Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan: T2BP-EJP-0045

Harris-Stornoway 132kV OHL Works Engineering Justification Paper

1. Executive Summary

Our paper A Risk Based Approach to Asset Management[1] sets out our approach to network risk and how we subsequently identify assets that require intervention to limit the rise of risk over the RIIO-T2 period.

This paper identifies the need for intervention on the Harris-Stornoway wood pole circuit. The primary driver for the scheme is the asset condition with a secondary driver of network resilience.

Following a process of optioneering and detailed analysis, as set out in this paper, the proposed scope of works in response to the identified need is:

- The offline replacement of the existing line with an "H" pole trident circuit.

This scheme will cost £35.7m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetised risk benefit of R£47,681.1m;
- A reduction of total network risk calculated as R£143.1m;
- Address the asset upgrade requirements by addressing the condition need;
- Improved operational flexibility and resilience in line with or goal to aim for 100% transmission network reliability for homes and businesses;
- Contribution to our goal of one third reduction in greenhouse gas emissions through the reduced need for backup diesel generation in the Western Isles due to unplanned outages on the existing circuit.

The Harris – Stornoway 132kV OHL works is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

[1] A Risk Based Approach to Asset Management

Name of Scheme/Programme	Harris-Stornoway Overhead Line Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2028
Output references/type	NLRT2SH2028
Cost	£35.7m
Delivery Year	Within the RIIO-T2 period
Reporting Table	C0.7 Non-Load Master Data
Outputs included in RIIO T1 Business Plan	No

2. Introduction

This Engineering Justification Paper sets out our plans to undertake network condition work during the RIIO-T2 period (April 2021 to March 2026). The planned work is on the overhead line (OHL) between Harris and Stornoway as shown on Figure 1 below.

The Engineering Justification Paper is structured as follows:

Section 3: Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the "need".

Section 4: Optioneering

This section presents all the options considered to address the need that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

Section 5: Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

Section 6: Conclusion

This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

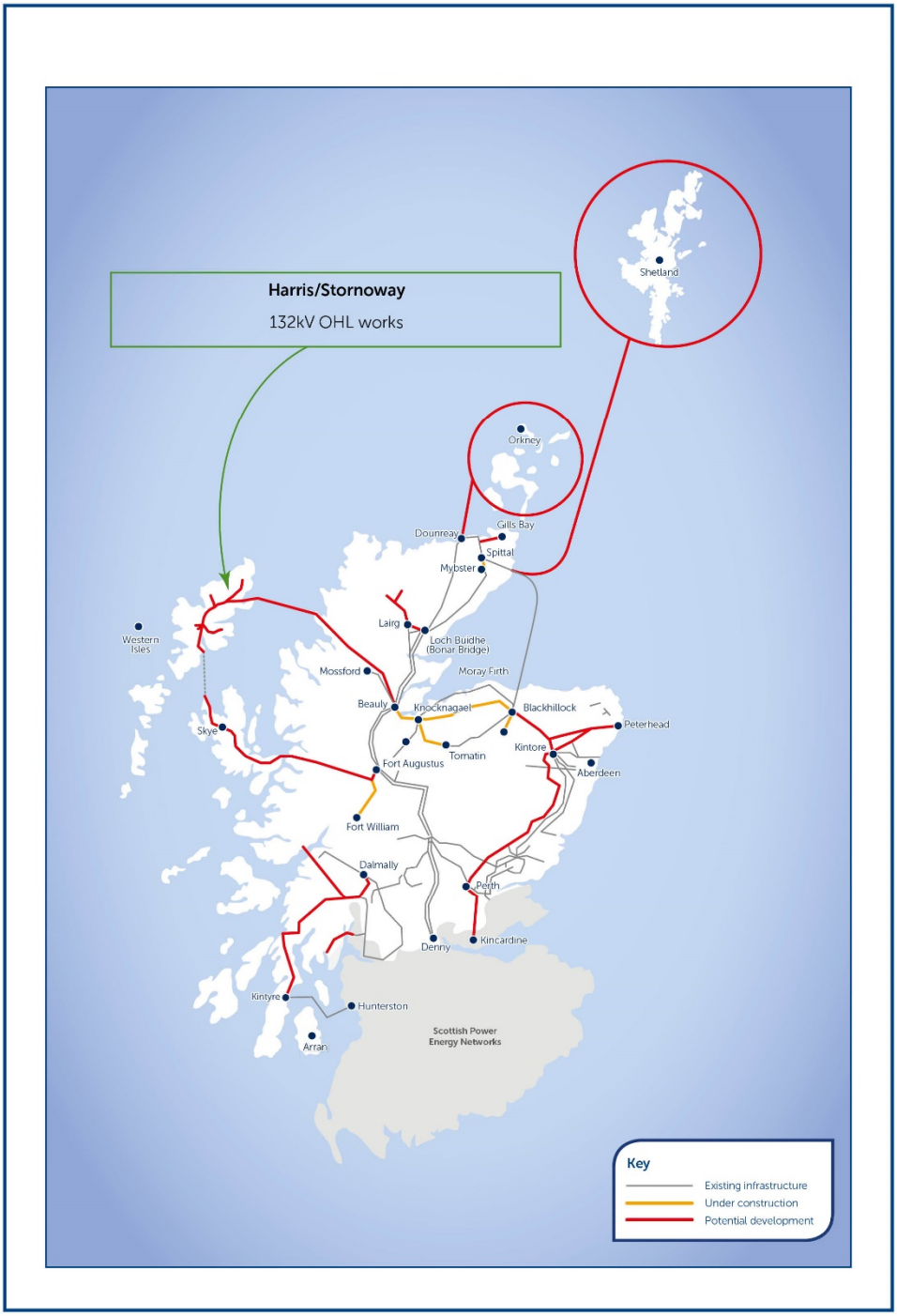
Section 7: Price Control Deliverables and Ring Fencing

