Scottish & Southern Electricity Networks

RIIO ED2 Engineering Justification Paper (EJP)

Lochinver Primary Substation

Worst Served Customer Proposal

Investment Reference No: 343_SHEPD_WSC_LOCHINVER

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

1 Executive Summary

This Engineering Justification Paper (EJP) covers the strategic investment required to address the high volume of interruptions on the Lochinver network which serves the North West of Scotland area. Lochinver supplies 846 customers of which 540 are WSCs. Customers have experienced up to 14 interruptions over the three consecutive years between 2017 and 2019 with average interruption length of around three hours.

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

- Build a new 7.5km 11kV overhead line with 38mm^2 hard-drawn copper (HDC) conductor between end of Lochinver OHL circuit and 11kV T junction point at Rhiconich 013 OHL circuit end point;
- Build a new 10.5km 33kV overhead line (operating at 11kV) with 70mm^2 HDC conductor between 11kV T junction point at Rhiconich 013 OHL circuit end point and Tumore Lodge PMT location.
- Rebuild approx. 10km of existing 11kV OHL to 33kV overhead line (operating at 11kV) with 70mm^2 HDC conductor between Tumore Lodge PMT and start of the Tumore Lodge OHL spur section;
- Build a new 1km 11kV overhead line with 25mm^2 hard-drawn copper (HDC) conductor to interconnect different spurs in the Dunnan area;
- Install two 11kV voltage regulators;
- Allowance for refurbishment of approx. 125 11kV poles to remedy the worst performing areas of the existing circuit.

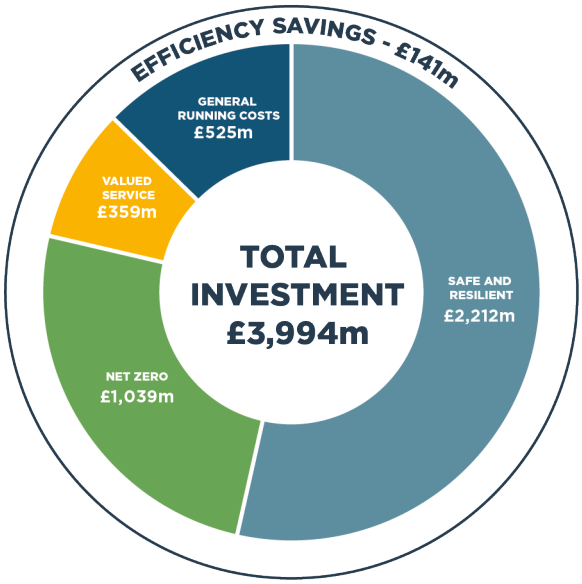
Delivering a safe, resilient and responsive network

The anticipated cost to deliver the preferred solution is £3.49m. The North West of Scotland area is relatively remote area of Scotland and on average access to this area takes a significant length of time which results in longer fault interruption lengths. Due to other WSC schemes having higher network investment priority scores and the complexity of the consenting, this scheme is planned for delivery in Year 5 of ED2 period with the refinement phase commencing in the early years of ED2.

The scheme delivers following outputs and benefits:

- Improved network performance for the 540 WSCs at Lochinver by providing an 11kV OHL ring as part of the circuit; this is expected to take all 540 WSC out of this classification.
- Improved CI/CML performance as a result of the works with expected volume reductions of 1826 CIs and 183955 CMLs in the SHEPD area per year.
- Improves the network performance of the neighbouring circuit Rhiconich 013 via interconnection with the new 11kV ring.
- A staged improvement for the wider North West of Scotland network area which when further developed in future years, will achieve P2 security of supply compliance and further enhance the network resilience for the primary substations and associated circuits in the area.

