January 2026

Powerlink 2027-32 Revenue Proposal

Project Pack

CP.02919 Broadsound Primary Plant Replacement

Project Status: Stage 1 Approved

Network Requirement

The Broadsound 275kV Substation was commissioned in 1983 and is a critical node in Powerlink Queensland's 275kV transmission network between Central Queensland and North Queensland. Staged expansion has occurred since this time to provide additional 275kV feeders to the west, south and north and more recently, with the addition of a new bus reactor and renewable generation connections. The substation now comprises 10 275kV feeder bays in a breaker-and-a-half layout, as well as two 275kV line reactors a 275kV bus reactor.

The primary plant from the original substation construction is now over 40 years old and requires selective replacement. A number of instrument transformers are oil filled and in porcelain housing and due to their age, now have an increased probability of explosive failures with catastrophic safety consequences. Circuit breakers are also approaching end of life and maintenance records show a history of maloperations and SF6 leaks. In addition, a number of capacitive voltage transformers are of a type known for their high 'mid-life' failure rate, leading to unplanned outages and negatively affecting the reliability of the network [1].

The oil separation tank for the line reactors is an old open type tank and in the event that oil enters the containment system the water discharge quality is unlikely to comply with Powerlink's requirements.

Powerlink's 2025 Central scenario load forecasts confirm an enduring need for an ongoing supply of bulk electricity to the Lilyvale 275kV substation and the surrounding 132kV region. In addition, there is an enduring need for a 275kV switching substation between the Central and North Queensland zones to maintain power transfer capability.

The removal or reconfiguration of the Broadsound Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact the power transfer capability between central and north Queensland [2].

Recommended Option

As this project is currently 'Not Approved', project need and options will be subjected to the public RIT-T consultation process to identify the preferred option closer to the time of investment. The objective is to address the asset condition issues identified with the originally installed primary plant.

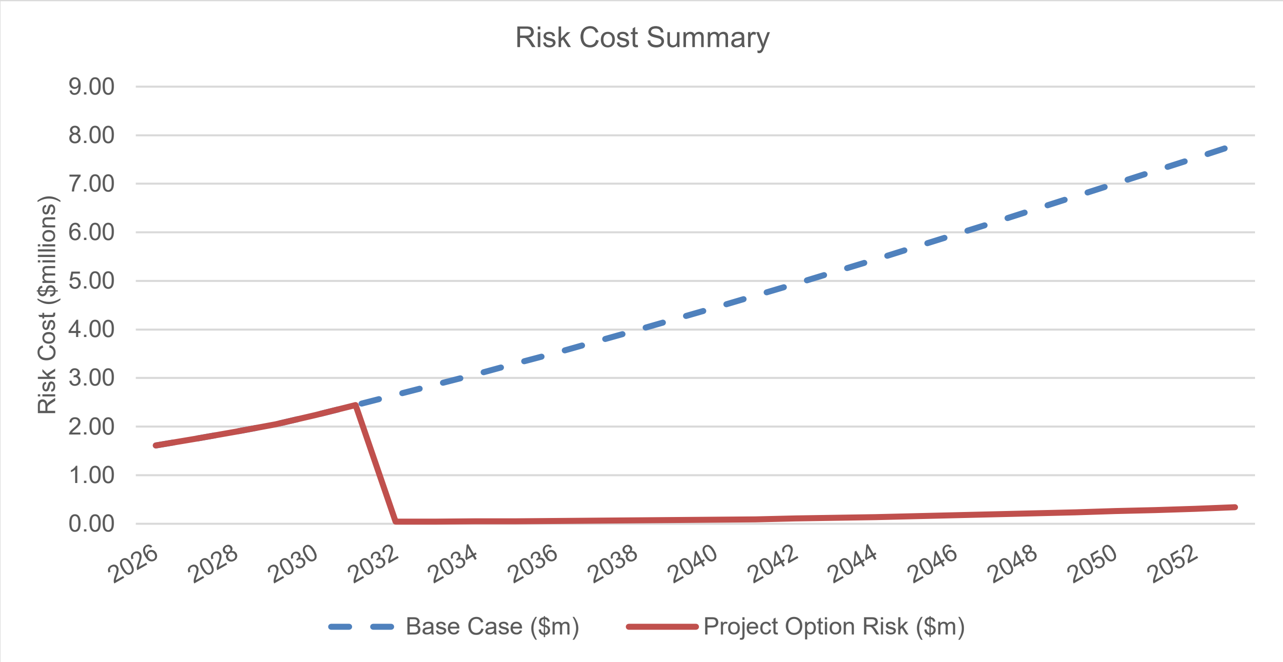
The current recommended option involves the replacement of selected 275kV primary plant and replacement of the existing oil separation system for the 275kV line reactors by October 2030 [3].

Options considered but not proposed include:

- Do Nothing – rejected due to non-compliance with reliability obligations;
- Full primary plant replacement – expected to be greater overall cost; and
- Non-network option – no viable non-network options have been identified at this time.

Figure 1 shows the current recommended option reduces the forecast risk monetisation profile of the Broadsound Substation primary plant from around $2.44 million per annum in 2031 to less than $0.05 million from 2032 [4].

Figure 1



Cost and Timing

The estimated cost to replace selected 275kV primary plant is $14.5 million ($2025/26) [5].

Target Commissioning Date: October 2030.

Documents in CP.02919 Project Pack

Public Documents

1. H020 Broadsound Condition Assessment Report
2. CP.02919 Broadsound Selective Primary Plant Replacement – Planning Statement
3. CP.02919 Broadsound Selective Primary Plant Replacement – Project Scope Report
4. CP.02919 Broadsound Selective Primary Plant Replacement – Risk Cost Summary Report
5. CP.02919 Broadsound Primary Plant Replacement – Concept Estimate

H020 BroadSound Substation
Primary Plant Condition Assesment Report

Report requested by:	[redacted]	**Request Date:**	01/02/2019
Report Prepared by:	[redacted]	**Date of site visit:**	14/08/2019
AUTHOR/S:	[redacted]		
Report Approved by: **Report Approval Date:**	[redacted]	**Report Approval Date:**	18/12/2019
Report Reviewed by: **Report Approval Date:**	[redacted]	**Review Date:**	14/12/2019
Issue Approved by: **Report Approval Date:**	[redacted]	**Issue Date:**	20/12/2019

Date	Version	Objective ID	Nature of Change	Author	Authorisation
30/11/2025	2	A6013525	Desktop Update	[redacted]	[redacted]

Note: *Where indicator symbol ☼# is used (# referring to version number) it indicates a change/addition was introduced to that specific point in the document. If the indicator symbol ☼# is used in a section heading it means the whole section was added/changed.*

IMPORTANT: - The condition assessment report provides an overview of the condition of all structures and equipment (excluding protection relays, control systems and telecommunication equipment)as stated in the scope and high level recommendations for their timely replacement. As it is snapshot in time and subject to the accuracy of prediction methodology, it is valid for 3 years form site visit date stated above.

Contents

EXECUTIVE SUMMARY

This report provides an overview of the condition of the Powerlink owned high voltage equipment at H020 Broadsound substation, as per defined scope below. The report is intended to identify asset condition triggers requiring intervention in a way of refurbishment or replacement of high voltage substation equipment, their supporting structures and associated substation infrastructure. The report may contain some recommendations and suggestions triggering condition based or corrective maintenance activities.

The assessment has been formulated based on the data extracted from computerised maintenance management system (SAP) including notifications and work orders, dissolved gas analysis (DGA) and other test and measurement results, equipment age information combined with available photos, historical data analysis and site inspection.

The summary of recommendations is contained in Table 17 presented in Section 3 of this report.

1. INTRODUCTION

This condition assessment is based on information acquired through site visit conducted on 08/12/2020, available design data and drawings, updated SAP data (May 2025) and the civil condition assessment report dated 15/02/2021 (Objective Id. A4628548).

1.1 System information

Broadsound substation is a 275kV transmission substation located in the Central Queensland. The substation was established in 1983. Further additions have been made with major additions to provide additional 275kV feeders to the west, south and north.

H020 Broadsound substation consists of two 275 kV busbars, two 275kV line reactor bays, nine 275 kV feeder bays and six 275 kV bus coupler bays. It has three oil filled line reactors (24MVA, 35 MVA and 150 MVA).

[redacted]

Figure 1- Single Line Diagram of Site (2024)

Photo 1: Aerial Photograph of H020 Broadsound Substation

[redacted]

Figure 2-H020 Broadsound General Arrangement

Figure 3-Overview of Broadsound HV Supply Network

1.2 Asset age

Broadsound 275kV substation was established in the mid-1980s, with equipment replacements as detailed below.

Upgrades undertaken at this site by Powerlink in the last 20 years include:

- CP.01186 275kV feeder 8846 to Nebo in 2008
- CP.00384 275kV feeder 850 to Lilyvale in 2004
- CP.01292 Broadsound Secondary system upgrade in 2011
- CP.02715 Clarke Creek Wind Farm Connection in 2024
- CP.02827 H020 Broadsound 275 kV Bus Reactor 2024
- CP.02924 Broadsound Energy Park connection 2025

Apart from the above additions or replacements all other originally installed equipment is still in service and is now 36 years old.

1.3 Ratings

The highest fault levels calculated in May 2025 are:

- 275 kV Line to Ground- 15.75 kA
- 275 kV 3 Phase-15.30 kA

Below table provides overview of continuous current and fault current ratings of all 275kV bays in Broadsound substation, incl. recommendations.

Table 1-- Broadsound Bay Ratings

Functional Loc.	Description	Start-up date	Bay Continuous Rating	Bay Fault Current Rating	Fault Current Period	Comments on rating
H020-C01-501	275kV 1 COUPLER BAY	01/07/1988	2500A	31.5kA	1.0s	Limiting ratio set at 1200A
H020-C01-833	833 FEEDER BAY	01/07/1988	1250A	31.5kA	1.0s	Limiting ratio set at 1200A
H020-C01-856	856 FEEDER BAY	01/07/1984	2500A	31.5kA	1.0s	Limiting ratio set at 1600A
H020-C02-502	275kV 2 COUPLER BAY	01/07/1984	2400A	31.5kA	1.0s	Limiting ratio set at 2400A
H020-C02-820	820 FEEDER BAY	01/07/1984	2500A	31.5kA	1.0s	Limiting ratio set at 1600A
H020-C02-834	834 FEEDER BAY	01/07/1983	2500A	31.5kA	1.0s	Limiting ratio set at 1600A
H020-C03-503	275kV 3 COUPLER BAY	30/07/2001	2500A	40kA	1.0s	Limiting ratio set at 3000A
H020-C03-8831	8831 FEEDER BAY	16/08/2002	2500A	40kA	1.0s	Limiting ratio set at 1600A

H020-C03-8847	8847 FEEDER BAY	12/10/1995	2500A	40kA	1.0s	Limiting ratio set at 2400A
H020-C04-504	275kV 4 COUPLER BAY	21/02/2008	2500A	31.5kA	1.0s	Limiting ratio set at 2400A
H020-C04-593	SPARE 3 FEEDER BAY	21/02/2008	2500A	31.5kA	1.0s	Standard Bay rating
H020-C043-8846	8846 FEEDER BAY	21/02/2008	2500A	40kA	1.0s	Limiting ratio set at 2400A
H020-C05-571	2 BUS 1 REACTOR 275KV BAY	04.06.2024				Limiting ratio set at 400A
H020-C06-506	275kV 6 COUPLER BAY	22.02.2024				
H020-C06-8924	8924 FEEDER BAY	15.02.2024	2,630 A	40kA	1.0s	Limiting ratio set at 400A
H020-C06-8925	8925 FEEDER BAY	15.02.2024	2,630 A	40kA	1.0s	Limiting ratio set at 1600A
H020-C51-500	275kV 0 COUPLER BAY	08/10/2004	2500A	40kA	1.0s	Standard Bay rating
H020-C51-850	850 FEEDER BAY	08/10/2004	2500A	40kA	1.0s	Limiting ratio set at 800A
H020-C51-8934	8934 FEEDER BAY	19.08.2025	2500	40KA	1.0s	Standard Bay rating
H020-C51-BLF	SPARE 275kV FEEDER BAY	08/10/2004	2500A	40kA	1.0s	Standard Bay rating
H020-KC--KC1-H020-KC1-1BUS	275 KV 1 BUS	05/07/1999	3,271 A	40kA-	1.0s-	Less than Standard rating of 4000A
H020-KC--KC2-	275 kV 2 BUS	05.07.1999	3,271 A	40kA	1.0s	Less than Standard rating of 4000A
H020-M01-1REA	856 REACTOR1 REACTOR	13/10/1995	-	-	-	
H020-M02-2REA	820 REACTOR2 REACTOR	30/07/1998	-	-	-	
H020-M03-3REA	1 REACTOR	04.06.2024				

The fault rating of some listed bays are rated for 31.5 kA are below the current substation fault level rating. The further fault level contribution calculations are required to determine if these are underrated for all network configuration or only for some, but in any case the upgrade of these bays should be considered or substation configuration modified accordingly

1.4 Scope of Site Condition Assessment

The site condition assessment is restricted to Powerlink owned high voltage equipment and associated support structure and site infrastructure at H020 Broadsound substation with the **exclusion** of:

- Protection and control systems which are subject to the separate condition assessment report.
- Reactors (Their condition is detailed in another specific condition assessment report).
- 275KV substation plant listed below which are relaviely new and has been in service less than 20 years.

Table 2- Overview of 275 kV bays replacements.

Functional Loc.	Description	Equipment's Replacement Details	Start-up date
H020-C04-504	275kV 4 COUPLER BAY	New bay installed under project CP.01186	21/02/2008
H020-C04-593	SPARE 3 FEEDER BAY	New bay installed under project CP.01186	21/02/2008
H020-C04-8846	8847 FEEDER BAY	New bay installed under project CP.01186	21/02/2008
H020-C06-506	275kV 6 COUPLER BAY	New bay installed under project CP.02715	22.02.2024
H020-C51-8934	8934 FEEDER BAY	New bay installed under project CP.02924	19.08.2025
H020-C06-8924	8924 FEEDER BAY	New bay installed under project CP.02715	15.02.2024
H020-C06-8925	8925 FEEDER BAY	New bay installed under project CP.02715	15.02.2024
H020-C05-571	2 BUS 1 REACTOR 275KV BAY	New bay installed under project CP.02827	04.06.2024
H020-M03-3REA	1 REACTOR	New bay installed under project CP.02827	04.06.2024

2. CONDITION ASSESSMENT

2.1 Buildings

The control building +1 was established in 1984 and is 41 years old. The building was constructed on a concrete slab with concrete brick walls and a steel roof. The building is in good condition and if maintained it could provide an adequate service for a number of decades 275kV protection and control panels for Bay C051 and half of Bay C04 and telecommunication devices and their associated accessories are located in this building.