This section provides a view of whether the proposed scheme should be ring-fenced or subject to other funding mechanisms.

Section 8: Outputs included in RIIO-T1 Business Plan

This section identifies if some or all the outputs were included in the RIIO-T1 Business Plan and provides explanation and justification as to why such outputs are planned to be undertaken in the RIIO-T2 period.

Figure 1 – Network Map showing Harris Stornoway 132kV OHL



3. Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the need.

3.1 Background

The 132kV overhead line between Harris and Stornoway is routed through both the Isle of Harris and the Isle of Lewis and is part of the Western Isles circuit that runs from Stornoway to Fort Augustus. This route is a wood pole line that was constructed in 1990 and consists of a single circuit that runs for circa 58km. The location of this line is very susceptible to storm damage, with high winds affecting the region and therefore requires ongoing work and monitoring. The poles on this circuit have a history of storm damage in both 2006 and 2015, and the condition and Modulus of Rupture (MoR) -related issues raise concerns as the wood poles on the circuit continue to age.

Harris - Stornoway also provides a point of connection for backup diesel generators at Battery Point and Arnish, both connected at Stornoway GSP. These are used to supply Stornoway GSP during unplanned outages as well as providing a portion of the backup generation for the Western Isles and Skye in case of disconnection from the transmission network further down the line. An illustration of the network this circuit forms part of is provided in Appendix A.

With regards to the application of the Security & Quality of Supply Standard (SQSS), a derogation was granted in 2010 by Ofgem for the Western Isles single circuit (running from Fort Augustus to Stornoway) that allows the continued operation of existing generation on the circuit without the need for further reinforcement of the line (including the single circuit section at Harris-Stornoway).

3.2 Asset Need

An asset condition report containing all the historic condition information gathered on the Harris-Stornoway circuit assets was compiled. The resulting condition report[2] provides, in detail, the condition of existing assets and recommendations for intervention in the RIIO-T2 period. A summary of the highlighted condition related issues is;

- 40 poles are recommended for replacement due to wear, decay and damage,
- 63 poles on the circuit are at risk of failure under severe weather conditions,
- Testing has identified that the modulus of rupture (MoR) for all the wood poles originally installed on the circuit in 1990, are only 77% of specified standard values and expected to decrease with age.

