Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan: T2BP-EJP-0028

Whistlefield – Dunoon 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 Whistlefield – Dunoon 132kV overhead line asset. The primary driver for the works is the asset condition and fault performance of the existing OHL.

There is a secondary load related driver on this project. In addition to the condition driver for refurbishment there is contracted generation in the Dunoon area that impacts on the power flow on the Whistlefield - Dunoon circuit. The contracted generation requires an increase in the capacity rating of the overhead line to connect to the network in order that we maintain compliance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

Following optioneering and detailed analysis, as set out in this paper, the proposed scope of works is;

- Rebuild of the existing OHL with L7 Steel lattice towers and Upas AAAC conductor to meet the minimum rating requirement identified in the Need section of this justification paper.
- Dismantling and removal of the existing OHL towers and conductors.

This scheme will cost £40.8m to deliver the following outputs and benefits during the RIIO-T2 period;

- A long-term monetised risk benefit of R£464.3m.
- A reduction of total network risk calculated at R£14.0m.
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The Whistlefield Dunoon 132kV OHL Works project 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	Whistlefield – Dunoon 132kV OHL Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT202
Output references/type	NLRT2SH202
Cost	£40.8M
Delivery Year	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 refurbishment works of existing assets during the RIIO-T2 period (April 2021 to March 2026). The planned work is on the Whistlefield – Dunoon 132kV OHL as shown on the map in 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.

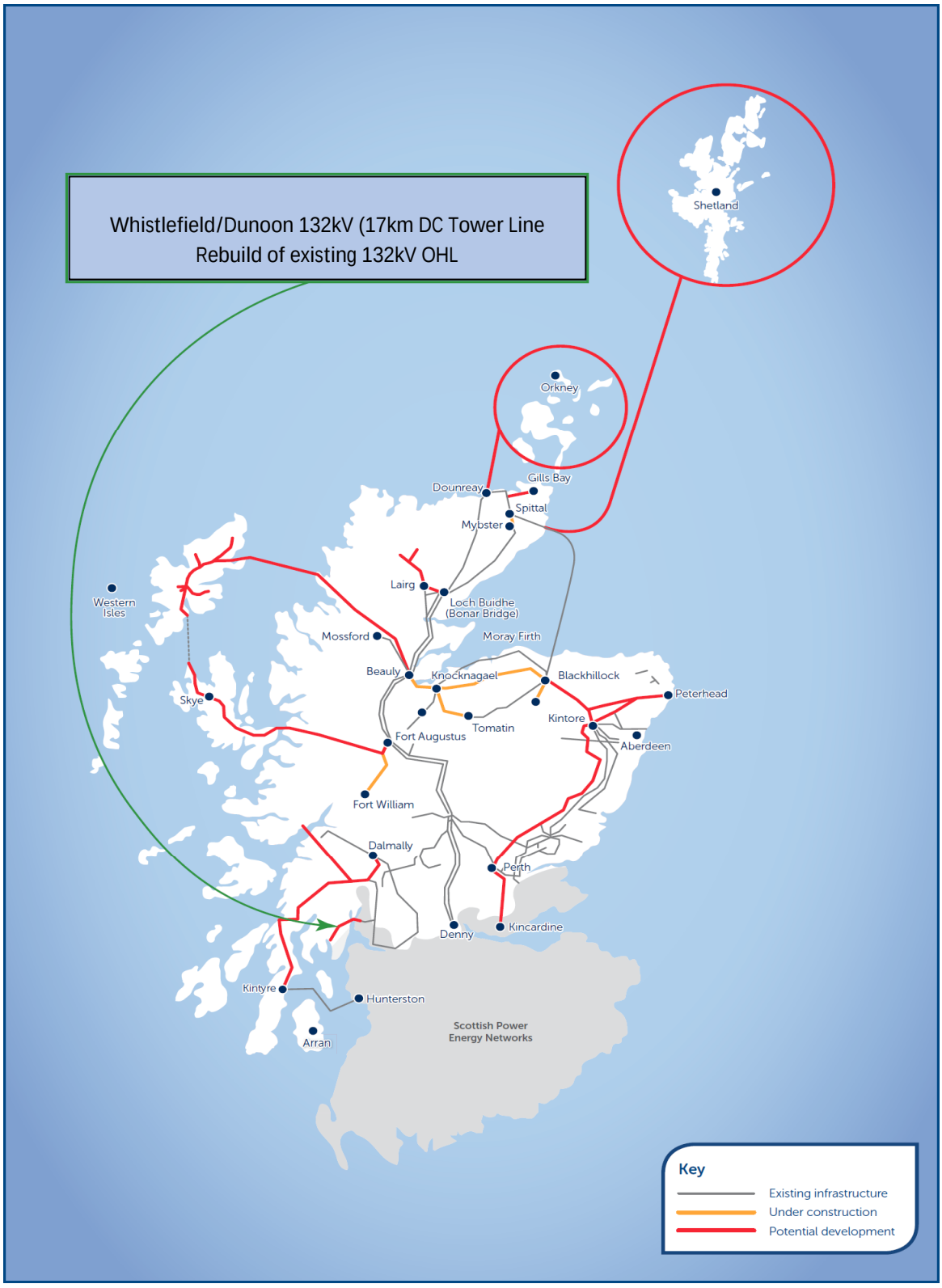
Section.7 Price Control Deliverables and Ring Fencing

