SSEN Transmission

RIIO-T2 Business Plan T2BP-EJP-0044

Scottish & Southern Electricity Networks

Kintore 275/132kV 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 justifies the need for intervention on the three SGTs, one of the GTs and the 132kV double busbar at Kintore substation. 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:

- The offline replacement of the 132kV AIS double busbar with a GIS solution in a plot of land just to the North-East of the substation. Following on from the adoption of recent industry developments in the use of non-SF_6 insulating mediums, the new GIS double busbar will be a non-SF_6 variant;
- The offline replacement of the 275/132kV SGTs onsite, which includes SGT1, 2 & 3 with 240MVA units. The replacement of these SGTs will also require the replacement of the corresponding 275kV CBs with equivalent switchgear with point on wave (POW) switching capability;
- The offline replacement of 132/33kV GT2 rated at 60MVA with a higher rated 120MVA unit, in combination with decommissioning GT1 in order to maintain SQSS compliance and in light of predicted connected generation uplift in the medium term;
- The replacement of the oil filled cabling onsite.

This scheme will cost £74.2m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetized risk benefit of R£450.3m;
- A risk reduction of total network risk calculated as R£9.7m and;
- 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.

The Kintore scheme is flagged as eligible for early competition due it being over Ofgem's £50m threshold. However, there is no contestable solution for intervention at Kintore due to the nature of works, namely the replacement of existing assets within an existing substation complex.

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[1] A Risk Based Approach to Asset Management

Name of Scheme/Programme	Kintore 275/132kV Substation Works
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2021)
Output references/type	NLRT2SH2021
Cost	£74.2m
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 condition-related work during the RIIO-T2 period (April 2021 to March 2026). The planned work is at Kintore substation, the location of which is shown in Figure 1 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.

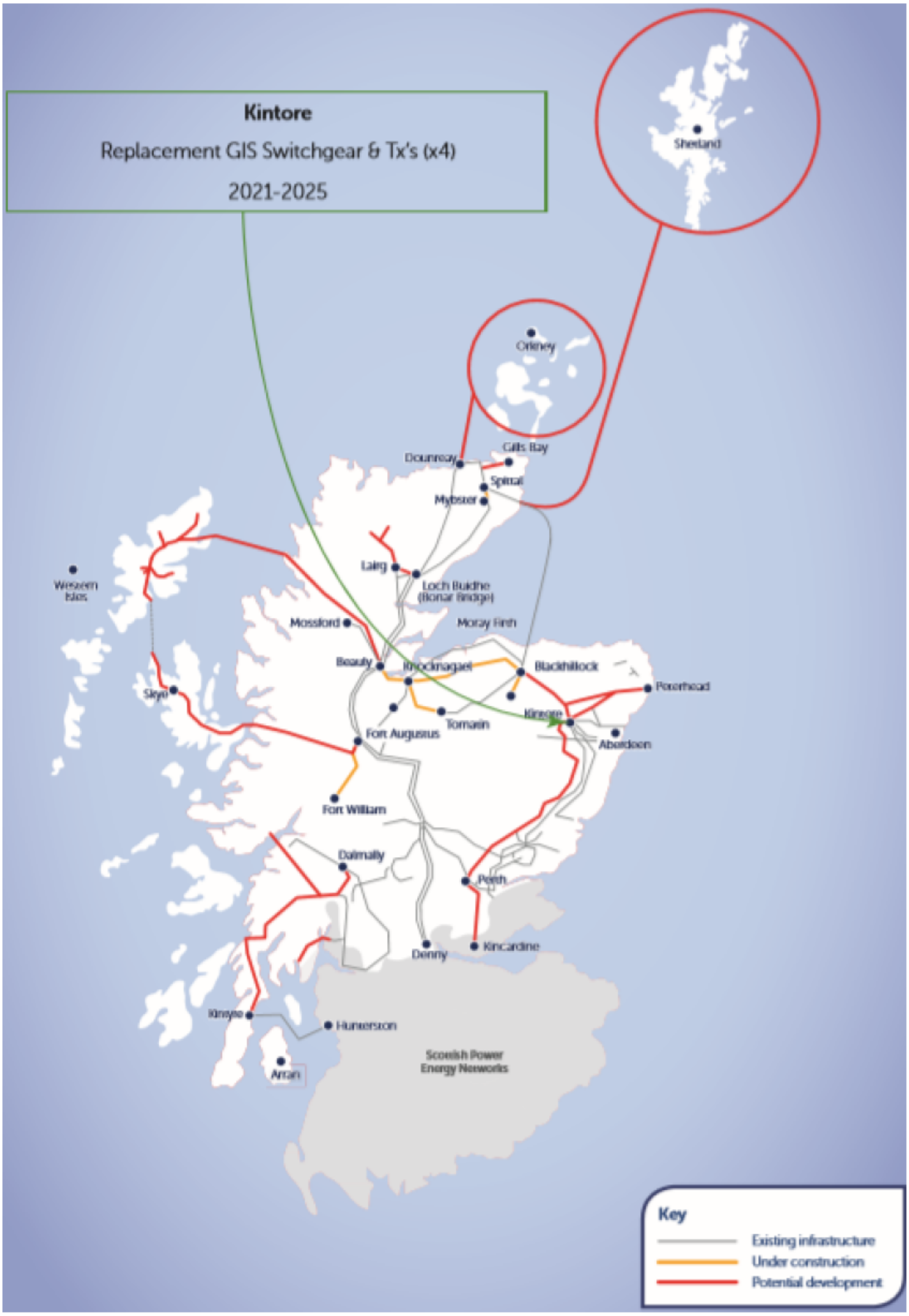
Section 7: Price Control Deliverables and Ring Fencing

