Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan T2BP-EJP-020

Elmwood-Glenagnes 132kV Cable Works Core Non-Load 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 CGN/CGS 132kV fluid filled underground cables and the 132kV overhead line between Charleston and Glenagnes substations. The primary driver for the scheme is asset condition.

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

- Replace Elmwood-Glenagnes 132kV fluid filled underground cables with solid single core underground cables.
- Minimum refurbishment of the Charleston-Elmwood 132kV OHL.

This scheme will cost £11.4m and will deliver the following outputs and benefits during the RIIO-T2 period:

- A long-term monetised risk benefit of R£917.3m;
- A reduction of total network risk calculated as R£3.6m;
- Improved safety by removing porcelain sealing end terminations; and,
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

[1] A Risk Based Approach to Asset Management

Name of Scheme/Programme	Elmwood – Glenagnes 132kV Cable Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2027
Output references/type	NLRT2SH2027/Lead
Cost	£11.4m
Delivery Year	RIIO T2
Reporting Table	0.7 Non-Load Master Data
Outputs included in RIIO T1 Business Plan	No

2 Introduction

This Engineering Justification Paper sets out our plans to undertake condition-related work during the RIIO-T2 period. The planned work is on the CGN/CGS Charleston-Glenagnes 132kV circuits which is shown on the map overleaf.

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

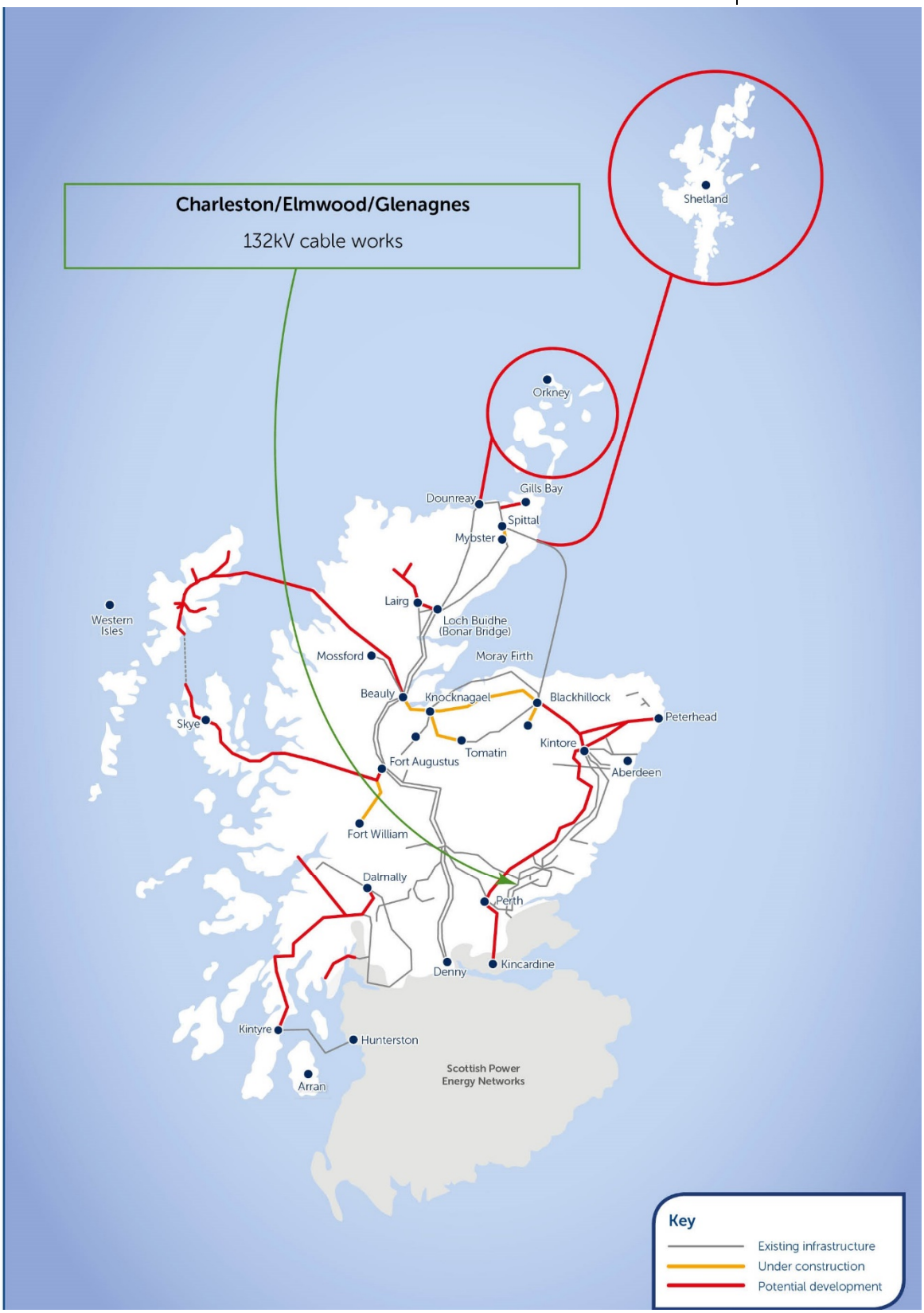
This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

