Longannet 275kV switchgear replacement project - OFGEM justification paper	
Name of Scheme/Programme	Longannet 275kV switchgear replacement (includes future 400kV upgrade)
Primary Investment Driver	Asset Health (Lead asset – Circuit-breaker)
Scheme reference/ mechanism or category	SPNLT 2099 / Circuit-breaker
Output references/type	NLRT2SP2099 (275kV gas insulated Circuit-breaker (ID) / 275kV Switchgear Other / 275kV Batteries / 275kV OHL Tower / 275kV OHL Tower line conductor)
Cost	£ 69.29 m (For preferred 275kV option – included under uncertainty) £ 98.37 m (For 400kV option – included under uncertainty)
Delivery Year	2026
Reporting Table	C0.7 / C2.2a_CI / C2.2a_AP / C2.3 / 5.18
Outputs included in RIIO T1 Business Plan	No

Issue Date	**Issue No**	**Amendment Details**
July 2019	Issue 1	First issue of document
October 2019	Issue 2	CBA update – NPV / Monetised risk benefit, gross cost update
December 2019	Issue 3	(1) Scheme name update (2) 275kV Optioneering – preferred option updated (2) Gross cost, NPV, Monetised Risk, Long Term Risk Benefit values, delivery year and future pathways – Net zero text updated. (3) Reference to proposed 400kV upgrade works at Longannet 275kV substation included. (4) Project proposed to be delivered under Uncertainty mechanism now (included in table 5.18).

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1 Introduction

Longannet 275kV substation is an indoor AIS substation located in vicinity of the now decommissioned Longannet power station and serves as a key node on the SP transmission network. With connections to Kincardine 275kV substation, Windyhill 275kV substation, Denny North 275kV substation and Westfield 275kV substation, Longannet 275kV is a critical node of the main interconnected transmission system (MITS) and responsible for significant amount of East-West / North-South power transfer.

The existing system at Longannet 275kV is a 20 bay 1½ switch scheme with bus section disconnectors. Please find below a list of existing live circuits at Longannet (please refer to the GSN drawing in the appendix):

1. Clydesmill (referred to as 'CLYM' henceforth)
2. Easterhouse (referred to as 'EERH' henceforth)
3. Lambhill / Windyhill ((referred to as 'WIYH/LAMB' henceforth)
4. Denny North (referred to as 'DENN' henceforth)
5. Westfield (referred to as 'WFIE' henceforth)
6. Mosmorran (referred to as 'MOSM' henceforth)
7. Kincardine 1 (referred to as 'KINC1' henceforth – this circuit also has Series reactor with bypass disconnector arrangement installed)
8. Kincardine 2 (referred to as 'KINC2' henceforth – this circuit also has Series reactor with bypass disconnector arrangement installed)
9. MSCDN1 (referred to as 'MSCDN1' henceforth)
10. MSCDN2 (referred to as 'MSCDN2' henceforth)

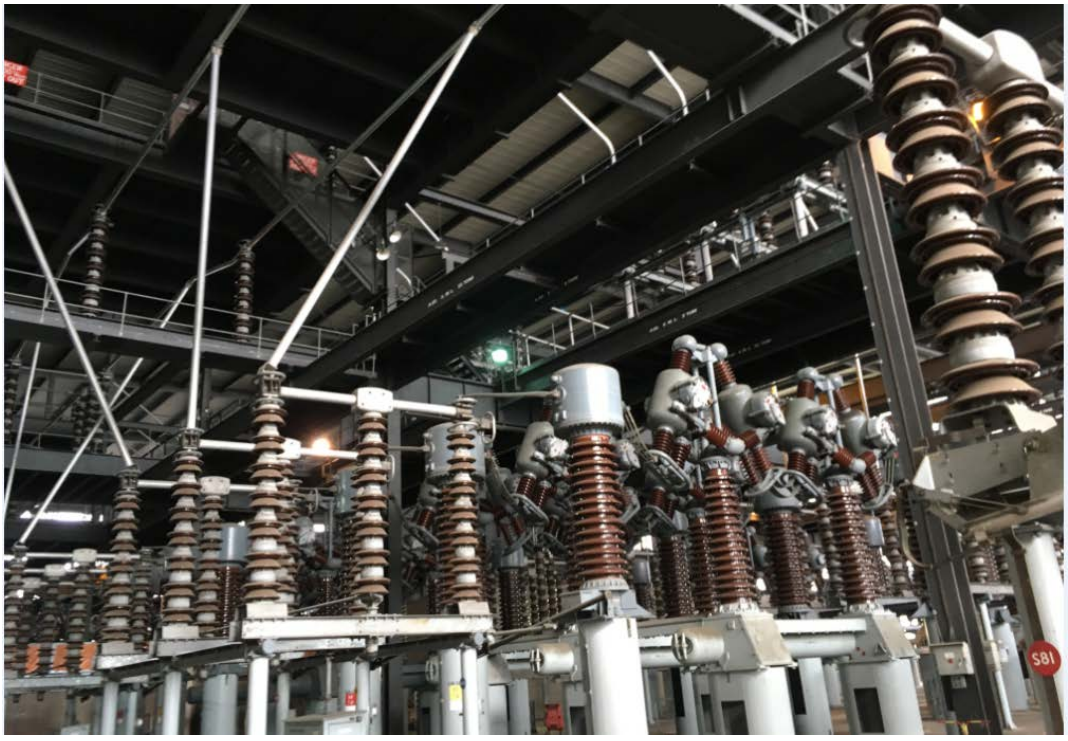


Figure 1: Longannet 275kV substation

With the closure of the power station the following circuits have now been decommissioned and are in the process of being disconnected from the network:

- Station transformer 1
- Station transformer 2
- Generator 1
- Generator 2
- Generator 3
- Generator 4

The primary plant equipment for these circuits has been left in situ and are partly in service to assist the 1 ½ switch operational design of the substation.