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

Kintore substation, which is situated approximately 20km north west of Aberdeen, is an important site on the SHE Transmission Main Interconnected Transmission System (MITS). An illustration of the network this substation sits within is provided in Appendix A. The 275kV double busbar at Kintore connects three 275kV double circuits from the north and two from the south, namely:

- Blackhillock/Cairnford double circuit, as well as two double circuits from Peterhead in the North (one of which connects to Kintore via Persley);
- Tealing and Fetteresso double circuits that go to the South.

[redacted]

Kintore substation includes three of the six circuits that connects the Grid Supply Points (GSPs) at Kintore, Dyce, Willowdale, Clayhills, Redmoss, Tarland and Craigiebuckler to the 275kV network. The remaining two circuits are at Persley 275/132kV substation and a single 132kV circuit from Tealing (via Craigiebuckler). The three circuits at Kintore comprise of three 275/132kV Supergrid Transformers (SGTs):

- SGT1 & SGT3 rated at 240MVA;
- SGT2 rated at 120MVA.

[redacted]

With regards to the local 132kV MITS, the majority of the GSPs supplied by Kintore (in parallel with Persley and the 132kV circuit via Tealing) are connected via three of the five 132kV circuits connected to the 132kV double busbar. The final two provide the sole point of connection to Dyce GSP which feeds Aberdeen Airport, and Aberdeen Bay substation which provides Aberdeen Offshore Windfarm with a connection to the wider network.

This substation also supplies the local network through three 132/33kV Grid Transformers (GTs):

- GT1 & GT2 rated at 60MVA;
- GT3 rated at 90MVA.

[redacted]

3.2 Asset Need

Ongoing site inspections provide detailed condition assessment of the plant along with the data gathered from testing and analysis. The resulting Asset Condition Report[2] provides in detail the condition of existing assets and recommendations for intervention in the RIIO-T2 period. A summary of the key points of this report are provided below.

132kV Air insulated double busbar

A summary of the highlighted condition-related issues with the 132kV switchgear are:

- 24 of the 33 disconnectors on the 132kV double busbar were originally installed in the 1960s and exhibit corrosion;
- The interlocking systems (that prevent disconnector operation before the correct circuit breaker (CB) state has been set up) are failing;
- Of the 12 earth switches at 132kV, five were originally installed in the 1960s and exhibit a similar level of deterioration and corrosion to the disconnectors onsite installed in the same period.

In addition to the condition-related issues outlined with various 132kV switchgear, there are multiple operational limitations on the existing double busbar configuration that are worth noting:

- None of the five 132kV circuits incoming to Kintore substation has a selectable configuration that allows the switching of circuits between the main and reserve busbars (a requirement for new build marshalling substation design according to the Security and Quality of Supply Standard or SQSS). This issue also extends to the GTs where two out of three of the existing GTs simply connect to one busbar;

[2] Kintore Substation Works Asset Condition Report T2BP-ACR-0003

- The older disconnectors lack telecontrol capability which restricts the resilience and speed of network response to faults, and increases the safety risk to staff who need to operate the plant manually and in close proximity;
- Spares for the older disconnectors and earth switches are difficult to source;
- The 132kV double busbar has smaller spacing between switchgear assets than would be allowed under a modern equivalent construction. This means maintenance of any individual assets require more extensive outages (thus imposing a higher local and wider network risk) than would otherwise be necessary with a modern equivalent construction.

