[redacted]Circuit Breaker Programme - OFGEM Justification Paper	
Name of Scheme/Programme	1. Kilwinning 132kV (Mech replacement 2. Meadowhead 132kV (Mech replacement 3. Torness 132kV (Gas and air leak issues)
Primary Investment Driver	Asset Health (Lead asset – Circuit Breakers)
Scheme reference/ mechanism or category	1. SPNLT2085 (Kilwinning 132kV Mech replacement) 2. SPNLT2086 (Meadowhead 132kV Mech replacement) 3. SPNLT2090 (Torness 132kV Gas and air leak issues)
Output references/type	Circuit Breaker
Cost	1. SPNLT2085 - £ 0.286 m 2. SPNLT2086 - £ 0.526 m 3. SPNLT2090 - £ 1.05 m
Delivery Year	1. SPNLT2085 - 2022 2. SPNLT2086 - 2022 3. SPNLT2090 - 2024
Reporting Table	C0.7 / C2.2a_CI / C2.2a_AP / C2.3 /C2.4b / C2.5 / C2.5a
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

First generation pneumatic and hydraulic mechanism SF_6 circuit-breakers have provided reliable service since their installation began in the mid-1980s. However, the mechanisms are now proving to be unreliable and intervention is required. The issues and solutions differ by circuit-breaker model and so interventions are considered on this basis.

[redacted]132kV [redacted]circuit-breakers are a model where significant unreliability issues have been experienced and intervention is required to ensure ongoing operation. [redacted].

The proposed solution is the replacement of [redacted]circuit-breakers. The programme will take place at three sites during the RIIO-T2 period, prioritised by the unreliability of existing circuit-breakers and according to the availability of system access.

- Circuit breakers disposed: 11 units
- Circuit breaker addition: 11 units

Note in line with SPT's strategy to remove sources of SF_6 fugitive emissions and to consider alternative insulating and interruption mediums where technically feasible, the use of SF_6 free 132kV live tank circuit-breakers has been considered for this project.

2 Background Information

[redacted]SF_6 CBs are constructed using SF_6 as the insulation and interruption medium and use a pneumatic energy source to open and close the mechanism. While the actual circuit-breaker interrupters are in good condition, the area of deterioration is within the pneumatic mechanisms and failures have begun to occur. These are caused by corrosion of the auxiliary pipes and equipment, which have led to mal-operation of plant to either open or close. In addition, the generation of these types are now unsupported by the manufacturers due to the lower cost of spring mechanisms making them the preferential choice. The main current carrying components of the circuit-breakers are all a similar technology and are in good condition.

Issues have also occurred with the circuit-breakers' mechanisms due to corrosion failure at the pneumatic seals. Ongoing maintenance has been in place however there is a lack of manufacturer support for the existing mechanism. The availability of spare components is very limited and further maintenance will cease to be practical.

These circuit-breakers are considered mid-life, however without intervention they will cease to be operable before they have reached their design life.

Please find below the details of the circuit breakers identified for intervention.

SPEN corporate asset ID	Asset Description	Manufacturer	Model	Year of manufacture	EoL	Risk £
14148142	KILW132GCB405	[redacted]	132kV [redacted]	1987	11.97	£ 369,617.38
14148847	KILW132GCB305	[redacted]	132kV [redacted]	1988	11.97	£ 129,748.42
14166313	MEAD132GCB205	[redacted]	132kV [redacted]	1988	12.14	£ 139,650.36
14167026	MEAD132GCB120	[redacted]	132kV [redacted]	1988	12.14	£ 3,166,695.60
14167045	MEAD132GCB105	[redacted]	132kV [redacted]	1988	12.14	£ 139,650.36
14195269	TORN132GCB780	[redacted]	132kV [redacted]	1983	11.46	£ 376,082.47
14195293	TORN132GCB515	[redacted]	132kV [redacted]	1983	11.46	£ 250,309.44
14195316	TORN132GCB330	[redacted]	132kV [redacted]	1983	11.46	£ 376,082.47
14195345	TORN132GCB220	[redacted]	132kV [redacted]	1983	11.46	£ 376,082.47
14195357	TORN132GCB230	[redacted]	132kV [redacted]	1983	11.46	£ 34,408.42
14195406	TORN132GCB415	[redacted]	132kV [redacted]	1983	11.46	£ 250,309.44

Table 1 132kV Circuit Breakers Identified for Intervention

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

3 Optioneering

A summary of the options considered for interventions were as follows:

	Option	Status	Reason for rejection
Baseline	Replacement with SF_6 circuit-breaker in RIIO-T3	Proposed	The circuit-breakers without intervention will reach end of life before the end of 2026, EOL band 10. Due to the network risk and approaching end of life RIIO-T3 intervention is proposed only as a counterfactual.
1	Replacement with non-SF_6 equivalent in RIIO-T2	Proposed	
2	Replacement with SF_6 circuit-breaker in RIIO-T2	Proposed	
3	Refurbishment in RIIO-T2	Rejected	The cost of refurbishing with a replacement mechanism is approximately the same as for a like-for-like SF_6 replacement circuit breaker (option 2). Option 2 provides greater benefit but at the same cost as this option. Option 3 is therefore rejected

Table 2 Option summary

4 Detailed Analysis

4.1 Options

The options considered for intervention for SF_6 circuit-breakers were as follows:

Baseline – Replacement with SF6 breaker in RIIO-T3:

The baseline (counterfactual) option for the do minimum investment for the circuit-breaker programme considered was deferring all intervention until RIIO-T3. On this assumption, as there would be no intervention in RIIO-T2, the only available option in RIIO-T3 would be to replace the units.

Option 1 – Replacement with non-SF6 equivalent in RIIO-T2:

This option is for the replacement of the circuit-breaker with a newer design of circuit-breaker which does not use SF_6. Circuit-breakers of this type are now commercially available and are considered technically feasible based on the existing substation configuration at Kilwinning, Meadowhead and Torness 132kV substations.

Option 2 – Replacement with SF6 circuit-breaker in RIIO-T2:

This option considers replacing all units with new circuit-breakers using SF_6. The cost of this option is approximately the same as replacing the mechanisms.

4.2 CBA Outputs

As the schemes considered in this paper include an option for use of non SF6 insulating medium, high carbon prices CBA template along with the standard template CBA have been completed for this.

The CBA results are detailed below

4.2.1 Kilwinning 132kV

Options	Proposal	NPV £m	NPV £m (High carbon CBA)
Baseline	Replacement with SF_6 circuit-breaker in RIIO-T3	£ 12.17	£ 12.17
1	Replacement with non-SF_6 equivalent in RIIO-T2	£ 14.64	£ 14.65
2	Replacement with SF_6 circuit-breaker in RIIO-T2	£ 14.64	£ 14.64

4.2.2 Meadowhead 132kV

Options	Proposal	NPV £m	NPV £m (High carbon CBA)
Baseline	Replacement with SF_6 circuit-breaker in RIIO-T3	£ 81.39	£ 81.39
1	Replacement with non-SF_6 equivalent in RIIO-T2	£ 98.23	£ 98.26
2	Replacement with SF_6 circuit-breaker in RIIO-T2	£ 98.20	£ 98.20

4.2.3 Torness 132kV

Options	Proposal	NPV £m	NPV £m (High carbon CBA)
Baseline	Replacement with SF6 circuit-breaker in RIIO-T3	£ 45.60	£ 45.60
1	Replacement with non-SF6 equivalent in RIIO-T2	£ 53.51	£ 53.53
2	Replacement with SF6 circuit-breaker in RIIO-T2	£ 53.48	£ 53.49

The results of high carbon CBA give a similar NPV distribution as the standard CBA.

5 Conclusion

Four options for the management of the condition issues associated with [redacted] [redacted]132kV circuit-breakers have been presented and three of those shortlisted for detailed review. The technical analysis and the outcome of the CBA support the replacement of the circuit-breakers in the RIIO-T2 period.

For Meadowhead and Torness 132kV, replacing with a non-SF6 unit is the preferred option based on the highest NPV calculated in the standard CBA template. For Kilwinning 132kV, the NPV calculated for replacing with a SF6 unit and non-SF6 unit is the same.

We have also tested the sensitivity on the preferred option for higher carbon prices using the values in the template provided by OFGEM. This has made no material difference to the best NPV option with the results being similar to the standard CBA template.

Considering the marginal incremental cost, it is being proposed to consider use of Non-SF6 circuit breakers at all sites. This is in line with SPT's environmental commitment and sustainability policy for RIIO T2 period which considers use of alternative insulating medium within switchgear where technically feasible.

Please find project details below

Scheme reference	Scheme name	Total cost (£ m)	Lifetime benefit (Lr£m)	Declared output	Delivery year
SPNLT2085	Kilwinning 132kV (Mech replacement)	0.29	£ 14.80	Addition: 2 units Removal: 2 units	2022
SPNLT2086	Meadowhead 132kV (Mech replacement)	0.53	£ 98.11	Addition: 3 units Removal: 3 units	2022
SPNLT2090	Torness 132kV (Gas and air leak issues)	1.05	£ 54.12	Addition: 6 units Removal: 6 unit	2025

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

N/A