Considering the pollution from adjacent Longannet power station and previously decommissioned Kincardine power station situated nearby, the existing Longannet 275kV was housed within a 137 x 43 mtrs building. The substation is built over three levels with the line entries for CLYM / EERH / DENN / WIYH-LAMB coming from the top level via wall bushings and dropping down to the bottom level on the 1 ½ switch scheme arrangement.

The switchgear (OIBR 80 circuit breakers and Switchgear & equipment RCP disconnectors) are of a unique design and purposely built for this substation. All the steelwork, frame of the building & access walkways – steps, bay spacings etc. have been built considering the clearances available for the existing bays and cannot be altered in any shape or form. Further due to the unique build of the substation over 3 levels, it is not possible to change the configuration (e.g. go from a 1 ½ to a double busbar arrangement) in the same location within the existing building.

MSCDN equipment along with series reactor & bypass disconnectors (in KINC circuits) is located outside the substation building and connected via 275kV cables in cable tunnels.

Civil assessment carried out on the existing building found major condition issues in terms of drainage, flooding, internal lighting, building services, doors, glazing, asbestos in parts of control room and cable trenches and in general, poor state of the building. The assessment report is available is available for review.

Based on the issues identified the building would require either major intervention or complete replacement in the RIIO T2 period, the associated cost has been included in the various options considered.

The control room is located within the existing building and connected via internal cable trenches. Refurbishment works are also envisaged on internal building services.

All the OIBR80 air blast Circuit Breakers (18 off) have EoL modifier scores of 10.44 or higher at end of RIIO T2 period (without intervention) and so require a major intervention / replacement within RIIO T2 period. Except the OIBR80 air blast Circuit Breakers, 2 off ABB HPL300B2 SF6 Circuit Breakers with EoL modified scores of 0.56 are located in MSCDN bays and are being considered to be reused without any refurbishment works for this project.

The condition of the non-lead assets – disconnectors/earthing switches, busbars, instrument transformers, busbars, insulators and structures – have also been assessed and in all cases, significant intervention is required.

Condition assessment report of all non-lead assets at this site is available for review.

In line with above, the proposed 275kV outputs to be delivered in this project for the selected option are:

- 275kV Circuit Breaker disposed: 18 units
- 275kV Circuit Breaker addition: 13 units

Note the addition units (13 off) are based on the preferred GIS option 2 which is considering a double busbar indoor GIS substation with 2 bus couplers on extreme ends, and a bus section circuit breaker bay on the main busbar. Reserve busbar shall a disconnector only bus section bay.

In line with the system security and operational requirements, the 2 off bus coupler and the bus section bay provides the required level of flexibility necessary for Longannet 275kV. This will maintain a reliable and operable MITS network and reduce the consequences of a busbar fault at the substation. This arrangement also provides ongoing network security benefit while carrying out maintenance work on the busbar switchgear and provides additional system security critical for Longannet 275kV substation.

The delivery of the project is characterised by multiple outage stages requiring significant temporary works to secure the wider network and to maximise its capability, minimising constraints.

2 Background Information

This paper supports a proposal to replace the existing 18 off OIBR 80 air blast circuit-breakers and associated non-lead assets at Longannet 275kV substation. Based on the values determined in accordance with the NARM methodology, the circuit-breakers will all have an EoL modifier score of 10.44 or higher at end of RIIO T2 period, have significant operational and maintenance issues and are identified for replacement during the RIIO T2 period. The unique design of these Circuit Breakers also makes it impossible to source any replacement spares.

Please find below details of the 18 off Circuit-Breakers identified for replacement.

SPEN corporate asset ID	Asset Description	Manufacturer	Model	Year of manufacture	EoL	Monetised risk £ (at end of RIIO T2 period without intervention)
14227248	LOAN275ACBF25	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 128,140.83
14227272	LOAN275ACBW20	REYROLLE	OIBR80 ACB TRANS	1968	10.63	£ 131,374.58
14227336	LOAN275ACBM20	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 54,492.82
14227386	LOAN275ACBF35	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 255,070.36
14228291	LOAN275ACBW30	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 255,070.36
14228308	LOAN275ACBM30	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 54,492.82
14228463	LOAN275ACBF75	REYROLLE	OIBR80 ACB TRANS	1969	10.49	£ 75,585.06
14228492	LOAN275ACBW70	REYROLLE	OIBR80 ACB TRANS	1969	10.69	£ 79,471.74
14230569	LOAN275ACBM70	REYROLLE	OIBR80 ACB TRANS	1969	10.59	£ 55,256.34
14230668	LOAN275ACBF85	REYROLLE	OIBR80 ACB TRANS	1969	10.69	£ 101,765.49
14230699	LOAN275ACBW80	REYROLLE	OIBR80 ACB TRANS	1969	10.69	£ 101,765.49
14230731	LOAN275ACBM80	REYROLLE	OIBR80 ACB TRANS	1969	10.69	£ 56,653.91
14230788	LOAN275ACBF45	REYROLLE	OIBR80 ACB TRANS	1968	10.44	£ 142,004.77
14231275	LOAN275ACBW40	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 145,615.52
14231589	LOAN275ACBL40	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 76,440.24
14231845	LOAN275ACBF65	REYROLLE	OIBR80 ACB TRANS	1968	10.44	£ 80,832.33
14231983	LOAN275ACBW60	REYROLLE	OIBR80 ACB TRANS	1968	10.54	£ 76,440.24
14232000	LOAN275ACBL60	REYROLLE	OIBR80 ACB TRANS	1968	10.44	£ 74,544.80

The remaining 2 off SF6 Circuit Breakers (ABB HPL300B2 type) in MSCDN bays have EoL modifier scores of 0.56 and are being considered for reuse without any intervention. Based on the condition assessment carried out, the associated non – lead assets located in the MSCDN bays are also being considered for reuse without any intervention.