275/132kV SGTs

A summary of the highlighted condition-related issues with the SGTs are:

- Kintore SGT2 is displaying symptoms of solid insulation ageing (as demonstrated by the increasing total furan and 2-FAL trends shown in the transformer oil analysis reports);
- The external condition SGT1 & SGT3 are both considered poor and exhibit multiple oil leaks. Internally, both units exhibit condition parameters within acceptable limits, but do show signs of cyclic increases in moisture content & reduced voltage breakdown measurements.

In addition to the condition-related issues with the SGTs, there is also another issue to consider with regards to 120MVA SGT2, namely the loading placed on it. It has been determined that the existing SGT2 regularly runs at a loading between 60 & 120MVA. In addition, during an outage on either SGT1 or SGT3, SGT2 reaches loadings as high as 90% of its 120MVA rating. This combination of loading issues presents a need to increase the rating of SGT2 to match the rating of SGT1 and 3.

132/33kV GT2

A summary of the highlighted condition-related issues with GT2 are:

- The external condition of GT2 is determined to be poor, with multiple oil leak sources present and notably signs of corrosion;
- GT2 tap changer also has an outstanding operational restriction as well as recent suspected internal arcing issues (the tap changer has had its tapping fixed and an exclusion zone set up around it due to this as well as recent suspected arcing with the tap changer).

In addition to the condition-related issues outlined, there are multiple operational limitations on the existing GT that are worth noting:

- GT2 is also non-compliant with internal fire separation standards due to the lack of fire zone segregation between GT2 and the associated earthing transformer;
- The electrical banking of GT1 & GT2 to ensure SQSS compliance introduces complication and duplication of assets to be operated and maintained on the network.

3.3 Growth Need

A summary of the latest demand and generation capacity connected via the GTs to the wider network is summarised in the table below:

Table 1: Kintore GSP Demand & Generation Summary

Demand		Generation		
Winter Peak (MW)	Summer Min (MW)	Connected (MW)	Contracted (MW)	Total (MW)
67	5.75	72	9	81

To accommodate the connection of embedded generation at the Kintore GSP and retain compliance with the Generation Connection criteria of the SQSS, works were completed in 2018 to bank GT1 & GT2 such that both are either connected or disconnected at the same time. This banked configuration ensures that on planned outage of GT3 (90MVA) followed by an unplanned outage on one of the 60MVA GTs, no overloading of the remaining 60MVA GT occurs.

On review of the demand and generation profiles of this site:

- Demand is not projected to significantly rise in the medium term to require preemptive intervention on the GTs or 33kV boards;
- While generation is not projected to rise above 90MVA in the certain view, however a further small increase in generation would trigger an uplift in installed transformer capacity (once both connected and contracted generation is considered) is considered marginal.

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.

There have been three identified categories of options identified, namely:

- 132kV double busbar interventions;
- 275/132kV SGT interventions;
- 132/33kV GT interventions.

Each category contains separate options that were considered as part of addressing the asset condition at Kintore. A summary of these are presented in the tables below:

Table 2: 132kV Double Busbar Intervention Options (Category 1)

Option	Option Detail	Taken forward to Detailed Analysis?
1-1	In-situ replacement of the poor condition disconnectors and earth switches	No
1-2	Offline replacement of the 132kV double busbar with an air insulated switchgear (AIS) solution. This would be in the area adjacent to the existing substation just to the North East (NE)	No
1-3	Offline replacement of the 132kV double busbar with a GIS solution. This would be in the area adjacent to the existing substation just to the NE	Yes
1-4	Offline replacement of the 132kV double busbar with a GIS solution. This would be in the area adjacent to the existing substation just to the North West (NW)	No

Table 3: 275/132kV SGT intervention Options (Category 2)

Option	Option Detail	Taken forward to Detailed Analysis?
2-1	Refurbishment of the SGTs	No
2-2	In-situ replacement of the SGTs, no capacity change	No
2-3	Offline replacement of the SGTs, no capacity change	No
2-4	Capacity uplift of SGT2 from 120MVA to 240MVA as part of offline replacement of the SGTs	Yes

