

RIIO-T2 Transformer Refurbishment Programme - OFGEM Justification Paper	
Name of Scheme/Programme	RIIO-T2 Transformer Refurbishment Programme
Primary Investment Driver	Asset Health
Scheme reference/mechanism or category	SPNTL2068 / SPNTL2069 / SPNTL2070 / SPNTL2071 / SPNTL2072 / SPNTL2073 / SPNTL2074 / SPNTL2094 / SPNTL2095 / SPNTL2096
Output references/type	NLRT2SP2068 / NLRT2SP2069 / NLRT2SP2070 / NLRT2SP2071 / NLRT2SP2072 / NLRT2SP2073 / NLRT2SP2074 / NLRT2SP2094 / NLRT2SP2095 / NLRT2SP2096
Cost	<ol style="list-style-type: none"> 1. SPNLT2068 - £ 0.61 m 2. SPNLT2069 - £ 0.70 m 3. SPNLT2070 - £ 0.63 m 4. SPNLT2071 - £ 0.72 m 5. SPNLT2072 - £ 0.72 m 6. SPNLT2073 - £ 0.56 m 7. SPNLT2074 - £ 0.58 m 8. SPNLT2094 - £ 0.46 m 9. SPNLT2095 - £ 0.57 m 10. SPNLT2096 - £ 0.48 m
Delivery Year	<ol style="list-style-type: none"> 1. SPNLT2068 - 2026 2. SPNLT2069 - 2024 3. SPNLT2070 - 2023 4. SPNLT2071 - 2025 5. SPNLT2072 - 2025 6. SPNLT2073 - 2024 7. SPNLT2074 - 2024 8. SPNLT2094 - 2025 9. SPNLT2095 - 2025 10. SPNLT2096 - 2026
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Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue No	Amendment Details
July 2019	Issue 1	First issue of document
December 2019	Issue 2	Gross cost, NPV, Monetised Risk, Long Term Risk Benefit values, delivery year and future pathways – Net zero text updated.

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1 Introduction

Through inspection, condition assessment and application of the NOMS models, a number of transformers have been assessed as being in a deteriorated condition and should be considered for intervention. This programme presents the assessment of each candidate and determines the level of intervention required to deliver a mid-life refurbishment to bring the assets back to a condition to maximise their remaining lives. The range of works will cover all aspects of the transformer and are expected to be a bespoke intervention for each for each asset. This paper supports a proposal to undertake the refurbishment of 10 SPT transformers over the RIIO-T2 period.

2 Background Information

A detailed review of the SPT transformer and reactor asset base identified 63 transformers for which consideration of an intervention was required. This intervention could either be replacement or refurbishment. The candidates identified have were assessed by a desktop survey to review oil and physical condition to determine the most appropriate course of intervention as per the methodology identified in TRAN-01-003. Of these 63, 34 were determined to be candidates for refurbishment.

Transformer refurbishment general requirements are detailed within the SPEN Document TRAN-03-034. Within this document it is a requirement that all transformers are tested prior to refurbishment. This ensures that the transformer is electrically suitable to be refurbished.

The 34 candidates determined for refurbishment were then prioritised to determine those which merited intervention in the RIIO-T2 period. Using the output of the NOMS deterioration models, the time to reach end of life was forecast for each transformer. This information was used to produce a prioritised list of the 34 transformers. All transformers whose condition needs to be managed in the RIIO-T2 period have been included in this programme. The remainder of the transformers have been considered for inclusion in future price control periods.

Please find below the details of the transformers identified for intervention.

Table 1 Identified Transformer Refurbishments

SPEN corporate asset ID	Asset Description	Manufacturer	Year of manufacture	EoL	Risk £
14163414	KEOO132TRXT2	HAWKER SIDDLLEY	1974	10.89	£ 492,467.96
14242737	WIYH275TRXSGT3	BRUCE PEEBLES	1967	10.23	£ 986,710.42
14159758	INKE132TRXT2	PARSONS PEEBLES	1970	10.42	£ 1,371,488.52
14236965	TORN400TRXSGT1	HAWKER SIDDLLEY	1986	9.34	£ 2,086,264.14
14238049	TORN400TRXSGT2	HAWKER SIDDLLEY	1986	9.34	£ 2,086,264.14
14198931	CATY132TRXT1B	BONAR LONG	1964	10.12	£ 1,460,105.74
14198951	CATY132TRXT2B	BONAR LONG	1964	10.12	£ 1,460,105.74

14220749	SACO025TRXT2C	BONAR LONG	1986	11.84	£	3,535,456.04
14164772	GRMO275TRXSGT1	ABB TRANSFORMATOREN	2003	10.40	£	2,435,907.73
14156329	PART132TRXT1	BRUCE PEEBLES	1961	10.00	£	877,790.95

The EOL and risk values are those at the end of the RIIO-T2 period without intervention.

