Scottish & Southern Electricity Networks

SSEN Transmission

RIIO-T2 Business Plan - T2BP-EJP-0039

Invergarry T 132kV OHL 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 FI 132kV single circuit OHL between Invergarry power station and the tee off onto the OHL circuit, FFW, which connects Fort Augustus and Fort William. The primary driver for the scheme is the asset condition with a secondary driver of network resilience.

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

- Reconductoring of the FI circuit with Upas AAAC;
- Replacement of the earthwire with Keziah OPGW ;
- Strengthening of towers and foundation upgrades in line with latest design standards;
- Replacement of all fittings including insulator sets;
- Painting of all towers;
- Repair and coating of all muffs;
- Connect the aerial earthwire to the Invergarry earth mat via 650m of underground earth tape.

This scheme will cost £2.4m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long term monetised risk benefit of R£1.4m;
- A reduction of total network risk calculated as R£6.0k;
- Improved operational flexibility and resilience in line with or goal to aim for 100% transmission network reliability for homes and businesses.

The Invergarry T 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	Invergarry T 132kV OHL Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2011 OHL Refurbishment
Output references/type	NLRT2SH2011 OHL Refurbishment
Cost	£2.4m
Delivery Year	Within the RIIO-T2 period
Reporting Table	C0.7 Non-Load Master Data
Outputs included in RIIO T1 Business Plan	No

2 Introduction

This Engineering Justification Paper sets out our plans to undertake the refurbishment of the 132kV OHL between Invergarry power station and the tee off onto FFW circuit, located between Fort Augustus and Fort William, during the RIIO-T2 period (April 2021 to March 2026). The planned work between Invergarry and the tee off is shown on the map on the next 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.

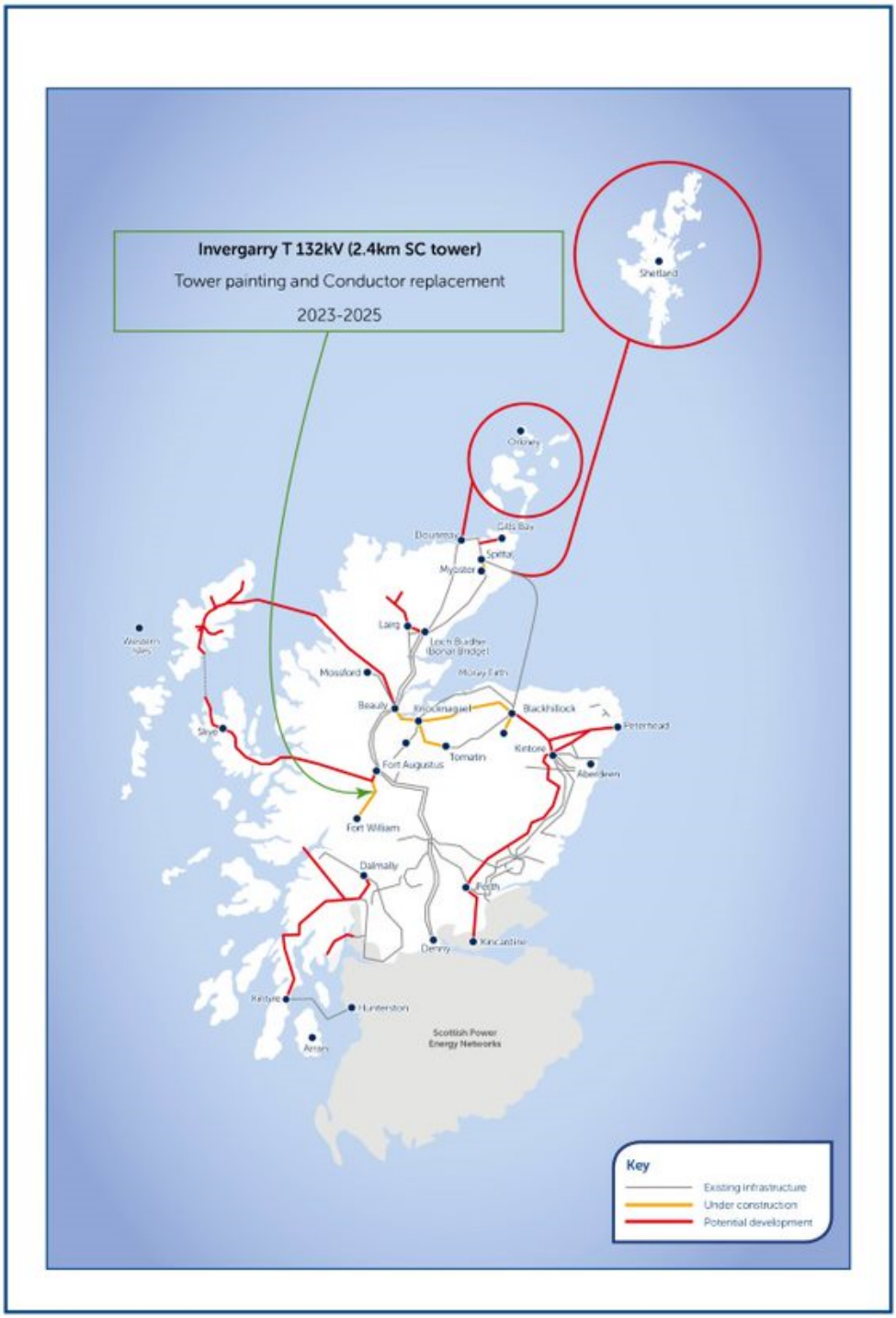
Section 7: Price Control Deliverables and Ring Fencing