Figure 2: OIBR80 circuit-breakers at Longannet 275kV substation

The associated rotating centre-post (RCP) disconnectors / Earth switches for the 18 off OIBR80 bays were also installed with their associated circuit-breakers and are of a unique design specific to Longannet 275kV. Spare parts for these special RCP Disconnectors are also not available readily in the market making it difficult to maintain these. Condition assessment of the associated 275kV disconnectors and earthing switches has shown that the mechanical components are at a level of deterioration where intervention is required and the electrical components are at the end of their serviceable life. A significant level of corrosion has also been observed on the operating mechanism and operating rods.

Due to the difficulties associated with sourcing spares for these uniquely designed disconnectors, and considering the high cost of any in-situ refurbishment it has been considered to replace all the RCP Disconnectors and earthing switches within all the options considered.

The current transformers (SF6 insulation) have also deteriorated with regular leaks detected. SF6 is a potent greenhouse gas with a global warming potential of approximately 23,500 TCO_2 e. In line with SP Transmission sustainability policy and considering the leakage history of these assets, it has been considered to replace these Current transformers for all the options considered.

A detailed site review and technical assessment of the condition of these non-lead assets has been carried out by SP Energy Networks as part of this project's development work and can be supplied as required. Recommendations from this report have been included within the options considered.

Series reactors R1 and R2 will have an EoL modifier score of 8.26 at end of RIIO T2 period, with a history of oil leakage and have been considered for refurbishment in the RIIO T2 period. Refurbishment of the reactors, along with respective Reactor bypass disconnector and refurbishment / replacement of any associated civil bund/structure would form part of a separate project (SPNLT 2063 Longannet series reactor refurbishment) but will be integrated and co-ordinated with this scheme for optimal efficiency and ease of deliverability.

The existing building is in poor state and requires a major intervention within the RIIO T2 period for its continual operation. There are ongoing issues with asbestos contamination, rain water entry, drainage etc. that would require to be addressed if the building is to be considered for reused for a further 40 year service life. The building refurbishment would also consider removal of all the glass panels and replace them back with cladding, along with upgrading the building services inside the building. Detailed condition assessment report for the building highlighting this issue is available for review with SP Energy Networks if required.

The ground around the existing substation sits in the flood plain of the adjacent Forth Estuary with a 1:1000 year flood level of 5.2 m AoD (Current ground level 4.55m AOD). The final option considered for this project will need to take this into account.

A range of different new innovative technologies have also been considered in detail and discussed within the options considered.

3 Optioneering

The following is a summary of the options considered for this project. The respective associated drawings for each of these options are available for review if required.

	Option	**Status**	**Reason for rejection**
Baseline	Do nothing in RIIO T2 period / intervention within RIIO T3 period. Scope of works similar to option 2.	Proposed	-
1	In situ AIS to AIS switchgear replacement of existing 18 off OIBR80 breakers	Proposed	-
2	Offline 275kV GIS build with SF6 GIBs - GIS located [redacted]	Proposed	-
3	Offline 275kV AIS build - AIS located [redacted]	Proposed	-
4	Offline 275kV GIS with SF6 *free* GIBs - GIS located [redacted]	Proposed	-
5	Offline 275kV GIS build - [redacted]	Rejected	[redacted] Also this site was adjacent to coal mine workings, gas tanks and gas pipelines resulting in additional project cost.
6	Offline 275kV AIS build [redacted]	Rejected	[redacted] Also this site was adjacent to coal mine workings, gas tanks and gas pipelines resulting in additional project costs.
7	Reconfigure transmission network so as to remove Longannet 275kV substation.	Rejected	Based on the current configuration of transmission network, removal of Longannet 275kV substation results in significant reduction in boundary capabilities. As per network development study carried out, a substantial investment in excess of the capital costs of competing options would be required in stages over multiple years to reinforce the network and restore the existing boundary capabilities.

8	Carry out in situ refurbishment of existing 18 off OIBR 80 circuit breakers	Rejected	As explained in SWG-05-105[1], Reyrolle OIBR80 275kV air blast circuit breakers now have numerous issues, which have to be considered when reviewing the continued serviceability of the circuit breaker. Many of the issues discussed in this document have the potential, if left unchecked, to end in a catastrophic failure of the circuit breaker. Further the circuit breaker suffers from several issues which lead to forced outages thereby impacting the wider MITS and exposes customers to unacceptable outage risks. With limited quantities of spares available from redundant bay Circuit Breakers any refurbishment activity will only reduce the risk value partly, leaving the network exposed to significant risks from Circuit Breaker failure at all times.

Based on the data collected from CBRM, site assessment and existing civil assets testing / analysis, the following 5 options have been identified for further investigation and have been reviewed in detail for the project scope:

- Baseline option: Do nothing in RIIO T2 period / intervention in RIIO T3 period. Scope of works similar to option 2 (Offline GIS build)
- Option 1: In situ replacement of existing switchgear – online build
- Option 2: 275kV GIS substation located [redacted]
- Option 3: 275kV AIS substation [redacted]
- Option 4: 275kV GIS substation with SF6 free GIBs located [redacted]

Brief description for option 7 (Removing Longannet 275kV substation from SPT network) along with issues associated has also been included in section 4 for reference.

[1] SWG-05-105 Operational issues with Reyrolle OIBR80 Air blast circuit-breaker

4 Detailed analysis

All the 5 options considered achieve the main objective of removing OIBR80 Circuit-Breakers while refurbishing or replacing non-lead assets and thereby reducing the overall risks to the network.