Table 4: 132/33kV GT intervention Options (Category 3)

Option	Option Detail	Taken forward to Detailed Analysis?
3-1	Refurbishment of GT2	No
3-2	In-situ replacement of GT2, no capacity uplift	No
3-3	Offline replacement of GT2, no capacity uplift	No
3-4	Capacity uplift of GT2 from 60MVA to 90MVA as part of asset replacement, and the decommissioning of GT1	Yes
3-5	Capacity uplift of GT2 from 60MVA to 120MVA as part of asset replacement, and the decommissioning of GT1	Yes

With regards to interfacing projects that need to be taken into account when reviewing these options, any outages taken at Kintore for proposed works must be coordinated with East Coast 275kV and East Coast 400kV works due to the limitations these works will put on the North to South transfer of the existing 275kV MITS.

Transmission reinforcement works south of Craigiebuckler on the East Coast 132kV network have also been entered as an option into the 2019/20 Network Options Assessment. These works propose the splitting of the East Coast 132kV network between Craigiebuckler and Tealing thus reducing the number of circuits feeding the demand group between Kintore, Craigiebuckler and Persley from six circuits to five. [redacted]

4.1 132kV Double Busbar Intervention Options

Option 1-1: In situ replacement of poor condition disconnectors & earth switches

This option considers the in-situ replacement of the poor condition disconnectors and earth switches. Due to the compact nature of the existing 132kV AIS double busbar, the outages required to isolate a section of the network to ensure both safety of operational staff and allow work will be significant. This, in combination with the lack of selectors previously outlined in the Need section, puts a larger proportion of the network (both at Kintore GSP where not all customers can be backfed, and other GSPs in the Aberdeen area) at single circuit risk and thus at increased risk of disconnection. In addition, an in-situ replacement of the poor condition disconnectors and earth switches would leave unresolved:

- the clearance issues due to the compact nature of the existing 132kV switchgear configuration;
- The lack of circuit selectors in the existing 132kV double busbar configuration.

Due to the issues with outages outlined above, along with the clearance and selector limitations such an in-situ solution would not resolve (thus presenting the same outage issues for any future works or indeed maintenance), it was determined such a solution would not be suitable and has been discounted.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 1-2: offline replacement of 132kV double busbar with an AIS solution (to the NE)

This option considers the offline replacement of the 132kV double busbar with an AIS solution. This would be in the area adjacent to the existing substation just to the North East. Due to previously highlighted issues to carry out in-situ works, an offline build just to the North East of the existing substation is the only feasible solution. However, there are the following concerns associated with this option:

- The extensive land footprint that would need to be purchased for such an option;
- The proposed area to the North East is heavily wooded. These would not only need to be removed and disposed of, but under the Scottish Government's Policy on Woodland Removal as well as the existing Aberdeenshire Council Local Development Plan, an equivalent forest habitat that is removed needs to be replanted in another location;

- The challenges of gaining the necessary planning consents considering the previous two points and the potential impact on timescales of the project.

It is for these reasons the offline AIS solution is considered an unrealistic proposal.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 1-3: offline replacement of 132kV double busbar with an GIS solution (to the NE)

This option considers the offline replacement of the 132kV double busbar with a GIS solution. This would be in the area adjacent to the existing substation just to the North East. Due to constraints on the available space as outlined in Option 2, a GIS option has been considered. This will reduce the footprint substantially, and thus reduces the impact on (and subsequent need for replanting) of the proposed woodland where the North-East extension is proposed.

PROGRESS TO DETAILED ANALYSIS

Option 1-4 offline replacement of 132kV double busbar with an AIS solution (to the NW)

This option considers the offline replacement of the 132kV double busbar with a GIS solution. This would be in the area adjacent to the existing substation just to the North West. With regards to this location for the offline build of the 132kV double busbar the following issues were identified:

- This proposed area of land partly encroaches on the likely location for the 400kV works proposed under the North East 400kV OHL upgrade & East Coast Phase 2 schemes;
- Dewsford burn also runs in very close proximity to the Northern edge of this proposed location.