Figure 4 - Control Building +1

The building wall was stained at the water tank connection as shown in Figure 5. Based on the stain it is likely that there is a leak from the connecting pipe. The leak should be investigated and fixed to prevent further damage. This building has a remaining service life of 20+ years.

Figure 5: Building +1 Water Leak

Figure 6 - Control Building +7

Control building +2 is a demountable building housing SDM8 generation control equipment for 275 kV equipment. The building was established in around 2011. The building is basically in as new condition as expected considering its age.

2.2 275 kV Switching bays

2.2.1 H020 - C01- 501 – 275kV 1 Coupler Bay

The equipment for this bay is listed Table 3 including their health indices.

This bay was built in 1985, with most original equipment still in service and 40 years old.

Table 3-Bay 501 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C01-501--5010-1	EARTH SWITCH	VSB	1/07/1977	MORLYNN POWER	20011007	6
H020-C01-501--5010-2	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011008	6
H020-C01-501--5012	CIRCUIT BREAKER	HPL300/25B1 SPAR P	13/09/1988	ASEA	20004953	7
H020-C01-501--5012CTA	CURRENT TRANSFORMER	IMB300C6H4	12/03/2010	ABB AUSTRALIA	20063601	4
H020-C01-501--5012CTB	CURRENT TRANSFORMER	IMB300C6H4	12/03/2010	ABB AUSTRALIA	20063602	4
H020-C01-501--5012CTC	CURRENT TRANSFORMER	TG300	19/11/2020	ABB	20128022	2
H020-C01-501--5018	ISOLATOR	DR	1/07/1985	EGIC	20004984	6
H020-C01-501--5019	ISOLATOR	HCB	12/01/1989	MORLYNN POWER	20004989	6

The C phase CT in this bay were replaced in 2020 with SF6 CT and the previous CT which was ABB model 345259 300 kV CTs had been identified as presenting an unacceptable risk of explosive failure due to asset condition. A&B phase CTs were replaced in 2008 with oil filled CTs as the previous CTs were Tyree 275kV post type dead tank CTs that had unreliable internal high voltage primary insulation. [redacted] The maintenance records show that both the disconnector has Grade 2 corrosion and these should be rectified during the next periodic service.

The circuit breaker in this bay is ABB HPL300/25B1 manufactured in 1988 and installed in the same year. It has motor operated spring closing mechanism of type BLG. This circuit breaker is permanently filled with SF6 gas normally at a pressure of 0.5Mpa. These are C1 & M1 class and is rated for only 2000 operations. Powerlink has Installed 72 of these CBs in its network and presently 40 of them are in service and 32 breakers have been removed from service, mainly due to failures at various ages ranging from 23 to 32 years . At Powerlink these fleet of ABB HPL300/25B1 CBs has known issues of SF6ngas leaks due to the corrosion of aluminium flanges and associated O-ring grooves within the breakers and it also that there were cracks in the collars of operating rods which occurred due to design and manufacture faults in the rod itself, in particular in the use of pressed aluminium couplings. In addition to these since this CB is class C1 and has a probability of restrike failure due to its age.

This CB 5012 is 37 years old and is in satisfactory condition. Maintenance records show issues with this breaker due to aging and B phase has SF6 leaks. This CB has been operated 5441 times. The CB operating times are within the allowable limit. Based on known issues associated with this type of CB mentioned above and its current condition, it is expected that the condition of this CB will deteriorate over time. Based on these observations it is recommended to replace this CB in the next 5 years.

The associated structures and foundations in this bay have a remaining service life of 20 years.

Recommendation: Based on the above observations it is recommended to replace CB5012 in the next 5 years, rest of the primary plant in this bay is in good condition and no replacements are recommended in the next 10 year outlook.

Failure of this coupler CB5012 will cause issues with load transfer and reduced operational flexibility for maintenance and switching operations.

2.2.2 H020-C01-833- 275kV 833 Feeder Bay

The equipment for this bay is listed in Table 4 , including their health indices.

This bay was built in 1988, with most of the original equipment still in service and 33 years old.

Table 4- Bay 833 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C01-833--17VTA	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	2/09/2012	TRENCH LIMITED	20072079	3
H020-C01-833--17VTB	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	1/07/1988	HAEFELY	20005027	6
H020-C01-833--17VTC	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	2/09/2012	TRENCH LIMITED	20072080	3
H020-C01-833--8330	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011018	5
H020-C01-833--8330-1	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011019	6
H020-C01-833--8330-2	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011020	6
H020-C01-833--8330-3	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011021	5
H020-C01-833--8331	ISOLATOR	DR	1/07/1985	EGIC	20004990	6
H020-C01-833--8332	CIRCUIT BREAKER	HPL300/25B1 SPAR P	1/07/1985	ASEA	20004955	6
H020-C01-833--8332CTA	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004973	6
H020-C01-833--8332CTB	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004968	6
H020-C01-833--8332CTC	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004961	6
H020-C01-833--8333	ISOLATOR	DR	1/07/1985	EGIC	20004991	6
H020-C01-833--8337	ISOLATOR	DR	1/07/1985	EGIC	20004992	5
H020-C01-833--833SAA	SURGE ARRESTOR (GAPLESS)	ZSE-C2Z	1/01/1984	MEIDENSHA	20005008	7
H020-C01-833--833SAB	SURGE ARRESTOR (GAPLESS)	ZSE-C2Z	1/01/1984	MEIDENSHA	20005007	7
H020-C01-833--833SAC	SURGE ARRESTOR (GAPLESS)	ZSE-C2Z	1/01/1984	MEIDENSHA	20005006	7

A & C phase CVTs were replaced under CP.01292 to remove the Line Traps in 2011. CTs are original and maintenance records show no major issues and DGA analysis are satisfactory. These CTs are oil filled and in porcelain housing and have increased trend of explosive failures with catastrophic safety consequences after 37 years in service. It is recommended that all CTs and B phase CVT be replaced within 3-5 years.

The circuit breaker 8332 in this bay is ABB HPL300/25B1 manufactured in 1985 and installed in the same year. This CB is similar to CB5012 and all its circumstances explained in section 2.2.1 is applicable to CB 8332 as well. This CB is 36 years old and is in satisfactory condition considering its age. Maintenance records show that there are SF6 leaks from the top seals and has been topped up with 2.9kg of SF6 gas. The CB operating times are within the allowable limit. This CB has failed to operate once while in service. Based on these observations it is recommended to replace the CB in 3-5 years.

The Surge arrestors are of Meidensha make and in porcelain housing and is in service for last 37 years and it is recommended to replace these with a polymer housed SAs.

The maintenance records show that both the disconnector has corrosion and these should be rectified during the next periodic service.

The associated structures and foundations in this bay have a remaining service life of 20 years,

Recommendation: In summary, it is recommended that the B phase CVT, the CTs, SAs and the CB 8332 be replaced in 3 to 5 years including their structures and foundations.

2.2.3 H020-C01-856- 275kV 856 Feeder Bay

The equipment for this bay is listed in Table 5, including their health indices.

This bay was built in 1988, with most of the original equipment still in service and 37 years old.

Table 5-Bay 856 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C01-856--18VTA	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	20/07/2018	TRENCH LIMITED	20072082	3
H020-C01-856--18VTB	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	20/07/2018	TRENCH LIMITED	20070811	3
H020-C01-856--18VTC	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	20/07/2018	TRENCH LIMITED	20072081	3
H020-C01-856--8560	EARTH SWITCH	VSB	5/07/1999	MORLYNN POWER	20011030	4
H020-C01-856--8560-1	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011031	6
H020-C01-856--8560-2	EARTH SWITCH	VSB	1/07/1977	MORLYNN POWER	20011032	6
H020-C01-856--8560-3	EARTH SWITCH	VSB	1/07/1977	MORLYNN POWER	20011033	6

H020-C01-856--8560-4	EARTH SWITCH	VSB	1/07/1977	MORLYNN POWER	20011034	6
H020-C01-856--8561	ISOLATOR	HCB	12/01/1989	MORLYNN POWER	20004979	7
H020-C01-856--8562	CIRCUIT BREAKER	HPL300/25B1 SPAR P	12/01/1989	ASEA	20004956	7
H020-C01-856--8562-1	CIRCUIT BREAKER (SF6 SPRING MultiVol)	HPL300B1 SPAR	1/11/2024	ABB, SWEDEN	20085354	3
H020-C01-856--8562CTA	CURRENT TRANSFORMER	IOSK300/1050	10/01/1989	HAEFELY	20004967	6
H020-C01-856--8562CTB	CURRENT TRANSFORMER	IOSK300/1050	10/01/1989	HAEFELY	20004966	6
H020-C01-856--8562CTC	CURRENT TRANSFORMER	IOSK300/1050	10/01/1989	HAEFELY	20012040	6
H020-C01-856--8563	ISOLATOR	DR	1/07/1985	EGIC	20004981	7
H020-C01-856--8567	ISOLATOR	HCB	12/01/1989	MORLYNN POWER	20012202	6
H020-C01-856--8569	ISOLATOR	HCB	12/01/1989	MORLYNN POWER	20004980	6
H020-C01-856--856SAA	SURGE ARRESTOR (GAPLESS)	EXLIM P240-AM300	1/07/1988	ABB POWER TRANSMISSION	20005476	5
H020-C01-856--856SAB	SURGE ARRESTOR (GAPLESS)	ZSE-C2Z	1/01/1985	MEIDENSHA	20005013	7
H020-C01-856--856SAC	SURGE ARRESTOR (GAPLESS)	ZSE-C2Z	1/01/1985	MEIDENSHA	20005009	7

All CVTs were replaced under CP.01292 to remove the Line Traps in 2018. CTs are original and maintenance records show no major issues and DGA analysis are satisfactory. These CTs are oil filled and in porcelain housing and have increased trend of explosive failures with catastrophic safety consequences after 36 years in service. It is recommended that CTs be replaced within 3-5 years.

The feeder circuit breaker 8562 in this bay is ABB HPL300/25B1 manufactured in 1985 and installed in the same year. This CB is similar to CB5012 and all its circumstances explained in section 2.2.1 is applicable to CB 8562 as well. This CB is 36 years old and is in satisfactory condition. Maintenance records show that this CB has a history of SF6 leaks and has been topped up with 3.82 kg of SF6 gas. The CB operating times are within the allowable limit. This CB has failed to operate more than 5 times while in service due to various faults. Based on these observations it is recommended to replace the CB in 3-5 years.

The reactor circuit breaker 8562 ~ 1 in this bay is ABB HPL300B1GS manufactured in 2001 and installed in the same year. Maintenance records show no issues with this CB and is in good condition.

The Surge arrestors are of Meidensha make and in porcelain housing and is in service for last 37 years and it is recommended to replace these with a polymer housed SAs.

The maintenance records show that both the disconnector has corrosion and these should be rectified during the next periodic service.

The associated structures and foundations in this bay have a remaining service life of 20 years,

Recommendation: In summary, it is recommended that the all SAs , the CT's and the CB 5062 be replaced in 3 to 5 years including their structures and foundations.

2.2.4 H020 - C02- 502 – 275kV 2 Coupler Bay

The equipment for this bay is listed in Table 6, including their health indices.

This bay was built in 1985, with most original equipment still in service and 40 years old.

Table 6- Bay 502 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C02-502--5020-1	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011009	5
H020-C02-502--5020-2	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011010	6
H020-C02-502--5022	CIRCUIT BREAKER	250-SFM-40B	11/02/1985	MITSUBISHI	20004954	7
H020-C02-502--5022CTA	CURRENT TRANSFORMER	IOSK300/1050	10/01/1985	HAEFELY	20004970	6
H020-C02-502--5022CTB	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004960	6
H020-C02-502--5022CTC	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004959	6
H020-C02-502--5028	ISOLATOR	DR	1/07/1985	EGIC	20004983	7
H020-C02-502--5029	ISOLATOR	DR	1/07/1985	EGIC	20004982	5

CTs are original and maintenance records show no major issues and DGA analysis are satisfactory. These CTs are oil filled and in porcelain housing and have increased trend of explosive failures with catastrophic safety consequences after 36 years in service. It is recommended that CTs be replaced within 3-5 years.

The maintenance records show that both the disconnector has Grade 2 corrosion and these should be rectified during the next periodic service.

The circuit breaker in this bay is Mitsubishi 250-SFM-40B manufactured in 1984 and installed in the year 1985. It has pneumatic operating mechanism with spring used for energy storage and SF6 gas for insulating medium. These are C1 & M1 class and is rated for only 2000 operations. SFM type Mitsubishi CBs of this vintage have asbestos impregnated washers of friable nature associated with the heater inside the mechanism box, which was removed. Mitsubishi does not produce this type of circuit breaker anymore and sourcing of spare parts has become a major issue. In addition to these since this CB is class C1 and has a probability of restrike failure due to its age. Powerlink has Installed 17 of these similar age(1980-85) CBs in its network and presently 12 of them are in service and 5 breakers have been removed from service, either due to failures or for other reasons. Out of the remaining 12 in service 9 of them having been already recommended for replacement under various capital projects.

Maintenance records show that this CB 5022 has issues with SF6 leaks. Air compressor was replaced twice and issues with leaks in the nematic system. This CB operating times are within the tolerable limits. Based on known issues associated with this type of CB mentioned above and its current condition, it is expected to deteriorate with time and it is recommended to replace them in the next 3 -5 years

The associated structures and foundations in this bay have a remaining service life of 20 years,

Recommendation: In summary, it is recommended that the all the CT's and the CB 5022 be replaced in 3 to 5 years including their structures and foundations.

2.2.5 H020-C02-820- 275kV 820 Feeder Bay

The equipment for this bay is listed in Table 7, including their health indices.

This bay was built in 1985, with most of the original equipment still in service and 40 years old.