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

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. Map showing the Whistlefield – Dunoon 132kV OHL works on a map of SHET network.



3 Need

This justification paper considers the Whistlefield – Dunoon OHL. This is a 132kV double circuit formed of steel lattice towers in the south west region of our network. The circuits were constructed in 1972 connecting Dunoon substation to the transmission network. We own part of the line and SPT own part of the line, with the ownership boundary being mid span between tower 13 and tower 14. This document only refers to proposed intervention works on our section of the line from Dunoon (Tower 93) to Tower 13/14.

Our section of the circuit is 17km in length and consists of 80 variant spec PL16 type steel lattice towers. The circuit is strung with single Tiger ACSR phase conductors and a Skunk ACSR earth wire conductor.

The earth wire was reconductored in 2014, however the phase conductors are the original conductors installed when the line was constructed in 1972. By the end of RIIO T2 the phase conductors will be 54 years old, while the earth wire will be 12 years old.

3.1 Asset Need

An Asset Condition Report[2] (ACR) has been prepared for this circuit which identified a need for intervention. The ACR draws up on information from a variety of sources with the key points summarised below.

The circuit has been subject to ongoing issues with faults and is rated among the worst performing circuits in our network. Analysis of the last 13 years has indicated an average of 10 outages per year on this circuit covering faults, repairs, line inspection and maintenance. The period from May to September is the most common period of the year for trips on the circuit, with the fault logs indicating it is predominantly the top phase that causes the trip. A number of investigations have been carried out with numerous remedial measures implemented throughout the circuit lifetime taking into consideration creepage distances on insulators, dry band arcing, or the reduced phase to earth clearances. None of these works have resolved the fault issues on the circuit.

The design dimensions of the existing tower structures are a limiting factor in the ability to increase phase – earth electrical clearances and to provide any increase to insulation levels to rectify recurring circuit trip events.

Survey information contained within Cyberhawk's iHawk system which has identified that numerous modifications have been made to the OHL since the original construction. The line now consists of a range of different insulator types and components which were installed to try and improve the performance of the line and reduce the number of faults which have occurred over the last 30 years.

[2] Whistlefield – Dunoon 132kV OHL Asset Condition Report T2BP-ACR-0004

A Cormon conductor assessment undertaken on the phase conductors in 2014 shows no signs that they have been affected by corrosion. The life of the phase conductor will not exceed the industry mean asset life of 54 years by the end of the RIIO T2 period. Damage has been identified on the phase conductor on the Loch Long crossing between towers 13 and 14 and will require replacement. Damage to the earth wire conductor has also been identified at one tower, and in addition six earth wire bonds require replacement.