This 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

Name of Scheme/Programme	Lochinver Substations WSC Proposal					
Primary Investment Driver	North of Scotland Resilience					
Scheme reference/mechanism or category	*343_SHEPD_REGIONAL_WSC_LOCHINVER*					
Output reference/type	As above					
Cost	Cost for the selected Investment is £3.49m					
Delivery year	2026/27					
Reporting Table	CV15 North of Scotland Resilience (SHEPD)					
Outputs included in RIIO ED1 Business Plan	**No**					
Spend Apportionment (£m)	**2023**	**2024**	**2025**	**2026**	**2027**	**Total**
	0	0	0	0	3.49	**3.49**

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. Each option is described in detail in section 6, with the justifications set out for those options which are deemed unviable solutions, and therefore not taken forward to the Cost Benefit Analysis. This is based on the background information and fault data analysis detailed in section 4. 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 as detailed within this EJP will increase the realiabilty and security of the 11kV network at LochInver. Post improvement works, due to lower numbers of faults impacting the Lochinver customers, all customers will be removed from WSC classification.

The high numbers of WSCs on the Lochinver 11kV has varied throughout ED1, ranging from 360 to 833 customers. In 2019, the circuit had a total of 540 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

Lochinver Primary is located on the North West Coast of Scotland within the Assynt District of Sutherland, Highland, Scotland. The substation is supplied from Grudie Bridge Grid 33kV circuit 526-301 and supplies one 11kV feeder with 854 customers. The existing 33kV circuit (of which 90% operates as a radial) from Grudie Bridge 301 to Lochinver is made up of 96km 33kV overhead line circuit via Ullapool with Lochinver Primary located at the terminal end point of the 33kV radial circuit. Lochinvar 11kV circuit 011 has no interconnection with any other 11kV circuits. The nearest 11kV circuit is Rhiconich (NRN 544) feeder 013. The Lochinver 011 circuit involves extensive radial 11kV overhead line network, stretching approximately 85km and this is compounded by being supplied via a 33kV radial circuit. Both Lochinver and Rhiconich primaries have P2 derogations.

Table 2: Lochinver 11kV circuit

11kV Circuit	Number of connected customers	Number of PSR customers	Length of OHL (km)	Length of UG cable (km)
556-011	846	138	84.73	2.93