It is for these reasons that this location has been deemed unsuitable for development in comparison to the North East area and is therefore not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

4.2 275/132kV SGT intervention Options

Option 2-1: Refurbishment of the SGTs

This option considers the refurbishment of SGT1, 2 & 3. In assessing this option, it is worth viewing SGT2 separately due to it differing internal condition (and the similarity of the condition of SGT1 & 3). The issue with refurbishment of SGT2 stems from the nature of the need:

- Kintore SGT2 is displaying symptoms of solid insulation ageing as shown by the increasing total furan and 2-FAL trends oil analysis reports;

- Such deterioration can only be remedied through the refurbishment of the internal windings and associated paper insulation.

With regards to SGT1 & 3, such work would relate primarily to remedying the external condition. With this proposal there are the following concerns:

- Opportunity for outages on these SGTs (which would be required for refurbishment) are constrained. This is due to the constraints on the 132kV MITS where outages on one of these SGTs at Kintore increasing the load drawn via the Persley SGTs and causing resultant overloads of the 132kV network. This would be especially prevalent during outages on the 275kV network between Peterhead and Kintore as part of East Coast 400kV OHL Upgrade works;
- The uncertainty associated with the effectiveness of refurbishment, especially when considering the risks associated with introducing additional moisture or other contaminants during the refurbishment onsite.
- Space is required around each of the SGTs to set up a controlled environment necessary to allow refurbishment. This is considered impractical due to the close proximity of SGT1 & 3 (they sit in the same bund separated by a brick fire wall).

With regards to completing refurbishment, it also leaves the following issues unresolved:

- SGT1 & 3 bund is uncompliant due to them not having enough clearance from each other to be considered as being in separate fire damage zones;

It is this combination of factors that lead to the refurbishment option for SGT1 & 3 to be discounted.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2-2: In-situ replacement of the SGTs

This option considers the in-situ replacement of SGT1, 2 & 3. In line with our standards such replacement requires the installation of associated 275kV CBs with Point-On-Wave (POW) switching capability. As alluded to in the previous option, outages on these SGTs for in-situ replacement would be difficult to obtain based on both the existing constraints on the local 132kV MITS (especially when considered alongside other outage requirements during the RIIO-T2 period). As mentioned in the previous option, this solution would not address the issues surrounding the non-compliance of the bunds for SGT 1 &3. This option is therefore not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2-3: Offline replacement of the SGTs

This option considers the offline replacement of SGT1, 2 & 3. In line with our standards such replacement requires the installation of associated 275kV CBs with POW switching capability. This option has the advantage of minimising the need for outages during replacement works. It would also be feasible considering the space that would be cleared in the existing substation perimeter by the offline rebuild of the 132kV double busbar. However, it does not address the need imposed by the existing load profile on SGT2 where at 120MVA its ONAN rating would be regularly exceeded. This option is therefore not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 2-4: Offline replacement of the SGTs (including capacity uplift of SGT2 from 120MVA to 240MVA)

This option considers the offline replacement of SGT1 & 3 along with the offline replacement of SGT2 with a 240MVA unit. In line with our standards such replacement requires the installation of associated 275kV CBs with POW switching capability. The driver behind this stems from the need to lower the proportion of time SGT2 is highly loaded. Considering a new 120MVA unit would be put through a similar level of high loading conditions especially when one of the other SGTs is on outage, uplifting the rating of the news SGT2 to 240MVA is deemed the preferred option for the SGT category. This option is therefore progressed to detailed analysis.

PROGRESSED TO DETAILED ANALYSIS

4.3 132/33kV GT intervention Options

Option 3-1: Refurbishment of the GT2

This option considers the refurbishment of the GT2. Such an option raises the following concerns:

- The refurbishment does not deal with the need for separate fire zones between the GT and associated earthing transformer;
- It leaves unresolved the exclusion zone and fixed tap in place on the GT2 tap-changer due to the historic operational restriction.

It is this combination of factors that lead to the refurbishment option for GT2 to be discounted.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 3-2: In-situ replacement of GT2

This option considers the in-situ replacement of GT2. This option cannot be achieved while meeting current engineering standards. This option is therefore not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 3-3: Offline replacement of the GT2

This option considers the offline replacement of the GT2. This option will comply with current engineering standards but still needs to be banked with SGT1 to achieve SQSS compliance. This option is therefore not progressed to detailed analysis.

NOT PROGRESSED TO DETAILED ANALYSIS

Option 3-4: Offline replacement of GT2 with a 90MVA unit, and the decommissioning of GT1

This option considers the capacity uplift of GT2 from 60MVA to 90MVA as part of asset replacement, and the decommissioning of GT1. This removes the need to operate banked transformers to comply with SQSS, removing complexity of the plant and protection systems required to achieve this.