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: Geographical Representation



3 Need

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

3.1 Background

The existing Invergarry Tee (FI) circuit was constructed in 1955 and is made up of a 132kV single circuit comprising of steel lattice towers and 150m of underground cable. The circuit is 2.4km in length and uses 11no. SC PL16 type towers, and 150m of 2000mm^2 Al underground cable which was installed in 2018.

The circuit tees off the Fort Augustus – Fort William (FFW) circuit at tower 33. From the tee point, the circuit travels 150m via underground cable and then 2.4km of OHL to Invergarry power station. The circuit is built entirely through hilly woodland. There are no road crossings or underrunning circuits which need to be diverted. There are no Sites of Specific Scientific Interest, Special Areas of Conservation, Special Protection Areas or Nature Reserves along the route of the circuit.

The OHL portion of the circuit is strung from tower 1 to 11 with single Lynx ACSR phase conductors with a Horse ACSR earthwire between tower 11 and tower 3. The earthwire is not connected to the power station earth mat, which contributes to the high impedance values at Invergarry.

As a result of works undertaken on the FFE FFW scheme during the RIIO-T1 price control, the FI circuit was transferred from FFE to FFW via underground cable in 2018. As a result, the RIIO-T2 FI scheme does not require any intervention to the FI cable between tower 11 and the FFW tee off.

The current network diagram, showing these current circuits can be seen in Appendix A.

3.2 Asset Need

The need for intervention on the FI circuit is based on current asset performance and available condition assessments as detailed in the Asset Condition Report.[2]

By the end of the RIIO T2 period, these circuits will be 65 years old, having aged beyond their design life of 40 years and beyond the 54-year industry mean asset service life.

We undertook a drone assessment of the OHL in 2018. This assessment graded the components from 1-4 with the following descriptions related to the respective gradings;

[2] Invergarry Tee 132kV OHL Asset Condition Report T2BP-ACR-0029

Table 1 – Condition Assessment Grading

Grade Score	Description
1	No visible/ quantifiable deterioration or damage
2	Apparent normal wear, intervention to be done in the next refurbishment
3	Significant deterioration or damage that requires some specific action or indicates increased risk of failure in the medium term
4	Serious deterioration or damage that requires specific action in the short term.

From this survey, it was identified that the condition of the steelwork and insulators along this overhead line are showing signs of significant to serious levels of corrosion;

- Steelwork on towers scored 55% as Grade 3 and 45% as Grade 4
- The insulators scored 70% as Grade 3 and 18% as Grade 4

There have not been any recent conductor condition surveys undertaken on this circuit, however it is of similar age to the FFE/FFW circuit from tower 33 to tower 2 which was refurbished in 2018/2019. As a comparison of conductors of similar age and location it is expected that the conductor and earthwire is of similar condition which showed possible and partial corrosion from a Cormon report in 2002.

The step and touch potential at Invergarry power station is one of the highest identified on our transmission network, therefore it is recommended that the earth wire, which terminates at Tower 3 is connected to the station earth mat. Towers FI1-3 are a flat formation type tower which cannot accommodate an aerial earthwire, which therefore means a ground deployed solution is required.

The protection and communications link was upgraded as part of the RIIO T1 FFE/FFW project, therefore no additional works are required for the main circuit protection.