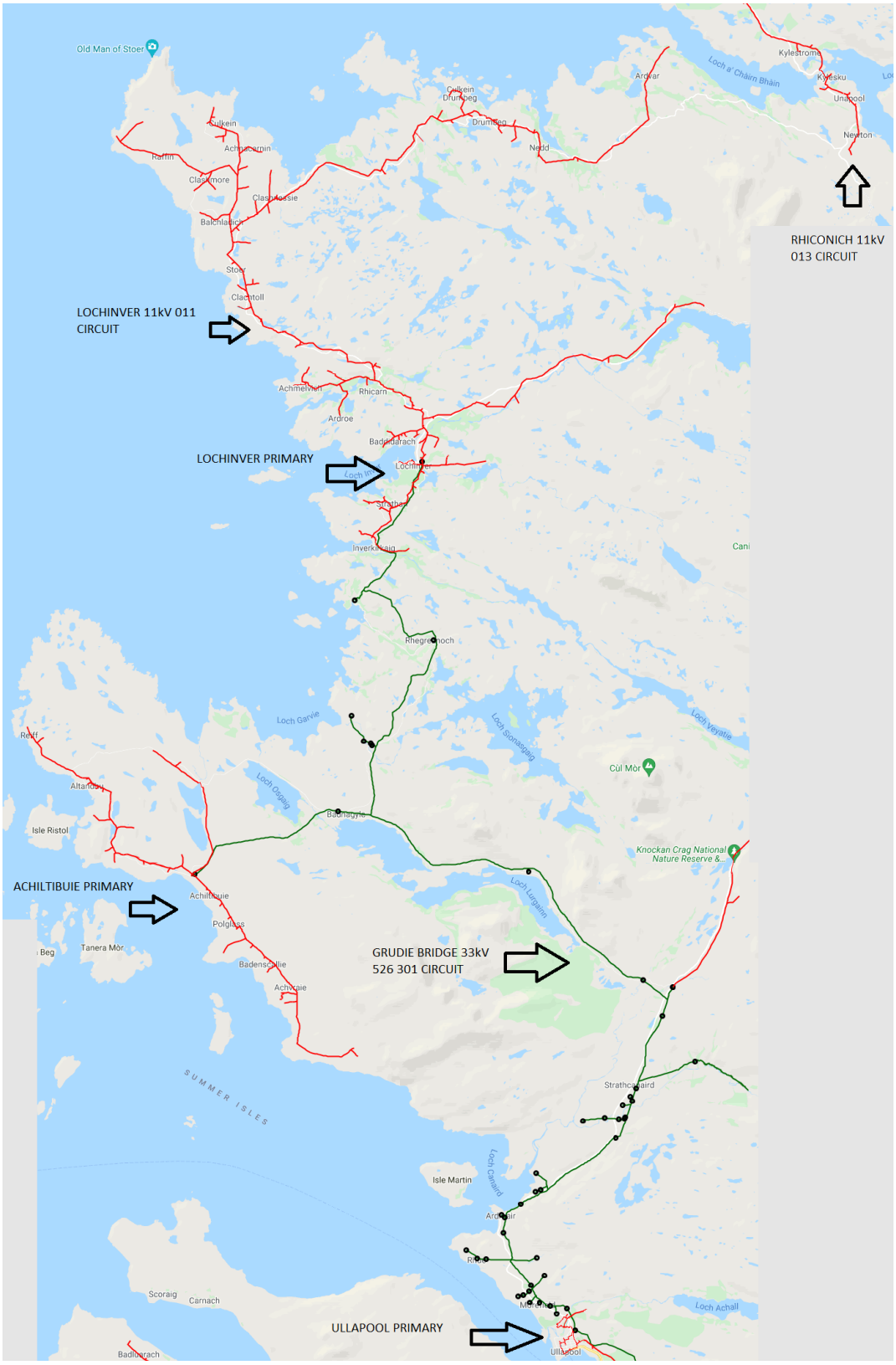


Figure 1: The existing 11kV network of Lochinver and sections of the 33kV network supplying Lochinver

4.2 WSC Network Performance

The table below shows the WSC network performance on Lochinver 011 circuit. 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.

The average interruption length for this circuit is significantly higher than the average SHEPD circuit. This is due to the remoteness of the site and the lack of interconnection. Retained staff are located in Ullapool which is approximately 1 hour drive to Lochinver primary substation. Due to the remoteness of the site, the retained staff carry out switching operations only and do not carry out damage repairs. Personnel, vehicles or equipment required to respond to a damage fault or out of typical hours fault are dispatched from Inverness which is approximately 2 hours and 15 minutes' drive to Lochinver primary. If the fault is located at the far end of the 11kV circuit this can add approximately 45 minutes to the journey in good weather.

The table below shows the WSC network performance on the 11kV circuit basis. It shows the WSC number and the range of interruptions over the 3-year period from the reporting year 2019/20 against each circuit. As part of the feedback from the stakeholder engagement event, the interruption duration and the customer vulnerability are also considered as key factors in scheme proposal. These are also shown in the table.

Table 3: WSC Network Performance

11kV Circuit	WSC No.	Range of interruption No. over 3-year	Average interruption length (mins)	Network Investment Priority score (high score = more vulnerable)
556-011	540	12-14	175	3.9

4.3 Demand Forecast

The demand forecast between 2021 and 2033 at Lochinver and Rhiconich are shown in the table below. This is based on the consumer transformation scenario. The average annual growth rates for Lochinver and Rhiconich are 6.06% and 2.18% respectively.