PROGRESSED TO DETAILED ANALYSIS

Option 3-5: Offline replacement of the GT2 with a 120MVA unit, and the decommissioning of GT1

This option considers the capacity uplift of GT2 from 60MVA to 120MVA as part of asset replacement, and the decommissioning of GT1.This option has been proposed as the distribution connected generation on the Kintore 33kV network is approaching the capacity of the existing arrangement. The increased GT capacity avoids the need to replace GT2 should additional generation connect.

PROGRESSED TO DETAILED ANALYSIS

4.4 Assessment Summary

The decisions from the options can be summarised as follows:

- For the 132kV double busbar needs identified, only Option 1-3 is deemed suitable;
- For the 132/275kV SGT needs identified, only option 2-4 is deemed suitable;
- For the 132/33kV GT needs identified options 3-4 & 3-5 are deemed suitable.

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

A Cost Benefit Analysis (CBA) has been carried out in order to assess the preferred choice between Options 3-4 & 3-5. Our CBA Methodology[3] sets the process and mechanics of our approach to CBA. In order to carry out this CBA, the following complete solutions were costed to allow comparison:

Table 5: CBA Solutions for Comparison

	Solution A	Solution B
Category 1 selection (T2 works)	**Option 1-3**: offline replacement of 132kV double busbar with an GIS solution (to the NE)	**Option 1-3**: offline replacement of 132kV double busbar with an GIS solution (to the NE)
Category 2 selection (T2 works)	**Option 2-4**: Offline replacement of the SGTs (including capacity uplift of SGT2 from 120MVA to 240MVA)	**Option 2-4**: Offline replacement of the SGTs (including capacity uplift of SGT2 from 120MVA to 240MVA)
Category 3 selection (T2 works)	**Option 3-5**: Offline replacement of the GT2 with a 120MVA unit, and the decommissioning of GT1	**Option 3-4**: Offline replacement of the GT2 with a 90MVA unit, and the decommissioning of GT1
Future Works	N/A	Replacement of the newly commissioned GT2 with a 120MVA unit at a later date
Cost of solution	**£74.2m**	**£74.0m under T2 works + £2.7m under future works**

[3] Cost Benefit Analysis Methodology

Both potential solutions contain Option 1-3 for the 132kV double busbar and Option 2-4 for the SGTs. The difference lies in the GT component:

- Solution A has GT2 being replaced with a 120MVA unit under the RIIO-T2 scheme (Option 3-5);
- Solution B has GT2 being replaced with a 90MVA unit under the RIIO-T2 scheme (Option 3-4), while another scheme to replace this 90MVA unit with a 120MVA unit is also included in a later year.

It is assumed the risk benefit (included in the CBA for both Solutions) are the same:

- due to the same asset-related need being satisfied to the same degree in both;
- due to the 'Future Works' intervention in Solution B being a load-driven intervention that has no impact on the risk benefit;

The results of the CBA, including relevant calculated Net Present Values (NPVs), are shown in the table below.

Table 6: CBA Total NPV Equalisation

CBA Option No.	Total Forecast Expenditure (£m)	Total NPV	Delta (Option to baseline)	Total NPV (Incl. Monetised Risk £m)
Baseline	-£75.45	-£71.53		£185.61
Option 1	-£77.99	-£71.52	£0.01	£185.86

From this analysis using the CBA tool it was found that in order to have the NPVs between the two solutions match, the later expenditure associated with Solution B to replace the 90MVA GT commissioned under the RIIO-T2 works with a 120MVA unit would have to be in 2069. If this later expenditure in solution B was projected to be spent in an earlier year it always yields a superior NPV value for Solution A.

Based on this CBA analysis (and when compared to the existing connected and contracted generation at Kintore GSP), it is concluded that Solution A would be the appropriate investment to make. This is in light of the view taken that potential future connected generation at Kintore GSP could increase to require a 120MVA GT significantly sooner than the NPV equalisation years set out in both the main CBA and associated sensitivity scenarios.

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 8: Sensitivity Analysis table

Sensitivity	Test and impact observed – switching inputs
Asset Performance / deterioration rates	Switching deterioration assumption: Improved - need driven by asset condition report and will not improve in intervening period. Deteriorated – Need remains, 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, both the options move in parallel and have no impact on ordering within CBA.
Demand variations	No significant demand forecast
Energy scenarios	We have considered the potential for a marginal further increase in the contracted generation, and factored that into the proposed solution
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 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, optioneering and detailed analysis and the impacts this has on the selection of the preferred solution.

