Scottish & Southern Electricity Networks

Culligran Substation 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 132/11kV Generation Transformer (GT) at Culligran substation. The primary driver for the scheme is the asset condition.

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

- Establish and construct a new indoor 132/11kV single transformer substation near the existing site.

This scheme will cost £14.3m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long term monetised risk benefit of R£24.7m,
- A reduction of total network risk calculated as R£2.2m,
- Improved visual impact,
- Improved separation of assets between SHE Transmission and the customer,
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The Culligran 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	Culligran Substation Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT208
Output references/type	NLRT2SH208
Cost	£14.3m
Delivery Year	RIIO T2
Reporting Table	C 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 (April 2021 to March 2026). The planned work is at Culligran substation as 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

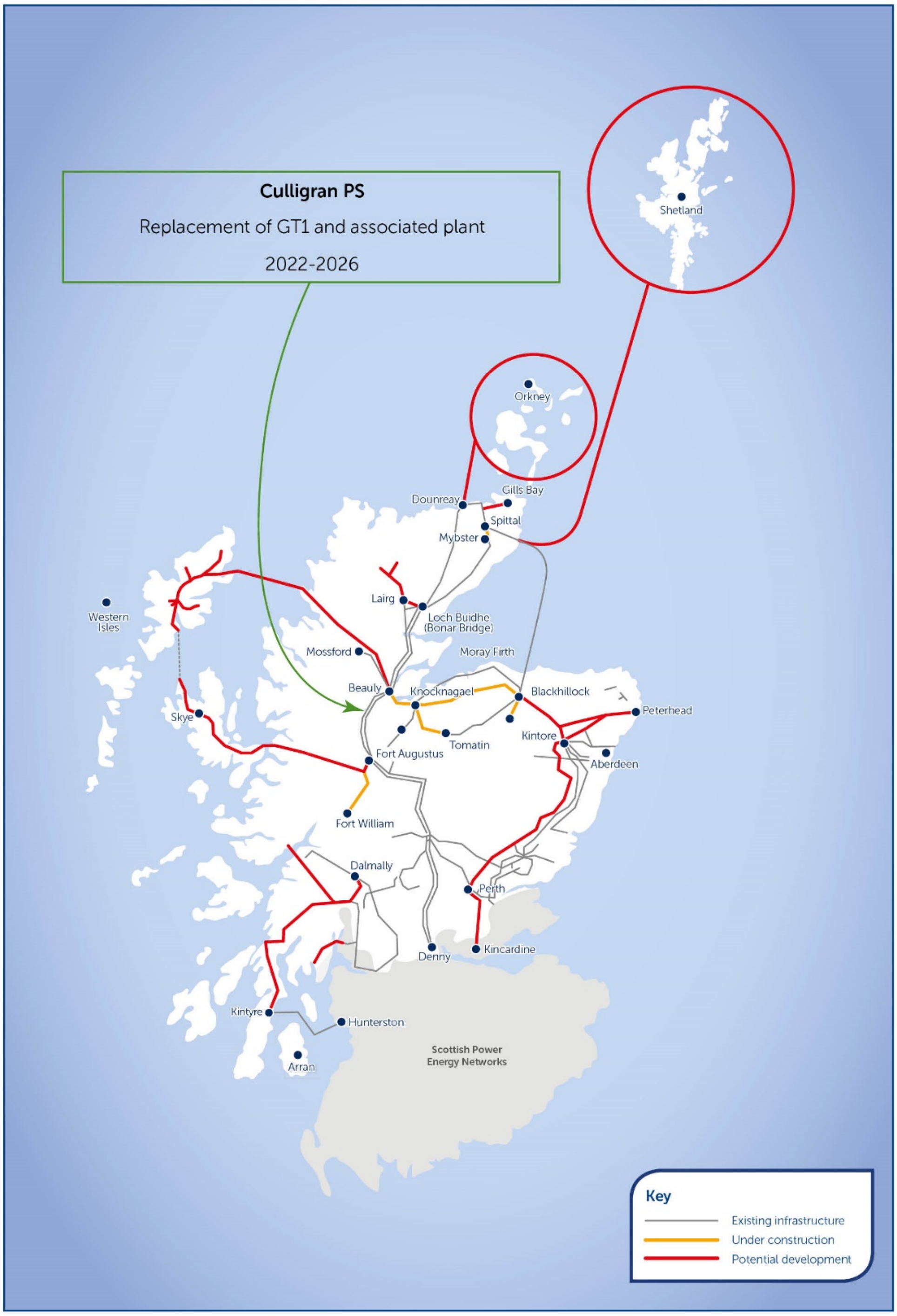
This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

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.