Following have been the key factors while reviewing the options involved:

- Staged approach with individual outages on different circuits at different times with the primary consideration of minimising network impact.
- For the option considering in-situ replacement – Issues associated with existing building along with future access-egress requirements after power station is demolished.
- For options involving relocation of substation - land purchase and planning permission for new substation and overhead line circuits
- All options consider reuse and (where required) relocation of existing MSCDN bay components (MSCDN and respective switchgear components).

For all the options where the substation is being relocated (Option 2 & 3) there are a number of factors which are specifically attributable to the site conditions at Longannet that need to be considered in context of specific costs for these projects. There is also a risk element for these factors that have been included in the Risk & Contingency costs for this project.

Please find below a summary of the options reviewed.

4.1 Baseline option: Do nothing in RIIO T2 period / intervention within RIIO T3 period (Scope of works similar to option 2)

As the scope of works for this option is exactly similar to option 2, a common description is included along with option 2 description. Kindly refer section 4.3.

4.2 Option 1: Insitu AIS replacement

In situ online AIS to AIS switchgear replacement within the existing building. The first bay (CLYM) would be constructed in the spare bay space available on one side of the building. This will be followed by staged demolition and construction of individual bays in a sequence, with the 9 diameter 1 ½ switch circuit arrangement being maintained.

Due to the condition of existing lead and non-lead assets within the substation, the following factors are to be considered which result in additional costs / additional construction timescales:

1. Refurbishment cost for existing building
2. Substantial scaffolding removal and installation works required for replacement of assets on the first floor. The repeated cycle of scaffolding removal and installation will have a major impact on overall timescales.
3. Repeated requirement of outages on adjacent circuits for disconnection of busbars and removal of equipment.
4. A 22 m high scaffold / working platform on the outside of building would be required for any works on the second floor. This will be an external platform which will need to be relocated for each bay works. This will also involve removal of glass panels with asbestos fibres from the building for accessing the second floor equipment.

5. As this option considers a staged approach for the replacement of each bay, individual control and protection cables would require to be disconnected in a staged manner. Due to the existing building infrastructure there is no space to install new trenches and any new cables would require to be installed in same trench. The existing cable trenches are completely full making it almost impossible to identify any cables for removal. Further, disturbing the existing cables may cause asbestos fibres located in trench walls to be released thereby presenting a significant health hazard. A specialist asbestos contractor would be required at each stage of cable removal. This would extend the construction timescale and impact the project cost.
6. The existing bay configuration on the ground floor has lifting beams located over the sections of Circuit breaker and CT. Clearance to these lifting beams have been designed considering the existing OIBR 80 air blast circuit breakers. Any new switchgear or plant equipment going in the same bay location would need to be designed considering this clearance distance. This required clearance from existing steel infrastructure is only available with ABB HPL300B2 Circuit Breaker limiting the competition at tendering stage.
7. To carry out any refurbishment on the building or for dismantling and installing new switchgear, scaffolding would require to be built in different areas of the substation. Based on their locations and for stages when long length objects require to be moved through the site in close proximity to live circuits, outages of varying durations would be required on the live circuit. For certain circuits like CLYM, EERH, DENN, WIYH-LAMB, KINC1 - KINC2, a double circuit outage of even a few hours can result in substantial constraint cost. This would also weaken the SPEN transmission network for a prolonged length of construction period and affect the boundary power flow capabilities resulting in continuous network constraint costs. A conservative value has been considered for the sake of this assessment which is subject to further review.

The total project impact from the above issues would be an additional £ 26.62m over the actual switchgear replacement works cost. The construction timescale would also be over 7 years which would have a significant impact on the transmission network capability. Further, continuous health and safety risks (Work at high level inside a building in close proximity to live circuits, asbestos contamination, risk of trip etc.) would require to be managed during the construction. The additional risks would result in extended construction timescales and project costs at each stage.

4.3 Option 2: Offline 275kV GIS substation located [redacted]

Note as the scope of works between option 2 and option 4 is exactly similar with the only difference being the use of SF6 free GIBs in option 4, a common description is included here.

These options consider an offline build of a new 275kV GIS substation located [redacted].

The new GIS substation would have a double busbar 13 bay configuration, with two sets of bus couplers at extreme ends of the busbar and a bus section bay.

The feeder configuration would remain exactly the same, with each of the twin circuits split across the different sides of the bus section.

Please note the following issues that result in an incremental cost for this option:

- Based on the location of this proposed option, WFIE and MOSM circuits would be the first to be diverted from old to new substation with the OHL rerouted. To maintain system security and power flow, fully rated interconnector would be required between the 275kV GIS and the existing 275kV AIS substation after this until the last circuit transfer. For this a temporary OHL circuit using between the two substations is proposed. This would require a temporary tower to be constructed, with one of the existing circuit breaker (DENN) at Longannet AIS substation having a T-connection on this short section of temporary OHL line.
- The proposed land for this substation sits in an area with high water level table requiring pilling for the building foundation.
- The area also sits in the flood plain of the adjacent Forth Estuary and so needs to be designed with flood defence measures. For this submission and related costing, raised platform has been considered for the GIS substation building. Respective line entry gantries, outdoor switchgear and associated GIB foundation / installation also require to be designed accordingly.
- As this is an industrial land located within the power station premises, [redacted]

Additional costs for the above issues have been included within the total costing of this project for this review.

4.4 Option 3: Offline 275kV AIS located [redacted]

This option considers an offline build of 13 bay 275kV substations outdoor AIS double busbar substation built [redacted].

Note the following in regards to the proposed substation build:

- [redacted]

Construction of the substation on this site is feasible and it is located away from locations which records indicate are coal mining areas although the flood defence and compensation measures results in significant costs being added. This would involve a detailed study of the water flow in the complete area with flood defence measures required to be installed over a large section around the proposed substation.

An indicative cost for this has been included for this although this will be revised after a detailed flood survey is carried out prior to project delivery.