Table 7- Bay 820 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C02-820--8200	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011013	5
H020-C02-820--8200-1	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011014	5
H020-C02-820--8200-2	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011015	6
H020-C02-820--8200-3	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011016	5
H020-C02-820--8200-4	EARTH SWITCH	HCB	1/07/1977	MORLYNN POWER	20011017	5
H020-C02-820--8201	ISOLATOR	DR	1/07/1985	EGIC	20004978	6
H020-C02-820--8202	CIRCUIT BREAKER	250-SFM-40B	7/02/1985	MITSUBISHI	20004950	7
H020-C02-820--8202-1	CIRCUIT BREAKER	HPL300B1GS SPAR	1/04/2001	ABB SWITCHGEAR	20032612	5
H020-C02-820--8202CTA	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004972	6
H020-C02-820--8202CTB	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004976	6

H020-C02-820--8202CTC	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004975	6
H020-C02-820--8203	ISOLATOR	DR	1/07/1985	EGIC	20004996	6
H020-C02-820--8207	ISOLATOR	DR	1/07/1985	EGIC	20004995	6
H020-C02-820--8209	ISOLATOR	HCB	12/01/1989	MORLYNN POWER	20012099	6
H020-C02-820--820RESAA	SURGE ARRESTOR (GAPLESS)	AZG3025G190240	1/01/1996	COOPER POWER SYSTEMS	20014968	4
H020-C02-820--820RESAB	SURGE ARRESTOR (GAPLESS)	AZG3025G190240	7/07/1998	COOPER POWER SYSTEMS	20014971	4
H020-C02-820--820RESAC	SURGE ARRESTOR (GAPLESS)	AZG3025G190240	7/07/1998	COOPER POWER SYSTEMS	20013255	4
H020-C02-820--820SAA	SURGE ARRESTOR (GAPLESS)	3EL2 240-2PM32-4KA1	9/03/2012	SIEMENS	20074385	2
H020-C02-820--820SAB	SURGE ARRESTOR (GAPLESS)	3EL2 240-2PM32-4KA1	9/03/2012	SIEMENS	20074386	2
H020-C02-820--820SAC	SURGE ARRESTOR (GAPLESS)	3EL2 240-2PM32-4KA1	27/03/2012	SIEMENS	20074387	2

All the primary plant in this bay was installed in 1985. CTs are original and maintenance records show no major issues and DGA analysis are satisfactory. These instrument transformers are oil filled and in porcelain housing and have increased trend of explosive failures with catastrophic safety consequences after 36 years in service. It is recommended that all CTs be replaced within 3-5 years.

The feeder circuit breaker 8202 in this bay is Mitsubishi 250-SFM-40B manufactured in 1985 and installed in the same year. This CB is similar to CB5022 and all its circumstances explained in section 2.2.4 is applicable to CB 8202 as well. This CB is 36 years old and is in satisfactory condition. Maintenance records show that this CB has a history of SF6 leaks and has been topped up with 1.8 kg of SF6 gas. The CB operating times are within the allowable limit. This CB has been locked out once due to unknown reason. Air compressor motor has issues with overheating and issues with leaks in the nematic system. This CB operating times are within the tolerable limits. Based on known issues associated with this type of CB and its current condition, it is expected to deteriorate with time and it is recommended to replace this in the next 3 -5 years

The reactor circuit breaker 8202 ~ 1 in this bay is ABB HPL300B1GS manufactured in 2001 and installed in the same year. Maintenance records show no issues with this CB and is in good condition.

The Surge arrestors are of Cooper Ps make and in porcelain housing and is in service for last 37 years and it is recommended to replace these with a polymer housed SAs.

The maintenance records show no major issues with disconnector and earth switches. They are in reasonable condition considering its age.

The associated structures and foundations in this bay have a remaining service life of 20 years,

Recommendation: In summary, it is recommended that the all the SAs, CT's and the CB 8202 be replaced in 3 to 5 years including their structures and foundations.

2.2.6 H020-C02-834- 275kV 834 Feeder Bay

The equipment for this bay is listed in Table 8, including their health indices.

This bay was built in 1988, with most of the original equipment still in service and 37 years old.

Table 8-Bay 834 Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-C02-834--19VTA	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	14/09/2018	TRENCH LIMITED	20072083	3
H020-C02-834--19VTB	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	1/01/1983	HAEFELY	20005028	7
H020-C02-834--19VTC	CAPACITOR VOLTAGE TRANSFORMER	TEMP287C	14/09/2018	TRENCH LIMITED	20072084	3
H020-C02-834--8340	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011022	5
H020-C02-834--8340-1	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011023	5
H020-C02-834--8340-2	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011024	5
H020-C02-834--8340-3	EARTH SWITCH	DR	1/07/1977	MG EGIC	20011025	5
H020-C02-834--8341	ISOLATOR	DR	1/07/1985	EGIC	20004994	6
H020-C02-834--8342	CIRCUIT BREAKER	250-SFM-40B	11/02/1985	MITSUBISHI	20004957	8
H020-C02-834--8342CTA	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004971	6
H020-C02-834--8342CTB	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004962	6
H020-C02-834--8342CTC	CURRENT TRANSFORMER	IOSK300/1050	1/01/1983	HAEFELY	20004969	6

H020-C02-834--8343	ISOLATOR	DR	1/07/1985	EGIC	20004993	6
H020-C02-834--8347	ISOLATOR	DR	1/07/1985	EGIC	20004985	6

A & C phase CVTs were replaced under CP.01292 to remove the Line Traps in 2018. CTs are original and maintenance records show no major issues and DGA analysis are satisfactory. These CTs are oil filled and in porcelain housing and have increased trend of explosive failures with catastrophic safety consequences after 36 years in service. It is recommended that CTs and B phase CVT be replaced within 3-5 years.

The feeder circuit breaker 8342 in this bay is Mitsubishi 250-SFM-40B manufactured in 1985 and installed in the same year. This CB is similar to CB5022 and all its circumstances explained in section 2.2.4 is applicable to CB 8342 as well. This CB is 36 years old and is in satisfactory condition. Maintenance records show that this CB has history of compressor faults. The CB operating times are within the allowable limit. Air compressor was replaced once and has issues with leaks in the nematic system. This CB operating times are within the tolerable limits. This CB has been operated 770 times. Based on known issues associated with this type of CB and its current condition, it is expected to deteriorate with time and it is recommended to replace this in the next 3 -5 years

The maintenance records show that the disconnectors has surface corrosion and these should be rectified during the next periodic service.

The associated structures and foundations in this bay have a remaining service life of 20 years,

Recommendation: In summary, it is recommended that the all B phase CVT and the CT's and the CB 8342 be replaced in 3 to 5 years including their structures and foundations.

2.3 275 kV Bus Diameters/Bays

As show in Figure 1, H020 Broadsound has a double bus arrangement in a breaker and half configuration.

2.3.1 H020-KC--KC1- 275kV 1 BUS

The equipment for 1 Bus bay is listed below in Table 9, including their health indices.

Table 9- KC1 Bus Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index

H020-KC--KC1--4VTA	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005015	5
H020-KC--KC1--4VTB	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005030	5
H020-KC--KC1--4VTC	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005029	5
H020-KC--KC1--5910	EARTH SWITCH	DR	01.07.1977	MG EGIC	20011011	5

The CVTs are visually in reasonable condition but have been in service for 26 years and considering they are in porcelain housing leaving them to fail in service would not only result in significant network outages and also would represent increased safety risk for workers and contractors when working on this site. It is therefore recommended that these instrument transformers be replaced within 5 years.

The earth switch was also installed in 1977. It appears to be in good condition.

The associated structures and foundations in the Bus -1 have a remaining service life of more than 20 to 30 years.

Recommendation: Based on the above observations, the all CVT's to be replaced in 5 years.

2.3.2 H020-KC--KC2- 275kV 2 BUS

he equipment for 2 Bus is listed below in Table 15, including their health indices.

Table 10-KC2 Bus Equipment list

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-KC--KC2--6VTC	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005016	5
H020-KC--KC2--6VTB	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005017	5
H020-KC--KC2--6VTA	CAPACITOR VOLTAGE TRANSFORMER	CVE300/1050	05.07.1999	HAEFELY	20005018	5
H020-KC--KC2--5920	EARTH SWITCH	DR	01.07.1977	MG EGIC	20011012	6

All CVTs are in reasonable condition and have been in service for 26 years and maintenance records show no major issues and DGA analysis are satisfactory.

The earth switch was installed in 1977. It appears to be in good condition.

The associated structures and foundations in the Bus-2 have a remaining service life of more than 20 years, but condition monitoring of earth switch foundation and support structure needs to continue.

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and no replacements are required in the next 10 year outlook.

2.4 Strung Bus and Structures

From ground level both 275kV strung bus conductors and connectors over the bays appear to be in good condition.

As per the civil condition assessment report, the lattice type towers and beams were found to be in a good condition. The structures that were built before 1985 have 30-40 years of remaining life.

All overhead earths protecting all strung buses appear to be in good condition. The connections of the earth wire to their strain towers vary in configuration but these are also in good condition

2.5 Site infrastructure

2.5.1 AC & DC Supply

The AC supply is via two sets of 275 /0.433 kV Power voltage transformers connected to the Bus1 and Bus2. These provide adequate and reliable local supply for this substation.

These two sets of PVTs are in “as new” condition as they were replaced in 2011.

Figure 5 –PVT Bus-1

Figure 5 – PVT Bus-2

Table 11- Auxiliary Equipment

Functional Location	Object Description	Model number	Start-up date	Manufacturer	Equipment	Health Index
H020-SIN-ACSU-10STNA	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070801	3
H020-SIN-ACSU-10STNB	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070802	3

H020-SIN-ACSU-10STNC	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070803	3
H020-SIN-ACSU-1DIESEL	DIESEL ALTERNATOR	150 kVA MEGA–GEN	30/03/2012	JOHN DEERE / STAMFORD	20074384	3
H020-SIN-ACSU-7STNA	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070792	4
H020-SIN-ACSU-7STNB	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070793	3
H020-SIN-ACSU-7STNC	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070794	3
H020-SIN-ACSU-8STNA	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070795	3
H020-SIN-ACSU-8STNB	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070796	3
H020-SIN-ACSU-8STNC	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	18/08/2011	MWB TRENCH	20070797	3
H020-SIN-ACSU-9STNA	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070798	3
H020-SIN-ACSU-9STNB	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070799	3
H020-SIN-ACSU-9STNC	POWER VOLTAGE TRANSFORMER - SF6	PSVS300	19/08/2011	MWB TRENCH	20070800	3

Recommendation: Based on the above observations, the primary plant in this bay is in good condition and no replacements are required in the next 10-15 year outlook.

2.5.2 Yard

2.5.2.1 Cubicles

The cabinets are generally constructed from aluminium. Only the electric fence cabinets are made from stainless steel. No issues were noted in relation to the cabinets, their support structures or foundations.

2.5.2.2 Structure and equipment earthing

The structures and plant earths all appear to be in good condition.

2.5.2.3 Earth grid

2.5.2.4 Structure and equipment earthing

The lowest rated earth tail is suitable to conduct fault current of 19.6 kA for 500 ms, which is suitable for fault current level for this site and circuit breakers operating times if these are within prescribed limits.

2.5.2.4.1 Earth grid

A grid injection test was performed in August 2015 and the results were satisfactory. The earth grid is rated for fault currents up to 8.94 kA for 250 ms (The primary protection time for 275 kV of 120ms).

2.5.2.5 Fences

The substation security fence has two parts. The newer part is generally in line with the current requirements. The fence is approximately 3m tall, has a bottom rail and barbed wires at the top. At the base of the fence is a concrete strip in line with Powerlink's standard requirements. See Figure 1.

Figure 7: Security Fence – Newer Section

The older part is only around 2.2m tall, has chain wire fence with top and bottom rails and two barbed wires on the top as shown in Figure 2. There is no concrete strip at the base of the fence. The newer part of the fence is in very good condition and should last for at least 20 years. The older part of the fence is still in reasonable condition without advanced above ground corrosion. The remaining life of the older fence is estimated to 10 years.

Figure 8: Security Fence – Older Section

2.5.2.6 Cable ducts and cable duct covers

The cable ducts and the associated cable covers were in good condition however in places the covers were misplaced and could present a tripping hazard as shown in Figure 37.

Figure 9 – Cable trenches

2.5.2.7 Drainage

The substation drainage appeared to be in a satisfactory condition. No issues with the surface water drainage were noted however the inspection was conducted in dry weather.

2.5.2.8 Roads

The substation is accessed from a local unsealed road with good and clear visibility. The internal roads are of unsealed gravel construction and are in a reasonable condition and reasonably clearly marked. No work outside of regular maintenances is required.

2.5.2.9 Switchyard lighting

The switchyard lighting appears to be in good condition. There was no corrosion visible and the clear plastic covers were still clear with no signs of clouding.

2.5.2.10 Oil Containment system

Reactors 1 and 2 bunds drain into an oil containment tank. The tank is an old open type tank, as shown in Figure 15, and it is believed that only one of such tank in Powerlink's system. This type of oil containment tank is considered less reliable.

Figure 10: Oil Separation Tank

The tank drains into a retention basin shown in Figure 11. The retention basin is surrounded by a stock proof fence, however the fence was open in one section and the basin is accessible to cattle. It is suspected that the local farmer is using the basin as a source of water for his/her cattle. The fence should be closed to prevent cattle accessing the basin.

Figure 11: Retention Basin

Figure 12: Oil Containment Tank Outlet

The tank should be replaced as early as possible and it is very unlikely that the water discharge quality would comply with Powerlink's requirements if there is a presence of oil in the oil containment system.

3. ASSET CONDITION ASSESSMENT OVERVIEW

In addition to the above mentioned recommended maintenance actions, it is recommended to replace below listed equipment in the next 5 year outlook. It is necessary to confirm the enduring need for this equipment prior to scoping of a replacement project.

Table 12- Recommendations

Asset	Action Req. (Y/N)	Asset Replc. Recom. (Y/N)	Refurb. Recom. (Y/N)	Corr. Maint. Rec. (Y/N)	Comments
H020 - C01- 501	Y	Y	N	N	CB in 3 to 5 years.
H020-C01-833	Y	Y	N	N	B phase CVT,CTs ,SAs and CB in 3 to 5 years
H020-C01-856-	Y	Y	N	N	CTs, SAs and CB in 3-5 yrs
H020 - C02- 502	Y	Y	N	N	CTs and CB in 3-5 yrs
H020-C02-820-	Y	Y	N	N	CTs, SAs and CB in 3-5 yrs
H020-C02-834	Y	Y	N	N	B phase CVT,CTs and CB in 3 to 5 years
H020-SIN-TRF-OILSEP1	Y	Y	N	N	Replace oil containment system

3.1 Conclusions

The condition assessment of Broadsound 275kV substation revealed issues related to the plant condition, unavailability of spares and therefore the inability to maintain the existing equipment. A high number of damaged porcelain insulators was also found on site. All of these represent risks to the provision of reliable supply and to safety of both personnel and public. Each risk is different and has a different consequence, from minor to extreme. To manage the worst of these risks, replacement of recommended plant needs to be undertaken within next 3-5 years. Appropriate maintenance activities will be required to manage the remaining risks.