Steelwork assessments have identified damaged steelwork members at two towers which will require rectification. There is limited corrosion noted on the steelwork members. Tower concrete stubs and muffs have been assessed to be in good condition, both structurally and their coating.

Following the completion of a detailed assessment using finite element analysis modelling tools which were not available during the original design, it has been identified that there are potential clearance infringements present if the conductor reaches maximum operating temperature during the summer months. As such there is a requirement to propose mitigation of the potential infringements in 19 spans to ensure the line remains fully compliant with ESQCR clearance requirements.

Composite insulators in spans 44 to 57 are showing the build-up of pollutants. The insulators were installed as rectification measures to address circuit performance and have since exceeded their design life. All insulators on these towers are recommended for replacement.

The recommendations from the condition assessment report is that damaged steelwork members are replaced. The conductors in the Loch Long crossing span should be replaced, and earthwire bonds at six towers should be replaced. Insulator strings on the circuit should be replaced with a consistent design along the OHL. However, it should be noted that insulation levels cannot be increased on the existing towers due to the inherent dimensional limitations of the existing tower design.

The condition assessment report has shown the need to undertake limited refurbishment works on this OHL circuit, however there are also significant fault performance issues identified on this circuit due to the tower design and the insulation level provided. The required insulation level cannot be met on the existing structures to provide reliable circuit performance.

3.2 Growth Need

The contracted generation at Dunoon GSP requires an increase in the network capacity on the existing Whistlefield – Dunoon OHL. Ardtaraig is a 32MW wind farm generator developed by [redacted] which is contracted to connect to the distribution network at Dunoon. As Dunoon GSP is connected radially to the Main Interconnected Transmission System, the connection of generation at Dunoon directly impacts the power flow on the Whistlefield – Dunoon 132kV OHL. Power system studies on the local network, considering the connected and contracted background, have concluded that the existing Tiger ACSR conductors do not provide sufficient capacity to enable the connection of the contracted generation. The contracted generation therefore requires an increase in the capacity rating

of the overhead line to connect to the network in order for SHE Transmission to maintain compliance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

The 2019 Future Energy Scenarios (FES) out to 2050 have shown an anticipated increase in the embedded generation at Dunoon GSP, particularly in relation to embedded solar generation. When accounting for this anticipated increase, and the connected and contracted generation at Dunoon GSP, the minimum summer pre-fault rating requirement on the Whistlefield – Dunoon 132kV OHL is 120MVA.

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. Table 1 lists each option and a brief summary.

Table 1. Option summary table

Option	Option Detail	Taken Forward to Detailed Analysis
Do Nothing Option	Undertake no refurbishment work on the assets.	No
1	Retain the existing conductor, replace insulator strings and strengthen the towers.	No
2	Reconductor with a higher capacity conductor, replace insulator strings and strengthen the towers.	No
3	Rebuild the OHL with a higher capacity conductor.	Yes

Do Nothing Option

The do nothing option does not undertake any refurbishment on the OHL circuit. This option has been discounted at this stage as the network asset risk and asset condition assessments have concluded a need to refurbish the assets. In addition, the existing conductor does not have sufficient capacity to accommodate the future load requirements. For these reasons this option has not been progressed.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 1

This option considers the retention of the existing conductor and includes for tower upgrades and ground clearance mitigations to ensure compliance with minimum statutory clearances and to replace damage steelwork identified. The phase conductor between spans 13 and 14 (Loch Long crossing) should be replaced. Insulator strings across the circuit should be replaced with a consistent design and with increased insulation levels.