4.5 Option 5: Offline 275kV GIS build - GIS located [redacted]

This was the preferred option in the previous issues of this paper (for the July and October business plan drafts), however further detailed examination has led to it being excluded through the shortlisting process.

[redacted] gas tanks, gas pipelines and historical coal mining activities. The mitigation measures necessary for the known mine workings and the risk costs attributable to the [redacted] would lead to increased project costs and diminish the favourability of this site. [redacted]

The review also considered the proposal submitted to the NOA process (please refer to section 7) for the extension of the uprating of existing 275kV circuits that would require Longannet to be constructed at 400kV. This site could not accommodate a 400kV substation (either AIS or GIS) and associated transformers and as such would not facilitate this reinforcement.

4.6 Option 7: Reconfiguring SP Energy Networks transmission network to check feasibility of removal of Longannet 275kV substation

Although this option has been rejected, details are included here to describe the reasons for rejection.

SP Energy Networks had undertaken a detailed study to explore the possibility of removing Longannet 275kV substation in totality and reconfiguring the transmission network with the objective of maintaining the required network capability

The study considered the following as part of the network reconfiguration:

- Reprofilling the East Coast circuits (ECU2 NOA project)
- Turning the Windyhill – Lambhill – Longannet circuit into Denny North 275kV substation. This will result in two separate circuits Windyhill – Lambhill – Denny North and Denny North – Longannet 275kV substation.
- West coast 400kV fault infeed reinforcement
- Hunterston- Neilston network reconfiguration NOA works
- 4 new bays are proposed at Denny North 275kV substation for diverting the ZC(S) and ZD circuits.

This was considered to be a multi staged option with different investment proposals linked to this option. Some of the major investment proposals as part of this option are as below:

- New 400kV DENN – CLYM connection with respective auto transformers
- Strathaven – Torness turn into Wishaw 400kV
- New 400kV /275kV Auto transformer at Windyhill

The results of this study show that without these extensive reinforcement works, there is a substantial reduction in the capability of boundary B5. The reconfiguration works mentioned here will take a number of years to restore the existing level of B5 boundary capability.

Based on the current configuration of transmission network, the removal of Longannet 275kV substation results in significant erosion of network capability. It is noted proposals for increasing the capability of boundary B5 from current levels have been recommended to proceed to the earliest in service dates by successive Network Options Assessment (NOA) reports.

Considering the implications of the consequential reductions in boundary capability and the costs to restore them, this option was ruled out and is not being pursued further.

The analysis report is available for review.

4.7 Specific factor attributable to additional costs:

Please find below a brief summary of specific issues that result in incremental cost in general across all options proposed for this project:

- Flood plain – Some areas of land around Longannet 275kV substation lie within the flood plain area of adjacent Firth of Forth where flood mitigation measures would be required.
- Ground conditions – Coal mining has been carried out in vicinity of existing substation which may require extensive ground remedial works to be carried out. The options have been based on 'Coal authority map', [redacted]
- Demolition of existing building – Indicative cost based on initial visual survey by demolition contractor has been included within respective options. Exact costs would be finalised after detailed demolition and asbestos surveys in all sections of existing building which would be carried out during project execution stage.
- [redacted]
- 275kV overhead line or 275kV cable temporary interconnector between old and new substations during staged circuit transformer
- MSCDN dismantling, relocation, installation and commissioning costs

4.8 Selected option

Please find below a cost and construction timescale summary of all the options reviewed:

	Baseline option - Works deferred to RIIO T3 period (Scope similar to option 2 but additional costs considered for ongoing building refurbishment/ maintenance till RIIO T3)	**Option 1 – In situ AIS replacement**	**Option 2 – GIS** [redacted]	**Option 3 – AIS** [redacted]	**Option 4 – GIS replacement (with SF6 free GIBs)** [redacted]
Cost (£K)	£ 80.84m	£ 79.53m	£ 68.58m	£ 74.01m	£ 69.29m
Construction timescales	3.5 years	7 years	3.5 years	3.5 years	3.5 years

Please also find below the NPVs calculated for each option from the CBA analysis:

Options	**Deferral**	**NPV (£m)**
Baseline	Baseline option - Works deferred to RIIO T3 period	- £ 3.57
1	In situ AIS replacement	£ 0.12
2	GIS replacement [redacted]	£ 6.04
3	AIS replacement [redacted]	£ 5.49
4	GIS replacement with SF6 free GIBs adjacent to existing substation	£ 9.91

Based on the results of CBA, and considering SP Energy Networks commitment to sustainability, option 4 (GIS replacement with SF6 free GIBs adjacent to existing substation) is the preferred option.

Note that the 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 from the design layouts 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.

4.9 Sustainability

This option removes the existing 275kV oil filled cable within existing Longannet 275kV substation.

The final preferred option also includes removal of 104 off 275kV SF6 CTs from the network resulting in significant reduction of SF6 on the network.

4.10 Innovation

The following innovative scheme has been reviewed in detail for the purpose of the preferred GIS option 2:

Serial No.	Description	Associated Project(s)	Conclusion
1.2.2.2	Future Intelligent Transmission Network Substation (FITNESS)	SPTEN02	To be included in scheme development

4.10.1 Innovation Option 1.2.2.2 Future Intelligent Transmission Network Substation (FITNESS)

Use of digital substation technology is deemed feasible for this option and would be explored in further detail during project development stage

5 Conclusion

The primary objective of removing the OIBR80 circuit breakers from the network and thereby reducing the network risks are being achieved in all the options selected.

Please find below a summary of each option and main issues associated with it.

Option 7 is distinctly different from the other conventional options proposed as it relates to reconfiguration of the transmission network and removing the risks associated with these assets completely. However the substantial reduction in B5 boundary flow capability for a prolonged period outweighs any potential cost savings possible from this option.