Table 4: WSC Network Performance

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
LOCHINVER	1.30	1.31	1.43	1.57	1.77	1.82	1.88	1.97	2.10	2.27	2.44	2.54	2.62
RHICONICH	1.68	1.68	1.68	1.68	1.69	1.69	1.69	1.70	1.77	1.90	2.02	2.10	2.17

4.4 Fault Data Analysis

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	11kV fault: Wind and Gale, Broken OHL Jumper	350
2017	11kV fault: Deterioration, Faulted fuse carrier	74
2017	11kV fault: Deterioration, Faulted ABSD	661
2017	11kV fault: Transient, Mobile Generation failure	420
2017	11kV fault: Deterioration, Pole burnt due to OHL binder failure	106
2018	11kV fault: Windborne Materials, Removal of Kite from OHL	424
2017	33kV fault: Wind and Gale, Ullapool 33kV 1S0 CB tripped (all of Lochinver customers affected plus further customers connected to 33kV line north of Ullapool)	1353
2018	33kV fault: Transient, 33kV PMCB operation (all Lochinver customers affected plus other 33kV line connected customers)	841
2018	33kV fault: Transient, Grudie Bridge 301 33kV CB tripped (all customers connected to this 33kV circuit affected)	2653
2018	33kV fault: Incorrect Protection, A fault on generator customer's network caused Grudie Bridge 301 33kV CB trip (all customers connected to this 33kV circuit affected)	2653
2018	33kV fault: Transient, Grudie Bridge 301 33kV CB tripped (all customers connected to this 33kV circuit affected)	2661
2019	33kV fault: Lightning, Faulty surge Arrestor (all of Lochinver customers affected plus further customers connected to 33kV line north of Ullapool)	1382
2019	33kV fault: Deterioration, Failure of Air Break Switch (all of Lochinver customers affected plus further customers connected to 33kV line north of Ullapool)	1385

There were in total 7 number 33kV interruptions on Grudie Bridge Grid (526-301) between 2017 and 2019 affecting the supply to Lochinver. As a result of the current network arrangement, any 33kV faults result in the supply interruption of the (854) customers on the Lochinver 11kV plus the additional customers associated to the 33kV network, this can been shown in the customer numbers detailed above.

On the Lochinver 11kV circuit, there were six interruptions between 2017 and 2019 that affected more than 100 customers. The average restoration time of these interruptions is over 3 hours. This is due to the remoteness of these areas for fault restoration and repair activities. It is the combination of 11kV and 33kV faults which lead to WSC performance of this circuit.

Figure 2: Locations of 11kV and 33kV faults which have affected Lochinver customers

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 which are both least regrets and represents best value for money for network customers are identified.

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. Maintenance and Inspection activities continue as normal.	No additional cost	WSCs will continue experiencing high number of interruptions.	Option 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 No large upfront CAPEX	Additional maintenance resource required Significant proportion of customers remain as WSCs Increase in OPEX No new fault resilience added to the circuit	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.	Improves the network performance but this degrades over time No further maintenance or inspection required	Increase in CAPEX Lower utilisation of existing assets WSCs will fall back in this category over short period of time. No new fault resilience added to the circuit	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 circuit Long term investment Wider benefits to network users including Net Zero targets	Often costly when compared with other options Longer delivery time due to the likely requirement of additional consent	Taken forward to CBA/preferred option.

5. Flexible solutions	Use battery storage or other alternative mean to support the network and mitigate interruptions	Reduced requirement of reinforcing the network Competitive cost compared to the reinforcement option	Technology and mechanism is yet to be proven 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

Lochinver primary and the remote end of the 11kV circuit 011 is geographical isolated and has no interconnection at 33kV and 11kV. 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: £135k

This option is to carry out enhanced maintenance on the Lochinver 11kV and Grudie Bridge 33kV circuit. This will target the assets with poor health condition and the worst performing sections with targeted measures 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 likely 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 Lochinver customers could experience WSC equivalent performance during the full ED2 period.

6.3 Option 3: Replacement of existing network (Replacement)

Estimated Cost: £2,223k

Under this option, the following the worst performing sections of the overhead line elements are being re-built:

- Re-build of [redacted] of the 11kV overhead line network in varying sections beyond Torbreck S/S (this is approx. 25% of the circuit length away from the primary in a northwards direction);

As a result of the proposed works, it is expected that the network performance will result in reasonable improvements however the network performance 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 and so the whole 11kV circuit would remain exposed to faults arising from external factors.