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4. APPENDIX

4.1 Reference information

- *Equipment list (SAP)*
- *Notifications, work orders and measurement documents (SAP)*
- *Discussions with Powerlink technical staff*
- *Discussions with the maintenance service provider*
- *Powerlink drawings*

5. HEALTH INDEX METHODOLOGY

Health index for substation equipment is based on the condition of the equipment in the bay, condition of structures and foundations (all being assigned health index as condition indicator). It provides an indication of the remaining life based on its condition and criticality, rather than based on nameplate age.

Table 13-HI Methodology Overview

RI	Estimated Remaining Life(yrs)	Action	Comment	Comment
10	1 -2	Condition assessment (CA) required on annual basis (or special maintenance regime)	Project scoped and approved, included in the current Reset period	**Poor condition needs urgent action.**
9	2-3	CA required on annual basis (or special maintenance regime)	Project scoped and in final approval stages, included in the current Reset period	Poor condition, needs prompt, planned action.
8	3 - 5	CA required on annual basis (or special maintenance regime)	Project scoping, options analysis	
7	5 - 10	High level project scoped	High level project scoped for regulator, ca done	
6	10 - 20	CA trigger	CA to be done within 1 year and ready for next Reset, scope project before next Reset	Deteriorating condition, future replacement required, but in a planned fashion.
5	20 - 25	Plan CA in 5 yrs		Aged satisfactory condition.
4	25 - 30	Mid-life CA (desktop)	Desktop assessment of notified issues	Needs some replacements, typically only few, minor components
3	30 - 35	Annual review of HI and RI begins	Aging - good condition	
2	35-40	Good condition, annual review of notifications, dealing with infant mortality issues		
1	≥40	New		

Planning Report		27/10/2020
Title	CP.02919 H020 Broadsound 275kV Substation Reinvestment	
Zone	Central West Queensland	
Need Driver	Network and safety risks arising from the condition of ageing primary plant in diameter C01 & C02.	
Network Limitation	Broadsound Substation is required to maintain the CQNQ power transfer capability to the North Queensland load centres and to meet Powerlink Queensland's N-1-50MW/600MWh Transmission Authority reliability standard.	
Pre-requisites	None	

Executive Summary

The 275kV Broadsound Substation is located in the Central West Queensland zone. It was established in 1984. Staged expansion has occurred since this time, to provide additional 275kV feeders to the west, south and north and more recently, with the addition of a new bus reactor and renewable connections.

Condition assessment [1] shows deterioration of primary plant and significant safety and network risk associated with the equipment failing.

The Central scenario load forecasts confirm an enduring need for an ongoing supply of bulk electricity to the Lilyvale 275kV substation and the surrounding 132kV region. In addition, there is an enduring need for a 275kV switching substation between the Central West and North Queensland zones.

The removal or reconfiguration of the Broadsound Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact the power transfer capability between central and north Queensland.

The preferred network solution for Powerlink to continue to meet its statutory obligations is the replacement of the at-risk primary plant.

This will ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

Table of Contents

1. Introduction

Broadsound Substation located in the Central West Queensland zone. The substation was established in 1984. Staged expansion has occurred since this time, to provide additional 275kV feeders to the west, south and north and more recently, with the addition of a new bus reactor and renewable customer connections.

Figures 1 and 2 shows the geographic location and network topology in the vicinity of the Broadsound Substation.

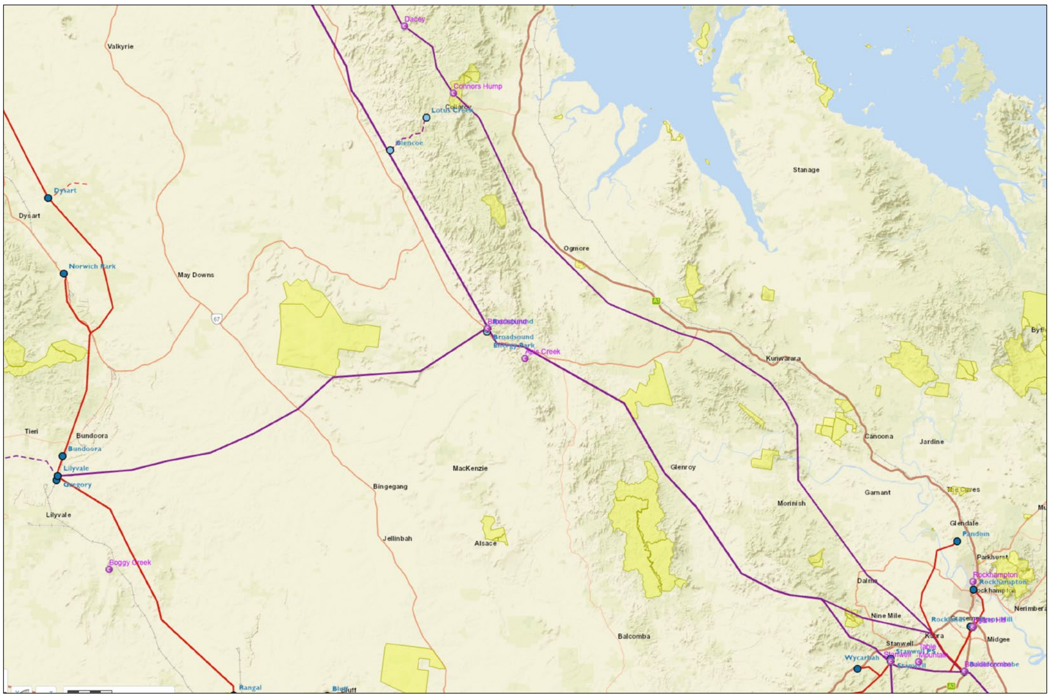


Figure 1. Geographic location of the Broadsound Substation

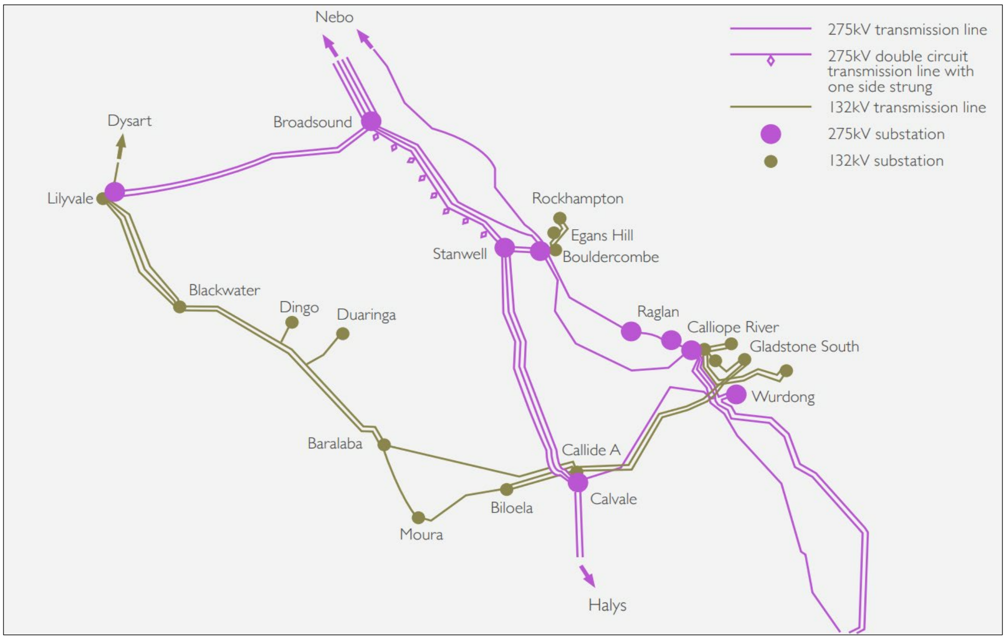


Figure 2. Network topology near the Broadsound Substation

The condition assessment [1] confirms the primary plant from the original substation construction in diameters C01 and C02 is now over 40 years old and requires selective replacement as there is an increased probability of explosive failures with safety consequences.

This report assesses the impact that removal of the at-risk plant would have on the performance of the network and Powerlink's statutory obligations. It also establishes the indicative requirements of any potential alternative solutions to the current services provided by Broadsound Substation.

2. H020 Broadsound Substation configuration

Figure 3 shows the existing connection configuration of the Broadsound Substation, highlighting the primary plant reaching end of life.

[redacted]

Figure 3. Broadsound 275kV Substation operating diagram

3. North Queensland Demand Forecast

The Northern region includes substations between the Central and Far North Queensland (excluding the Central West and Gladstone zones). The combined load must be met by the North Queensland generation and the power transfer capacity of the CQNQ 275kV grid section.

Figure 4 shows that the maximum demand for these loads is expected to gradually increase over the forecast period.

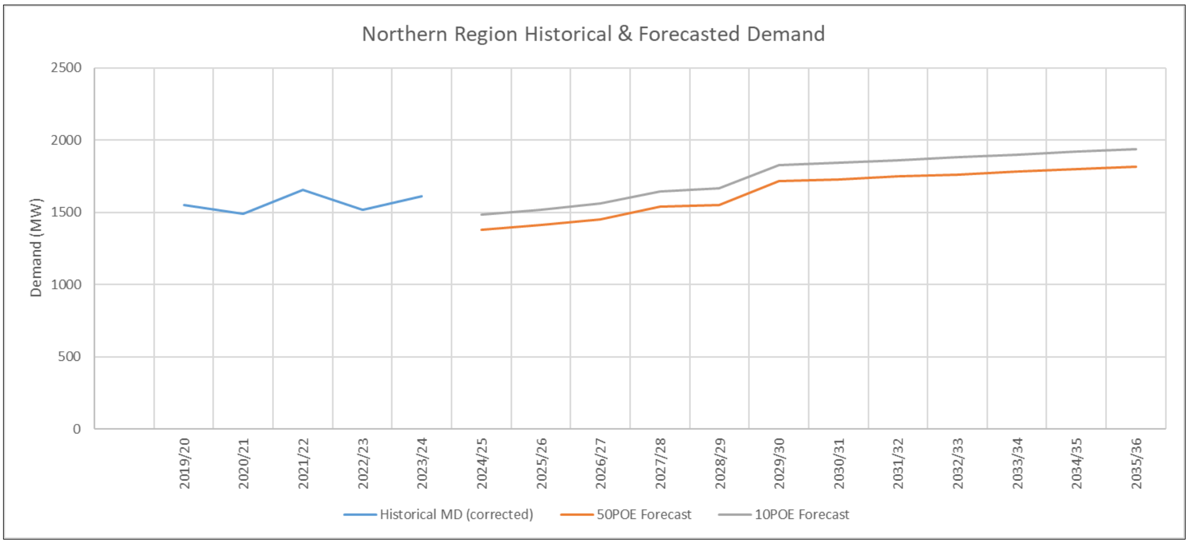


Figure 4. Northern Queensland demand forecast

The historical load duration curves for the combined Far North Queensland, Ross and North Queensland zones are shown in Figure 5.

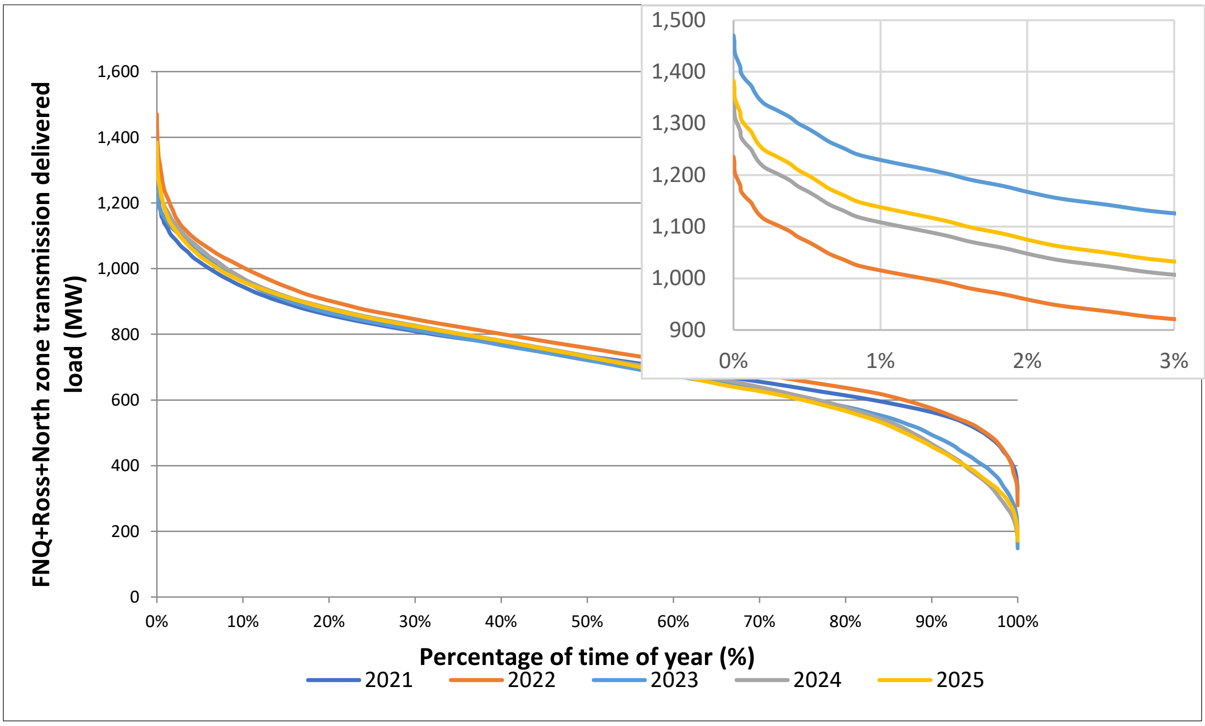


Figure 5. Historical Load Duration Curves for the aggregate of FNQ, Ross and North Queensland zones.

4. Statement of Investment Need

The Broadsound Substation is the main supply to the Lilyvale Substation and a connection point for renewable generations (Clarke Creek Wind Farm and Broadsound Solar Farm). The Broadsound Substation also provides a critical network switching hub for 275kV feeders between the Central West zone and northern Queensland. There are currently three 275kV circuits into Broadsound Substation from Central Queensland (820, 8831 and 856), three 275kV circuits to North Queensland (834, 8846 and 8847) and two 275kV circuits to Lilyvale Substation.

Removing C01 and C02 diameters could connect the following circuits:

- Feeder 833 and Feeder 856 (Stanwell to Lilyvale, ~260km)
- Feeder 834 and Feeder 820 (Bouldercombe to Nebo, ~290km).

Both would require the installation of line connected shunt reactors to manage over voltages during energisation. The change in topology also removes a high capacity 275kV circuit (856) from the Central to North Queensland transmission capacity. It also places a lower capacity circuit (820) in series with a higher capacity circuit (834). Both would have a significant impact on the CQ-NQ transmission capability.