Although this option will result in the existing route and structures being re-utilised, it does not satisfy all of the recommendations from the condition assessment report. Namely the recommendation to increase insulation levels on the OHL in order to provide a reliable performance on the circuit. This is

not possible on the existing circuit due to limitations in the existing tower design. This option would not address the fault related issues associated with this OHL. Also, the retention of the existing conductor would not meet the requirement for an increase in the capacity of the OHL to accommodate the contracted generation at Dunoon substation. As a result, this option is not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2

This option considers reconductoring the OHL with higher rated conductor than the existing Tiger ACSR, to meet the load related driver requirements. An OHL consultancy was employed to consider a range of conductors to meet the rating requirement. AACSR Pastel conductor was recommended from the study undertaken based upon this conductor giving the best sagging results under all conditions. This option also includes for tower upgrades and ground clearance mitigations to ensure compliance with minimum statutory clearances, to accommodate the larger conductor proposed, and to resolve damage steelwork identified. Insulator strings across the circuit should be replaced with a consistent design and with increased insulation levels.

This option will result in the existing route and structures being re-utilised, however it does not satisfy all of the recommendations from the condition assessment report. Namely the recommendation to increase insulation levels on the OHL in order to provide a reliable performance on the circuit. This is not possible on the existing circuit due to limitations in the existing tower design. Also, as a result of the larger conductor on the circuit and the resultant clearance infringements, it would be necessary to replace a significant number of towers on the circuit. Also due to the increased conductor size a design study has shown that tension towers on the circuit were found to be significantly overloaded. The structural analysis concluded that the level of strengthening works required for all tension towers would not be viable and therefore replacement structures would be needed. This would result in over half of the towers on this circuit being replaced in situ. The increased conductor size would also require strengthening works to be undertaken on the suspension towers. As a result, double circuit outages, or single circuit outages with multiple temporary diversions, would be required. This option would not address the fault related issues associated with this OHL. Therefore, this option is not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 3

This option considers a rebuild of the existing OHL. The new circuit would be constructed with L7 Steel lattice towers and Upas AAAC conductor to meet the minimum rating requirement identified in the Need section of this justification paper. Following completion of the rebuild the existing OHL towers and conductors would be dismantled and removed.

All of the recommendations from the condition assessment report will be met by this option. It would improve the fault performance of the OHL by ensuring the phase to earth distances meet current standards. The new OHL would be constructed offline, reducing the length of outages required with only short duration single circuit outages to enable the connection to Dunoon substation at one end of the line and to SPT's network at the other end of the line. OPGW earth wire would add optical fibre connection to the circuit, improving the communications on the OHL. This option has been progressed to detailed analysis.

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.

Of the four options that were discussed in section 4 "Optioneering", only Option 4 has been considered for taking forward as a proposed solution to meet the existing asset condition and fault performance of the OHL, and to meet the load related driver.

5.1 Cost Benefit Analysis

Only one technically acceptable solution has been identified during optioneering, therefore no Cost Benefit Analysis has been undertaken.

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 2. Sensitivity Analysis table

Sensitivity	Test and impact observed – switching inputs
Asset Performance / deterioration rates	Switching deterioration assumption: The asset performance / deterioration rates can only improve or deteriorate. As the need for this project is driven by an asset condition report (as outlined in Section 3), the asset condition will not improve in the intervening period. The second option is for the asset performance to deteriorate and therefore the need remains, and the 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, as only one option was taken forward to detailed analysis and therefore there is no impact on the preferred solution.

Demand variations	No significant demand forecast.
Energy scenarios	Sensitivity considered in Section 3 (Need) already. As there is only a marginal increase in capex to deliver the works at a higher capacity to accommodate the forecasted "certain view" generation. Please see Section 3 of the EJP and our paper "A Network for Net Zero – Scenarios" for further details.
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 as part of section 5 (Detailed Analysis) 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 (section 3), optioneering (section 4) and detailed analysis (section 5) and the impacts this has on the selection of the preferred solution. For example, the projects have considered the impact of the UK Governments' Net Zero emission by 2050 target, SQSS and ESQCR.

5.3 Proposed Solution

Based on the output of the optioneering exercise, the proposed solution we propose to proceed with in RIIO-T2 is Option 4 as detailed in the section 4 Optioneering of this justification report.