The key driver for this work is the asset condition, which was informed by the results of the Cyberhawk drone assessment. The proposed scheme intervention will deliver an asset that should be fit for service without further intervention for at least 15 years at which time it should be assessed to determine if re-painting is required. The conductors and earth wire replacement will be designed for a 40-year life span as a minimum.

3.3 Growth Need

The FI circuit has no additional need for increased capacity.

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.

The options consider the replacement of the components and conductors on this OHL which have exceeded their intended design life and have been identified from the Asset Condition Assessment Report as showing signs of corrosion. This means that "doing nothing" is not an option and non-load intervention is required during the RIIO-T2 price control.

Based on the requirements set out in the Asset Engineering Condition Report, and the Engineering assessment summarised above, only 1 technically viable solution was identified which is detailed below;

Table 2 – Options Summary

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis
1	Full refurbishment of existing circuit, reconductoring with Upas AAAC conductor and Keziah earthwire.	2.4	Yes

Option 1: Reconductor with Upas AAAC

An Engineering review of the project has identified Upas AAAC conductor as the preferred conductor for replacement, the considerations for this conductor choice are summarised below;

Conductor assessment has taken a Lynx ACSR standard replacement as Upas AAAC. The replacement of ACSR conductors with AAAC is standard industry practice, as ACSR conductors are gradually being phased out by suppliers and are unlikely to be standard products in the years to come.

- The Upas AAAC conductor has been selected for the Lynx ACSR replacement as it has been used widely on the UK Network and meets the electrical and mechanical requirements of the OHL. As the Upas conductor is stronger than the Lynx conductor, the resulting works on the scheme will include tower and foundation strengthening as well as clearance infringements mitigation to ensure that minimum statutory clearances are met. Alternative, smaller, AAAC conductors were assessed which would achieve the required electrical rating, however were ruled out as the mechanic loading would exceed the limits specified by the suppliers.

As a result, this option proposes full reconductoring and refurbishment of the OHL consisting of;

- Reconductoring of the FI circuit with Upas AAAC.
- Replacement of the earthwire with Keziah OPGW ACSR
- Strengthening of towers and foundation upgrades in line with latest design standards as required.
- Replacement of all fittings including insulator sets
- Painting of all towers
- Repair and coating of all muffs
- Connect the aerial earthwire to the Invergarry earth mat via 650m of underground earth tape.

This option will re-utilise the existing asset and route however new access will be required to establish pulling positions for the new conductor.

This option is the minimum solution which meets the required engineering standards.

Due to the restricted access of the tie in to Invergarry and the shallow rock ground conditions, a rebuild option has not been considered.

5 Detailed Analysis

5.1 Cost Benefit Analysis

As only 1 viable solution has been identified, therefore Cost Benefit Analysis has not been undertaken for this scheme.

5.2 Project Sensitivity

As outlined in our core RIIO-T2 business plan document, A Network for Net Zero[5], 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[1] 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: Project Sensitivities

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 demand at this site and none forecast
Energy scenarios	Sensitivity considered in 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•	Any works at this site will require a whole station outage and planning consent. This is the case for either option considered•
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 presented option proposes full refurbishment and reconductoring of the OHL. The earthwire will be replaced with a Keziah OPGW, the phase conductors with a Upas AAAC conductor and include all associated insulators and fittings. All towers will be painted, and concrete muffs repaired as recommended in the Asset Engineering Condition Assessment report.

The refurbishment of the line will ensure that the design complies fully with SSEN Design Guidance and British Standard requirements set out in BS EN 50341 part 1 and part 2. This approach will ensure that the design is robust for the additional asset life of at least 40 years.

The full refurbishment option also improves the step and touch potential at Invergarry power station by connecting the new earthwire to the substation earth mat via an underground connection for the final 3 spans.

Table 4: Outputs from the preferred option

Plant		Replacement for
132kVsingle circuit tower line refurbishment	2.4km Upas AAAC phase conductor 2.4km OPGW Fixtures and fittings	2.4km Lynx ACSR phase conductor 2.4km Horse earth wire Fixtures and fittings

