2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack - PUBLIC

CP.01151
Calvale & Callide B
Secondary Systems Replacement

Delivering better value

INVESTMENT & PLANNING

INVESTMENT OPTIONS PAPER

CP.01151 Calvale Secondary Systems Replacement

Document Control

Issue Date	Responsible Person	Objective Document Name	Background
	[redacted]	Investment Options Paper CP.01151 Calvale Secondary Systems Replacement	

Approval

	Name	Position	Signature	Date
Endorsed	[redacted]	A/Manager Network Integration	[redacted]	11/11/15
Approved	[redacted]	Group Manager – Strategy & Planning		12/11/15

Executive Summary

Calvale 275/132kV secondary systems are reaching the end of serviceable life. The condition assessment of the secondary systems conducted in July 2015 (A2334966) identified condition issues that will require reinvestment in the 275/132kV secondary systems equipment in the next two years.

This report sets out the investment recommendation to address the end of life strategies for the 275/132kV secondary systems at Calvale substation.

Four options were considered:

1. Minimal in situ replacement by October 2018, followed by full replacement in 2023
2. Partial and in situ replacement by October 2018
3. Majority full replacement by October 2018
4. Staged Replacement - 1988 secondary systems by October 2018 and 1998 secondary systems by October 2023

Each of the above options was considered against a range of criteria to identify the most suitable action to address the end of life drivers identified in the condition assessment report. These included:

- the need for a reliable electricity supply into the future and to comply with the National Electricity Rules and mandated reliability of supply standards;
- economic (NPV) analysis;
- operational risks; and
- other technical assessment parameters.

Option 3, Majority full replacement by October 2018, is the preferred option for implementation. The estimated cost of these works is $16.06M ($15/16).

Background & Need

Background

Calvale 275/132kV substation which is located in Central Queensland was established in 1988 and is a key switch point for the region with power flowing to the north and east of the State as well as beyond to south Queensland. At times of State peak demand, it is necessary for some of the output from the existing power stations in the Calvale area to flow to the north and east of Calvale in order to maintain a reliable electricity supply to customers across the State. Significant industrial demand dominates the load in the Gladstone, Yarwun and Boat Creek areas. This area also includes industry of economic significance to Queensland which has been identified as a 'sensitive load' by the Jurisdictional System Security Coordinators.

Originally the substation was established to connect to Callide A and B Power Stations. Calvale substation was extended to connect to Callide C Power Station and Tarong in 1998 and further expanded in 2013 as part of the Calvale to Stanwell augmentation to meet increased demand in the region which is largely associated with industrial, commercial and residential loads. As a result, the substation now has a mixture of secondary systems equipment ranging in age between one and twenty-seven years old.