[2] Harris-Stornoway OHL Asset Condition Report T2BP-ACR-0010

3.3 Growth Need

A summary of the circuit ratings of the Harris-Stornoway line, which has 125mm^2 Tiger ACSR conductors, is summarised in the table below:

Table 1: Harris-Stornoway Ratings

RATINGS	Winter		Spring/Autumn		Summer	
	Amps	MVA	Amps	MVA	Amps	MVA
Pre-Fault Continuous	365	83	335	77	290	67
Post-Fault Continuous	430	99	400	92	345	79

A summary of the latest demand and generation capacity connected via GT1 at Stornoway to the wider network is summarised in the table below:

Table 2: Stornoway GSP Demand & Generation Summary (Excluding Battery Point)

Demand		Generation		
Winter Peak (MW)	Summer Min (MW)	Connected (MW)	Contracted (MW)	Total (MW)
19.4	3.4	33.13	11.7	44.83

On review of the demand and generation profiles for this GSP in comparison to the circuit rating:

- Demand is not expected to significantly rise in the medium term to require an MVA uplift on the existing Harris-Stornoway conductor;
- Generation is not expected to significantly rise in the medium term to require an MVA uplift on the existing Harris-Stornoway conductor.

[redacted] This means the proposed work to reconductor a section of the Harris-Stornoway line as well as install the Western Isles HVDC link (works needed due to the existing 2010 derogation not allowing connection of this level of additional generation to the Western Isles without such reinforcement) is still uncertain.

4. Optioneering

This section presents all the options considered to address the need that is described in Section 3. Each option considered at the optioneering stage is either taken forward for detailed analysis or is discounted with justified reasoning provided.

The recommendation from the need, outlined in section 3, means that intervention is required in the RIIO-T2 price control period so the "do nothing" option is not valid.

The need section identified the 132kV Harris-Stornoway line as requiring intervention. A summary of the options is presented in the table below:

Table 3: Options Summary

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis?
1	Replacement of High-Risk Poles	N/A	No
2	Offline Rebuild of the full route with Wood Pole Replacement	36.85	Yes
3	Offline Rebuild with Composite Pole Replacement	59.75	Yes

Any works and associated outages would have to consider not only the need to minimise the disconnection of the Western Isles circuit and the associated need for the use of backup generators situated there, but also the outages needed for the Broadford works, Quoich Tee works, and the potential works driven by the Skye strategy.

Option 1: Replacement of High-Risk Poles

This option considers the replacement of pole that have been identified as requiring intervention due to their current condition. This option presents the lowest form of intervention of all the options, but comes with the following risks;

- Each pole replacement (whether that be in-situ replacement of poles or connecting new diversions that are to replace poles) would require extensive outages on the existing line.

- Reliance on backup generation at Battery Point and Arnish to supply the local demand at Stornoway GSP.

- Increase the risk on the network due to disconnection of the backup generators at Battery Point and Arnish from the rest of the Western Isles & Skye.

Overall, while this solution would replace the highlighted high-risk poles, it does not deal with the flexural strength deficiencies of all the wood poles on this circuit. It is for these reasons this option is not being taken forward to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2: Offline Rebuild with Wood Pole Replacement

This option considers the offline rebuild of the 132kV circuit to current standards between Harris Grid Supply Point and Stornoway Grid Supply Point, thus replacing the existing single pole trident design with an "H" Pole trident wood pole line. The preference for a new route would be to follow that of the existing OHL at an offset, as the current route avoids significant environmental designations with no other significant receptors identified on route. Additionally, this route roughly follows the main A859 road between Stornoway and Harris, providing access points to proposed pole locations. This option satisfies all the identified needs and minimises the need for outages that disconnect Stornoway GSP as well as Battery Point and Arnish backup generators from the rest of the network.

PROGRESSED TO DETAILED ANALYSIS

Option 3: Offline Rebuild with Composite Pole Replacement

This option considers the offline rebuild of the new 132kV OHL circuit to current standards between Harris Grid Supply Point and Stornoway Grid Supply Point, replacing the current single pole trident design with composite poles. This replacement option is considered appropriate to consider due to:

- the increased strength of composites in comparison to wood poles;
- the increased span length that can be achieved with higher strength composites, thus presenting an opportunity to reduce the overall footprint of the circuit through reduced number of required supports;
- composites do not require the use of preservatives and can be recycled at the end of the useful lives.

The preference for a new route would be to follow that of the existing OHL at an offset, as the current route avoids significant environmental designations with no other significant receptors identified on route. Additionally, this route roughly follows the main A859 road between Stornoway and Harris, providing access points to proposed pole locations. This option satisfies all the identified needs and minimises the need for outages that disconnect Stornoway GSP as well as Battery Point and Arnish backup generators from the rest of the network.

