Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan: T2BP-EJP-0042

Tummel Bridge Substation 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 outlines and demonstrates the key intervention requirements for asset replacement works at Tummel Bridge 132/11kV substation.

The primary driver for the works is asset condition.

In addition to this, there are several secondary drivers.

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

- Decommissioning and removal of existing Tummel Bridge assets and infrastructure;
- Network reconfiguration, removing Tummel Bridge tees from the Errochty to Rannoch circuits;
- Offline construction of 2 new replacement GT bays at Errochty Substation,
- Connection to Tummel Bridge Substation at 11kV, via new 11kV cable routes.

This scheme will cost £14.8m and deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetised risk benefit of R£16m;
- A reduction of total network risk calculated as R£2.5m;
- Improved operational flexibility and resilience, in line with our goal to aim for 100% transmission network reliability for homes and businesses;
- A reduction in the volume of SF_6 on the network from the use of innovative non SF_6 equipment contributing to our goal of a one third reduction in greenhouse gas emissions.

The Tummel Bridge 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	Tummel Bridge Substation Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2015
Output references/type	NLRT2SH2015
Cost	£14.8m
Delivery Year	Within the RIIO T2 period.
Reporting Table	C.07 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 at Tummel Bridge during the RIIO-T2 period (April 2021 to March 2026) at Tummel Bridge substation as shown on the map on the following page.

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.

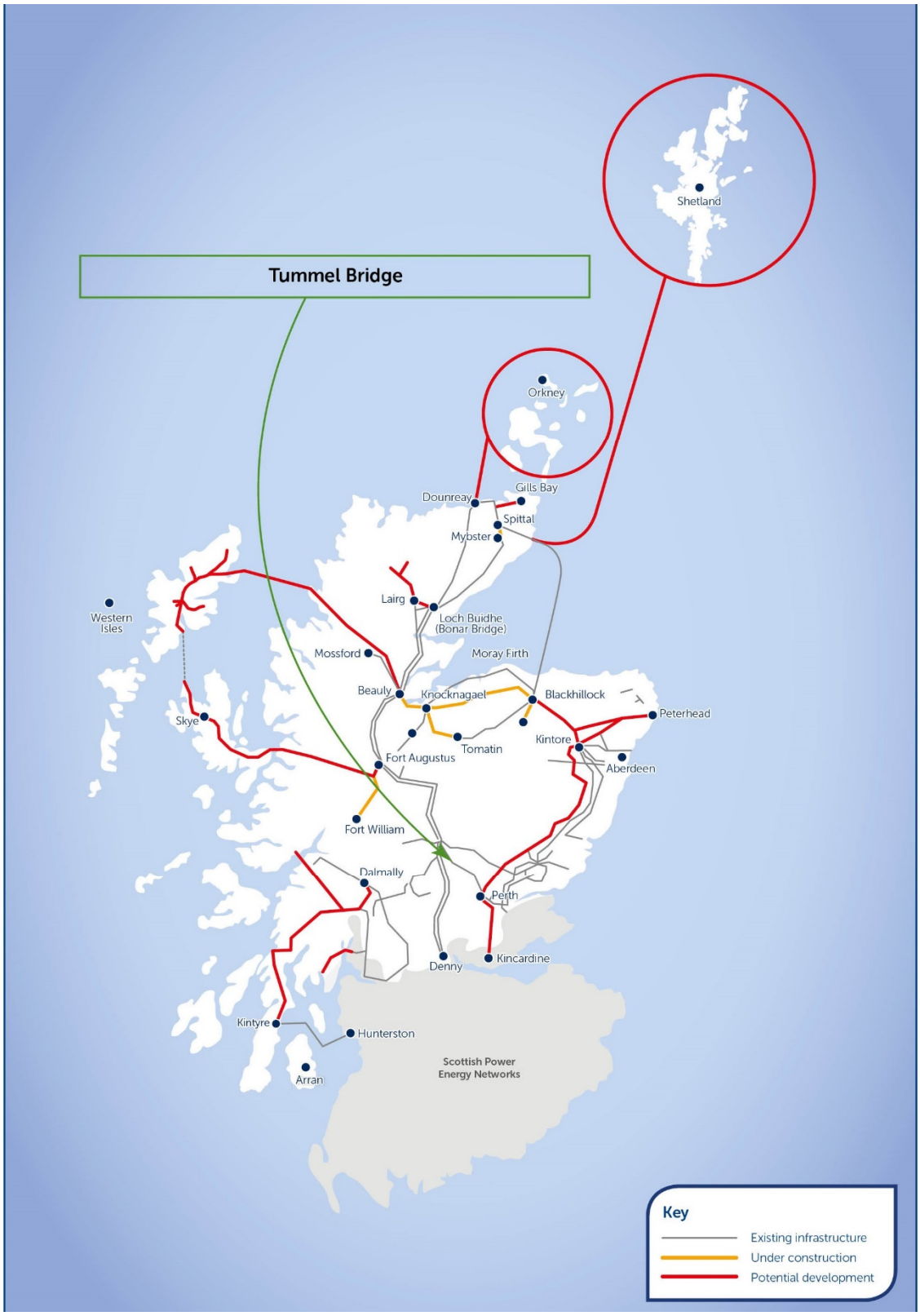
Section 7: Price Control Deliverables and Ring Fencing