Figure 1: *Geographical location of Calvale Substation*

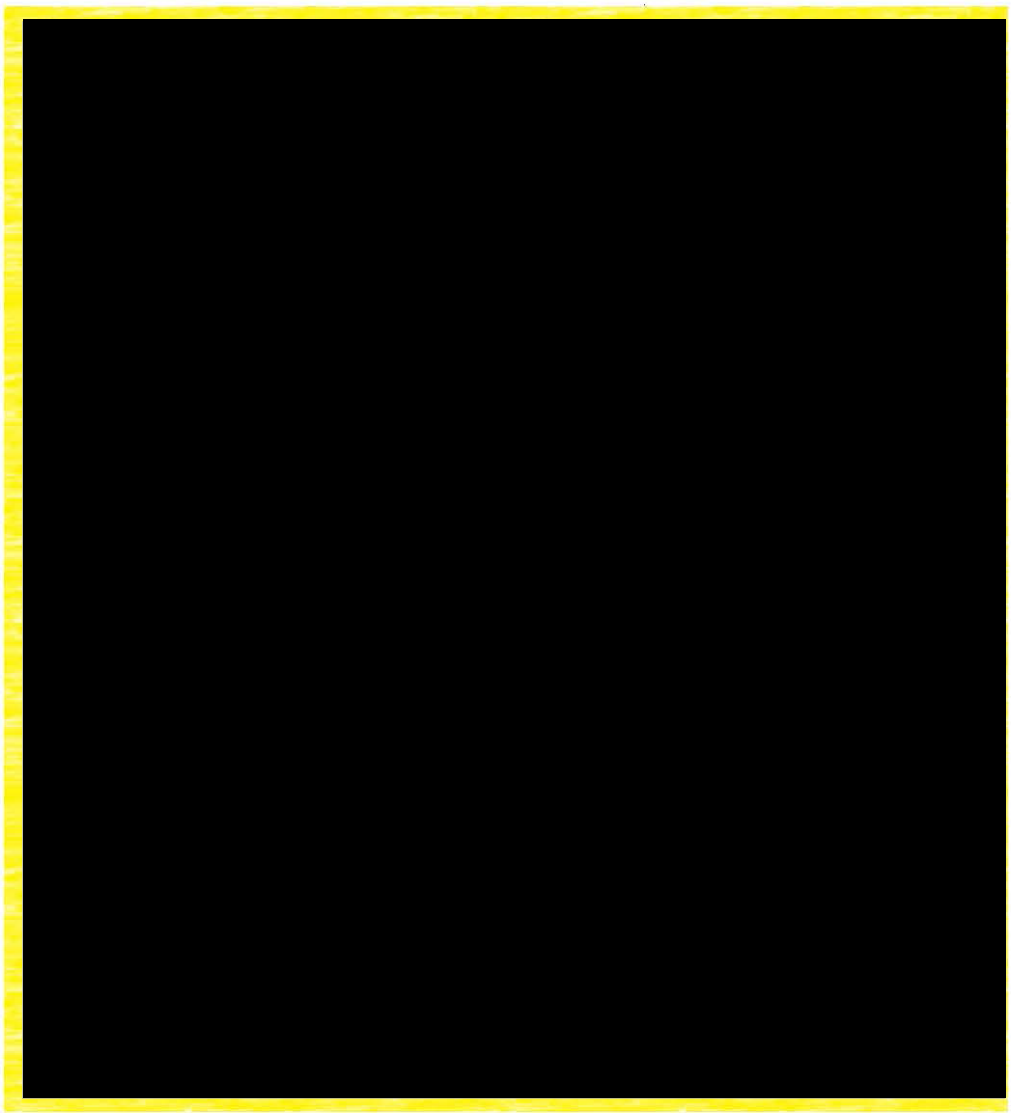
The Calvale Substation site includes:

- 4 x 275kV generator feeder bays (2 x 17 years old, 2 x 27 years old)
- 6 x 275kV feeder bays (1 x 27 years old, 3 x 17 years old, 2 x 2 years old)
- 1 x 275kV spare transformer bay (27 years old)
- 2 x 275kV reactor bays (17 years old)
- 7 x 275kV coupler bays (2 x 17 years old, 3 x 27 years old, 2 x 2 years old)
- 1 x 275/132kV transformer bay (27 years old)
- 2 x 275kV bus bays (27 years old)
- 1 x 132kV feeder bay (27 years old)

Powerlink secondary systems equipment at Callide B Power station (to interface with Calvale Switchyard) includes:

- 2 x high speed telemetry equipment SEL2506
- 1 x C50 common RTU for misc alarms, telecoms and protection (28 years old)

Figure 2: *Line diagram of Calvale Substation & Callide B*



Investment Need

The majority of the existing secondary systems equipment at Calvale Substation was commissioned with corridor panels from 1988 – 1998 and is now between 17 and 27 years old. Two new 275kV bays =C01 and =C02 were commissioned in 2013 as part of the Calvale to Stanwell double circuit transmission line augmentation project CP.01705. As a result, the secondary systems are a mixture of SDM8 and preSDM7.