Culligran PS
Replacement of GT1 and associated plant
2022-2026
Shetland
Orkney
Dounreay
Gills Bay
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

Culligran 132/11 kV substation, built in 1959, is situated within the Braulen Estate, Glen Strathfarrar, Inverness-shire. The site is accessed via a single-track road which is itself accessed from the A831.

Culligran 132/11 kV substation exists to provide a hydro generation connection to the associated generator (19MW). The substation contains a single Grid Transformer (GT1), manufactured by Bonar Long in 1962. The transformer is a single rated 25MVA (ONAN) ground mounted unit situated outdoors within the generators site.

3.2 Asset Need

The Asset Condition Report – Culligran 132/11kV Substation[2] highlights the poor health of the transformer, the lack of adequate bunding surrounding the earthing transformer and the questionable efficacy of the stone wall for fire or blast protection on the GT. Transformer oil sampling indicates very high moisture content and externally there is evidence of excessive corrosion. The internal and external condition makes intervention by replacement necessary within the RIIO-T2 period.

The existing transformer protection is reliant on the operation of a third party LV circuit breaker which is not an arrangement that meets current standards. The existing protection arrangements for the transformer fall below current standards and is reliant on intertrips to Beauly (due to a lack of 132kV circuit breaker) and manual interventions to restore supplies to other substations supplied by the circuit. The current configuration also means that there is no Delayed Auto Reclose facility.

Battery and LVAC systems are shared with the customer and housed in space shared with the customer, a situation which does not meet with current business separation requirements and also presents issues with access and control of assets.

As is discussed in the Beauly – Deanie 132kV OHL Engineering Justification Paper[3] for the refurbishment of the BDN/BDS line which connects these substations; there is a need to address the pilot wire and PLC communications used by the intertripping schemes for these sites. Under the refurbishment of BDN/BDS a new Optical Ground Wire (OPGW) will replace the earth wire thereby providing adequate protection on these circuits. As well the consequential improvement in the protection provided by the BDN/BDS works, the necessary outages for tower painting and phase wire replacement present a timely opportunity to undertake the upgrading of the ageing assets served by

[2] Asset Condition Report – Culligran 132/11kV Substation T2BP-ACR-0024
[3] Beauly – Deanie 132kV OHL Engineering Justification Paper T2BP-EJP-0034

these circuits. This approach presents a coordinated package of work to the impacted local communities and improves the overall network impact, performance and risk.

3.3 Growth Need

There are no known load related capacity increases in the immediate network which would drive upgrade work at this site. Therefore, the asset health of the plant, network operability, resilience and the nature of the site are the main considerations for the replacement work.

A meeting was held with the Culligran customer to discuss the customers portfolio of hydro generation schemes that would be affected by our works during the RIIO T2 period. The generation site exporting at Culligran has no plans for increasing output in the foreseeable future and no capacity increase is proposed or required.

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 poor asset health is the driver for the replacement of the GT at Culligran. There is also a requirement for upgrade of the substation compound and auxiliary assets as well as the installation of switches at both 132kV and 11kV.

The asset condition, as detailed in the Asset Condition Report[2], means that further deferral of the asset replacement works is not viable and intervention in the RIIO-T2 period is required.

The outdoor AIS substation is located adjacent to the tunnel entrance for the generator. Culligran 132/11 kV substation has a relatively conventional substation layout for its era and is in a remote area.

Any development of the site will need to be sensitive to the local environment due to the location of the site within a number of environmental designations (SPA, SAC and SSSI): see Beauly- Deanie 132kV OHL Engineering Justification Paper[3] for more detail) as well as the history of project delivery in the Beauly area.

The currently installed unit at the power station is rated at 25MVA (naturally cooled). While there is no increase in capacity required by this connection and no demand at this site, there is therefore no driver to install a higher rated transformer. The smallest 132/11kV transformer on the transformer framework is rated at 30/36MVA. Therefore, there will be a consequential capacity increase at this site, as it is more economical to procure a standard from our range than to order bespoke units.

Table 1 – Options Summary

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis
1	In-situ replacement	-	No
2	Offline Build	14.3	Yes

Option 1

Replace GT1 and install new 132kV and 11kV switchgear in a new indoor S/S in the existing S/S location which meets current engineering standards. In order to facilitate the necessary site upgrades that include a replacement 132/11kV Grid Transformer (GT) with associated HV and LV switchgear and a new control building, the overall site footprint will require a significant increase which is not available.