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: Location of Tummel Bridge Substation



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

Tummel Bridge Substation is the connection point to the transmission network for the Tummel Bridge Hydro Generation scheme and is located 0.5km from Tummel 275kV substation, 0.7km from Errochty 132kV substation. The site lies 13 miles to the west of Pitlochry.

The site is a shared location with SHE Transmission, third party generator and Scottish Hydro Electric Power Distribution (SHEPD) plant, equipment and common shared services. Transmission primary assets are located within a single shared compound with SHEPD assets. Our secondary assets are within the third-party generator building.

3.2 Asset Need

Tummel Bridge substation requires replacement due to the condition of the plant and equipment.

The Asset Condition Report 2(ACR) document supports the need for such investment and details the issues and risks comprehensively. Key items include:

- Oil samples indicate that the grid transformers show ageing of insulation, indicating they are approaching the end of their serviceable life:
- The 132kV disconnectors and earth switches are manually operated and the disconnectors have been refurbished with drive mechanisms from other manufacturers.
- The 132kV switchgear is obsolete and there are recorded operational failures of the 132kV switchgear.
- The protection systems at Tummel are obsolete and require replacement.
- Intertripping systems at Tummel are sub optimal and do not meet current standards.
- The condition of the assets are a risk to continuity of the connection of the hydro generation scheme for export, if no suitable intervention work takes place.

Although the primary driver for works is the condition of assets; several secondary drivers are present within the existing infrastructure:

[2] Tummel Bridge Substation Asset Condition Report T2BP-ACR-0016

- Legacy of shared assets with third parties with operational constraints
- Environmental risk from current infrastructure which lacks facilities for transformer oil handling and containment
- [redacted]
- Operational flexibility is limited as 132kV disconnectors and earth switches are manually operated so manual intervention is required for any planned or fault switching
- Plant and system protection does not meet current standards

3.3 Growth Need

There is need to increase the capacity of the existing GT's at Tummel Bridge, based on the units being operated beyond their current combined capacity limit of 42 MVA. The peak load was 108% of capacity in Winter 2018. The connected generation at the GSP is 130% of the current capacity limit. There is also a need to consider n-1 contingency, which is not currently met with the existing asset capacity.

System analysis works were carried out to verify the proposed GT ratings, based on a number of network running arrangements and load scenarios.

There are no identified growth needs for the site related to load schemes.

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 to Detailed Analysis in Section 5.

The Asset Condition Report does not support "do nothing" scenario(s). Leaving the installed assets in their current condition is not an option due to poor asset health and presents increasing risk of failure.

It is considered that the asset replacement works must occur within the RIIO-T2 period (April 2021 to March 2026).

Table 1: The two options considered for Tummel Bridge

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis?
1	In situ rebuild at Tummel Bridge	N/A	No
2	Offline build at Errochty, connect to Tummel Bridge	14.8	Yes

Option 1 – In situ rebuild at Tummel Bridge

This option considers the minimal in situ replacement of the existing switchgear, protection and GTs at Tummel Bridge.