A secondary systems Condition Assessment Report (CA) dated 15 July 2015 (A2334966) states that the main issues at Calvale are:

- Maintainability - aging equipment with increased risk of failure
- Reliability - limited spares with limited or no manufacturer support available
- deteriorated control cables – orange sheathed cables have been deteriorating
- Safety risks due to the exposed wiring and constrained space

Powerlink also has secondary systems at Callide B Power Station to provide an interface with the Calvale switchyard. The high speed telemetry unit and SCADA RTU were installed with the dual AGC links and dual SCADA paths under CP.02103 in 2012 and are in good condition. A duplicated fibre network will become available between Calvale and Callide B in December 2018 as a result of telecoms installations undertaken as part of Callide A Rebuild project CP.01546. The telecoms fibre installation will negate the need for the replacement of the current protection signalling equipment at Callide B which was installed in 1987 and is approaching obsolescence. To ensure compatibility with Powerlink secondary systems equipment, Powerlink will procure the remote end protection relays for Callide B Power Station and Callide Power Plant. The associated design, installation and commissioning works pertaining to these relays are to be carried out by others.

The overall condition of secondary systems equipment at Calvale has been assessed as fair. The CA advises replacement of secondary systems on the original secondary system bays (1988 and 1998) within the next two years. In particular, the C25 and C2025 RTUs and obsolete x and y protection relays have been identified as requiring more immediate replacement as no spares are available. Failure of these devices will lose the control and monitoring of primary plant. Repairs will be time consuming and lengthy outages would be required. As a result an operational project, OR.02027, is currently underway to address the current risks in relation to the C25 and C2025 RTUs and is due for completion in November 2015.

Assessment of Condition

A Condition Assessment Report prepared in July 2015 has identified the following condition and performance driven issues with the equipment:

- Bus zone protection panels
    - Bus zone protection devices and CT supervision have been in service between 17 and 27 years and have become obsolete with no spares available;
    - Current master-check design is not fully redundant (non-compliance with NER). Failure of the check scheme will cause all bus zone protection schemes to block and to clear a bus fault will rely on remote end distance protection with slow clearance time (non-compliance with NER) resulting in an entire 275kV bus being switched out;

- Higher failure rates on aging relays; and
- Replacement with current Powerlink standard relay will require major logic and wiring modification resulting in longer outage window.

- 275kV Feeder protection panels – Feeder 8874, 851, 852 and 871
  - Duplicate protection relays have been in service for 27 years;
  - These protection relays as well as the autoreclosing and CVT monitoring relays have experienced reliability issues and manufacturers have ceased to provide technical support and supply. There are no new system spares for these relays while there are some recovered spares. These spares are likely to be consumed within the next three years; and
  - Replacement with current Powerlink standard relays will require major logic and wiring modification resulting in longer outage window.

- 132kV Feeder protection panels – Feeder 7161 (Callide A)
  - Duplicate protection relays have been in service for 27 years;
  - These protection relays as well as the autoreclosing and CVT monitoring relays have experienced reliability issues and manufacturers have ceased to provide technical support and supply. There are no new system spares for these relays while there are some recovered spares. These recovered spares have a high probability of start-up failure and are likely to be consumed within the next three years; and
  - Replacement with current Powerlink standard relays will require major logic and wiring modification resulting in longer outage window.

- 275kV Feeder protection panels – Feeder 853, 8810, 854 and 8811
  - Duplicate protection relays have been in service for 17 years;
  - These protection relays as well as the autoreclosing and CVT monitoring relays have experienced reliability issues and manufacturers have ceased to provide technical support and supply. There are no new system spares for these relays while there are some recovered spares. These recovered spares have a high probability of start-up failure and are likely to be consumed within the next three years; and
  - Replacement with current Powerlink standard relays will require major logic and wiring modification resulting in longer outage window.