This option considers a 19km rebuild of the existing OHL. The new circuit would be constructed with L7 Steel lattice towers and Upas AAAC conductor to meet the minimum rating requirement identified in the Need section of this justification paper. It is the only option considered which addresses the issues with unreliable performance on the existing OHL related to the inherent dimensional limitations of the existing tower design Following completion of the rebuild the existing OHL towers and conductors would be dismantled and removed. The proposed programme for this solution would see energisation within the RIIO-T2 period.

Table 3: Outputs from Preferred Solution

Plant	Size of new plant	Replacement for
132kV overhead line	L7 tower with Upas AAAC Keziah OPGW	PL16 Tiger ACSR Skunk ACSR earthwire

The cost of the preferred option for works on Whistlefield - Dunoon scheme has been developed using rates from existing OHL framework contracts and benchmarks delivered RIIO-T1 projects. The total cost for delivering the scope of works for the preferred solution is £40.83m. The works are planned to be completed within the RIIO T2 period.

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

5.4 Competition

The Whistlefield Dunoon 132kV OHL Works project is not flagged as eligible for early or late competition due to it being under Ofgem's £50m and £100m thresholds respectively.

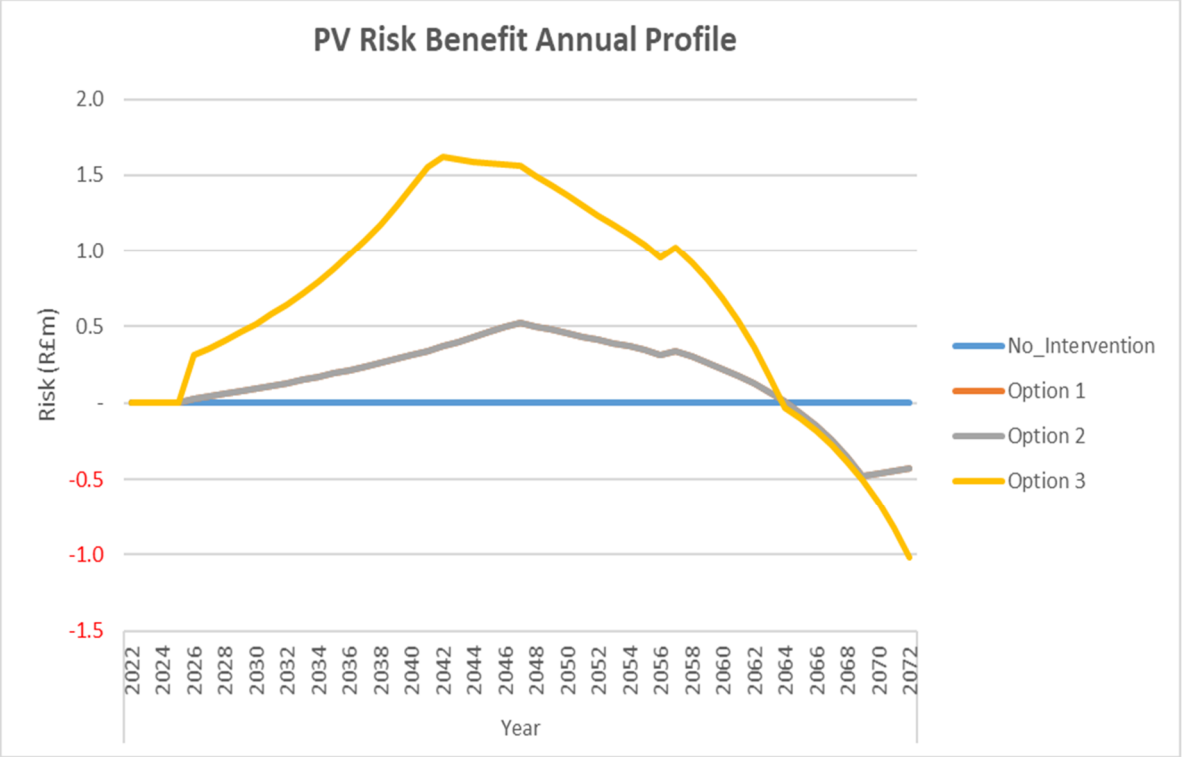
5.5 Risk Benefit

A Risk Benefit Analysis has been carried out in order to compare "no intervention" against the selected "with intervention" option. Please note 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]).

