Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan: T2BP-EJP-0041

St Fillans 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 sets out the need for intervention at St Fillans 132/11kV substation.

The primary driver for the works is asset condition.

In addition to this, there are several significant issues present which are considered to be 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 St Fillans assets and infrastructure;
- In situ construction of replacement 132kV Feeder and transformer bay;
- Provision of dedicated and segregated Transmission infrastructure.

This scheme will cost £6.8m and will deliver the following outputs and benefits during the RIIO-T2 period:

- A long-term monetised risk benefit of R£37.2m;
- A reduction of network risk calculated as R£1.2m;
- 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; and,
- Brings the infrastructure in line with current standards and practices, increasing network security and reducing operational risks.

The St Fillans 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	St Fillans Substation Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2014 Transformer
Output references/type	NLRT2SH2014 Transformer
Cost	£6.8m
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 during the RIIO-T2 (April 2021 to March 2026) period at St Fillans 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

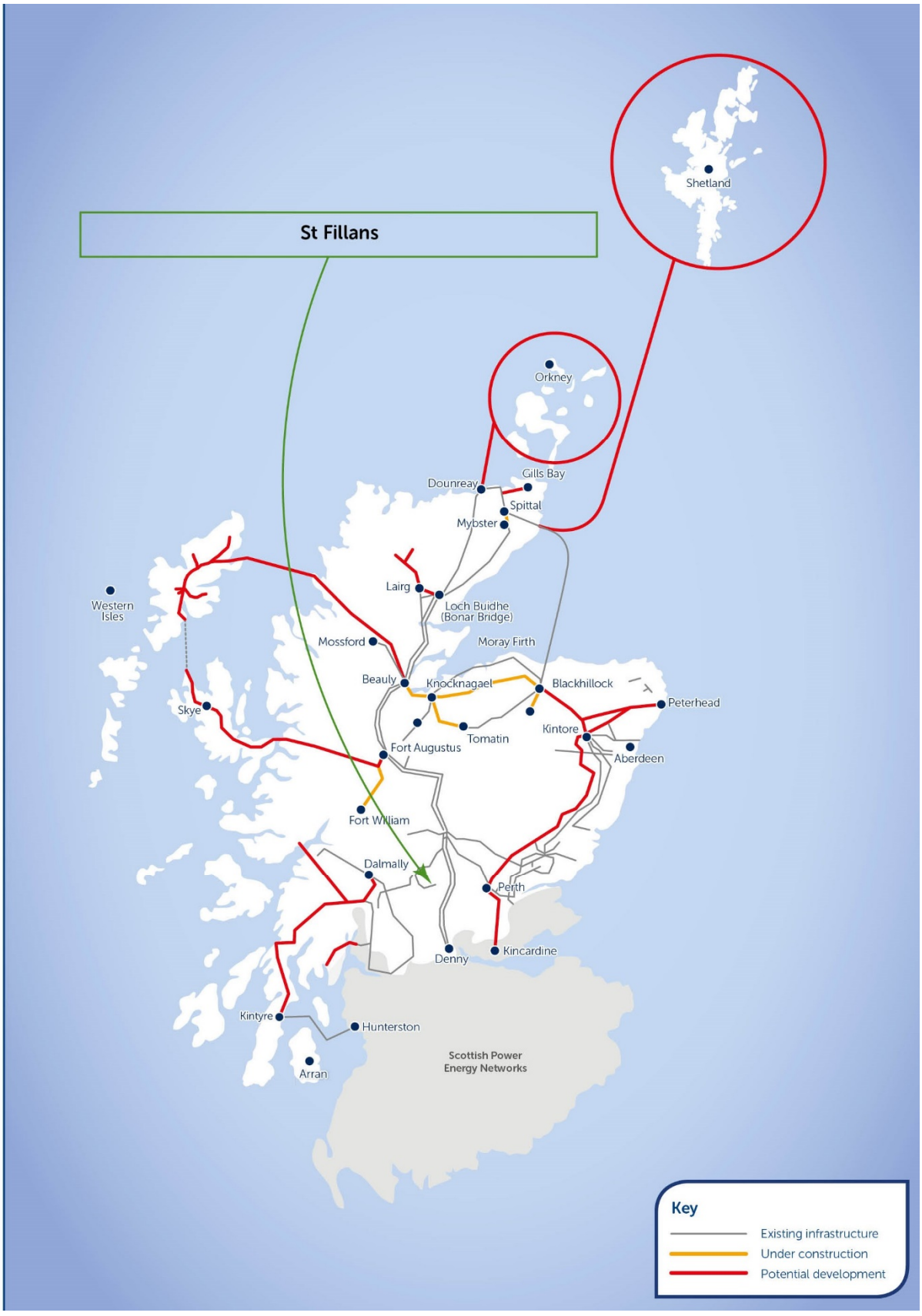
This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

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.