3 Optioneering

The following is a summary of the options considered for this project.

	Option	Status	Reason for rejection
1	Do nothing in RIIO-T2 with replacement in RIIO-T3 – Scope of works similar to option 3	Proposed	-
2	Refurbishment in RIIO-T2	Proposed	-
3	Replacement in RIIO-T2	Proposed	-
4	Refurbishment in RIIO-T3	Rejected	Condition assessment and a review of EoL score has defined a requirement for intervention on the units with either refurbishment or replacement in RIIO-T2 considered to be feasible options. If no intervention is carried out on these units in RIIO-T2, the condition of the units will have deteriorated materially by the end of the RIIO-T2 period and refurbishment in RIIO-T3 would not be viable. Accordingly refurbishment in RIIO-T3 has been rejected

4 Detailed analysis

4.1 Option Details

With regard to transformers identified as requiring intervention, the methodology developed in TRAN-01-003 has determined that the main driver for replacement is the DGA condition and not age. In some circumstances, the condition assessment can also lead to a replacement if the unit is determined to be beyond economic repair. This programme however is focussed on those candidates that have been assessed under this methodology and it has been established that refurbishment is an effective intervention.

The proposed options considered for intervention for transformers were as follows:

- Option 1 – Replacement in RIIO-T3
- Option 2 - Refurbishment in RIIO-T2
- Option 3 – Replacement in RIIO-T2

Option 1 – Replacement in RIIO-T3

The baseline option is do nothing in T2 and undertake replacement in RIIO-T3. Deferring works until RIIO-T3 will increase network risk as the identified condition issues remain with a higher probability of failures before the intervention can take place.

Option 2 –Refurbishment in RIIO-T2

Following replacements in previous price controls, post mortem examinations have been undertaken to better understand the underlying health of the asset on replacement. This examination has informed the strategy for management of transformer life.

The oil analysis of these transformers, as per TRAN-01-003 determines that these assets do not require to be replaced and that targeted refurbishment is the most appropriate intervention to maximise the remaining lives of the transformers under consideration. This option proposes undertaking a refurbishment of these assets within RIIO-T2, deferring any replacement until the DGA results indicate an EoL of the active part.

Option 3 –Replacement in RIIO-T2

The third option in this case would be to replace the transformers. The methodology TRAN-01-003 is used to assess each transformer to determine whether it should be replaced or refurbished.

The oil analysis of these transformers, as per TRAN-01-003 determines that these assets do not require to be replaced.

4.2 CBA Outputs

4.2.1 Methodology Rationale

With the detailed forensic post-mortems that SPT has undertaken of replaced transformers within the RIIO-T1 period, it has been determined that in some cases, the active part of the transformers were in a better conditions than expected and that there was an element of remaining life. The conditions of the other, equally important components of the transformer system (radiators, bushings, tap changer etc.) were confirmed as end of life and did require to be replaced.

The improved asset knowledge obtained from the body of evidence generated through forensic examination has informed the proposed strategy to refurbish transformers to extract their maximum economic life.

As the experience of the refurbishment progresses the life extension of these transformers will be able to be determined and the NARM models updated to reflect to the benefits of this course of action.

4.2.2 CBA Overview

A CBA was undertaken for each transformer – please find the NPV calculated for each option below:

4.2.2.1 Kendoon T2 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£16.16
1	Refurbishment in RIIO-T2	£18.44
2	Replacement in RIIO-T2	£18.22

4.2.2.2 Windyhill SGT3 275kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£38.73
1	Refurbishment in RIIO-T2	£41.82
2	Replacement in RIIO-T2	£43.21

4.2.2.3 Inverkeithing T2 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£52.29
1	Refurbishment in RIIO-T2	£55.95
2	Replacement in RIIO-T2	£54.56

4.2.2.4 Torness SGT1 400kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV (£m)</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£111.52
1	Refurbishment in RIIO-T2	£116.33
2	Replacement in RIIO-T2	£121.59

4.2.2.5 Torness SGT2 400kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£111.52
1	Refurbishment in RIIO-T2	£116.33
2	Replacement in RIIO-T2	£121.59

4.2.2.6 Carntyne T1B 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£59.93
1	Refurbishment in RIIO-T2	£61.38
2	Replacement in RIIO-T2	£65.44

4.2.2.7 Carntyne T2B 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£59.18
1	Refurbishment in RIIO-T2	£59.87
2	Replacement in RIIO-T2	£64.96

4.2.2.8 Saltcoats T2C 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£103.52
1	Refurbishment in RIIO-T2	£117.25
2	Replacement in RIIO-T2	£123.60