A key assumption at this stage is for all equipment to be housed in an indoor environment. Although there is no technical requirement for this (i.e. not a saline or corrosive environment), this decision is based on feedback from local council engagements and other recent planning applications regarding substations in similar rural locations. Small buildings are considered a preference to outdoor AIS compounds, primarily as a means of mitigating the overall infrastructure visual impact on the landscape. It is also noted that this location has three environmental designations.

The major impact of this approach would be the requirement for a long-term outage (9-12 months) to be taken on the power station and overhead line circuit to Beauly (BDN circuit). This BDN circuit connects both this site and another at Deanie back to Beauly substation.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2

This option proposes a complete offline build of a new substation compound. The key benefit of this option is a reduced impact to both the local power station and wider network with minimal outage requirements.

The new site will contain a single transformer building including a 132kV circuit switcher and earth switch as well as control room housing 11kV switchgear, control and protection equipment as well as all other ancillary items. The new connection to the existing overhead line can be achieved via extension of the existing tee connection by an additional span to reach a new terminal tower at the new compound.

A key assumption at this stage is for all equipment to be housed in an indoor environment. Although there is no technical requirement for this (i.e. not a saline or corrosive environment), this decision is based on feedback from local council engagements and other recent planning applications regarding substations in similar rural locations. Small buildings are considered a preference to outdoor AIS compounds, primarily as a means of mitigating the overall infrastructure visual impact on the landscape. It is also noted that this location has three environmental designations: SSSI, SPA and SAC.

Building off line requires the same works as the in-situ replacement without the extended outage impacts on the local customer.

PROGRESSED TO DETAILED ANAYLSIS

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

No CBA has been carried for this scheme. A new site delivers the same outputs as the in-situ replacement but with reduced impact to the customers: therefore, the proposed option is the off-line creation of a new site.

5.2 Project Sensitivity

As outlined in our core RIIO-T2 business plan document, "A Network for Net Zero", we believe we have a critical role to play in delivering Net Zero ambitions in both the UK and Scotland. Therefore our plan has been carefully designed with the flexibility to deliver pathways to Net Zero. Our policy paper "A Risk-Based Approach to Asset Management" outlines our approach to monitoring and assessing the condition of our assets to maintain the reliable and resilient network that is expected by our stakeholders. Where asset condition deteriorates, we undertake a programme of cost-effective, risk-based interventions to maintain the longevity and performance of the transmission network. Each of our non-load related projects for T2 is underpinned by Asset Condition Reports which clearly outline that the works are necessary and driven by reliability.

Table 2: Sensitivity Analysis table

Sensitivity	Test and impact observed – switching inputs
Asset Performance / deterioration rates	Switching deterioration assumption: The asset performance / deterioration rates can only improve or deteriorate. As the need for this project is driven by an asset condition report (as outlined in Section 3), the asset condition will not improve in the intervening period. The second option is for the asset performance to deteriorate and therefore the need remains, and the project would be considered for advancement within available outages.
Ongoing efficiency assumptions	Switching efficiency assumption: increased or decreased. Test would have no impact on (feasible) option selection, 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 scope of the proposed solution is to build a new indoor 132/11kV single transformer substation near the existing site. The project will be energized within the RIIO T2 period. Table 3 below details the outputs:

Table 3 – Outputs from Preferred Option

Plant	Size of new plant	Replacement for
132/11kV Transformer	30/36MVA	22.5MVA
132kV Circuit Switcher	1 x 132kV circuit switcher (1250A)	NA
11kV Circuit breaker	2 x 11kV circuit breakers (1250A)	NA