PROGRESSED TO DETAILED ANALYSIS

5. Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

5.1. Cost Benefit Analysis

Of the three options discuss in Section 4, Cost Benefit Analysis (CBA) using counterfactual Net Present Value (NPV) analysis has been carried out, on the two viable options, to demonstrate the potential benefits of each of the shortlisted options, with Option 2 presented as the baseline option for comparison purposes. Our CBA Methodology[3] sets the process and mechanics of our approach to CBA.

The results for this CBA, including relevant calculated Net Present Values (NPVs), are summarised below:

Table 4: CBA Options Summary

CBA reference	Description of Option	Total Forecast Expenditure (£m)	Total NPV	Delta (Option to Baseline)	Total NPV (inc monetised risk)
Baseline (Option 2)	Offline Rebuild with Wood Pole Replacement	-£180.84	-£100.59		£20,226.39
Option 3	Offline Rebuild with Composite Pole Replacement	-£198.58	-£120.23	-£19.64	£20,295.82

The results of the CBA demonstrate that Option 2 is the best option from an NPV assessment as it delivers £19.64m of additional value compared to Option 3. This option has been taken forward as the proposed solution to the needs for intervention that were identified.

[3] Cost Benefit Analysis Methodology

5.2. Project Sensitivity

As outlined in our core RIIO-T2 business plan document, "A Network for Net Zero", we believe we have a critical role to play in delivering Net Zero ambitions in both the UK and Scotland. Therefore, our plan has been carefully designed with the flexibility to deliver pathways to Net Zero. Our policy paper "A Risk-Based Approach to Asset Management" outlines our approach to monitoring and assessing the condition of our assets to maintain the reliable and resilient network that is expected by our stakeholders. Where asset condition deteriorates, we undertake a programme of cost-effective, risk-based interventions to maintain the longevity and performance of the transmission network. Each of our non-load related projects for T2 is underpinned by Asset Condition Reports which clearly outline that the works are necessary and driven by reliability.

Table 5: Sensitivity Analysis table

Sensitivity	Test and impact observed – switching inputs
Asset Performance / deterioration rates	Switching deterioration assumption: Improved - need driven by asset condition report and will not improve in intervening period. Deteriorated – Need remains, project would be considered for advancement within available outages.
Ongoing efficiency assumptions	Switching efficiency assumption: Increased or decreased. Test would have no impact on (feasible) option selection, both the options move in parallel and have no impact on ordering within CBA.
Demand variations	No significant demand forecast.
Energy scenarios	We have considered the potential for further generation increases in the uncertain view, and factored that into the proposed solution.
Asset utilisation	Our policy paper "A Risk-Based Approach to Asset Management" outlines our approach to monitoring and assessing the condition of our assets to maintain the reliable and resilient network that is expected by our stakeholders. Where asset condition deteriorates, we undertake a programme of cost-effective, risk-based interventions to maintain the longevity and performance of the transmission network. Each of our non-load related projects for T2 is underpinned by Asset Condition

	Reports which clearly outline that the works are necessary and driven for reliability.
Timing / delivery	We have considered timing of investments as part of our CBAs.
Consenting / stakeholders	Where applicable we have considered consenting and stakeholder engagement and the impact which this has had on the selection of the preferred solution.
Public policy / Government legislation	We have considered the impact of public policy, government legislation and regulations as part of the need, optioneering and detailed analysis and the impacts this has on the selection of the preferred solution.

5.3. Proposed Solution

The scope of the selected solution, Option 2, is an offline rebuild of single circuit 132kV "H" Pole route to replace the existing line. This option will upgrade the conductors replacing ACSR Conductors with AAAC is standard industry practice, as ACSR conductors are gradually being phased out by suppliers and are unlikely to be standard products in the years to come. The project will be energised within the RIIO-T2 period. The table below details the outputs.