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.


Charleston/Elmwood/Glenagnes
132kV cable works
Shetland
Orkney
Dounreay
Gills Bay
Spittal
Mybster
Lairg
Loch Buidhe
(Bonar Bridge)
Western Isles
Mossford
Moray Firth
Beauly
Knocknagael
Blackhillock
Peterhead
Skye
Kintore
Tomatin
Fort Augustus
Aberdeen
Fort William
Dalmally
Perth
Denny
Kincardine
Kintyre
Hunterston
Arran
Scottish Power
Energy Networks
Key
Existing infrastructure
Under construction
Potential development

3 Need

3.1 Background

The CGN/CGS Charleston-Glenagnes 132kV circuits consist of sections of both overhead line (OHL) and underground cable (UGC) and were constructed in 1959. The circuits are located in an urban, residential location in Dundee. An interface point between the OHL and UGC is located at Elmwood sealing end compound.

OHL consists of the following:

- Towers which are a mix of J.L.Eve PL16 and Blaw Knox PL16 type;
- Phase conductor is 250mm^2 'Bear' aluminium conductor steel reinforced (ACSR);
- Earthwire is 70mm^2 'Horse' ACSR; and,
- Five of the seven towers attract a 'high' ESQCR risk rating.

UGC consists of the following:

- 0.45in^2 Cu fluid filled cable with a pre-fault continuous circuit rating of 111/89MVA (Winter/Summer).
- Porcelain outdoor cable terminations; and,

The description above is shown in the semi-geographic diagram at Appendix A.

3.2 Asset Need

The need for intervention on the CGN/CGS circuit is based on current asset performance and condition assessment. By the end of RIIO T2 the circuits will be 67 years old, having aged beyond their expected design life of 40 years and beyond the 54 year industry mean asset service life.

One underground cable fault attributed to joint failure is recorded while three instances of abnormal tracking or sparking at the Elmwood CSEs have required unplanned outages[2].

The condition report[3] provides detail of asset condition and maintenance effort for the Elmwood to Glenagnes 132kV fluid filled cable circuits. SSEN Transmission strategy is to replace fluid filled cable circuits with a solid cable design when condition requires.

Present inspection and maintenance effort for the fluid filled cables far exceeds that of modern solid cable designs. [redacted]

[2] CAR section 3.3.4 UGC Faults for cables
[3] Elmwood – Glenagnes Cable Asset Condition Report T2BP-ACR-0017

[redacted] Cable sealing ends at Glenagnes and Elmwood are inspected annually to help mitigate against vandalism. Those at Elmwood have been repaired a number times.

CGN/CGS UGC circuits have suffered a number of leaks during their life, the most recent of these happened [redacted] in 2018 where the pipework from one of the oil tanks split and released oil across the park. Repairs were made and contaminated soil disposed of during an environmental clean-up.

SHE Transmission is reliant on the National Grid Cable Club or Cable Contractors to provide spares for these cables.

Ongoing site inspections provide detailed condition assessment of the circuit along with the data gathered from testing and analysis. The resulting Asset Condition Report that forms part of the Investment Decision Pack for this scheme, provides detail on the condition of existing assets and recommendations for intervention in the RIIO-T2 period.

A summary of the condition issues relating to the CGN/CGS 132kV UGC and OHL are:

- Fluid filled cables are at end of life;
- Porcelain cable sealing end terminations; The porcelain sealing ends at these sites, if they suffer a catastrophic failure, can shatter and throw large quantity of sharp shards of porcelain across a wide area up 50m away. The flying debris presents a risk to personnel as well as electrical plant and buildings. The urban location of these sites means that members of the public are also at risk.
- Fluid leaks; and,
- A history of cable joint failure.

4 Optioneering

This section presents 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.

4.1 UGC Options

This sub-section presents the options considered for the cable section of the circuit between Elmwood and Glenagnes. Based on the history of maintenance and repair on this circuit intervention by replacement is the only acceptable solution to address the asset condition.