The long-term risk monetised benefit of the preferred option (Option 3) which would be realised through the completion of this project is R£464.3m. The long-term risk monetised risk benefit for the rejected options (Options 1 and 2) are R£13.2m and R£64.1m respectively.

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 – Insulator prioritisation (Option 1), Conductor and Insulation prioritisation (Option 2) and Rebuild including towers (Option 3)



The long-term risk benefit for Option 1 and Option 2 shown in Figure 2 follow identical profiles throughout their lifetime and as such, the graph displays only one line. In addition to assessing the long-term risk benefit, a monetised risk benefit has also been determined. The monetised risk benefit of the preferred option (Option 3) which would be realised through the completion of this project is R£14.0m. The monetized risk benefit of the rejected options (Options 1 and 2) are R £30k and R£0.3m respectively.

5.6 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 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.

Table 3. Carbon Footprint Modelling for the Whistlefield – Dunoon 132kV OHL Works.

	Project Information	Baseline (Option 3)
Project info	Project Name/number	
	Construction Start Year	2026
	Construction End Year	2028
Cost estimate £GBP	Embodied carbon	£ 295,701
	Construction	£ 37,195
	Operations	£ 1,040
	Decommissioning	£ 17,029
	Total Project Carbon Cost Estimate	**£ 350,965**
Carbon footprint tCO2e	Embodied carbon	3,948
	Construction	489
	Operations	5
	Decommissioning	49
	Total Project Carbon (tCO2e)	**4,491**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	5
	Total Scope 2 (tCO2e)	-
	Total Scope 3 (tCO2e)	4,487
SF• Emissions	Total SF• Emissions 3 (tCO2e)	-

5.7 Cost Estimate

The cost of the preferred option for works for Whistlefield - Dunoon has been developed using rates from existing overhead line framework contracts and benchmarks from delivered RIIO-T1 projects. The total cost for delivering the scope of works for the proposed solution is £40.8m. The works are planned to be completed within the RIIO T2 period.

6 Conclusion

This paper identifies the need for intervention on the OHL asset. The primary driver for the reinforcement works in this project is due to design related fault performance of the existing OHL and to a lesser extent asset condition.

Load is a second primary driver for this asset intervention. The contracted generation requires an increase in the capacity rating of the overhead line to connect to the network in order for SHE Transmission to maintain compliance with the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

Following optioneering and detailed analysis, as set out in this paper, the proposed scope of works is;

- Rebuild of the existing OHL with L7 Steel lattice towers and Upas AAAC conductor to meet the minimum rating requirement identified in the Need section of this justification paper.
- Dismantling and removal of the existing OHL towers and conductors.

This scheme will cost £40.8m to deliver the following outputs and benefits during the RIIO-T2 period;

- A long-term monetised risk benefit of R£464.3m.
- A reduction of total network risk calculated at R£14.0m.
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The Whistlefield Dunoon 132kV OHL Works project 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 NARMS target, or a materially equivalent target, then we should be subject to a penalty. Equally, if we over-deliver against our target and are able to 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 NARMs 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 NARMs target.

8 Outputs included in RIIO T1 Business Plan

Although this scheme was originally included in our baseline for delivery during the RIIO-T1 period, changes in asset condition and prioritisation across our portfolio means that our asset program is under continual review. Our decision to defer this scheme means that we were able to substitute and deliver other schemes to meet our required absolute output target in line with our license obligation. An assessment will be undertaken at the end of the RIIO-T1 period to validate our performance against our licence target and associated Rewards and Penalties guidelines.

Appendices

Appendix A: Network Diagram Whistlefield – Dunoon

CONTENT DELETED