Replacement of:

- GT1 21 MVA, EAT1, associated CT's, associated 11kV cabling, associated Protection and Control equipment
- GT2 21 MVA, EAT2, associated CT's, associated 11kV cabling, associated Protection and Control equipment
- Line Disconnectors 113 (GT1), 213 (GT2) with Circuit Switchers 115 (GT1), 215 (GT2) and their associated structures
- Earth Switches 101 (GT1), 201 (GT2) with new equivalents and their associated structures
- GT 1 & 2 Bunds

- Common shared services - LVAC, DC Battery, Communications Systems with dedicated equivalents

This option does not resolve a number of the secondary drivers. There is limited scope to increase the transformer capacity beyond existing ratings.

To rebuild in situ, replicates the existing safety issues, operational constraints and network risks associated with the site. It does not segregate the GT's from the 132kV OHL or, the SHEPD and third party generator assets.

Therefore, this option is not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2 – Offline build at Errochty, connect to Tummel Bridge

This option considers the dismantling and decommissioning of the existing Tummel Bridge assets, with asset relocation and replacement at Errochty substation. The customer connection is made between the new GT bays at Errochty via 11kV cabling to the Tummel Bridge 11kV switchboard.

In summary, the works are for:

- Disconnection of the 132kV OHL Tee connection (Errochty Rannoch North and South Circuits)
- Decommissioning and removal works at Tummel Bridge for both GT bays
- Construction offline 2 off, 132/11kV GT bays at Errochty substation
- 11kV Cabling 2 off circuits from Errochty to Tummel Bridge substations

This option fully resolves the primary and secondary drivers.

The offline build away from the constraining infrastructure, resolves the existing safety issues, operational constraints and network risks associated with the existing site. It segregates the GT's from the 132kV OHL; SHEPD and third-party generator assets.

There is added benefit in reduction of outage durations, compared with Option 1.

Benefits:

The most considerable benefit for this proposal is the minimisation of outages based on an off-line build for the new equipment at Errochty substation. The outage constraints would be based on connection and cabling works only. This would limit the generator outages, compared with an in-situ replacement programme.

Several factors increase network security for the local substation group:

- Removal of the Tummel Bridge "T" from the Errochty to Rannoch circuits
- Introduction of an HV Circuit breaker on the GT circuits
- Dedicated 132kV GT bays, double busbar arrangement, dual busbar selection
- Standardised Protection, Control and Intertripping functionality to current standards
- Uprating to current standards the Errochty site Diesel generator, DC Battery Systems

The offline build of the new assets at Errochty; eliminate or, mitigate the previously stated concerns relating to:

- Asset failure risks, network security
- Operational and maintenance concerns, proximity restrictions, double circuit OHL outage requirements
- Environmental issues

There is an opportunity to provide alternate 132kV and 11kV circuit breakers, which do not utilise SF_6.

Incorporation of GT bunds with oil interceptors and bunded hard standings for oil spillages, handling and processing. This brings the facilities for the GT's up to the current standards and practices; eliminates the oil contamination risk in proximity to the River Tummel.

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

There is no requirement to undertake cost benefit analysis as only a single replacement proposal has been made.

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 3: 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, 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. Although the transformers have been sized to accommodate the network demand increases.
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 scope of the selected solution is dismantling and decommissioning of Tummel Bridge; asset relocation and replacement at Errochty substation. Install and connect cabling connections to Tummel 11kV Switchboard; undertaking all necessary improvements.

A copy of the proposed Errochty Single Line Diagram (SLD) is shown in Appendix B. The project will be energised within the RIIO-T2 period.

The proposed solution will replace the existing 132kV/11kV AIS substation (Tummel Bridge) with the plant in Table 2 installed at Errochty substation:

Table 2 – Outputs from Preferred Option

Plant	Size of new plant	Replacement for
132/11kV Transformer	2 x 60MVA 2 x 150kVA EAT	2 x 42MVA 2 x EAT
132kV Switchgear	2 x 132kV Circuit breakers 4 x 132kV Disconnectors 8 x 132kV Earth switches	NA
11kV Switchgear	2 x 11kV circuit breakers 2 x 11kV Disconnectors 4 x 11kV earth switches	NA
11kV Cables	2 x 11kV circuits	