5.4 Competition

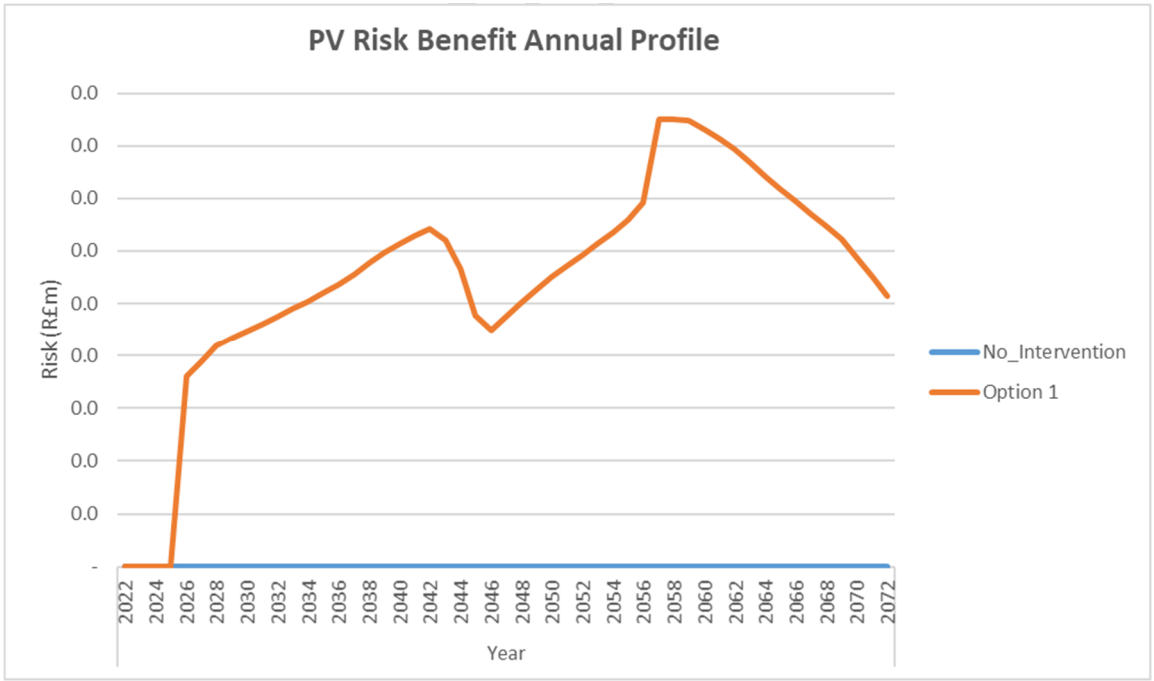
The Invergarry T scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

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 risk monetised benefit which would be realised through the completion of this project is R£1.4m. 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 – Replacement of the line and refurbishment of the towers



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£6.0k.

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.

In terms of the results of analysis for this project, which are captured in the carbon footprint results table,

1 Only 1 option has been assessed for this scheme which offers a comparative carbon footprint when assessed against other schemes.

Table 5: Carbon footprint results table

	Project Information	Baseline
Project info	Project Name/number	0
	Construction Start Year	2026
	Construction End Year	2028
Cost estimate £GBP	Embodied carbon	£77,547
	Construction	£37,449

	Operations	£68
	Decommissioning	£17,145
	Total Project Carbon Cost Estimate	**£132,209**
Carbon footprint tCO2e	Embodied carbon	1,035
	Construction	493
	Operations	0
	Decommissioning	49
	Total Project Carbon (tCO2e)	**1,578**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	0
	Total Scope 2 (tCO2e)	-
	Total Scope 3 (tCO2e)	1,577
SF_6 Emissions	Total SF_6 Emissions 3 (tCO2e)	-

5.7 Cost Estimate

The cost of the option for works at Invergarry Tee 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 £2.4m.

6 Conclusion

This project is driven by the condition of the 132kV tower line between Invergarry and a tee point located on the FFW circuit between Fort Augustus and Fort William.

Following a review of the scheme requirements, one clear option presented itself which was taken forward. As such, a CBA was subsequently not required for this scheme.

The proposal is the full refurbishment of the tower line as follows:

- Reconductoring of the FI circuit with Upas AAAC.
- Replacement of the earthwire with Keziah OPGW
- Strengthening of towers and foundation upgrades in line with latest design standards
- Replacement of all fittings including insulator sets
- Painting of all towers
- Repair and coating of all muffs
- Connect the aerial earthwire to the Invergarry earth mat via 650m of underground earth tape.

This scheme will cost £2.4m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long term monetised risk benefit of R£1.4m.
- A reduction of total network risk calculated as R£6.0k.
- Improved operational flexibility and resilience in line with or goal to aim for 100% transmission network reliability for homes and businesses.

The Invergarry Tee 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 were no works included in the RIIO T1 business plan for the FI circuit.

Appendix A

CONTENT REDACTED