Option 1 (In situ replacement) has inherent costs associated with issues related to construction in existing building. Further, the primary issue of managing the condition of the OIBR circuit-breakers is not fully addressed in this option due to the time taken to remove the assets from service. It should be anticipated that some reactive investment would be required prior to the completion of the works due to the increasing unreliability of the switchgear.

Option 3 is located within a flood plain greater than 1m and so would require substantial flood defence and compensation measures in and around the proposed compound.

Option 2 and 4 considers GIS solutions [redacted]

CBA analysis undertaken indicates Option 4 as the option with highest NPV. Further this also proposes use of SF6 free GIB solution which is in line with SP Energy Networks environmental and sustainability commitments.

In line with the costs prepared, the proposed scope of works and CBA analysis, option 4 (Offline 275kV GIS with SF6 free GIBs located [redacted]) is the selected option

- Forecast costs: £ 69.29m.
- Delivery year: 2026
- Declared outputs: Addition – 13 units / Removal – 18 units
- Long term risk benefit: Lr£74.12m

6 400kV upgrade works requirement at Longannet 275kV substation

6.1 Background:

As mentioned in the NOA 'Eastern B4 400kV reinforcement', the increasing levels of power flows expected over B4 following planned B4 boundary upgrades have led to a requirement to upgrade the existing 275kV circuits over B4 to 400kV. This helps in accommodating the additional power flow over B4. This is also reiterated by NOA4's national recommendations for B4 boundary reinforcement beyond existing reinforcement projects.

In line with this proposal, under this NOA it is proposed to upgrade a significant no. of circuits along with transmission substations in SPT license area to 400kV.

Please find below the single line diagrams showing the planned 400kV upgrades:

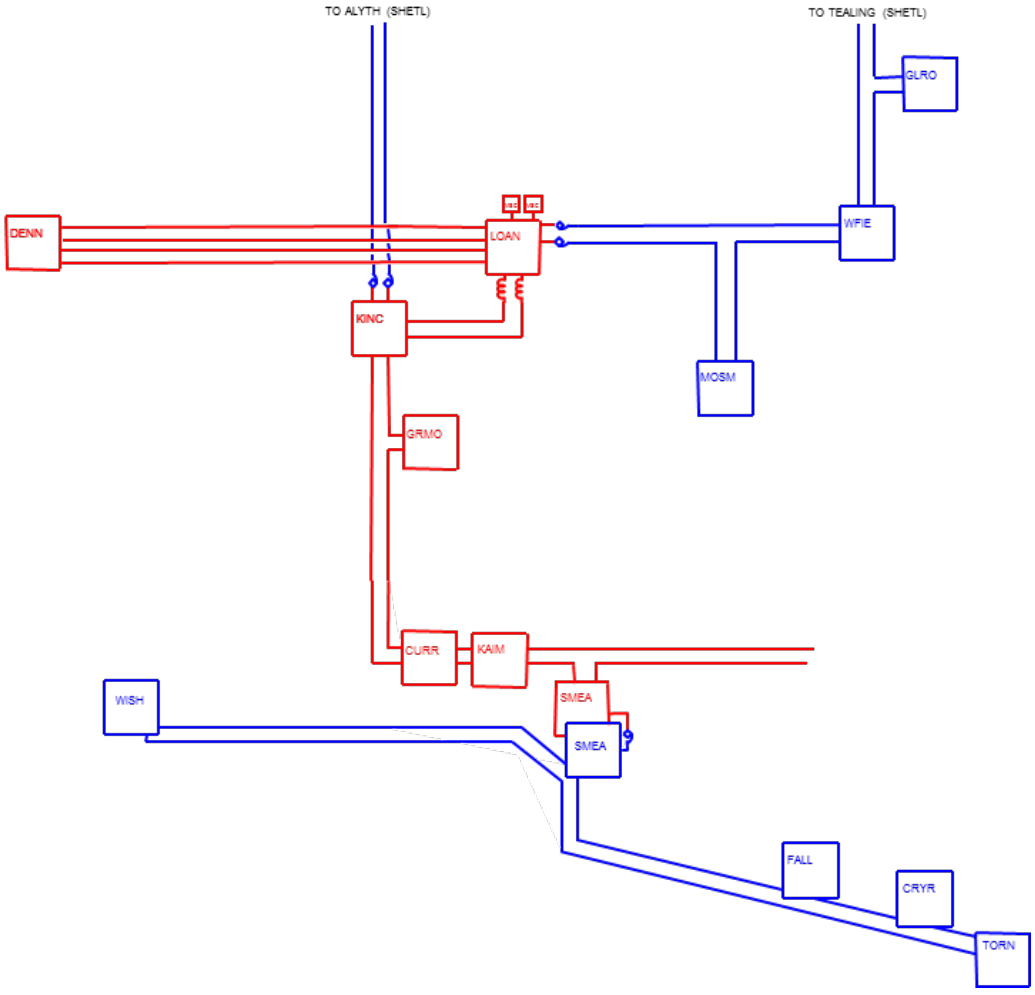


Figure 1: Indicative Single line Diagram - SHET/SPT Border to 400kV circuits between Wishaw and Torness (pre-HARB) (400kV circuits shown in blue / 275kV circuits in red)