Therefore, failure to replace at-risk primary plant at the substation would have a major impact on the performance of this network and the reliability of supply to associated loads, which would ultimately result in loss of load exceeding Powerlink's N-1-50MW / 600MWh Transmission Authority reliability standard for load supplied from Lilyvale Substation.

5. Network Risk

Following the failure of primary plant that disconnects feeder 833, the 132kV network would be opened north of Baralaba Substation and north of Dysart Substation. Table 1 summarises the resultant load at risk at Lilyvale, Blackwater and Dysart substations, for a subsequent trip of 850 (the parallel 275kV circuit between Broadsound and Lilyvale substations). The load at risk includes that supplied from rooftop PV.

Table 1 – Lilyvale, Blackwater and Dysart load at risk

At Risk	Contingency	Metric	2030/31 (Delivered)	2030/31 (Delivered + PV)
Lilyvale, Blackwater Dysart loads	H020-C01-833—17VT or H020-C01-833—833SA followed by outage of Feeder 850 (1)	Max (MW)	327	327
		Average (MW)	207	221
		24h Energy Unserved Max (MWh)	5974	6412
		24h Energy Unserved Average (MWh)	4966	5292

Note:

(1) Outage of equipment associated with the bus or coupler bays can still result in feeder 833 being taken out-of-service, but this would require an N-2 event and as such to result in any load loss, N-3.

6. Market impact

The at-risk primary plant can remove from service the following circuits:

- Feeder 820 (Bouldercombe to Broadsound)
  - CVT (H020-C02-820—20VT) - N-1 event
  - Surge arrester (H020-C02-820—820RESA) - N-1 event
  - CT or CB – N-2 event
- Feeder 856 (Stanwell to Broadsound)
  - CVT (H020-C01-856—18VT) - N-1 event
  - Surge arrester (H020-C01-856—856SA) - N-1 event
  - CT or CB – N-2 event
- Feeder 834 (Stanwell to Broadsound)
  - CVT (H020-C02-834—19VT) - N-1 event
  - CT or CB – N-2 event

Tables 2, 3 and 4 summarise the market impact of removing each of these circuits in-turn. Each table defines the maximum and average difference in total system costs (including emission reduction benefits) per 24-hour period with and without the at-risk circuit in-service. The analysis also takes account of any impact on the operation the VRE plant due to system strength impacts.

The analysis assumes that there is no impact on the generation investment pathway as a result of this outage.

The methodology used to assess these market impacts is outlined in Appendix B.

Table 2. Market impact of Feeder 820 out-of-service

At Risk	Contingency	Metric	$M
Dispatchable generation in NQ constrained	outage of 820	Max 24h incremental system cost ($m)	0.147
		Average 24h incremental system cost ($m)	0.003

Table 3. Market impact of Feeder 856 out-of-service

At Risk	Contingency	Metric	$M
Dispatchable generation in NQ constrained	outage of 856	Max 24h incremental system cost ($m)	1.738
		Average 24h incremental system cost ($m)	0.156

Table 4. Market impact of Feeder 834 out-of-service

At Risk	Contingency	Metric	$M
Dispatchable generation in NQ constrained	outage of 834	Max 24h incremental system cost ($m)	0.165
		Average 24h incremental system cost ($m)	0.003

7. Non-Network Options

Non-network solutions would need to replicate, in part or full, the support that Broadsound Substation gives to the supply of load from the Liliyvale Substation. The Lilyvale Substation, via the connection to Broadsound Substation, is also critical for connecting multiple renewable energy sources. The connection to Broadsound is also a critical source of system strength for the stable operation of these plants.

The potential non-network solutions would need to be capable of delivering up to 220MW of peak power and up to 4050MWh daily energy demand. The non-network solution would be required to be capable of operating continuous basis until normal supply is restored.

Powerlink is not presently aware of any Demand Side Solutions (DSM) in the Central West region capable of meeting this requirement. However, Powerlink welcomes submissions from proponents and will investigate the feasibility of potential non-network options as part of the formal RIT-T consultation process.

8. Network Options

This section discusses the options which were considered to address the above identified condition based secondary systems issues.

8.1 Proposed Option to address the identified need

To address the emerging condition issues of the primary plant at the Broadsound Substation it is recommended that the ageing and at-risk primary be replaced.

This will allow Powerlink to meet its reliability of supply and safety obligations under its Transmission Authority, the Electricity Act 1994 and Section 5.1 of the Rules.

The proposed network solution will not have any material inter-network impact, and as such does not need to formally consult with other Market Participants.

8.2 Do Nothing

“Do Nothing” would not be an acceptable option as the primary drivers (primary plant condition) and associated safety, reliability and compliance risks would not be resolved. Furthermore, the “Do Nothing” option would not be consistent with good industry practice and would result in Powerlink breaching their obligations with the requirements of the System Standards of the National Electricity Rules and its Transmission Authority.

9. Recommendations

Condition assessment [1] shows deterioration of primary plant and significant safety and network risk associated with the equipment failing.

The Central scenario load forecasts confirm an enduring need for an ongoing supply of bulk electricity to the Lilyvale 275kV substation and the surrounding 132kV region. In addition, there is an enduring need for a 275kV switching substation between the Central and North Queensland zones.

The removal or reconfiguration of the Broadsound Substation would violate Powerlink's N-1-50MW/600MWh Transmission Authority reliability standard and significantly impact the power transfer capability between central and north Queensland.

The preferred network solution for Powerlink to continue to meet its statutory obligations is the replacement of the at-risk primary plant.

This will ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

10. References

1. H020 Broadsound Primary Plant Condition Assessment Report (A4699908)
2. H020 Broadsound Civil Condition Assessment Report (A4628548)
3. CP.02919 – Broadsound Selective Primary Plant Project Scope (A509803)
4. 2025 Transmission Annual Planning Report (A6049612)
5. Asset Planning Criteria - Framework (ASM-FRA-A2352970)
6. Powerlink Queensland's Transmission Authority T01/98

11. Appendix A: Primary Plant to be replaced under CP.02919

Functional Location	Manufacturer	Description	Model	Network Impact
H020-C01-833—17VTA	TRENCH	CVT	TEMP287C	Removes 833
H020-C01-833—17VTB	TRENCH	CVT	CVE300/1050	Removes 833
H020-C01-833—17VTC	TRENCH	CVT	TEMP287C	Removes 833
H020-C01-833--8332	ASEA	CB	HPL300/25B1	N-1 856+833
H020-C01-833—8332CTA	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—8332CTB	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—8332CTC	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—833SAA	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-833—833SAB	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-833—833SAC	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-501--5012	ASEA	CB	HPL300/25B1	13.09.1988
H020-C01-856—18VTA	TRENCH	CVT	TEMP287C	Removes 856
H020-C01-856—18VTB	TRENCH	CVT	TEMP287C	Removes 856
H020-C01-856—18VTC	TRENCH	CVT	TEMP287C	Removes 856
H020-C01-856--8562	ASEA	CB	HPL300/25B1	01.07.1989
H020-C01-856—8562CTA	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—8562CTB	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—8562CTC	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—856SAA	ABB	SA	EXLIM	01.01.1988
H020-C01-856—856SAB	MEIDENSHA	SA	EXLIM	01.01.1988
H020-C01-856—856SAC	MEIDENSHA	SA	EXLIM	01.01.1988
H020-C02-502--5022	MITSUBISHI	CB	250-SFM-40B	11.02.1985
H020-C02-502—5022 CTA	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-502—5022CTB	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-502—5022CTC	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-820—20VTA	TRENCH	CVT	TEMP287C	Remove 820
H020-C02-820—20VTB	TRENCH	CVT	TEMP287C	Remove 820
H020-C02-820—20VTC	TRENCH	CVT	TEMP287C	Remove 820
H020-C02-820—8202	MITSUBISHI	CB	250-SFM-40B	07.02.1985
H020-C02-820—8202CTA	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—8202CTB	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—8202CTC	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—820RESAA	COOPER PS	SA	AZG3	01.01.1966
H020-C02-820—820RESAB	COOPER PS	SA	AZG3	01.01.1966

H020-C02-820—820RESAC	COOPER PS	SA	AZG3	01.01.1966
H020-C02-834—19VTA	TRENCH	CVT	TEMP287C	Remove 834
H020-C02-834—19VTB	TRENCH	CVT	CVE300/1050	Remove 834
H020-C02-834—19VTC	TRENCH	CVT	TEMP287C	Remove 834
H020-C02-834--8342	MITSUBISHI	CB	250-SFM-40B	07.02.1985
H020-C02-834—8342CTA	HAEFELY	CT	IOSK300/1050	10.01.1983
H020-C02-834—8342CTB	HAEFELY	CT	IOSK300/1050	10.01.1983
H020-C02-834—8342CTC	HAEFELY	CT	IOSK300/1050	10.01.1983

1. Appendix B – Market Impact Assessment

Market modelling was used to assess the operational market impact of network limitations as a result from outages of primary system equipment at the Broadsound Substation.

The market modelling approach is consistent with the regulatory investment test for transmission requirements that a market benefit "must be a benefit to those who consume, produce and/or transport electricity in the market, that is, the change in producer plus consumer surplus." Critically, a market benefit must not "include the transfer of surplus between consumers and producers".[1]

As such, the market impact is assessed by comparing the changes in costs for market participants due to the differences in the operational and maintenance costs (including fuel costs), changes in involuntary load shedding (at the value of customer reliability [VCR] [2]), and changes in greenhouse gas emissions (at the value of emissions reduction [VER] [3])

The market modelling simulations considered committed and anticipated generators were commissioned on time, coal units closed according to their announced dates (as of December 2025), and modelled generation and storage projects consistent with the Queensland Energy Roadmap 2025.[4] The profiles of demand and energy available for variable energy resources followed the 2015 weather reference year as published by AEMO, as being a year found to result in 'median' outcomes.

A schedule of generator planned outages was modelled. However, generator forced outages were not considered. Instead, a reserve requirement is maintained via a reserve constraint equation, and therefore unserved energy may be underestimated in some circumstances.

Appropriate network detail (in the form of network constraints or sub-regional transfer limits) was added to adequately represent the network capability across major grid sections.

The outage (transmission lines as a result of the failure of primary system equipment at Broadsound Substation) was modelled as occurring in perpetuity to approximately capture the effect of this occurring at any time.

The market impact was then quantified as the differential total system cost (as above) for each hour between a base case with all transmission equipment in-service against the state of the world with an outage of impacted plant. Both the hourly and a moving 24-hour differential cost were determined.

The values in the report tables capture the maximum differential total system cost for any 24-hour period (averaged over the 5-year analysis period) and the average differential total system cost for a 24-hour period (over the 5-year analysis period).

[1] AER, November 2024, "Regulatory investment test for transmission", p4

[2] AER, December 2024, "Values of customer reliability: Final report on VCR values" available at

[3] AER, May 2024, "Valuing emissions reduction: AER guidance and explanatory statement"

[4] The State of Queensland (Queensland Treasury), October 2025, "Energy Roadmap"

Project Scope Report

CP.02919

Broadsound Selective Primary Plant Replacement

Concept – Version 2

Document Control

Change Record

Issue Date	Revision	Prepared by	Reviewed by	Approved by	Background
19/3/25	1	[redacted]	[redacted]	[redacted]	
30/05/25	2	[redacted]		[redacted]	Added additional Trench CVTs to scope

Related Documents

Issue Date	Responsible Person	Objective Document Name
18/12/2019	[redacted]	H020 Broadsound Primary Plant Condition Assessment Report (A4699908)
15/02/2021	[redacted]	H020 Broadsound Civil Condition Assessment Report (A4628548)

Document Purpose

The purpose of this Project Scope Report is to define the business (functional) requirements that the project is intended to deliver. These functional requirements are subject to Powerlink's design and construction standards and prevailing asset strategies, which will be detailed in documentation produced during the detailed scoping and estimating undertaken by DTS (or OSD), i.e. it is not intended for this document to provide a detailed scope of works that is directly suitable for estimating.

Project Contacts

Project Sponsor	[redacted]
Strategist – HV/Digital Asset Strategies	[redacted]
Planner – Main/Regional Grid	[redacted]
Manager Projects	[redacted]
Project Manager	TBA
Design Manager	TBA

Project Details

1. Project Need & Objective

Broadsound substation is a 275kV transmission substation located in Central Queensland. The substation was established in 1984. Staged expansion has occurred since this time, to provide additional 275kV feeders to the west, south and north and more recently, with the addition of a new bus reactor and renewable connections.

The primary plant from the original substation construction in diameters C01 and C02 is now over 40 years old and requires selective replacement. A number of instrument transformers are oil filled and in porcelain housing and due to their age, now have an increased probability of explosive failures with catastrophic safety consequences. Circuit breakers are also approaching end of life and maintenance records show a history of maloperations and SF6 leaks.

In addition to this, a number of capacitive voltage transformers, manufactured by Trench, are known for their high 'mid-life' failure rate, leading to unplanned outages and negatively affecting the reliability of the network.

The oil separation tank for the feeder 820 and 856 line reactors is an old open type tank, as shown in Figures 4 and 5, and the water discharge quality, in the event that oil enters the containment system, is expected not to comply with Powerlink's requirements.

The objective of this project is to replace selected primary plant and the oil separation tank for the feeder 820 and 856 line reactors by October 2030.

This project will follow the two (2) stage approval process.