5.4 Competition

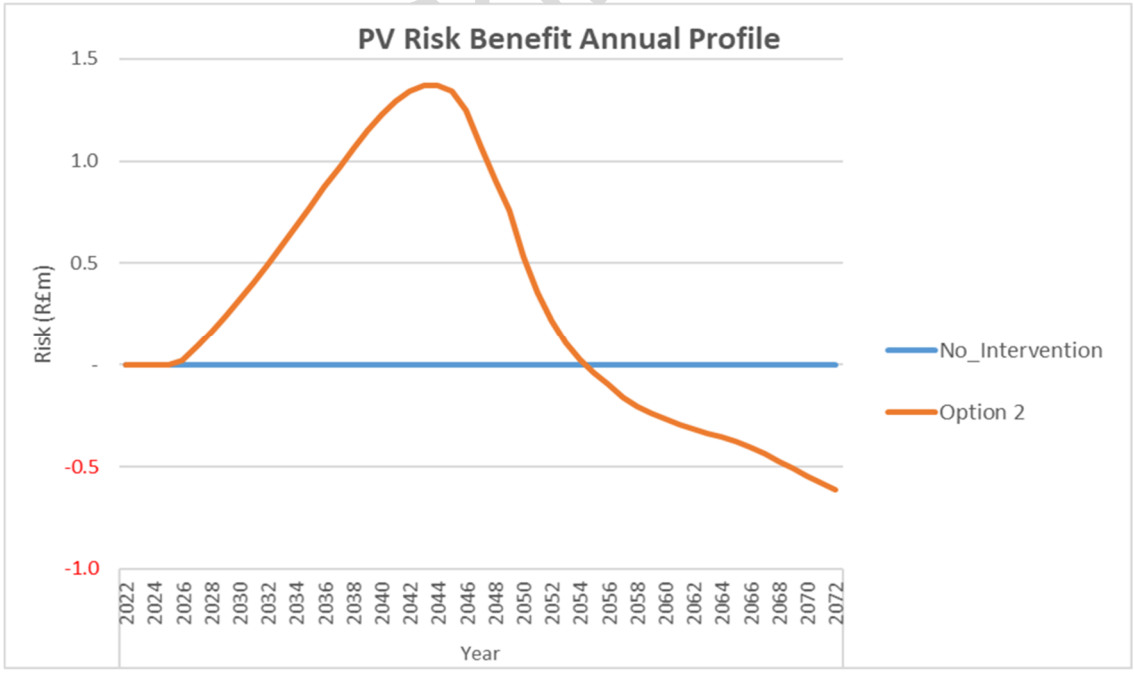
The Tummel Bridge scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

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 Management1).

The long-term risk monetised benefit which would be realised through the completion of this project is R£16m. 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 both GTs and adding 2 Circuit Breakers



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£2.5m.

5.6 Innovation & Sustainability

The installation 132kV CBs will employ a non-SF• filled solution in support of our Sustainability and Environmental policies.

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.

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

Table 4: Carbon Calculation Summary

	Project Information	Baseline
Project info	Project Name/number	0
	Construction Start Year	2026
	Construction End Year	2028
Cost estimate £GBP	Embodied carbon	£ 61,138
	Construction	£ 24,476
	Operations	£ 78,408
	Decommissioning	£ 11,206
	Total Project Carbon Cost Estimate	**£ 175,228**
Carbon footprint tCO2e	Embodied carbon	816
	Construction	322
	Operations	343
	Decommissioning	32
	Total Project Carbon (tCO2e)	**1,513**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	172
	Total Scope 2 (tCO2e)	171
	Total Scope 3 (tCO2e)	1,170
SF_6 Emissions	Total SF_6 Emissions 3 (tCO2e)	137

5.8 Cost Estimate

5.9 The cost of the preferred option for works at Tummel Bridge 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 £14.8m.

6 Conclusion

This paper identifies the need for intervention on existing assets at Tummel Bridge substation. The primary driver for the scheme is the asset condition of existing plant and infrastructure. There are several valid and significant secondary drivers present.

Two intervention options were identified for this scheme, however only one option was progressed to detailed analysis

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

- Decommissioning and removal of existing Tummel Bridge assets and infrastructure;
- Network reconfiguration, removing Tummel Bridge tees from the Errochty to Rannoch circuits;
- Offline construction of 2 new replacement GT bays at Errochty Substation,
- Connection to Tummel Bridge Substation at 11kV, via new 11kV cable routes.

This scheme will cost £14.8m and deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetised risk benefit of R£16m;
- A reduction of total network risk calculated as R£2.5m;
- Improved operational flexibility and resilience, in line with our goal to aim for 100% network reliability for homes and businesses;
- A reduction in the volume of SF_6 on the network from the use of innovative non SF_6 equipment contributing to our goal of a one third reduction in greenhouse gas emissions.