St Fillans
Shetland
Orkney
Gills Bay
Dounreay
Spittal
Mybster
Lairg
Loch Buidhe
(Bonar Bridge)
Western
Isles
Mossford
Moray Firth
Beauly
Knocknagael
Blackhillock
Peterhead
Skye
Tomatin
Kintore
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

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

St Fillans substation lies 12 miles to the west of Crieff. The site is the connection point to the transmission network for the St Fillans Hydro scheme and is the GSP for the 33kV Dalchonzie substation.

The site was constructed circa 1957 and has not been subject to refurbishment or modification since it became operational.

The site is a shared location with SHE Transmission, third party generator and Scottish Hydro Electric Distribution (SHEPD) plant, equipment and common shared services located within a single shared compound.

3.2 Asset Need

St Fillans 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.

The ACR highlights the following:

- The 132kV disconnectors and earth switches are manually operated, limiting operational flexibility and are obsolete;
- There are recorded operational failures of the 11kV switchgear circuit breaker 1T0, failing to trip and/or close;
- Grid Transformer (GT) 1 was manufactured in 1957. Oil sampling indicates that the transformer shows ageing of insulation from thermal overheating faults, high Furan levels and acidity; indicating the unit is approaching the end of its serviceable life;
- The protection systems at St Fillans are obsolete and require replacement.
- Intertripping systems at St Fillans are sub optimal and do not meet current standards;

[2] St Fillans Substation Works Asset Condition Report T2BP-ACR-0026

The condition of the assets is 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:

- Legacy of shared assets with third parties and associated operational constraints;
- Environmental risk from current infrastructure, which lacks facilities for transformer oil handling and containment;
- Network and Security risk arising from shared assets with the third party generator and SHEPD. There is no HV circuit breaker or switcher on the 132kV feeder;
- Operational Safety, 132kV disconnectors and earth switches are manually operated the 11kV switchgear is subject to an operational restriction;
- Plant and system protection do not meet current standards.

3.3 Growth Need

There are no identified growth needs for the site related to load schemes, however, there is a need to increase the capacity of the existing GT at St Fillans, based on the unit being operated near to its current capacity limit of 25 MVA. Analysis over the period August 2016 through December 2018 shows that the unit is regularly at 96% of its current capacity rating. As a result, the unit is experiencing overheating as identified in the oil analysis, which degrades insulation at an accelerated rate, reducing the service life of the unit.

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

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 ACR[2] does not support "do nothing" scenario(s). Leaving the installed assets in their current condition is not an option and presents increasing risk of failure; and/or presents risks to operational personnel which are unacceptable.

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

Table 1: The two options considered for St. Fillans

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis?
1	In situ replacement	6.8	Yes
2	Offline replacement	8.7	Yes

Option 1 – In situ replacement

This option considers the in-situ replacement of existing switchgear, protection and GT at St. Fillan's.

This proposal is for full decommissioning of all Scottish Hydro Electric Transmission (SHET) Assets and complete refurbishment of the existing civil infrastructure and extension of the site compound.

In summary, the works are for:

- Complete decommissioning of all assets and provision of new civil infrastructure
- Replace 132kV and 11kV switchgear, GT1, protection, control and intertripping schemes and common services
- Provide dedicated buildings for all SSEN Transmission assets

This option resolves the primary and secondary drivers.

Benefits:

The following summarises the identified benefits for this option:

- This option presents the lowest risk against planning consent and visual impact concerns, it requires no wayleaves and consents
- There is an opportunity to provide alternate 11kV circuit breakers, which do not utilise SF• as an insulating and arc quenching medium
- Incorporation of GT bunds with oil interceptors and bunded hard standings for oil containment, 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 Loch Earn.
- Standardised protection, control intertripping and common services to current standards

Risks and Concerns:

Option 1 would have the most significant impact on outages for the third party generator and SHEPD. The third party generator in particular would be subject to significant continuous outage during decommissioning and replacement works.