2. Project Drawing

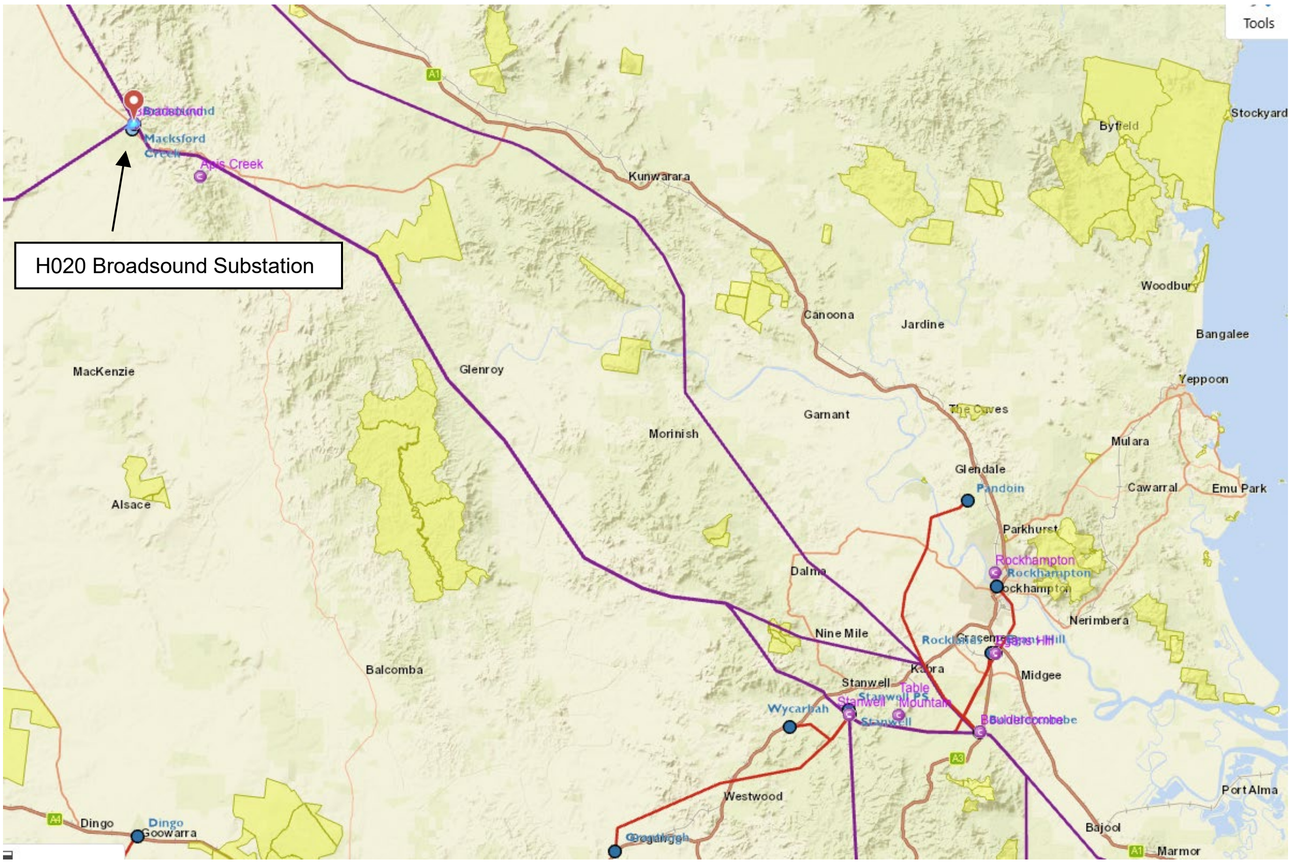


Figure 2: Location of Broadsound Substation

[redacted]

Primary Plant to be replaced under CP.02919 *ABB IMB300 CT to be replaced under CP.03105*

Figure 2: Broadsound Line Diagram A0-H-103059-001

[redacted]

Plant to be replaced under CP.02919

Figure 3: Broadsound General Arrangement A0-H-105432-001

Figure 4: Broadsound Aerial Photo

Figure 5: Existing Oil Separation Tank to be replaced

Figure 6: Existing Oil Separation Tank to be replaced

3. Deliverables

The following deliverables are to be provided in response to this Project Scope Report. The requirement dates for these deliverables will be communicated separately.

This project will follow the two stage approval process. The following deliverables are to be provided:

1. A report (e.g. Concept Estimate Report) detailing the works to be delivered, high level staging, resource requirements and availability, and outage requirements and constraints
2. A class 5 estimate (minimum)
3. A basis of estimate document and risk table, detailing the key estimating assumptions and delivery risks
4. Outline staging and outage plan

4. Project Scope

4.1. Original Scope

The following scope presents a functional overview of the desired outcomes of the project. The proposed solution presented in the estimate must be developed with reference to the remaining sections of this Project Scope Report, in particular *Section 7 Special Considerations*.

Briefly, the project consists of replacing selected primary plant and the oil separation tank for the feeder 820 and 856 line reactors.

4.1.1. Transmission Line Works

Not applicable

4.1.2. H020 Broadsound Substation Works

Primary Works

Design, procure, construct and commission the replacement of the selected 275kV primary plant listed in Attachment 1, with consideration of the following:

- For bays requiring both CB and CT replacement, consideration should be given to utilising dead tank circuit breakers; and
- Existing structures and foundations are to be reused where possible, ensuring they are fit for purpose for a minimum of 40 years.

Design, procure, construct and commission the replacement of the existing oil separation system for the feeder 820 and 856 line reactors, including associated civil works.

Remove and dispose of the existing oil separation system, including surface water outlet pipework.

Decommission and recover all redundant equipment, and update drawing records, SAP records, config files, etc. accordingly.

4.1.3. Telecoms Works

Not applicable

4.1.4. Easement/Land Acquisition & Permits Works

Not applicable

4.2. Key Scope Assumptions

The following assumptions should be included in the estimating of this scope:

- The following ABB IMB300 CTs will be replaced under CP.03105 Replace ABB IMB300 CTs – Central prior to commencing site works under this project:

Site	Functional location	Equipment	Functional Location Description	Priority
H020 Broadsound (8 CTs)	H020-C01-501--5012CTA	20063601	1 COUPLER CB CT A	3
	H020-C01-501--5012CTB	20063602	1 COUPLER CB CT B	3
	H020-C04-504--5042CTA	20054276	4 COUPLER 275KV CT A	3
	H020-C04-504--5042CTB	20054277	4 COUPLER 275KV CT B	3

Site	Functional location	Equipment	Functional Location Description	Priority
	H020-C04-504--5042CTC	20054278	4 COUPLER 275KV CT C	3
	H020-C04-8846-88462CTA	20054279	8846 NEBO 275kV CT A	3
	H020-C04-8846-88462CTB	20054280	8846 NEBO 275kV CT B	3
	H020-C04-8846-88462CTC	20054281	8846 NEBO 275kV CT C	3

4.3. Variations to Scope (post project approval)

Not applicable

5. Key Asset Risks

From an asset risk perspective, priority is to be given to replacement of the porcelain instrument transformers that have increased probability of catastrophic failure presenting a high safety risk.

Asset risk management shall be in accordance with the Asset Risk Management Process Guideline (A4870713).

6. Project Timing

6.1. Stage 1 Approval Date

The anticipated date by which the project will be approved is March 2027.

6.2. Site Access Date

This is an operational substation, therefore, site access is available.

6.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope and the decommissioning and removal of redundant assets, is 31st October 2030.

The project team is to assess the earliest possible delivery date for these works (as close as possible to the proposed commissioning date) as part of the Concept Estimate and provide a schedule of key milestones and funding requirements to meet this date. The project team are to advise the Sponsor as soon as possible if preapproval funding is required to procure long lead time equipment before completion of the estimate to meet the proposed commissioning date.

7. Special Considerations

Not applicable

8. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

Unless otherwise advised Pat Tighe will be the Project Sponsor for this project. The Project Sponsor must be included in any discussions with any other areas of Network and Business Development including Asset Strategies & Planning.

9. Asset Ownership

The works detailed in this project will be Powerlink Queensland assets.

10. System Operation Issues

Operational issues that should be considered as part of the scope and estimate include:

- interaction of project outage plan with other outage requirements;
- likely impact of project outages upon grid support arrangements; and
- likely impact of project outages upon the optical fibre network.

[redacted]

11. Options

Not applicable

12. Division of Responsibilities

Not applicable

13. Related Projects

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
CP.03105	Replace 275kV ABB IMB300 CT's - Central	2029	Definition
Co-requisite Projects			
Other Related Projects			

Attachment 1: Primary Plant to be replaced under CP.02919

Functional Location	Manufacturer	Description	Model	Start-up Date
H020-C01-833—17VTA	TRENCH	CVT	TEMP287C	02.09.2012
H020-C01-833—17VTB	TRENCH	CVT	CVE300/1050	01.07.1988
H020-C01-833—17VTC	TRENCH	CVT	TEMP287C	02.09.2012
H020-C01-833--8332	ASEA	CB	HPL300/25B1	01.07.1985
H020-C01-833—8332CTA	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—8332CTB	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—8332CTC	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C01-833—833SAA	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-833—833SAB	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-833—833SAC	MEIDENSHA	SA	ZSE-C2Z	01.01.1984
H020-C01-501--5012	ASEA	CB	HPL300/25B1	13.09.1988
H020-C01-856—18VTA	TRENCH	CVT	TEMP287C	28.07.2012
H020-C01-856—18VTB	TRENCH	CVT	TEMP287C	28.07.2018
H020-C01-856—18VTC	TRENCH	CVT	TEMP287C	28.07.2012
H020-C01-856--8562	ASEA	CB	HPL300/25B1	01.07.1989
H020-C01-856—8562CTA	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—8562CTB	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—8562CTC	HAEFELY	CT	IOSK300/1050	10.01.1989
H020-C01-856—856SAA	ABB	SA	EXLIM	01.01.1988
H020-C01-856—856SAB	MEIDENSHA	SA	EXLIM	01.01.1988
H020-C01-856—856SAC	MEIDENSHA	SA	EXLIM	01.01.1988
H020-C02-502--5022	MITSUBISHI	CB	250-SFM-40B	11.02.1985
H020-C02-502—5022 CTA	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-502—5022CTB	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-502—5022CTC	HAEFELY	CT	IOSK300/1050	10.01.1985
H020-C02-820—20VTA	TRENCH	CVT	TEMP287C	30.03.2011
H020-C02-820—20VTB	TRENCH	CVT	TEMP287C	30.03.2011
H020-C02-820—20VTC	TRENCH	CVT	TEMP287C	30.03.2011
H020-C02-820—8202	MITSUBISHI	CB	250-SFM-40B	07.02.1985
H020-C02-820—8202CTA	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—8202CTB	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—8202CTC	HAEFELY	CT	IOSK300/1050	01.01.1983
H020-C02-820—820RESAA	COOPER PS	SA	AZG3	01.01.1966
H020-C02-820—820RESAB	COOPER PS	SA	AZG3	01.01.1966
H020-C02-820—820RESAC	COOPER PS	SA	AZG3	01.01.1966
H020-C02-834—19VTA	TRENCH	CVT	TEMP287C	14.09.2018
H020-C02-834—19VTB	TRENCH	CVT	CVE300/1050	01.01.1983
H020-C02-834—19VTC	TRENCH	CVT	TEMP287C	14.09.2018
H020-C02-834--8342	MITSUBISHI	CB	250-SFM-40B	07.02.1985
H020-C02-834—8342CTA	HAEFELY	CT	IOSK300/1050	10.01.1983
H020-C02-834—8342CTB	HAEFELY	CT	IOSK300/1050	10.01.1983
H020-C02-834—8342CTC	HAEFELY	CT	IOSK300/1050	10.01.1983

CP.02919 Broadsound Primary Plant Replacement

Concept Estimate

Revenue Reset 2027 – 2032

Table of Contents

1. Executive Summary

Broadsound substation is a 275kV transmission substation located in Central Queensland, established in 1984. Staged expansion has occurred since this time, to provide additional 275kV feeders to the west, south and north and more recently, with the addition of a new bus reactor and renewable connections.

The primary plant from the original substation construction in diameters C01 and C02 is now over 40 years old and requires selective replacement. Several instrument transformers are oil filled and in porcelain housing, and due to their age, now have an increased probability of explosive failures with catastrophic safety consequences. Circuit breakers are also approaching end of life and maintenance records show a history of maloperations and SF6 leaks.

In addition to this, a number of capacitive voltage transformers, manufactured by Trench, are known for their high 'mid-life' failure rate, leading to unplanned outages and negatively affecting the reliability of the network.

The oil separation tank for the feeder 820 and 856 line reactors is an old open type tank and the water discharge quality is expected not to comply with Powerlink's requirements, in the event that oil enters the containment system.

The assessment in this proposal has established that the project can be delivered by October 2030.

This project will follow the two (2) stage approval process.

1.1 Project Estimate

No escalation costs have been considered in this estimate.

		Total ($)
Estimate Class	5	
Base Estimate – Un-Escalated (2025/2026)		14,493,965
TOTAL		**14,493,965**

1.2 Project Financial Year Cash Flows

No escalation costs have been considered in this estimate.

DTS Cash Flow Table	Un-Escalated Cost ($)
To June 2026	227,198
To June 2027	1,895,879
To June 2028	3,548,367
To June 2029	3,688,831
To June 2030	3,688,831
To June 2031	1,373,109
To June 2032	71,749
TOTAL	**14,493,965**

2. Project and Site-Specific Information

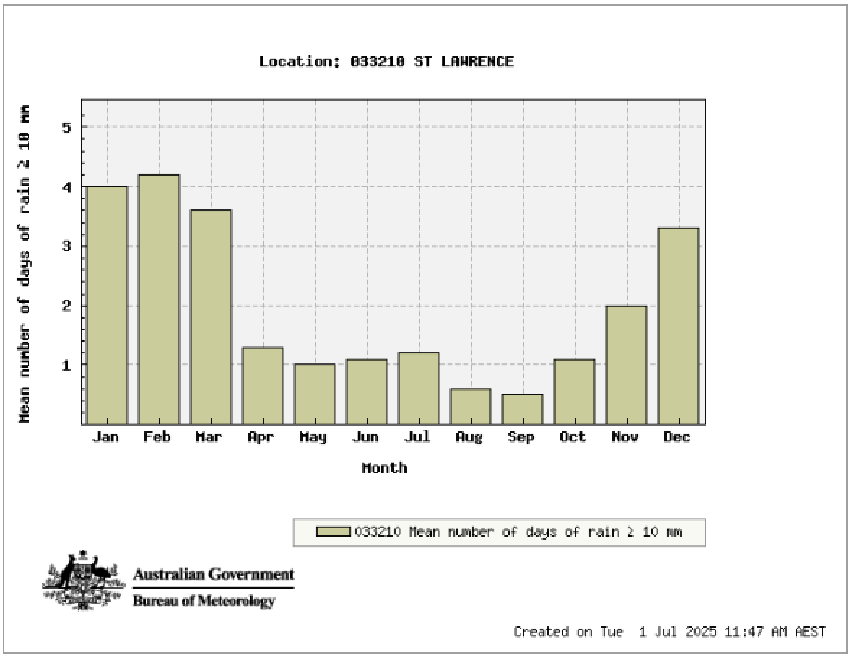
2.1 Project Dependencies & Interactions

This project is related to the following projects:

Project No.	Project Description	Planned Commissioning Date	Comment
Dependencies			
CP.03105	Replace 275kV ABB IMB300 CT's – Central	2029	Statewide CT Replacement program.
Interactions			
CP.02985	Trench CVT Replacement – Central North Phase 2	2027	Statewide CVT Replacement program.