Table 2 – UGC Optioneering Summary

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis
1	Replace fluid filled UGC between Elmwood and Glenagnes with solid UGC.	£11.4	Yes

Option 1. Replace fluid filled UGC between Elmwood and Glenagnes with solid UGC.

This option proposes the replacement of the existing end of life fluid filled cables between Elmwood and Glenagnes with solid XLPE insulated cables over an alternative cable route to minimise outage periods. Circuit ratings will match existing circuit ratings.

This option is technically feasible, but a significant area of engineering difficulty will be encountered when bringing the replacement cables into the already severely constrained location of Elmwood SEC. Space restrictions also exist within Elmwood SEC with no clear or obvious solution and do not meet present space, operational or design standards.

The contingency plan to the constraints at Elmwood SEC is to adopt the route of the existing cable approach for a short distance. This will complicate decommissioning of the existing cables and extend outage periods.

Other Considerations:

The delivery of this circuit replacement will be carried out with continued engagement with community liaison groups and Dundee City Council.

PROGRESSED TO DETAILED ANALYSIS

4.2 OHL Options

This sub-section presents the options considered for the OHL section of the circuit between Charleston and Elmwood as detailed below:

Table 3 – OHL Optioneering Summary

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis
1	Minimum refurbishment of OHL between Charleston and Elmwood.	£0.07m	Yes

Option 1. Minimum refurbishment

Minimum refurbishment of OHL between Charleston and Elmwood is required to keep the circuit operational for the next 10 years.

Minimum refurbishment of the Charleston-Elmwood OHL will ensure ESQCR compliance and remove condition based defects detailed within the OHL Asset Engineering Condition Report.

The Minimum Refurbishment scope of works is:

- Replace all anti-climbing guards and ID plates;
- Replace missing arcing horn on tower 2 downlead.

Fault records do not point to equipment or age related issues for this OHL or damage caused by weather. The only fault recordings are due to interference with the public/suspected vandalism. However, five of the seven towers on this circuit are categorised ESQCR risk rating 'high'.

Based on these factors this option is taken forward to detailed analysis.

PROGRESSED TO DETAILED ANALYSIS

5 Detailed Analysis

This section considers in more detail each of the options taken forward from Optioneering section 4. 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

As there is only one viable solution for each of the OHL and UG options, a CBA is not required.

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 4 – Sensitivity Analysis

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 this is a non-load project and the need is driven by the asset condition, the work would be required regardless of any changes to the energy scenarios.
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

The selected proposal to deliver the work identified for delivery in RIIO-T2 is as follows:

UGC Option 1. Replace fluid filled UGC between Elmwood and Glenagnes with solid UGC, 6km

This option proposes the replacement of the existing fluid filled cables between Elmwood and Glenagnes with solid XLPE insulated cables over an alternative cable route of up to 6km to minimise outage periods. Circuit ratings will match existing circuit ratings.

This option is technically feasible, however a significant area of engineering difficulty will be encountered when bringing the replacement cables into the already constrained location of Elmwood SEC. The arrangement at Elmwood SEC will be improved as part of this project to meet present space, operational or design standards and to adopt the route of the existing cable approach for a short distance. This will complicate decommissioning of the existing cables and extend outage periods.

OHL Option 1. Minimum refurbishment of OHL between Charleston and Elmwood, 7km

Minimum refurbishment of the Charleston-Elmwood OHL will remove ESQCR related defects and appropriate condition-based defects listed within the OHL Asset Engineering Condition Report.

Required works;

- Replace all anti climbing guards and ID plates; and,
- Replace missing arcing horn on tower 2 downlead.

Fault records do not point to equipment or age-related issues for this OHL or damage caused by weather. The only fault recordings are due to interference with the public/suspected vandalism. However, five of the seven towers on this circuit are categorised ESQCR risk rating 'high'.