4.2.2.9 Grangemouth SGT1 275kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£102.45
1	Refurbishment in RIIO-T2	£115.62
2	Replacement in RIIO-T2	£116.58

4.2.2.10 Partick T1 132kV CBA

<u>Options</u>	<u>Proposal</u>	<u>NPV</u>
Baseline	Do nothing in RIIO-T2 period with replacement in RIIO-T3 period.	£35.94
1	Refurbishment in RIIO-T2	£37.07
2	Replacement in RIIO-T2	£39.88

4.3 Environment & Sustainability

The SPT sustainability approach is to prioritise reuse, then refurbish and finally replace if there is no other option. Where there are opportunities to reuse or refurbish equipment they will be taken, and this is clearly evidenced in the adoption of this Transformer refurbishment programme within the RIIO-T2 submission.

4.4 Innovation

Innovation is a key component to deliver developments in all aspects of work. A prime example of this is with the proposed Refurbishment of transformers. This process follows on from the successful programme of transformer refurbishments by SP Distribution Licence (smaller 33/11kV, 12/24MVA units) delivered under DPR5 and RIIO-ED1. While the technology used in these projects will be standard, as yet there is no proven track record within the GB Transmission network for the life extension and consequences of interference with aged power transformer.

5 Conclusion

The refurbishment of transformers within T2 is programme that has been developed based on the findings of the post-mortems of transformers replaced in RIIO-T1.

For all transformers in this programme of works with the exception of Inverkeithing T2 and Kendoon T2, the option to replace them in the RIIO-T2 period has a higher NPV. However, detailed review of the condition factors of the transformers has established that there is remaining life in each transformer. When considered with the lower capital cost, it is proposed to proceed with Option 1 (Refurbishment in RIIO-T2) in all cases.

The project costs have been built up from individual costs for each element and included in a bill of quantities. The bill of quantities has been engineered based on initial design developed for each option. The basis of individual unit costs has been the SP Energy Networks MoSC (Manual of Standard Costs) tool which makes reference to costs incurred during previous similar projects.

Options have been proposed for the management of the transformer fleet and the proposed costs reflect the scope of work for each transformer.

Please find details of individual transformer refurbishment projects summarised below:

Table 2 Overall recommendations and cost

Project	Scheme reference	Cost (£m)	Monetised risk benefit (Lr£ m)	Declared lead asset addition/activity	Delivery year
Kendoon 132kV	SPNLT2068	0.613	£ 15.97	1 unit	2026
Windyhill 275kV	SPNLT2069	0.702	£ 35.08	1 unit	2024
Inverkeithing 132kV	SPNLT2070	0.627	£ 32.70	1 unit	2023
Torness 400kV	SPNLT2071	0.723	£ 67.47	1 unit	2025
Torness 400kV	SPNLT2072	0.721	£ 67.47	1 unit	2025
Carntyne 132kV	SPNLT2073	0.563	£ 39.56	1 unit	2024
Carntyne 132kV	SPNLT2074	0.580	£ 39.56	1 unit	2024
Saltcoats 132kV	SPNLT2094	0.456	£ 54.86	1 unit	2025
Grangemouth 275kV	SPNLT2095	0.567	£ 79.02	1 unit	2025
Partick 132kV	SPNLT2096	0.476	£ 28.66	1 unit	2026
TOTAL		£ 6.04 m	£ 460.36 R£m		

6 Future Pathways – Net Zero

6.1 Primary Economic Driver

The primary driver for this investment is asset condition and risk. The investment does not have a strong reliance on environmental benefits.

6.2 Payback Periods

The CBA indicates that a positive NPV results in all assessment periods (10, 20, 30 & 45 years) which is consistent with the lifetime of the intervention. Consumers benefit from reduced network risk immediately on completion of the project..

6.3 Pathways and End Points

The network capacity and capability that result from the proposed option has been tested against and has been found to be consistent with the network requirements determined from the ETYS and NOA processes. Additionally, the proposed option is consistent with the site-specific capacity requirements from SPT's Energy Scenarios.

6.4 Asset Stranding Risks

Electricity generation, demand and system transfers are forecast to increase under all scenarios. The stranding risk is therefore considered to be very low.

6.5 Sensitivity to Carbon Prices

Carbon price sensitivities have been applied using the higher case CBA template. The CBA outcome is influenced by losses and is sensitive to carbon prices.

6.6 Future Asset Utilisation

It has been assessed that the preferred option is consistent with the future generation and demand scenarios and that the risk of stranding is very low.

6.7 Whole Systems Benefits

Whole system benefits have been considered as part of this proposal. The capacity and capability of the preferred option is consistent with the provision of whole system solutions.

7 Outputs included in RIIO T1 Plans

This scheme does not contain any outputs or costs included in the RIIO-T1 business plan.