The following summarises the identified risks and concerns, noted against this option:

- General space constraints of the existing site and land ownership boundary
- An HV circuit breaker which would be preferable operationally, is not possible due to space restrictions
- Ground conditions are known to be challenging, requiring extensive rock breaking
- Outage duration for the third party and the 33kV GSP for SHEPD Dalchonzie substation, will be extensive.
- GT delivery and related road upgrades will be necessary
- Construction noise, planning consent and visual impact concerns

PROGRESSED TO DETAILED ANALYSIS

Option 2 – Offline replacement

This option considers the dismantling and decommissioning of the existing St Fillans site and replacement at a new local substation site including installation of cable connections to the St Fillans 11kV switchboard.

In summary, the works are for:

- Complete decommissioning of all SHE Transmission assets
- Offline build of a new substation with 132kV and 11kV switchgear, GT1, protection, control and intertripping schemes and common services
- Provide dedicated buildings for all SHE Transmission assets
- New cable connection from the 11kV Generation substation to the new SHE Transmission substation, connection to the 11kV SSEN Distribution switchboard
- Staged transfer to the new SHE Transmission substation site
- Road improvements and road construction to the new substation location

This option resolves the primary and secondary drivers.

Option 2 would have the least significant impact on outages for the third party generator and SHEPD. The third party generator and SHEPD would have limited outage exposure for periods of circuit transfer, post completion of the offline build.

The following summarises the identified benefits, noted against this option:

- A new location allows the construction of a full GT bay with an HV circuit breaker, which would be preferable operationally
- 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 Loch Earn.
- Standardised protection, control intertripping and common services to current standards

Risks and Concerns:

The following summarises the identified risks and concerns, noted against this option:

- Ground conditions are known to be challenging, requiring extensive rock breaking
- GT delivery and related road upgrades will be greater in scope and risk than Option 1
- Significant challenges relating to land purchase, wayleaves and consents are noted from historical works
- Construction noise, planning consent and visual impact concerns noted

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

We have carried out a Cost Benefit Analysis (CBA) using counterfactual Net Present Value (NPV) analysis to demonstrate the potential benefits of each of the shortlisted options, with Option 1 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 2: 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 1)	In situ replacement	-6.97	-6.41		19.24
Option 2	Offline replacement	-11.32	-10.62	-4.21	15.03

The results of the CBA demonstrate that Option 1 is the best option from an NPV assessment as it delivers £4.21m of additional value compared to Option 2.

The selection of Option 1 is in contradiction to our normal preference for offline build for generator connection refurbishments. The reasons for excluding Option 2 as the preferred option are highlighted in further detail below.

Option 1 has the lowest risk related to construction and planning. It is therefore, the preferred engineering option for the works.

[3] Cost Benefit Analysis Methodology

Option 2 holds too many significant risks to progress against. The main risks for Option 2 are considered to be related to ground conditions, transformer delivery, land acquisition, planning approval, wayleaves and consents.

- Land acquisition and wayleaves in the area have been difficult historically
- The construction of a dedicated site access road for transformer delivery may be impractical, costly and time consuming
- From provisional analysis, significant amounts of rock breaking, cutting and fill works would be required
- Planning consent risks include: construction noise, disruption and visual impact in a scenic location.

It should be noted that both Engineering Judgement and CBA assessment support Option 1 as the preferred option.

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 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, the options move in parallel and have no impact on ordering within CBA.
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

From the detailed analysis, Option 1 is the preferred and the proposed option for the works.

The scope of the selected solution is to rebuild the existing substation in situ; undertaking all necessary improvements. A copy of the proposed Single Line Diagram (SLD) is shown in Appendix B. The project will be energised within the RIIO-T2 period. The table below details the outputs.

Table 3: Outputs from proposed solution

Plant	Size of new plant	Replacement for
132kV substation	1 x 132kV circuit switcher	-
	1 x 132kV disconnector	1 x 132kV disconnector
	1 x 132kV earth switch	-
	1 x 45MVA 132/11kV transformer	1 x 25MVA 132/11kV transformer
	1 x 11kV circuit breaker	1 x 11kV circuit breaker
	1 x 11kV disconnector	1 x 11kV disconnector

