Dump 33kV cct. Barvas 2H0 tripped. Fuse on main battery found blown & Polar Relay blank - polarr relay replaced. | £0 | June 2015 | Deterioration due to Ageing or Wear (excluding corrosion) |
| Stornoway - Bennadrove Dump 33kV CCT. Cause of fault unknown. Tripped on E/F, restored with no fault found. Most customers restored from 11kV backfeeds. | £61,263 | September 2015 | Cause Unknown |
| Stornoway / Bennadrone Dump 33kV cct. Unidentified fault on Galson W/F spur. | £117,618 | November 2015 | Wind and Gale (excluding Windborne Material) |
| Stornoway S/S, Bennadrove Dump 33kV cct:- Broken steady pot at P80 of the Bennadrove Dump - Barvas Moor Teed 33kV cct. Suspect previous lightning strike. | £119,451 | November 2015 | Lightning |
| F16-513-1 ( this new job to replace F16-432-2 & F16-434-2 which were both closed down). Stornoway Grid - Benadrove Dump 33kV Cct. . Stornoway CB 3L5 tripped and supplies restored by tele-control from Control Room for first fault, tripped again at 06:59 due to deterioration of Barvas Road PMCB VT. Supplies @ Coll backfed from tele PMCB, Barvas S/S backfed from | £82,839 | April 2016 | Deterioration due to Ageing or Wear (excluding corrosion) |
| Stornoway Grid - Bennadrove Dump 33kV Cct. Cause:- Bird strike. 1 x blown HV fuse controlling Vodafone Barvas Moor tfr. | £37 | July 2016 | Birds (including Swans and Geese) |
| Stornoway Grid - Bennadrove Dump 33kV cct. Cause unknown. Stornoway 3L5 tripped and was reclosed from control. No fault found. | £55,884 | September 2016 | Transient Fault - No Repair |
| Stornoway Grid - Bennadrove Dump 33kV Cct. Unknown transient. Source CB 3L5 tripped to lockout ( one single trip and lockout alarm). All customers restored via tele switching. | £50,705 | December 2016 | Transient Fault - No Repair |
| Stornoway - Bennadrove Dump 33kV cct. Deliberate disconnection to remove dead bird @ Span 42 - 43 Westside School - Galson W/farm cct. | £140 | January 2016 | Birds (including Swans and Geese) |
| Stornaway - Bennadrove Dump 33kV Cct - Unknown cause. Burnt pole replaced P3 Westside School - Galson Windfarm cct due to broken steady pot. ESQC details to be measured in | £712 | February 2016 | Cause Unknown |
| Stornoway - Bennadrove Dump 33kV Cct. Cause:- Transient Fault - No Repair. Stornoway 3L5 33kV CB failed to Auto Reclose, closed from control. Follow up required to check out | £54,101 | March 2016 | Transient Fault - No Repair |
| F17-2-4. Stornoway Grid - Bennadrove Dump 33kV cct. Lightning, no fault found , cct restored succesfully via tele control. | £47,370 | April 2017 | Lightning |
| Stornoway - Bennadrove Dump 33kV Cct. Unknown transient.Broadbay View PMCB G010_X tripped. Stornoway 3L5 successful DAR. Existing FPIs checked and repositioned. | £22,841 | May 2017 | Transient Fault - No Repair |
| Stornoway - Bennadrove Dump 33kV cct. Lightning, no damage, blown HV fuse replaced at P99 Barvas Glen / Barvas Moor line, controlling Ice Mast TFR, found by passing linesmen. | £0 | April 2018 | Lightning |
| Stornoway Grid - Bennadrove Dump 33kV cct. CB 3L5 tripped but failed to auto-reclose, successfully closed from Control after 20 mins, with no fault found. Barvas automation scheme successfully operated saving approx £8K in IIS costs. Coll automation scheme failed to operate, cause now identified and rectified. | £47,859 | July 2018 | Birds (including Swans and Geese) |
| F19-1369-2 Stornoway - Bennadrove Dump 33kV cct. Unknown transient. Broadbay View PMCB tripped and was reclosed on site. Customers were backfed from Battery Point initially. | £21,993 | October 2019 | Transient Fault - No Repair |
| Stornoway - Bennadrove Dump 33kV cct. 2 x blown fuses P135 of the Barvas Road / Barvas Glen cct. Cause; suspect lightning. | £42 | February 2019 | Lightning |
| Stornoway - Bennadrove Dump 33kV Cct. Pole 99 Barvas Moor / Barvas Glen 33kV Cct. HV Fuse found blown after lightning. Restoration delayed by ongoing severe lightning storm. HV | £0 | June 2020 | Lightning |

## 16 Appendix 6. Assumptions for Flexible Solutions

| Contract Year | Availability Price – CMZ Secure (£/MW/Day) | Capacity offered (MW) | Potential Days Required | Maximum Total Availability price paid | Utilisation Price – CMZ Secure (£/MWh) | Maximum Potential Energy Required (MWh)for 30 days per annum | Total Utilisation Cost (£) per annum | Yearly total | |
|---|---|---|---|---|---|---|---|---|---|
| Year 1 | [redacted] | 3 | 365 | [redacted] | [redacted] | 2160 | [redacted] | [redacted] | |
| Year 2 | [redacted] | 3 | 365 | [redacted] | [redacted] | 2160 | [redacted] | [redacted] | |
| Year 3 | [redacted] | 3 | 365 | [redacted] | [redacted] | 2160 | [redacted] | [redacted] | |
| Year 4 | [redacted] | 3 | 365 | [redacted] | [redacted] | 2160 | [redacted] | [redacted] | [redacted] |
| Year 4 | [redacted] | 3 | 365 | [redacted] | [redacted] | 2160 | [redacted] | [redacted] | |

| Contract Year | Availability Price – CMZ Secure (£/MW/Day) | Capacity offered (MW) | Potential Days Required | Maximum Total Availability price paid | Utilisation Price – CMZ Secure (£/MWh) | Maximum Potential Energy Required (MWh)for 30 days per annum | Total Utilisation Cost (£) per annum | Yearly total | |
|---|---|---|---|---|---|---|---|---|---|
| Year 1 | [redacted] | 4 | 365 | [redacted] | [redacted] | 2880 | [redacted] | [redacted] | |
| Year 2 | [redacted] | 4 | 365 | [redacted] | [redacted] | 2880 | [redacted] | [redacted] | |
| Year 3 | [redacted] | 4 | 365 | [redacted] | [redacted] | 2880 | [redacted] | [redacted] | |
| Year 4 | [redacted] | 4 | 365 | [redacted] | [redacted] | 2880 | [redacted] | [redacted] | [redacted] |
| Year 4 | [redacted] | 4 | 365 | [redacted] | [redacted] | 2880 | [redacted] | [redacted] | |