Table 3: Outputs from preferred option

Plant	Size of new plant	Replacement for
132kV Cable	Single core XLPE cable system	Fluid filled cable system
132kV OHL	7km tower line refurbishment	-

5.4 Competition

The scheme is not flagged as eligible for early or late competition due 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 monetised risk benefit which would be realised through the completion of this project is R£917.3m. 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 1 - Long Term Benefit of Proposed Intervention – Option 1: Cable Replacement Works

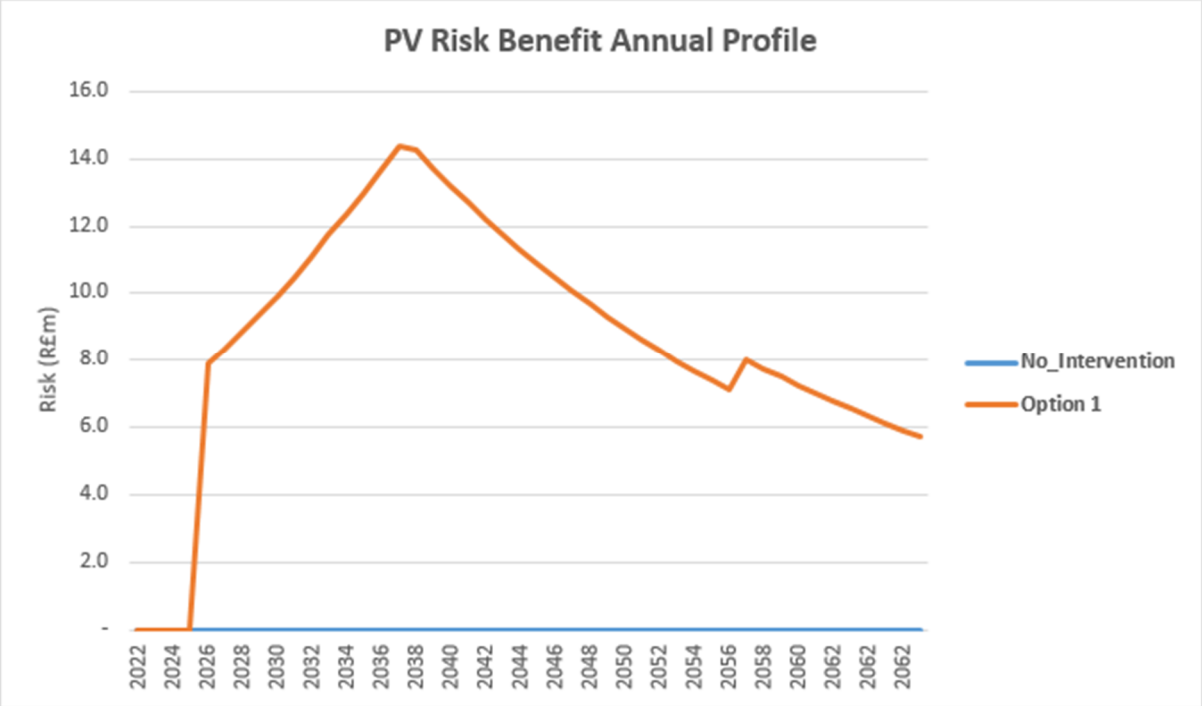


Figure 1 shows the long term benefit of Option 1. In addition to assessing the long-term risk benefit, a monetised risk benefit has also been determined. The monetised risk benefit which would be realised through the completion of this project is R£3.6m.

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 (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.

The results of analysis for this project, are captured in the carbon footprint results table.

Table 5 – Carbon Modelling

	Project Information	Baseline
Project Info	Project Name/number	0
	Construction Start Year	2026
	Construction End Year	2028
Cost Estimate £GDP	Embodied Carbon	£61,646
	Construction	£71,999
	Operations	£3
	Decommissioning	£32,963
	Total Project Carbon Cost Estimate	**£166,612**
Carbon Footprint TCO2e	Embodied Carbon	823
	Construction	947
	Operations	0
	Decommissioning	95
	Total Project Carbon (tCO2e)	1,865
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	0
	Total Scope 2 (tCO2e)	-
	Total Scope 3 (tCO2e)	1,865
SF• Emissions	Total SF• Emissions 3 (tCO2e)	-

5.7 Cost Estimate

The cost of the preferred option for works on Elmwood/Glenagnes 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 £11.4m.

6 Conclusion

This scheme is driven by condition of the 132kV UGC and OHL between Charleston, Elmwood and Glenagnes.

The proposal delivers OHL and Underground work as follows:

- Replace Elmwood-Glenagnes 132kV fluid filled underground cables with solid single core underground cables; and,
- Minimum refurbishment of the Charleston-Elmwood 132kV OHL.

This scheme will cost £11.4m and will deliver the following outputs and benefits during the RIIO-T2 period:

- A long-term monetised risk benefit of R£917.3m;
- A reduction of total network risk calculated as R£3.6m;
- Improved safety by replacing porcelain sealing end terminations with polymeric type; and,
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The scheme is not flagged as eligible for early or late competition due 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

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

Appendix A – Semi-Geographical layout of Charleston – Elmwood – Glenagnes

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