5.3 Proposed Solution

The scope of the selected solution is to:

- build an offline 132kV GIS building to house the new 132kV double busbar;
- replace SGT1, SGT2, SGT3 with 240MVA units and install corresponding CBS with POW capability;
- replace GT2 with a 120MVA unit and decommission GT1 and GT2;
- replace all oil filled cables associated with the decommissioned assets.

A copy of the Single Line Diagram (SLD) is shown in Appendix C. The project will be energised within the RIIO-T2 period. The table below details the outputs.

Table 7: Outputs from preferred option

Plant	Size of new plant	Replacement for
SGT1	240MVA	SGT1 240MVA
SGT2	240MVA	SGT2 120MVA
SGT3	240MVA	SGT3 240MVA
GT2	120MVA	GT1 & GT2 60MVA units
132kV fully selectable double busbar GIS	17x 132kV CBs 39x 132kV disconnectors 12x 132kV earth switches	Existing 132kV AIS double busbar arrangement
275kV CBs	3 x 275kV CBs with POW	3 x 275kV CBs
275kV and 132kV cable connections	3x 275kV cable sections 9x 132kV cable sections	Existing oil filled cable sections

5.4 Competition

This solution is estimated to cost more than the £50m threshold for early competition. Addressing the condition and operational inflexibility of the 132kV switchboard can only be addressed by replacement with a fully selectable double busbar. The condition of the SGTs and GT can only be addressed by replacement of these assets.

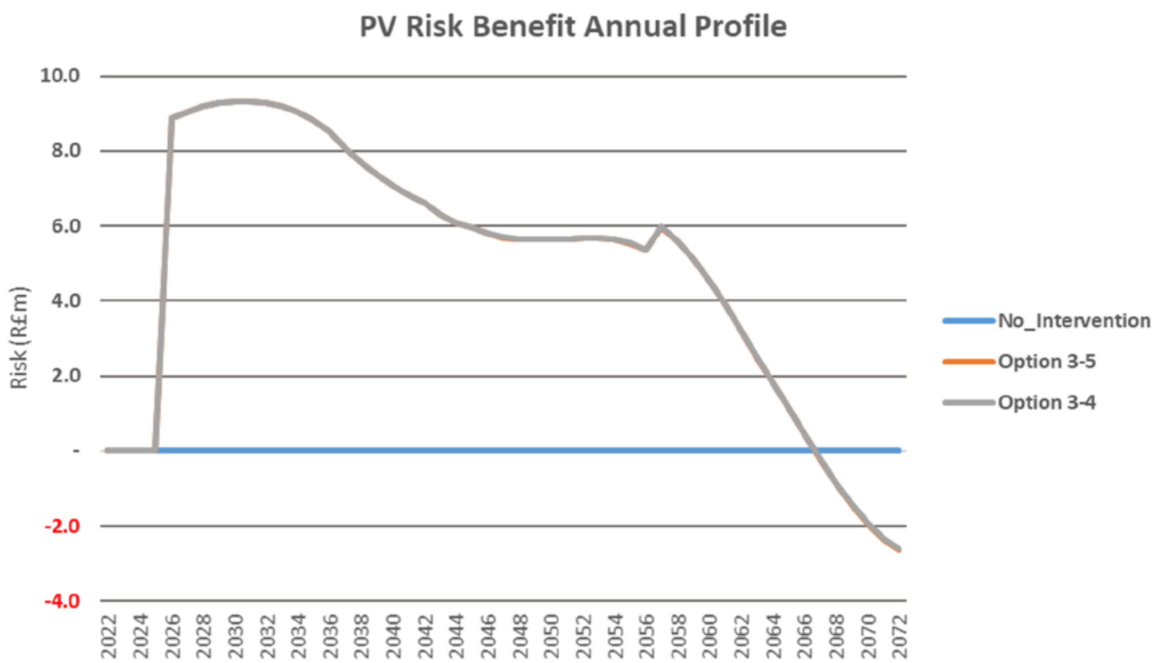
However, there is no contestable solution for intervention at Kintore due to the nature of works, namely the replacement of existing assets within an existing operational substation.