5.4 Competition

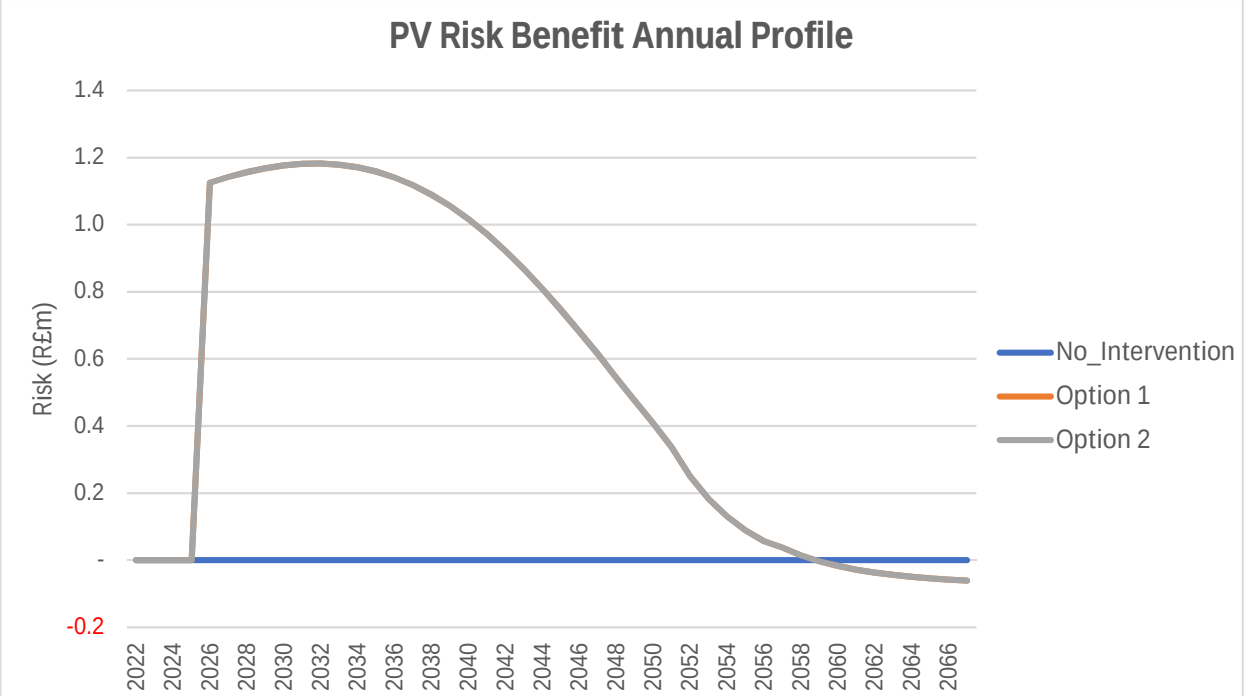
The St Fillans scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

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£37.2m. 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 – rebuild the SGT bay and Reactor in the same location.



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£1.2m.

5.6 Innovation & Sustainability

The installation of new switchgear 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.

In terms of the results of analysis for this project, which are captured in the carbon footprint results table, all options deliver the same carbon footprint due to the same lead assets and project lifecycle assumptions used for every option.

Table 5: Carbon Calculation Summary

	Project Information	Baseline (Option 1)	Option 2
Project info	Project Name/number		
	Construction Start Year	2026	2026
	Construction End Year	2028	2028
Cost estimate £GBP	Embodied carbon	£ 43,863	£ 95,987
	Construction	£ 36,085	£ 172,217
	Operations	£ -	£ -
	Decommissioning	£ 16,520	£ 78,845
	Total Project Carbon Cost Estimate	**£ 96,468**	**£ 347,050**
Carbon footprint tCO2e	Embodied carbon	586	1,282
	Construction	475	2,265
	Operations	-	-
	Decommissioning	47	227
	Total Project Carbon (tCO2e)	**1,108**	**3,773**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	-	-
	Total Scope 2 (tCO2e)	-	-
	Total Scope 3 (tCO2e)	1,108	3,773
SF_6 Emissions	Total SF_6 Emissions 3 (tCO2e)	-	-

5.8 Cost Estimate

The cost of the preferred option for works at St Fillans 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 £6.8m.

6 Conclusion

This paper identifies the need for intervention on existing assets at St Fillans substation. The primary driver for the scheme is the asset condition of existing plant and infrastructure. There are a number of primary and secondary drivers present.

Two intervention options were identified for this scheme. Both options were taken forward and considered for detailed analysis.

The proposed scope of work selected (Option 1) is:

- Decommissioning and removal of existing St Fillans assets and infrastructure;
- In situ construction of replacement 132kV Feeder and transformer bay; and,
- Provision of dedicated and segregated Transmission infrastructure.