During the proposed Option 3 works, it is likely that the proposals would be built as an 'online' build which requires circuit outages that 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.

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 period.

6.4 Option 4: Reinforcing existing network (Reinforcement)

Estimated Cost: £3,488k

To address the WSCs at Lochinver, it is proposed under this option to deliver the following elements as shown in the figure below:

- New build 7.5km of 11kV 38mm2 OHL from pole 52 approx 700 metres south of An Dun 556-011-635 transformer (pink square) to pole 520 near Lower Newton 544-013-700 transformer;
- 10.5km new build 70mm2 33kV construction OHL but operating at 11kV from 11kV OHL T junction near Lower Newton transformer 544 013 700 to Tumore Lodge transformer (purple square) following A837/A894 roads.
- 10km of re-build of existing OHL to 70mm2 33kV Construction but operating at 11kV of the Tumore Lodge spur of the Lochinver 011 circuit from pole 6 near the start of the spur to end of the spur at Tumore Lodge 556-011-140 (existing transformers on spur to be re-utilised).
- 1km 2 wire circuit loop from Laid 556-011-435 transformer and new PMCB to improve network on Dunnan spur;
- Installation of 2 off 11kV pole mount 2 tank voltage regulators
- Allowance for refurbishment of approx. 125 11kV poles to remedy the worst performing areas of the existing circuit.