2.2 Site Specific Issues

- H020 Broadsound substation is a 275kV transmission substation located in the Central Queensland area, 127km from Rockhampton.
- Broadsound does not have acceptable accommodation. Rockhampton is 127km to the south-east, and allowance should be made for 2 hours of travel a day each way for Rockhampton accommodation and necessary services.
- Asbestos Containing Material (ACM) has been identified within equipment and throughout the substation. Ensuring the ACM is maintained in a condition that prevents exposure may be compromised if major refurbishment works are undertaken on the identified equipment.
- There are 8 [redacted] at H020 Broadsound which have invoked a Restricted Access Zone(s) (RAZ) in the substation. The RAZ does not impact access to the H020 Broadsound Control Buildings, however access to the 275kV substation yard is restricted. An appropriate RAZ Works Plan will be required if the RAZ is not revoked by the time of works where access is required. The CTs are planned to be replaced by May 2026 under CP.03105, as such it is anticipated the RAZ will be revoked prior to construction commencement on site.
- The St Lawrence area (nearest Bureau station) is subject to the following average number of days of rain. Consideration was given to this when developing the project schedule.



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean number of days of rain ≥ 10 mm for years 2004 to 2025	4.0	4.2	3.6	1.3	1.0	1.1	1.2	0.6	0.5	1.1	2.0	3.3	23.9	21

Figure 1 - Number of Days of Rain >10mm St Lawrence (Source: Bureau of Meteorology 1st July 2025)

3. Project Scope

The following works have been costed for in the estimate.

3.1 Substations Works

H020 Broadsound

- Design, procure, construct and commission replacement of the following primary plant utilising existing structures and foundations:
  - H020-C01-833--17VT A/B/C [Voltage Transformer]
  - H020-C01-833--8332 [Circuit Breaker]
  - H020-C01-833--8332CT A/B/C [Current Transformer]
  - H020-C01-833--833SA A/B/C [Surge Arrestor]
  - H020-C01-501--5012 [Circuit Breaker]
  - H020-C01-856--8562 [Circuit Breaker]
  - H020-C01-856--8562CT A/B/C [Current Transformer]
  - H020-C01-856--856SA A/B/C [Surge Arrestor]
  - H020-C02-502--5022 [Circuit Breaker]
  - H020-C02-502--5022CT A/B/C [Current Transformer]
  - H020-C02-820--20VT A/B/C [Voltage Transformer]
  - H020-C02-820--8202 [Circuit Breaker]

  - H020-C02-820--8202CT A/B/C [Current Transformer]
  - H020-C02-820--820RESA A/B/C [Surge Arrestor]
  - H020-C02-834--19VT A/B/C [Voltage Transformer]
  - H020-C02-834--8342 [Circuit Breaker]
  - H020-C02-834--8342CT A/B/C [Current Transformer]
- For bays requiring both CB and CT replacement, a dead tank circuit breaker will be utilised. New structures and foundations will be required for the dead tank circuit breakers.
- Design, procure, construct and commission secondary systems modification, including:
  - Replacement of cabling between new primary plant and existing marshalling kiosks.
  - Upgrade of secondary terminals, specifically CT disconnect terminals, to current Powerlink standard - refer to DTS-SU0049 New Physical Disconnect Terminal for CT Circuits.
- Design, procure, construct and commission the replacement of the existing oil separation system for the feeder 820 and 856 line reactors, including associated civil works.
- Remove and dispose of the existing oil separation system, including surface water outlet pipework.
- Decommission and recover all redundant equipment, including switchyard control cables.
- Update drawing records, SAP records, config files, etc. accordingly.

[redacted]

Figure 2 - H020 Broadsound Line Diagram of Proposed Works

3.2 Major Scope Assumptions

The following key assumptions were made for this Project Estimate.

- Powerlink Internal Design teams and Design Service Panel will carry out the design works.
- Estimate is based on Powerlink architectures, standards and equipment in place and available at the time of development.
- H020 Broadsound [redacted] will be replaced, revoking the Restricted Access Zones, prior to work starting on the site.
- No further Restricted Access Zones will be deployed on this site during project lifetime.
- Outages will be available on request. Due to the substation arrangement (breaker and a half) it is expected extended feeder outages will not be required. Please refer to Section 4.2 Network Impacts for further details.
- MSP resources will be available to complete the works.
- Procurement of long lead items align with project delivery requirements.

The following assumptions have been made with respect to Secondary Systems design:

- Bay marshalling kiosks to be re-used.
- AC Changeover board is fit for purpose and will be re-used.

The following assumptions have been made with respect to the Civil design:

- The existing substation platform and yard drainage system drains freely and is fit for purpose.
- The existing internal substation roads are fit for purpose.
- Drainage for any new pits shall be provided into the existing drainage system or off the substation platform.
- New foundations and structure are required where the live-tanks being replaced with dead-tanks. These foundations and structures will fit within the existing layout of the bay.
- Foundations and structures of the existing CVTs, Surge arrestors and selected Circuit Breaker (like for like live-tank replacement), are fit for purpose and will not require replacement or upgrade.

3.3 Scope Exclusions

The following items are excluded from the Project Estimate:

- Easement acquisitions work, including permits, approvals, development applications or the like. All works are within Powerlink-owned land.
- Additional time and cost for Design, Planning and Implementation of any restoration plans required for outages is not included in this estimate.
- Major modification to the earth grid is included in this estimate.
- Removal of rock or unsuitable material, including asbestos and other contaminants.
- Costs for repairing or modification to the primary plants not listed to be replaced or repair under the scope.
- Modification and upgrade of the internal roads, lights, fences, gates and extension to platform.
- Relocation of existing cable trench and associated cables.
- Consideration for the location and layout of the existing conduits & underground cables.
- Modification on the existing transmission lines.
- No allowance has been made for Live Substation work.

4. Project Execution

4.1 Project Schedule

This project will follow the two (2) stage approval process.

A High Level Project Schedule has been developed for the project stages:

Milestones	High-Level Timing
Request for Class 5 Estimate	November 2025
Class 5 Project Proposal Submission	January 2026
Request for Class 3 Estimate	March 2026
Class 3 Project Proposal Submission	September 2026
Stage 1 Approval (PAN1) includes funds for design, procurement, ITT preparation & outage assessments.	November 2026
RIT-T (assumed 26 weeks)	December 2026 – June 2027
Project Development Phase 1 & Phase 2	November 2026 – June 2027
ITT Submission (8 Weeks)	February 2027 – March 2027
Evaluate Tender, Reconcile Estimate and Submit PMP for Stage 2 Approval	April 2027
Stage 2 Approval (PAN2)	June 2027
Execute Delivery (including award of SPA contract)	June 2027
SPA Site Establishment	April 2028
Staged SPA Civil Works and Construction	April 2028 – October 2030
MSP Site Establishment	April 2028
Staged MSP Bay Commissioning	April 2028 – October 2030
Project Commissioning	October 2030

4.2 Network Impacts

Powerlink Net Ops – Operating Manual 03 – CQ provides the following recommendations for outages of H020 Broadsound feeders.

275kV H020 Broadsound Feeders

An outage on Feeder 833 has the following network requirements and impacts.

- Network Requirements:
    - Fdr 850 in service.
    - 132kV network from H011 Nebo to T034 Moranbah to H035 Strathmore intact.
    - Deload of Feeder 7114/1 at T031 Baralaba.
    - Deload of Feeder 7150/2 at T035 Dysart.
    - Management of Capacitor Banks at T035 Dysart, T034 Moranbah, T220 Collinsville North and T069 Newlands.
    - H091 Haughton Synchronous Condensor in service.
- An outage on Feeder 883 has system strength impacts, further outage advice will be required to minimise impacts to IBR generators.
- Customer Impacts:
    - Load at Risk – Ergon and Aurizon
    - Generation at Risk – CQPPL (via Ergon), Clermont SF (via Ergon), Lilyvale SF, Emerald West, German Creek, Middlemount SPS, Longr SPS and Basol PS.
- Time of Year Guidelines:
    - Long term/overnight outages should be planned in shoulder periods.
    - For outages outside of the shoulder periods, outage recall times to a maximum of 12 hours.

An outage on Feeder 856 has the following network requirements and impacts.

- Network Requirements:
    - Fdr 8831 in service.
    - Fdr 820 & 821 & 848 & 849 in service.
- An outage on Feeder 856 has system strength impacts, further outage advice will be required to minimise impacts to IBR generators.
- Time of Year Guidelines
    - If outages in Summer period are required, outage recall times to a maximum of 12 hours.

An outage on Feeder 820 has the following network requirements and impacts.

- Network Requirements:
    - Fdr 856 & 8831 & 821 & 848 & 849 in service.
- An outage on Feeder 820 has system strength impacts, further outage advice will be required to minimise impacts to IBR generators.
- Time of Year Guidelines
    - If outages in Summer period are required, outage recall times to a maximum of 12 hours.

An outage on Feeder 834 has the following network requirements and impacts.

- Network Requirements:

   - Fdr 8846 and/or 8847 in service.
   - Fdr 821 in service.
- An outage on Feeder 834 has system strength impacts, further outage advice will be required to minimise impacts to IBR generators.
- Time of Year Guidelines
   - Outages during the Summer period, outage recall times to a maximum of 12 hours.

4.3 Resourcing

Design for the project will be completed by internal design resources with support from external design partners. The construction works will be completed by a combination of the Maintenance Service Providers and Substation Panel contractors.

5. Project Asset Classification

Asset Class	Base ($)	Base (%)
Substation Primary Plant	13,274,364	92
Substation Secondary Systems	1,179,618	8
Telecommunications	39,982	0
Overhead Transmission Line	-	0
TOTAL	**14,493,965**	**100**

6. References

Document name and hyperlink	Version	Date
Project Scope Report	1.0	19/03/2025

Risk Cost Summary Report

CP. 02919

Broadsound Selective Primary Plant Replacement

Document Control

Change Record

Issue Date	Revision	Prepared by
18/12/2025	1.0	Asset Strategies

Related Documents

Issue Date	Responsible Person	Objective Document Name

Document Purpose

The purpose of this model is to quantify the base case and option risk cost profiles for the equipment at the Broadsound Substation which are proposed for reinvestment under CP.02919. These risk cost profiles are then included as part of an overall cost-benefit analysis (CBA) to understand the economic benefit of the proposed upgrades. This process provides a benchmarking and internal gate process to support Powerlink in effectively identifying prioritised infrastructure upgrades.

The CBA was designed to demonstrate and quantify the value to be gained through specific infrastructure investments. To evaluate the CBA, an NPV is derived based on the present values of costs and benefits. The flow chart in Figure 4 below designates the methodology used in designing the CBA process.

Key Assumptions

In calculating the risk cost arising from a failure of the ageing equipment at the Broadsound Substation, the following modelling assumptions have been made:

- The functionality of the equipment is assumed to decay according to decay curves calculated by Powerlink, and associated probability of failure (PoF).
- Where equipment in scope is replaced, its associated Health Index (HI) score is reverted to one.
- The likelihood of personnel within the substation in the event of explosive failure of equipment (used to calculate safety risk) is assumed to be 25% (based upon historic site entry averages), with the likelihood of resulting injury or death depending on the explosive radius of the equipment, its housing, and the total substation land area. The modelling also assumes that personnel are equally likely to be anywhere within the substation land area. No escalation to the likelihood has been made during construction as it is assumed appropriate risk assessments and risk mitigation measures are completed by the project team.
- In the event of an SF6 gas leak, it is assumed that the entire quantum of SF6 gas is leaked.
- For the purposes of the cost-benefit analysis, the total useful asset life of 40 years has been applied.
- A site-specific value of customer reliability (VCR) of $25,750 has been applied when calculating network risks.

Base Case Risk Analysis

Risk Categories

Four main categories of risk are assessed as part of this project as consistent with Powerlink's Asset Risk Management Framework:

- Financial Risk
- Safety Risk

- Network Risk (including market impact if applicable)
- Environmental

Table 1: Risk categories

Risk Category	Failure Types	Equipment in scope
Safety Risk	Explosive failure	All equipment with the potential to fail explosively
Financial Risk	Peaceful failure	All equipment
	Explosive failure	All equipment with the potential to fail explosively
Network Risk	Peaceful failure	All equipment related to network elements identified in the planning statement
Environmental Risk	Peaceful failure	Circuit breakers and current transformers containing SF6

Base Case Risk Cost

The modelled and extrapolated total base case risk costs are shown in Figures 1 and 2 below.

Risk costs associated with the equipment in scope are expected to increase from $1.61 million in 2026 to $3.52 million in 2036 and $5.96 million by 2046. Key highlights of the analysis include:

- Financial risk forms approximately 75% of the base case risk. Of this, the majority is a result of peaceful failures modes with the risk dollars spread evenly across the bays included for re-investment.
- Network risk and safety risk accounts for approximately 17% and 7% of the total risk. A lower proportion of network risk is reflective of the circuit breaker and a half substation arrangement while low safety risks reflect a conservative assumption that personnel are unlikely to be in proximity of equipment during an explosive failure event
- Whilst environmental risk has been calculated it is immaterial to the overall base case risk.