This scheme will cost £6.8m and will deliver the following outputs and benefits during the RIIO-T2 period:

- A long-term monetised risk benefit of R£37.2m;
- A reduction of network risk calculated as R£1.2m;
- 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.
- Brings the infrastructure in line with current standards and practices, increasing network security and reducing operational risks.

The St Fillans 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.

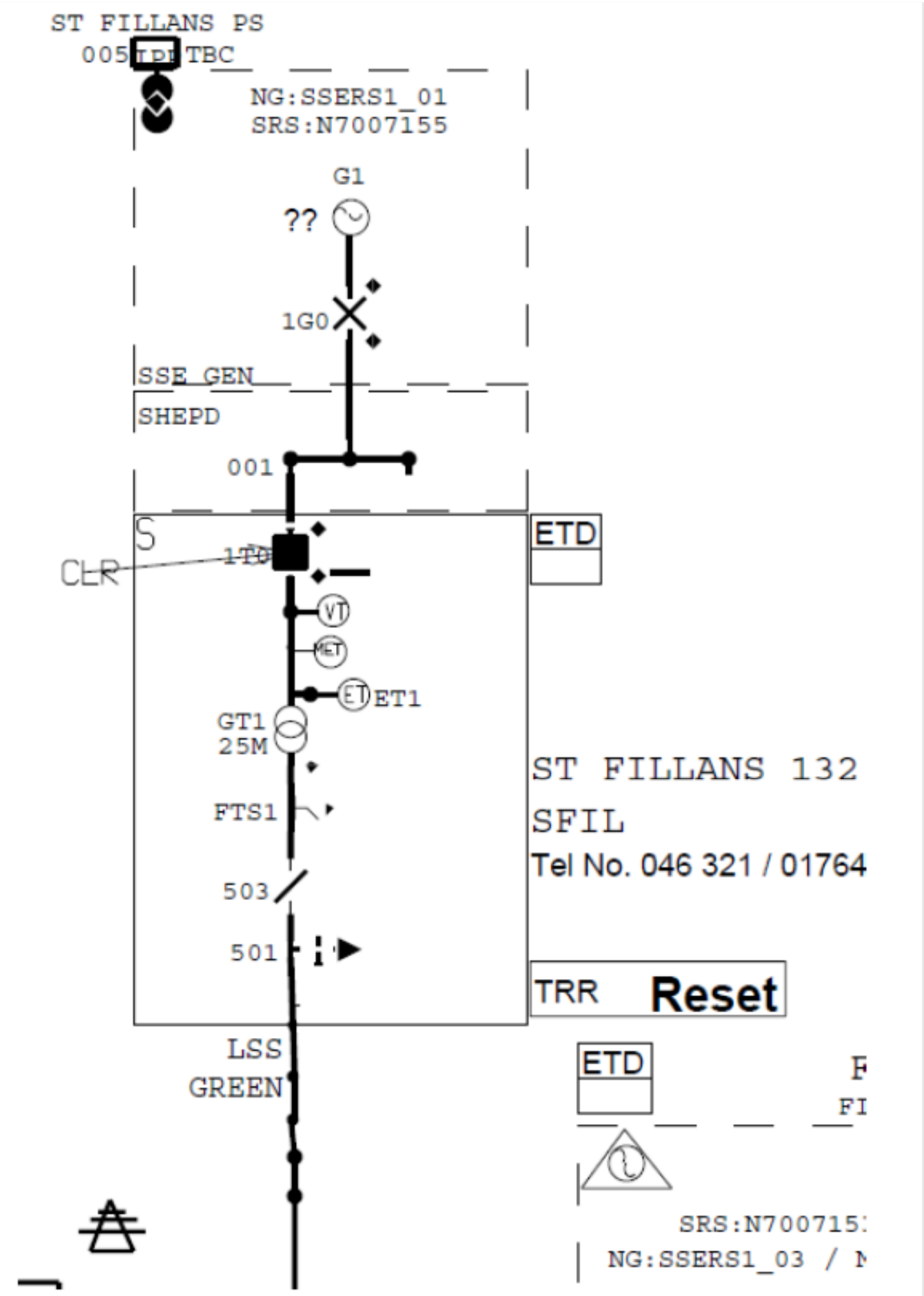
For our core non-load projects this means that we commit to delivering our overarching NARMs target. If we do not deliver the NARMS target, or a materially equivalent target, then we should be subject to a penalty. Equally, if we over-deliver against our target and are able to justify that the over-delivery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