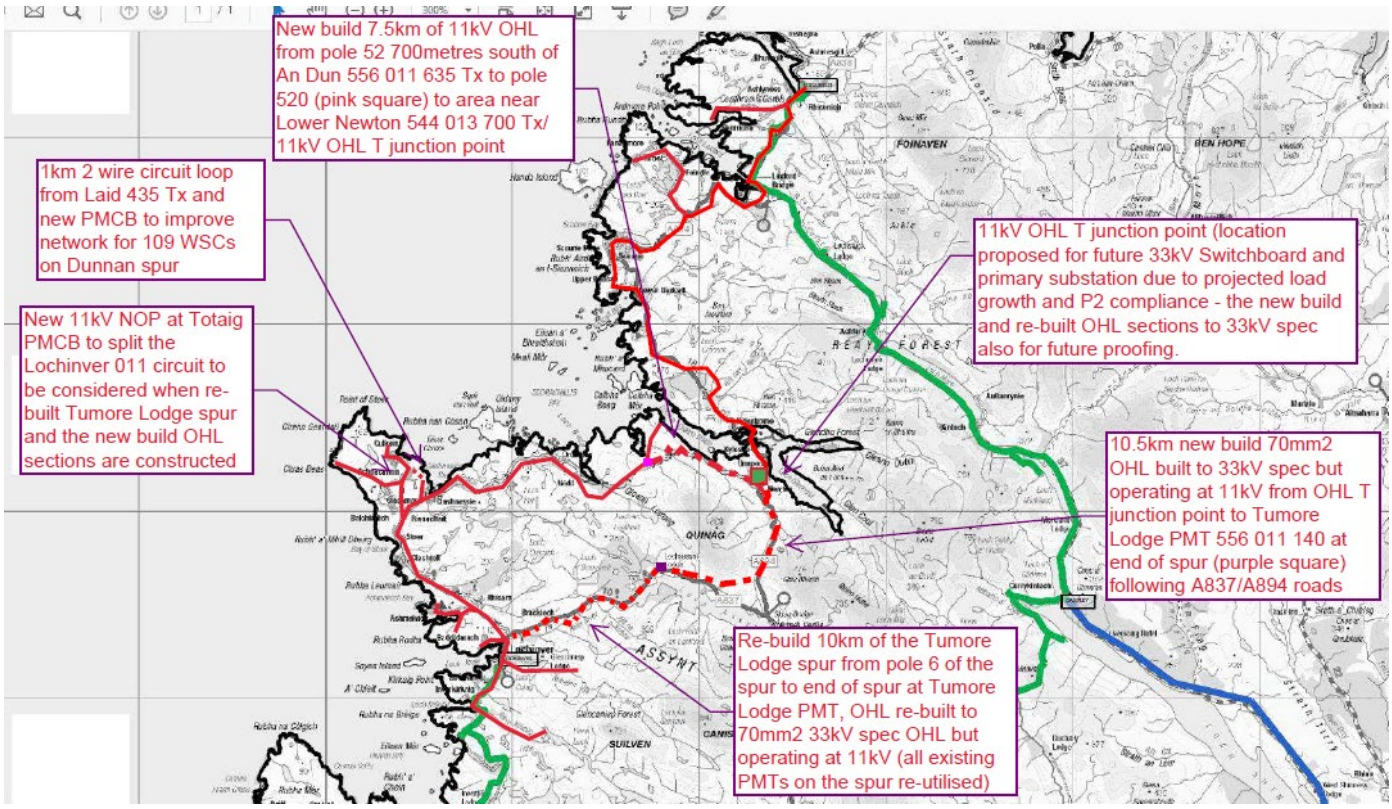


Figure 3: The proposed reinforcement works at Lochinver

The proposal would generate significant improvements to the network performance for the WSC as new fault resilience options are added to the 11kV circuit which will reduce numbers of customers being interrupted per 11kV fault and also provide potential for remote control recovery options. An additional benefit is that it improves the fault resilience of the neighbouring circuit Rhiconich 013 via interconnection with the new 11kV ring generating performance improvements for wider area customers. Rhiconich 013 will provide a level of fault resilience to the Lochinver circuit but it would not be able to support the full Lochinver circuit in all circumstances (i.e. a 33kV fault affecting Lochinver in winter periods).

33kV OHL construction is being utilised for sections of the proposed works as this construction type will provide enhanced resilience to the environmental conditions prevalent in the area (salt pollution, average high wind speed and storms).

Additionally, the proposed 33kV sections would establish the foundational elements of a staged resilience improvement plan for the wider North West of Scotland network area. When further developed, it will achieve P2 security of supply compliance and further enhance the network resilience for the primary substations and their associated circuits in the area. Currently Lochinver, Rhiconich and Ullapool primaries are P2 derogated primary substations which are non-compliant with P2 security of supply standard. The second stage would involve creating a North West of Scotland 33kV ring from Cassley Grid through to Grudie Bridge Grid substation which would provide significant resilience improvements across the wider area and multiple primary substations.

Due to the scale of the additional 33kV works and investment required to achieve the North West of Scotland resilience option, in the context of the Lochinver WSC, it is deemed more deliverable and justifiable to focus the investment proposal to mitigate potential Lochinver 11kV faults in the ED2 period. The Option 4 proposal puts these foundational elements in place for the likely future works that will tackle: the issue of potential 33kV faults; remove the derogations from the primary substations; and allow for the projected demand growth in the wider area, as outlined in section 4.3, to be accommodated.

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.

6.5 Option 5: Flexible Solution

Estimated Cost: £178k

Flexibility services could be used to support the Lochinver substation in the 33kV fault scenario. However due to nature of 11kV network, the flexible solution needs to be made available throughout the year and also be able to support the network over the period to allow the restoration. This period can be up to 3 hours based on the fault history. The technology is still unproven for a solution that can support the network of this size for this duration. This will also be unable to support the faults further on the 11kV feeders, hence has limited impact to the WSC performance improvement. Therefore, this option is not considered viable and has been rejected.

7 Summary of Cost Benefit Analysis (CBA)

This section of the report provides an overview for each option from the Cost Benefit Analysis (CBA). A detailed exercise has been undertaken to support the investment strategy that is described within this EJP. In total, three categories options within CBAs have been produced as described below. It provides an overall comparative review and analysis of the options, confirmation of the EJP preferred option and the associated justifications. 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 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 improved 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 does not provide the best value for money solution, reinforcing the case for Option 4.

The preferred option will bring wider benefits of improved network performance for this WSC site and a neighbouring 11kV circuit in the area whilst laying the foundational elements for a wider North West of Scotland resilience improvement plan in future years.