5.5 Risk Benefit Analysis

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 option 3-4 (60MVA replaced with 90MVA units) is R£450.3m. The completion of option 3-5 (60MVA replaced with 120MVA units) delivers a calculated long term monetized risk benefit of R£450.3m. 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 – Replacing with 90MVA GT and follow up replacement with 120MVA GT in 2031 (Option 3-4) or Replacing immediately with a 120MVA in 2026 (Option 3-5)



In addition to assessing the long-term risk benefit, a monetised risk benefit has also been determined. The monetised risk benefit which would be realized through the completion of the preferred option R£9.7m.

Therefore the immediate and longer term benefits from either option considered in the CBA is comparable.

5.6 Innovation & Sustainability

As part of this proposed solution, the six oil filled cable sections (one 275kV and five 132kV) that form part of the existing substation infrastructure are scheduled for replacement with XLPE equivalents. This approach is not only due to the impracticalities of reusing such assets in the new build, but also considers SHE Transmission's commitment to oil management under ISO 14001, in this case by designing out existing oil filled assets in the proposed works.

The installation of a GIS double busbar at Kintore will consider a non-SF_6 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 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 9: Carbon Calculation Summary

	Project Information	Baseline	Option 1
Project Info	Project Name /number		
	Construction Start Year	2026	2026
	Construction End Year	2028	2028
Cost Estimate £GDP	Embodied Carbon	769,495	791,196
	Construction	285,424	286,114
	Operations	993,555	993,555
	Decommissioning	130,675	130,990
	Total Project Carbon Cost Estimate	**2,179,149**	**2,201,855**
Carbon Footprint tCO2e	Embodied Carbon	10,275	10,565
	Construction	3,754	3,763
	Operations	4,344	4,344
	Decommissioning	375	376
	Total Project Carbon (tCO2e)	**18,749**	**19,049**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	3,974	3,974
	Total Scope 2 (tCO2e)	370	370
	Total Scope 3 (tCO2e)	14,405	14,704
SF• Emissions	Total SF• Emissions 3 (tCO2e)	3,897	3,897

5.8 Cost Estimate

The cost of the preferred option for works at Kintore has been developed using rates from existing substation framework contracts and benchmarks from delivered RIIO-T1 projects. These have been applied to indicative quantities obtained from layout drawings. The total cost for delivering the scope of works for the proposed solution is £74.2m.

6 Conclusion

This paper identifies the need for intervention on Kintore SGT1, 2 & 3, GT2, and 132kV double bubsar. The primary driver for the scheme is the asset condition with a secondary driver of network resilience.

Three option categories (two of which comprised four options, and the other five) were identified for this scheme. Of these two complete solutions were taken forward and considered for detailed analysis.

The proposed scope of work selected (consisting of a solution made up of options 1-3, 2-4 and 3-5) is:

- The offline replacement of the 132kV AIS double busbar with a GIS solution in a plot of land just to the North-East of the substation. Following on from the adoption of recent industry developments in the use of non-SF_6 insulating mediums, the new GIS double busbar will be a non-SF_6 variant;
- The offline replacement of the 275/132kV SGTs onsite, which includes SGT1, 2 & 3 with 240MVA units. The replacement of these SGTs will also require the replacement of the corresponding 275kV CBs with equivalent switchgear with point on wave (POW) switching capability;
- The offline replacement of 132/33kV GT2 rated at 60MVA with a higher rated 120MVA unit, in combination with decommissioning GT1 in order to maintain SQSS compliance and in light of predicted connected generation uplift in the medium term;
- The replacement of the oil filled cabling on site.

This scheme will cost £74.2m and will deliver the following outputs and benefits during the RIIO T2 period:

- A long-term monetized risk benefit of R£450.3m;
- A risk reduction of total network risk calculated as R£9.7m and;
- Improved operational flexibility and resilience in line with our goal to aim for 100% transmission network reliability for homes and businesses.

The Kintore scheme is flagged as eligible for early competition due it being over Ofgem's £50m threshold. However, there is no contestable solution for intervention at Kintore due to the nature of works, namely the replacement of existing assets within an existing substation complex.

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 delivers 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 were no outputs associated with this scheme included in the RIIO T1 plans.

Appendix A: Overall MITS Network Diagram

[redacted]

Appendix B: Kintore Substation Network Configuration

[redacted]

Appendix C: SLD for Kintore works

[redacted]