5.4 Competition

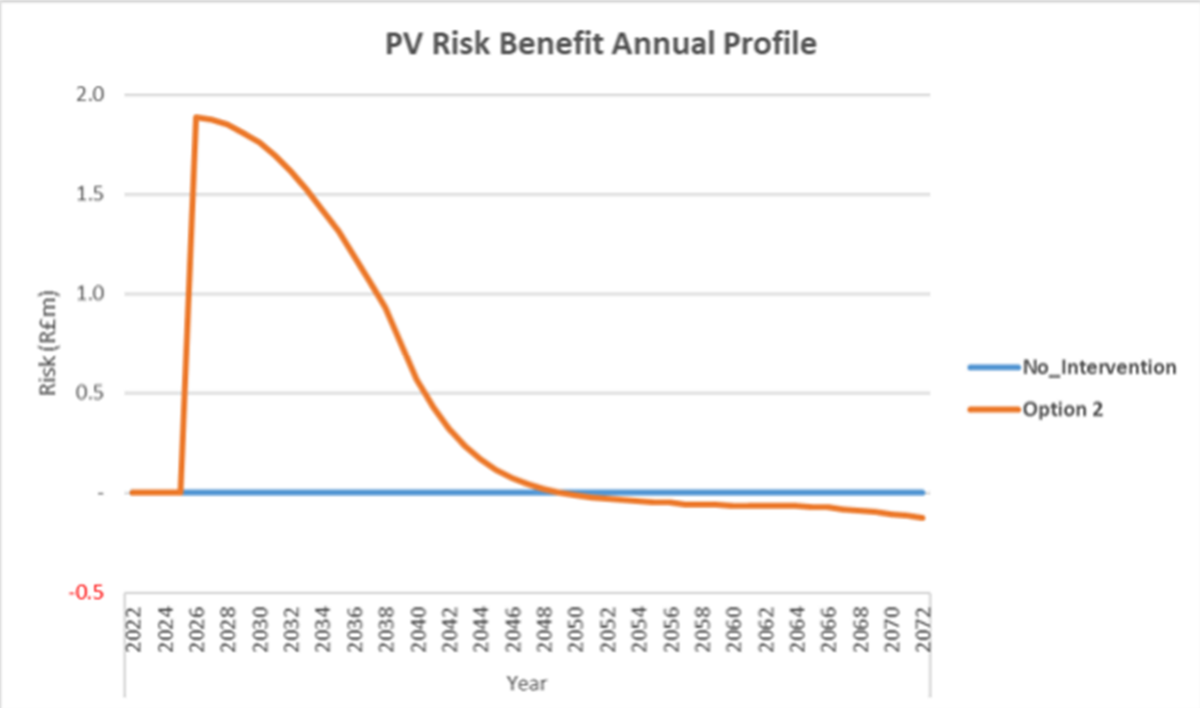
The Culligran scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

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£24.7m. 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 – new substation



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£2.2m

5.6 Carbon Modelling

We are committed to managing resources over the whole asset lifecycle – i.e. including the manufacturing of assets, construction, operations and decommissioning activities – to reduce our greenhouse gas emissions in line with climate science and become a climate resilient business. It is our aspiration that the carbon lifecycle cost of investment options plays a key role within our project development and is considered in the selection of a preferred solution. We have therefore developed an internal carbon pricing model that estimates a carbon cost for each option considered in our CBA through deriving values for:

1. Embodied carbon, which relates to the carbon emissions associated with the manufacturing and production of the materials use in production of the lead assets (transformer, reactors, underground cables and overhead lines. Overhead line is made up of tower/wood pole/composite pole, conductor and fittings) procured and installed as part of the project.

2. The carbon emissions associated with the main stages of the project lifecycle (construction, operations and decommissioning).

It is our vision to embed carbon considerations within our strategic optioneering and project development processes, which will require us to determine a way of flagging high carbon options within our CBA outputs. We will continue to develop our thinking in this space, which will involve our model being validated by a third party, so the results included in this EJP are indicative and subject to change.
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	£ 133,026
	Construction	£ 259,007
	Operations	£ -
	Decommissioning	£ 118,580
	Total Project Carbon Cost Estimate	**£ 510,613**
Carbon footprint tCO2e	Embodied carbon	1,776
	Construction	3,407
	Operations	-
	Decommissioning	341
	Total Project Carbon (tCO2e)	**5,524**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	-
	Total Scope 2 (tCO2e)	-
	Total Scope 3 (tCO2e)	5,524
SF_6 Emissions	Total SF_6 Emissions 3 (tCO2e)	-

5.7 Cost Estimate

The cost of the preferred option for works at Culligran 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 £14.3m.

6 Conclusion

The primary driver for the replacement of the transformer and the associated works is the condition of the unit. There are consequential benefits of this of work as this would deliver a substation which meets our current engineering standards as well as delivering improved asset separation between SHE Transmission and the customer.

The Asset Condition Report[2] informs us that further deferral of replacement work or asset refurbishment is not a feasible option and therefore immediate asset replacement in the T2 period is necessary to ensure continued generation access to the transmission network.

The options considered to achieve the transformer replacement were either an in-situ or off-line build. The off-line build is preferred delivering minimal impact on the customer. In addition, the delivery can be coordinated with the refurbishment of the 132kV circuit connecting this site to Beauly.

The proposed scope of work is:

- Establish and construct a new indoor 132/11kV single transformer substation near the existing site.

This scheme will cost £14.3m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long term monetised risk benefit of R£24.7m,
- A reduction of total network risk calculated as R£2.2m,
- Improved visual impact,
- Improved separation of assets between SHE Transmission and the customer,
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The Culligran 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 Plans

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