The Tummel Bridge 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.

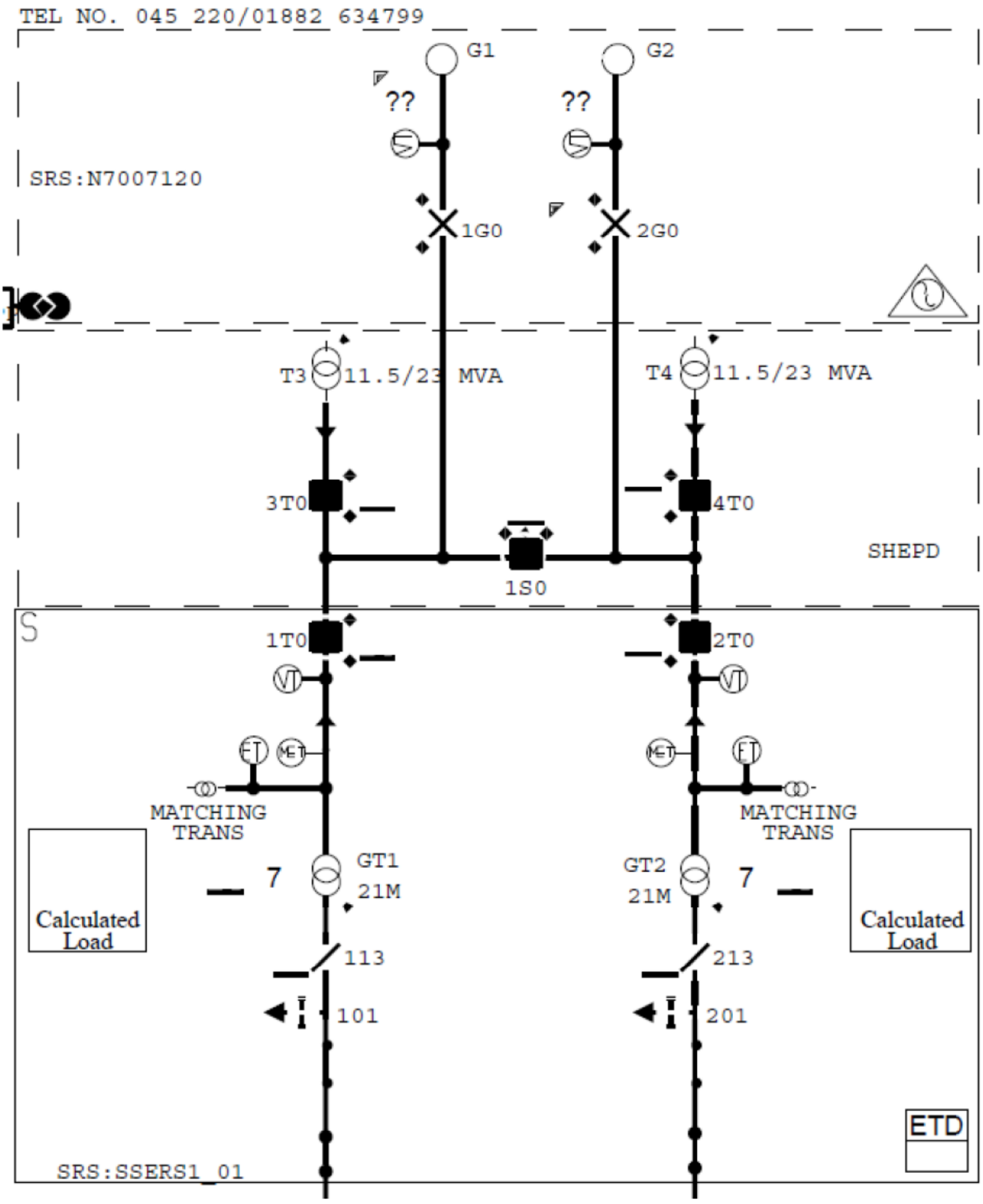
For our core non-load projects this means that we commit to delivering our overarching NARMs target. If we do not deliver the NARMS target, or a materially equivalent target, then we should be subject to a penalty. Equally, if we over-deliver against our target and are able to justify that the over-delivery 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 – Existing site single line diagram (SLD)



Appendix B – Proposed Errochty site single line diagram (SLD)