Table 7: Summary of CBA Comparisons

Options	NPV After 45 Years (£k)
Option 1 – Do Nothing	N/A
Option 2 – Enhanced Maintenance and Inspection	-690
Option 3 – Asset Replacement	-2,280
Option 4 – Circuit Reinforcement	-430
Option 5 – Flexible Solution – Not in CBA as solution not viable	N/A

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. The assumption is that 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: CI/CML Improvement for Option 2

	CI Improvement % (Actual Volume)	CML Improvement % (Actual volume)
Lochinver (556-011)	0.007 (58)	0.008 (6373)

7.3 Benefit Analysis of re-building of 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: CI/CML Improvement for Option 3

	CI Improvement % (Actual Volume)	CML Improvement % (Actual volume)
Lochinver (556-011)	0.018 (145)	0.02 (15932)

7.4 CI/CML Analysis of reinforcement of the network (Option 4)

The expected CI and CML improvements based on this option is as shown in the table below. This includes the benefits of improved CI and CML for Rhiconich as the proposal will enable the interconnection with Rhiconich feeder 013. The table shows a significant improvement for CI/CML and network performance relative to the customer numbers involved and this will remove all Lochinver customers from WSC classification.

Table 10: CI/CML Improvement for Option 4

	CI Improvement % (Actual Volume)	CML Improvement % (Actual volume)
Lochinver (556-011)	0.191 (1524)	0.127 (101458)
Rhiconich (544-013)	0.039 (302)	0.116 (82497)
Total	0.23 (1826)	0.243 (183955)

From the above tables, it is evident that the CI/CML improvement from the reinforcement option is significantly higher than the other proposed options. This confirms the case that Option 4 is the most preferable option as it delivers the required level of improvement to the network and will permanently remove those customers from WSC classification.

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	0	0	0	0.14	0.14
Option 3 – Asset Replacement	£m	0	0	0	0	2.22	2.22
Option 4 – Reinforcement	£m	0	0	0	0	3.49	3.49
Option 5 – Flexible Solution	£m	0	0	0	0	0.18	0.18

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 Preferred Option 4

Table 12: Volume of Preferred Option 4

Asset Category	Unit	2023/24	2024/25	2025/26	2026/27	2027/28	Total
6.6/11kV OHL (BLX or similar Conductor)	km	0	0	0	0	9.50	9.50
6.6/11kV Poles	#	0	0	0	0	136	136
11kV Voltage Regulator	#	0	0	0	0	2	2
6.6/11kV CB (PM)	#	0	0	0	0	1	1
6.6/11kV Switch (PM)	#	0	0	0	0	2	2
33kV OHL (Pole Line) Conductor	km	0	0	0	0	20.50	20.50
33kV Pole	#	0	0	0	0	293	293
11kV Poles Refurbishment	#	0	0	0	0	125	125

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 prioritized 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 on 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

Scottish National Heritage and Scottish Environment Protection Agency may object to OHL circuits or elements of them and request undergrounding of sections of the OHL proposed routes or impose various conditions related to archaeological or environmental or ecological requirements to carry out the works.

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 NoSR related investment in the Lochinver network.

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 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: Circuit Reinforcement
- Option 4: Asset Replacement
- 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 are proposed for delivery during RIIO ED2. The preferred investment for Lochinver substation in RIIO ED2 is Option 4: Reinforcement.

Table 13: Summary of CV Table

CV Table	Unit	2023	2024	2025	2026	2027	Total
CV15 North of Scotland Resilience (SHEPD) **RIIO ED2 Spend**	£m	0	0	0	0	3.49	**3.49**

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 private 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

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13 Appendix 3. Assumptions for Flexible Solutions Costing

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		2	365			1440			
Year 2		2	365			1440			
Year 3		2	365			1440			
Year 4		2	365			1440			[redacted]
Year 5	[redacted]	2	365	[redacted]	[redacted]	1440	[redacted]	[redacted]	