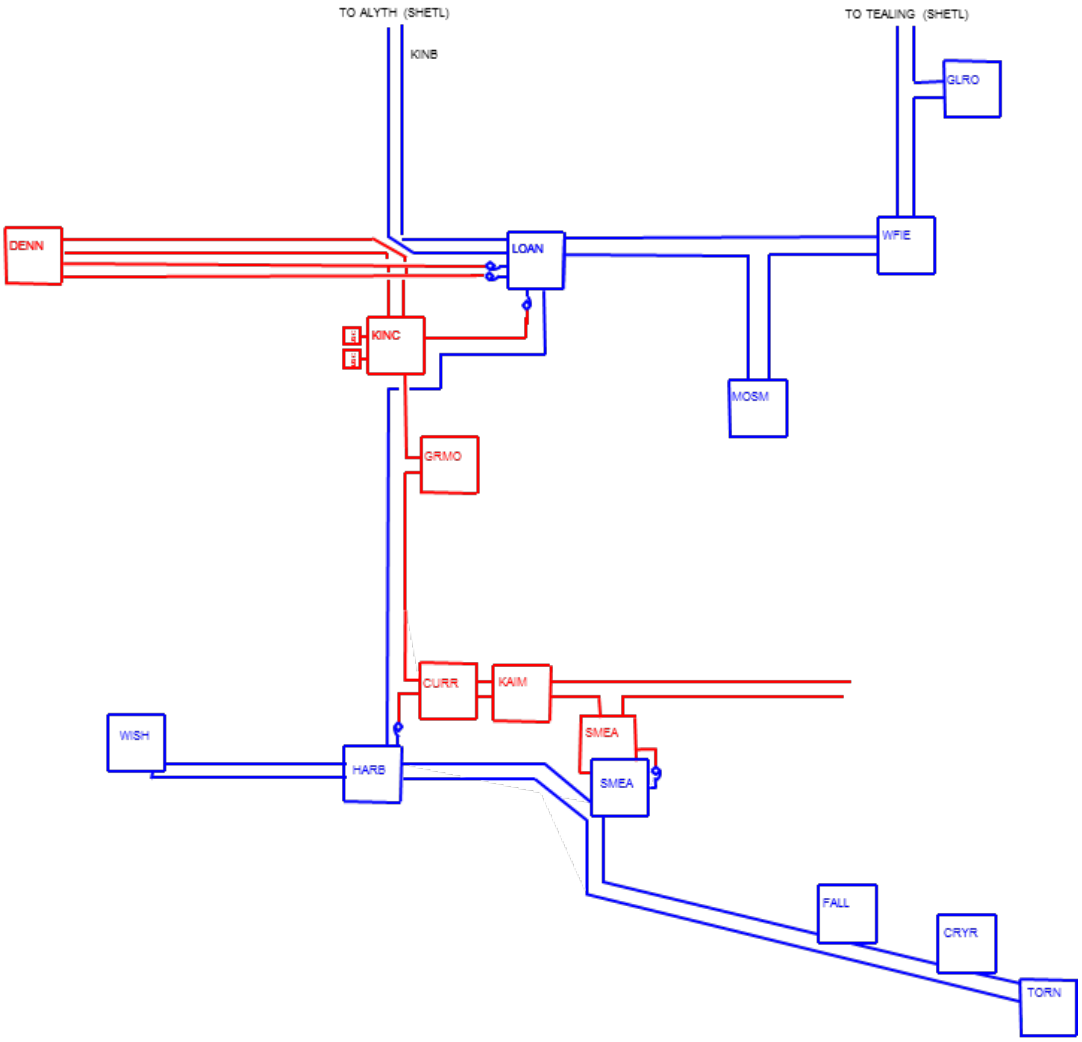


Figure 2: Indicative Single line Diagram - SHET/SPT Border to 400kV circuits between Wishaw and Torness (post-Harburn 400kV substation - 400kV circuits shown in blue / 275kV circuits in red)

As can be seen in the diagram, Longannet 275kV substation is proposed to be fully upgraded to a 400kV substation with significant changes to the circuit entry / feeder configurations as well. Further the development needs to be reviewed in context of a number of significant reinforcement schemes in vicinity of Longannet substation on the transmission network which will have an impact on development of Longannet.

6.2 Longannet 400kV substation

The Eastern boundary B4 400kV reinforcements are currently proposed with an EISD of 2030. This will mean that if the works proposed under the 275kV switchgear replacement are completed as planned in 2026, then the same substation would immediately require to be upgraded to 400kV substation for the NOA works.

As uprating a 275kV GIS to 400kV is not possible, it is proposed to build a 400kV GIS instead subject to approval of the NOA scheme as required.

Please find below the main features for this 400kV GIS substation:

- This will be a 14 bay 400kV GIS substation built in the same location as the proposed option 2 for 275kV solution (adjacent to existing substation building).
- Once completed, the GIS will be initially operated at 275kV at end of RIIO T2 and will be sequentially upgraded to 400kV substation in stages.
- The substation will comprise of the 8 existing feeder circuits, 2 off MSCDN bays, 2 off bus couplers and 2 off Bus section circuit breakers (on both main and reserve busbars). Considering this substation will have 4 off interconnectors from SHETL and vital transmission connections within SP Transmission network once the NOA works are complete, the 2 off bus couplers / 2 off Bus section CBs are included for maintaining a high level of system stability / security at this critical site.
- Exact details for the upgrade works of 275kV GIS to a 400kV GIS would be confirmed after exact particulars of the NOA scheme and other related transmission schemes are known.

6.3 Optioneering

Various network reconfiguration option have already been reviewed as part of the NOA process, and the 400kV upgrade works proposed here are deemed to be the most efficient option technically and commercially.

6.4 Costs

As per a high level initial estimate completed, the total cost for a 400kV rebuild would £ 98.37 m. (Incremental cost of £ 29.08 m over the 275kV rebuild option spread over the same delivery years).

This will be reviewed in further detail once the exact particulars of the NOA scheme are known in certainty.

7 Uncertainty

Note that considering the uncertainties associated with land purchase, planning permission and S37 consents along with the uncertainties around future 400kV development work planned under NOA ‘Eastern B5 400kV reinforcement’, this project is being proposed as a Price Control Deliverable for the RIIO T2 business plan.

It is proposed that the costs are excluded from baseline allowances and that a trigger mechanism is implemented. This would allow the required allowances to be applied when there is an appropriate degree of certainty of timing of the works.