Table 6: Outputs from preferred option

Plant	Size of new plant	Replacement for
"H" pole wood structure line	58km "H" pole line construction with AAAC conductors	Existing 58km 132kV single circuit pole line

5.4. Competition

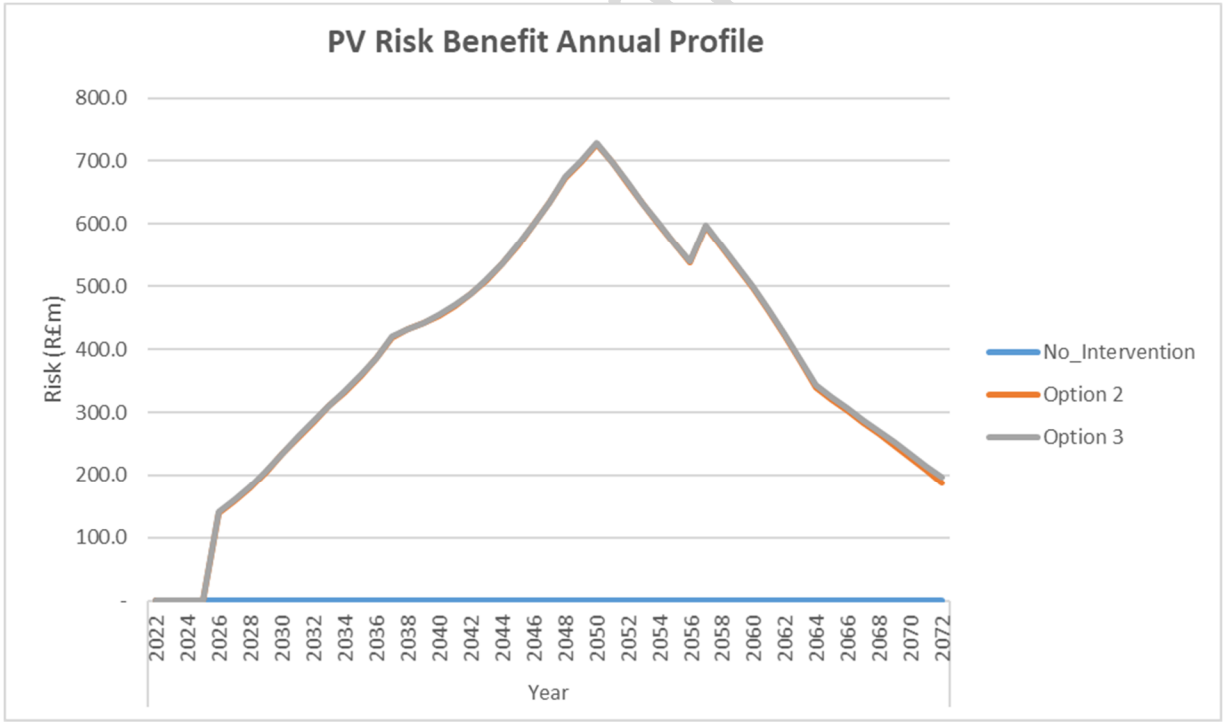
The Harris – Stornoway 132kV OHL works is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

5.5. Risk Benefit

A Risk Benefit Analysis has been carried out in order to compare "no intervention" against the selected "with intervention" option. Please not that while monetised risk is denoted as a financial figure, it is important to note that it is not "real" money and does not correspond to the cost that SHE Transmission would incur if an asset was to fail and these values are thus identified with R£ prefix (for more details please refer to A Risk Based Approach to Asset Management[1]).

he long-term risk monetised benefit which would be realised through the completion of the like for like replacement option is R£47,681.1m. The long-term benefit is derived by consideration of the risk of the asset experiencing a catastrophic failure weighted by the probability that the asset will survive for the Options and "no intervention" scenarios. The long-term benefit is an aggregation of the risk of all assets being considered within the option. The risk of each Option is then compared with the "no intervention" scenario. The "no intervention" scenario assumes that when the asset experiences a catastrophic failure the asset is replaced.

Figure 2: Long Term Benefit of Proposed Intervention – Replacing with like for like wood poles (Option 2) or Replacing with Composite Poles at a reduced volume (Option 3)



In addition to assessing the long-term risk benefit, an immediate monetised risk benefit has also been determined. The monetised risk benefit which would be realized through the completion of the like for like replacement option is R£143.1m.

5.6. Innovation & Sustainability

The selection of the option stated mitigates the outages required to complete such works, thus reduces the need for backup diesel generation and the associated additional greenhouse gas emissions associated with this inefficient form of generation to supply Stornoway GSP.