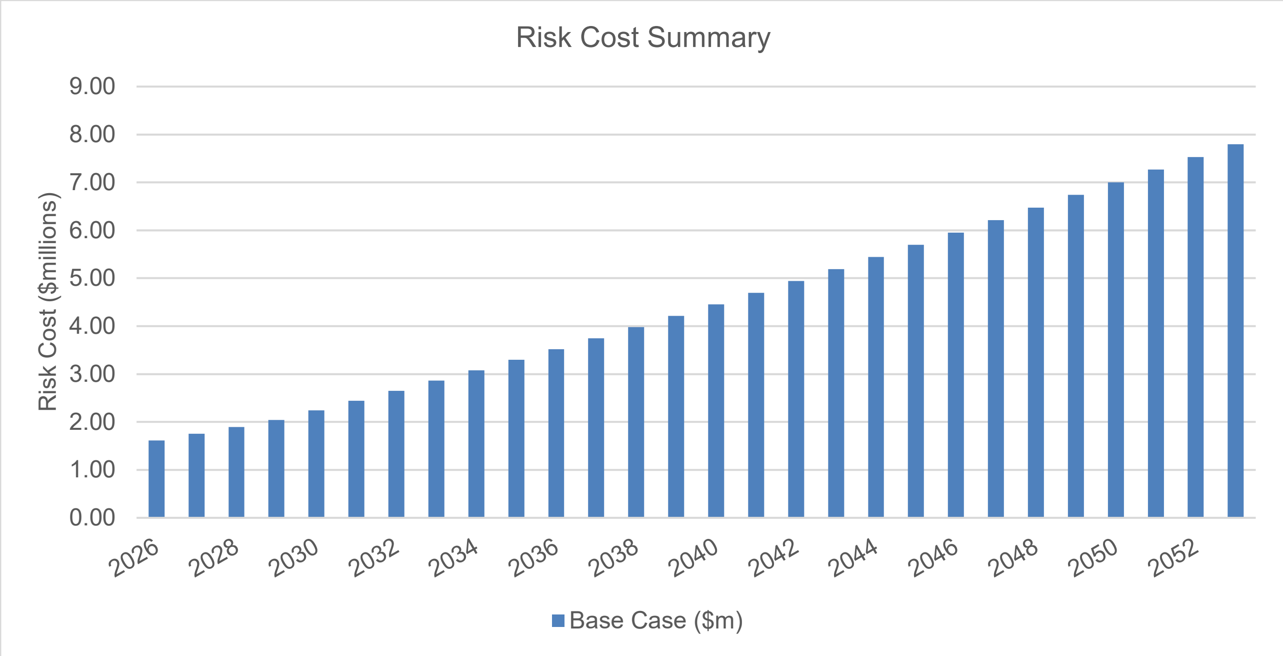


Figure 1: Total risk cost

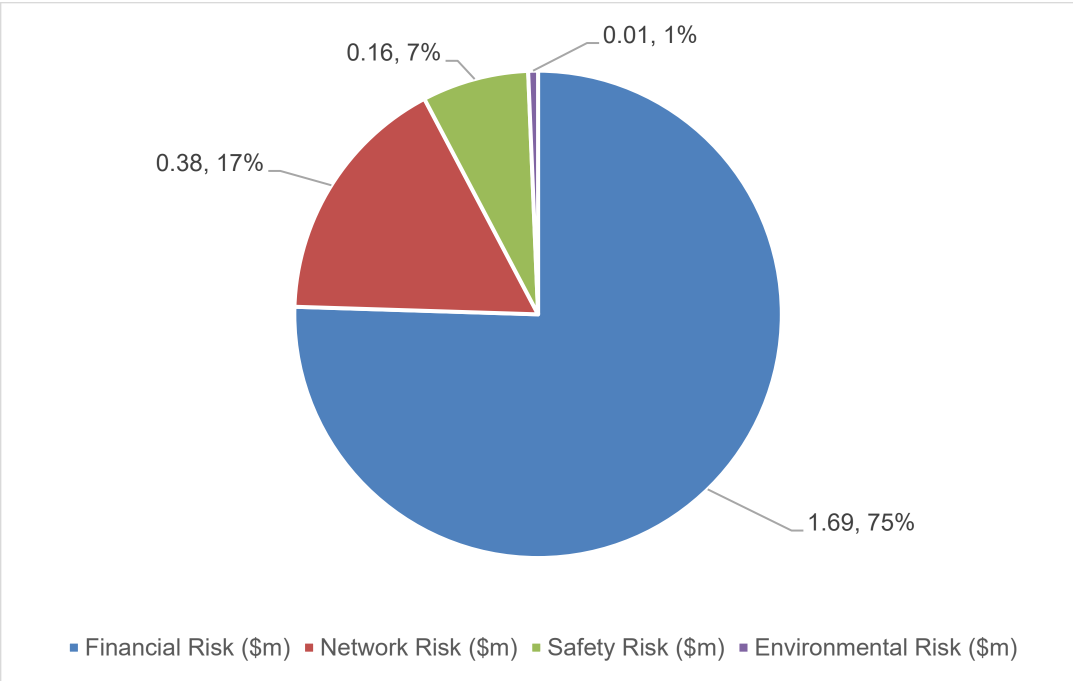


Figure 2: Base case risk cost by contributions (2030)

Option Risk Cost

For modelling purposes, the replacement of equipment at the Broadsound substation reduces effective HI scores to one, significantly lowering its probability of failure and therefore risk cost.

The figures below set out the total project case risk cost, and associated risk cost savings incremental to the base case.

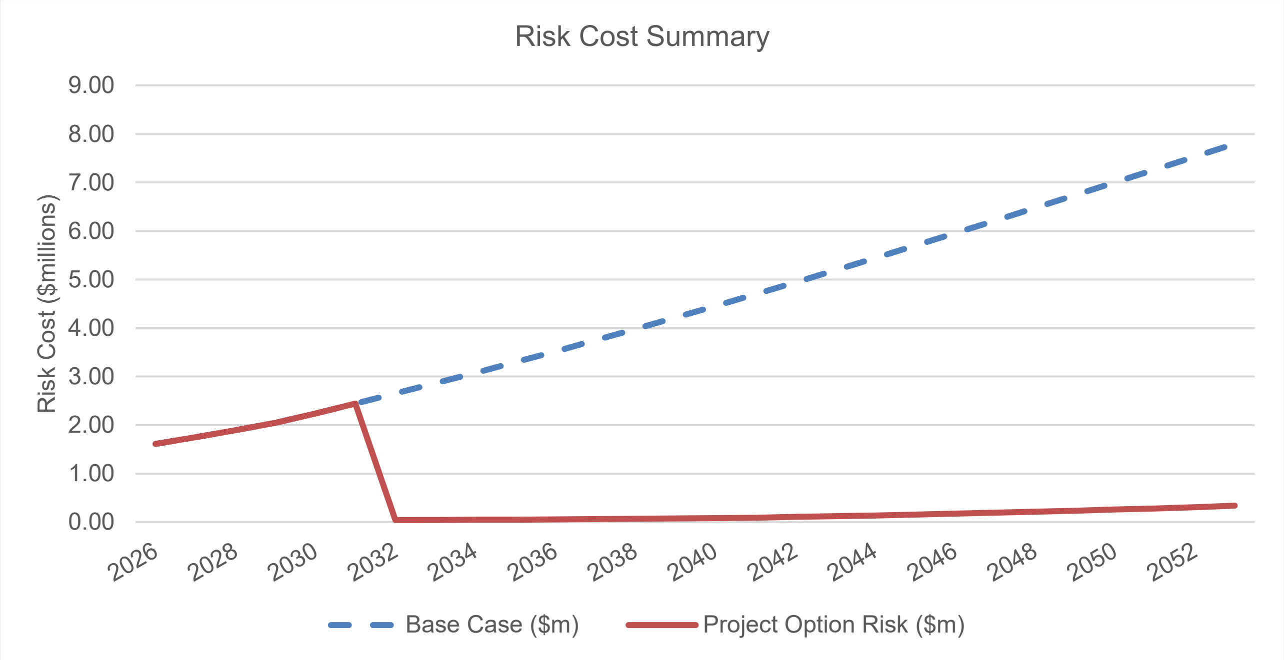


Figure 3: Project Option Risk Cost (compared to base case)

Following the year of investment (2031) the risk cost associated with the equipment in scope effectively reduces to approximately $0.04m. By 2046, the risk cost of the project option is approximately $0.17 million, compared with the base case risk cost of $5.96 million.

Cost Benefit Analysis

The methodology designed for the cost benefit is set out as per Figure 4 below.

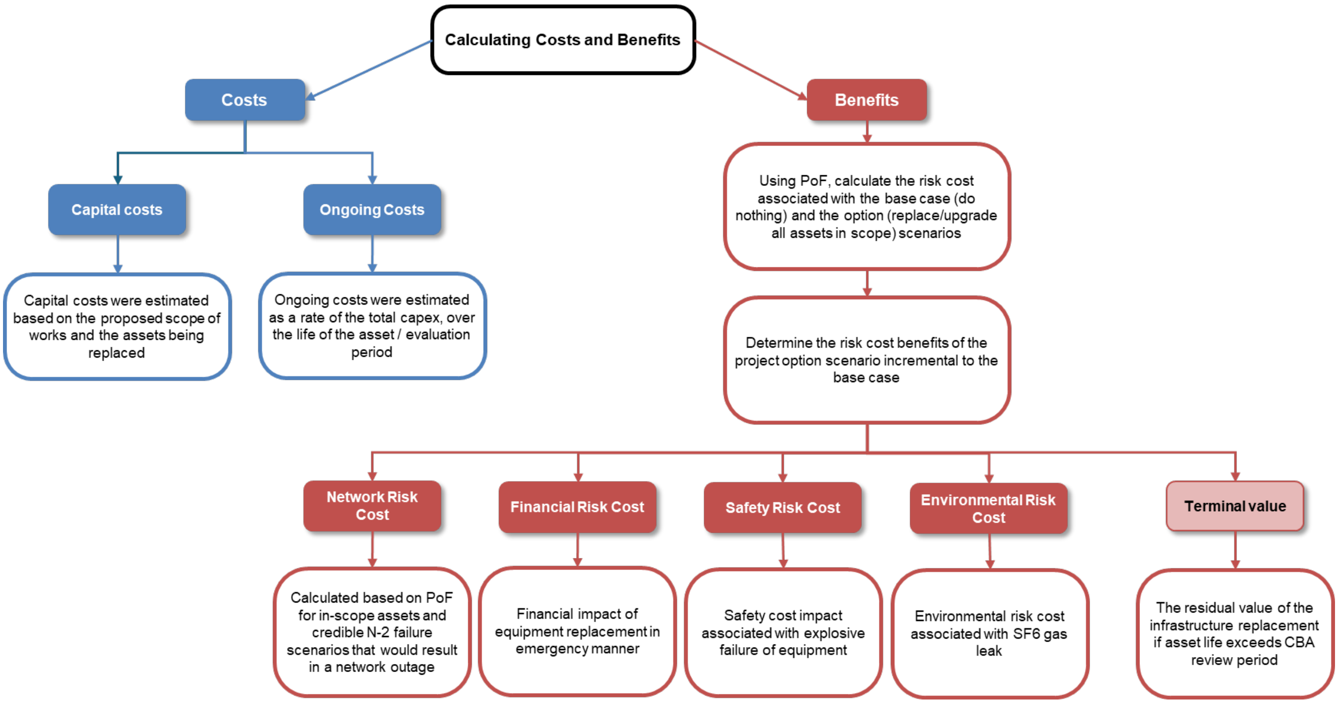


Figure 4: CBA methodology

The project is estimated to cost approximately $14.5 million. This represents a significant cost saving over the estimated financial risk cost of replacing assets individually in an emergency manner, due to the efficiencies associated with planned upgrades.

Based on a baseline discount factor of 7%, the project has a net present value (NPV) of $29.7 million over a 35-year period, and a benefit-cost ratio (BCR) of 4.07.

The project also has a positive NPV and BCR when a discount factor of 10% is applied.

Given this, replacement of the nominated assets within this project is considered appropriate.

Table 2: Net Present Value and Benefit-Cost Ratio

		Present Value Table ($m)		
Discount rate	**%**	**3%**	**7%**	**10%**
NPV of Net Gain/Loss	$m	$74.9	$29.7	$15.3
Benefit-Cost Ratio	ratio	7.17	4.07	2.87

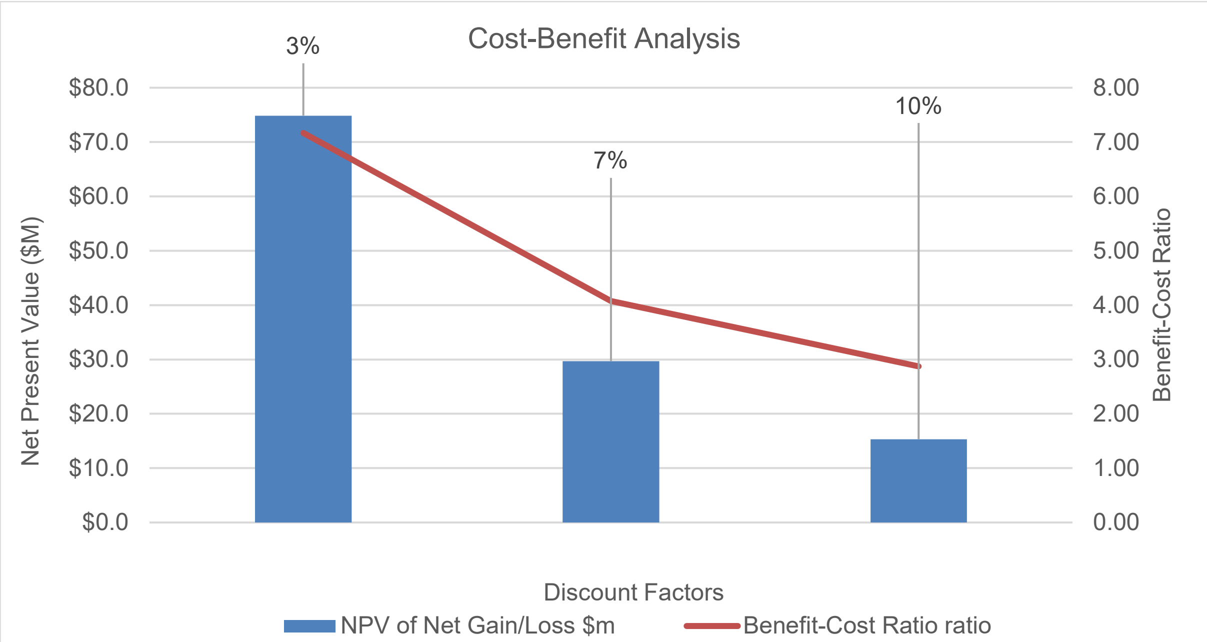


Figure 5: Cost benefit summary

Participation Factors

A sensitivity analysis was undertaken to determine the participation factors for key inputs to the risk cost models (i.e. to identify which inputs are most sensitive to overall risk cost). Applying a 50% reduction in key inputs still resulted in a cost benefit ratio greater than 3.5.

The participation factor is defined as the ratio of percentage change in output (i.e. risk cost) to a percentage change in input (e.g. VCR). The participation factors for key model inputs are shown in the table below.

Due to the non-linear nature of the risk cost model (especially network risk costs, which are a function of concurrent failures), the participation factor can change depending on the magnitude of input percentage change.

The model is most sensitive to:

- **changes in the restoration time** in the event of a network outage (halving the return to service time) represents decrease in risk cost of $0.14 million, or approximately 6.4% of the original base case risk.

- **changes in emergency premium (peaceful failure)** results in a decrease in risk cost of $0.12 million, or approximately 5.5% of the original base risk.

Table 3: Participation Factors

Input	Baseline value	Sensitivity value (-50%)	Change in risk cost at 2030 ($m)	Participation (%)
Safety				
Likelihood of personnel within substation	25%	13%	-0.08	-3.40%
Cost consequence of multiple fatality	$11,400,000	$5,700,000	-0.02	-1.09%
Cost consequence of single fatality	$5,700,000	$2,850,000	-0.05	-2.44%
Cost consequence of multiple serious injury	$4,206,600	$2,103,300	-0.02	-0.77%
Financial				
Emergency premium (peaceful failure)	20%	10%	-0.12	-5.51%
Emergency premium (explosive failure)	300%	150%	-0.08	-3.51%
Network				
VCR ($/MWh)	25,750	12,875	-0.10	-4.64%
Restoration Time (hrs)	72-720	36-360	-0.14	-6.41%