8 Future Pathways – Net Zero

8.1 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.

8.2 Payback Periods

The CBA carried out for 275kV option indicates that a positive NPV results in all assessment periods (10, 20, 30 & 45 years) except the baseline option, which is consistent with the lifetime of the intervention.

Consumers benefit from reduced network risk immediately on completion of the project.

CBA has not been completed for 400kV works as the NOA process has already determined the most commercially feasible option.

8.3 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 options are consistent with the site-specific capacity requirements from SPT's Energy Scenarios.

8.4 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.

8.5 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.

8.6 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.

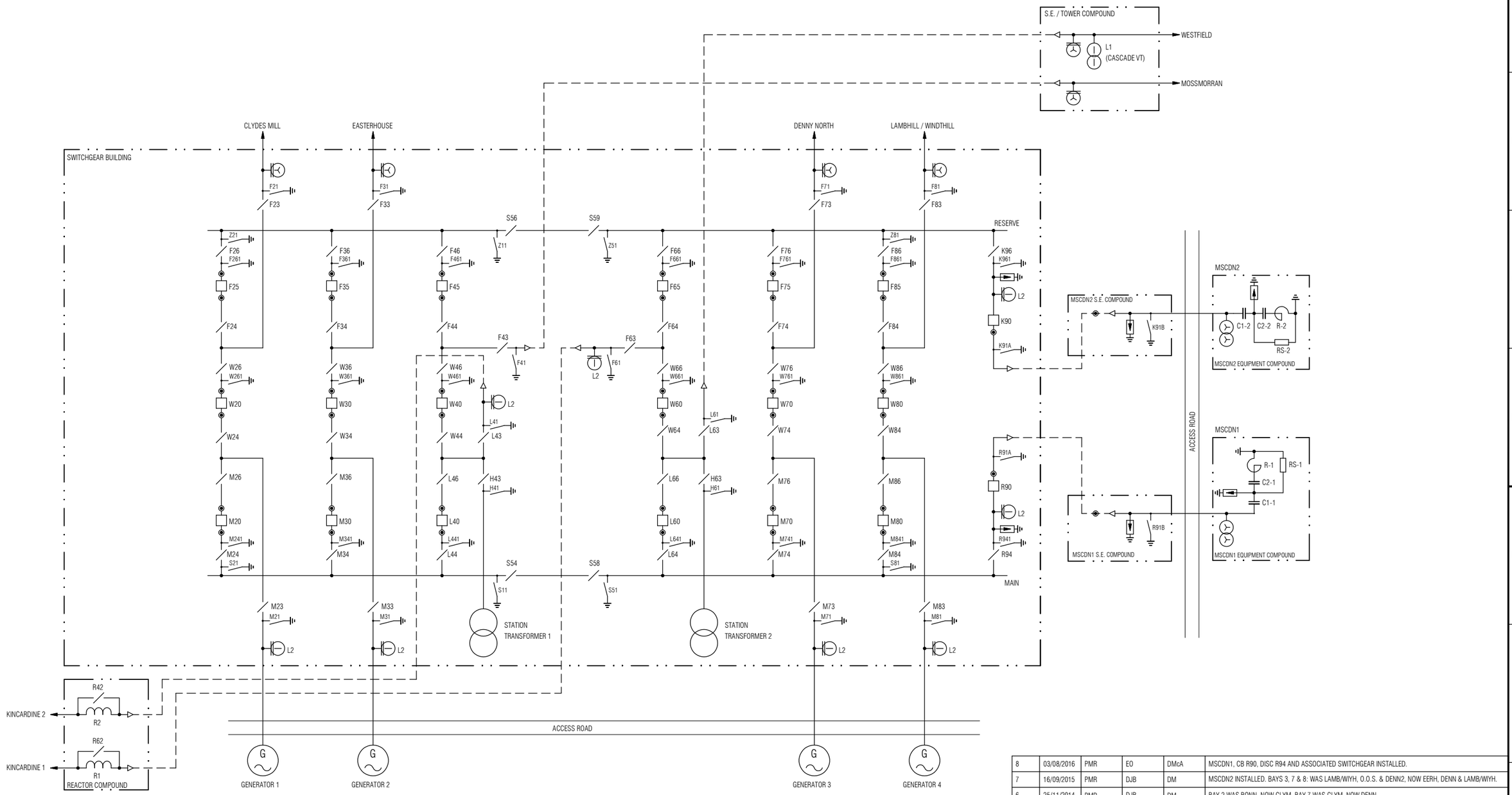
8.7 Whole Systems Benefits

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.

9 Outputs included in RIIO T1 Plans

N/A

10 Appendix: Drawings



Rev	Date	Drawn	Reviewed	Approved	Description of Change
8	03/08/2016	PMR	EO	DMcA	MSCDN1, CB R90, DISC R94 AND ASSOCIATED SWITCHGEAR INSTALLED.
7	16/09/2015	PMR	DJB	DM	MSCDN2 INSTALLED. BAYS 3, 7 & 8: WAS LAMB/WIYH, O.O.S. & DENN2, NOW EERH, DENN & LAMB/WIYH.
6	25/11/2014	PMR	DJB	DM	BAY 2 WAS BONN, NOW CLYM. BAY 7 WAS CLYM, NOW DENN.
5	26/11/2010	PMR	DJB	AMACL	Rev. 5
0					

SP ENERGY NETWORKS

Drawing State: Approved

Approval Status: For Issue

Project:

Location: LONGANNET

Voltage: 275KV

Drg. Title: SWITCHGEAR NUMBERING FOR LONGANNET 275KV SUBSTATION GSN91(B)

Drawn	Rev'd	App'd
PMR	EO	DMcA

Drg. No.: SP2070173

Sheet: –

Next: –

Rev: 8

Scale: NTS

Size: A2