5.7. Carbon Modelling

We are committed to managing resources over the whole asset lifecycle – i.e. including the manufacturing of assets, construction, operations and decommissioning activities – to reduce our greenhouse gas emissions in line with climate science and become a climate resilient business. It is our aspiration that the carbon lifecycle cost of investment options plays a key role within our project development (between gates 1 and 2) and is considered in the selection of a preferred solution. We have therefore developed an internal carbon pricing model that estimates a carbon cost for each option considered in our CBA through deriving values for:

1. Embodied carbon, which relates to the carbon emissions associated with the manufacturing and production of the materials use in production of the lead assets (transformer, reactors, underground cables and overhead lines. Overhead line is made up of tower/wood pole/composite pole, conductor and fittings) procured and installed as part of the project.

2. The carbon emissions associated with the main stages of the project lifecycle (construction, operations and decommissioning).

It is our vision to embed carbon considerations within our strategic optioneering and project development processes, which will require us to determine a way of flagging high carbon options within our CBA outputs. We will continue to develop our thinking in this space, which will involve our model being validated by a third party, so the results included in this EJP are indicative and subject to change.

In terms of the results of analysis for this project, Option 2(baseline) delivers the lowest the carbon footprint and results are summarised in the table below.

Table 7: Carbon Calculation Summary

	Project Information	Baseline	Option1
Project info	Project Name/number	0	0
	Construction Start Year	2026	2026
	Construction End Year	2028	2028
Cost estimate £GBP	Embodied carbon	£103,034	£814,825
	Construction	£41,447	£54,272
	Operations	£ 3,540	£ 1,801
	Decommissioning	£18,975	£24,847
	Total Project Carbon Cost Estimate	**£166,996**	**£895,745**
Carbon footprint tCO2e	Embodied carbon	1,376	10,880
	Construction	545	714
	Operations	15	8
	Decommissioning	55	71
	Total Project Carbon (tCO2e)	**1,991**	**11,673**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	15	8
	Total Scope 2 (tCO2e)	-	-
	Total Scope 3 (tCO2e)	1,975	11,665
SF_6 Emissions	Total SF_6 Emissions 3 (tCO2e)	-	-

5.8. Cost Estimate

The cost of the preferred option for works on the Harris-Stornoway line has been developed using rates from existing substation framework contracts and benchmarks from delivered RIIO-T1 projects. The total cost for delivering the scope of works for the proposed solution is £35.7m.

6. Conclusion

This paper identifies the need for intervention on the 132kV overhead line running between Harris and Stornoway. The primary driver for the scheme is the asset condition with a secondary driver being flexural strength deficiencies of the wood pole supports.

Three intervention options were identified for this scheme. Of these, two options were taken forward and considered for detailed analysis.

The proposed scope of work selected (Option 2) is:

- The offline replacement of the existing line with an "H" pole trident circuit.

This scheme will cost £35.78m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetised risk benefit of R£47,681.1m ;
- A reduction of total network risk calculated as R£143.1m ;
- Address the asset upgrade requirements by addressing the condition need;
- Improved operational flexibility and resilience in line with or goal to aim for 100% transmission network reliability for homes and businesses;
- Contribution to our goal of one third reduction in greenhouse gas emissions through the reduced need for backup diesel generation in the Western Isles due to unplanned outages on the existing circuit.

The Harris – Stornoway 132kV OHL works is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

7. Price Control Deliverables and Ring Fencing

As set out in our Regulatory Framework paper (section 1.12 and Appendix 3) we support a key principle from Citizens Advice – one that guarantees delivery of outcomes equivalent to the funding received - to ensure that RIIO-T2 really deliver for consumers.
For our core non-load projects this means that we commit to delivering our overarching NARMs target. If we do not deliver the NARM target, or a materially equivalent target, then we should be subject to a penalty. Equally, if we over-deliver against our target and can justify that the over-delivery is in the consumers interests and could not have been reasonably factored into our business plan at the time of target setting then we should be made cost neutral for this work.

Core non load projects should not be ring fenced. This is to allow for substitution of projects in order to meet that NARM target. We need flexibility to respond to up to date asset data information or external influences on our network during the price control; this information might drive us to substitute one project for another in order to ensure a reliable and resilient network. Ring fencing projects may result in sub-optimal decisions, having adverse consequences for the health of our network, which will ultimately be reflected in the NARM target.

8. Outputs included in RIIO T1 Business Plan

There are no outputs associated with this scheme included in our RIIO-T1 plans.

Appendix A: Overall Semi-Geographic Network Diagram

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