- 275kV Transformer panels
  - Various relays are used to protect the transformer which have been in service for 27 years;
  - These relays have experienced reliability issues and manufacturers have ceased to provide technical support and supply. There are limited system spares for these relays. These spares are likely to be consumed within the next three years; and
  - Replacement with current Powerlink standard relays will require major logic and wiring modification resulting in longer outage window.

- Corridor construction type panels
  - All the panels mentioned above are of construction with separate protection and auxiliary panels. This type of construction is vulnerable to cause human error or mis-tripping of primary plant when maintenance is conducted and it is also expensive to modify because of the inter-panel wiring; and
  - Increased safety risk due to the exposed wiring terminals and constrained space for maintenance on the tunnel control panel.

- DC Supply Circuitry
  - The current DC batteries have been in service for more than 10 years;
  - Battery failure could cause the protection system to maloperate and result in a forced outage of primary plant.
- Local control, SCADA and Opswan
  - All panels are fitted with C50 RTUs for local control between 1988 and 1998 and there are no spares available.
- LV cables
  - The control cables connecting to the primary plant equipment were installed in 1988, have been in service for 27 years and have become very hard and deteriorated.

Asset Risk

- The following risks have been identified associated deteriorated condition and reliability concerns of the 275/132kV secondary systems equipment.
- Maintainability - aging equipment with increased risk of failure,
- Reliability - limited spares with limited or no manufacturer support available
- Safety risks due to the exposed wiring and constrained space for maintenance on the tunnel control panel; and
- Operational issues (single bus zone protection scheme, distance blocking scheme) and obsolescence of HMI

The current level of risk for the secondary systems at Calvale is moderate. Relay failure will result in a loss of monitoring and remote control of primary plant and associated SCADA. Failure of the obsolete HMI device will result in a lack of local control for a prolonged period. The DC bus is over head and exposed and any work on site needs to be undertaken slowly to meet the level of caution required to mitigate the safety risk.

Calvale substation is an essential component of the transmission network supplying central and southern Queensland. The risks highlighted above are required to be addressed by October 2018 to maintain reliability of supply to the area.

Related approved projects

Project Number	Description	Target Commissioning Date
OR.02027	H024 Calvale Substation Urgent RTU Replacement	November 2015
CP.01546	Callide A Switchyard Replacement	December 2018

Regulatory Matters

The Calvale Secondary Systems Replacement project was included in Powerlink's 2010 Non Load Driven Plan and does not require RIT-T consultation.

Project Number	Description	Target Commissioning Date	Estimate	Life Cycle Cost
CP.01151	Calvale Secondary Systems Replacement	31/10/2018	$11.9m	Y

Strategies and Policies

Powerlink strategies and policies are overarched by the National Electricity Rules (NER). Policies of particular relevance to Calvale Substation Secondary Systems include:

(1) AM-POL-0463 Protection Design
(2) AM-POL-0970 Secondary Systems Design
(3) AM–POL–0164, SCADA Requirements for Operational Purposes
(4) AM-POL-0169 Secondary Systems Maintenance Policy
(5) AM-POL-0053 AC and DC Supplies

As noted in Powerlink policy, protection systems should be designed to ensure system security is consistent with NER requirements (Table 1 – Maximum Fault Clearance Times NER Table S5.1a.2).

Relevant Stakeholders

Portfolio Management	[redacted]	[redacted]
HV/DT Strategies	[redacted]	[redacted]
Network Customers	[redacted]	[redacted]
Network Integration	[redacted]	[redacted]

Assessment of Options

Option 1: Minimal in situ replacement by 2018, followed by a full replacement in 2023

Option Overview	Option 1 includes in situ replacement of: • secondary systems equipment within existing panels for the 275kV and 132kV bays : o 1 and 2 bus zone protection o =C03 – T1 transformer bay and coupler 503 bay o =C04 – all bays o =C05 – feeder 852 bay and coupler 504 bays o =C06 – feeder/reactor 8810 bay and coupler 506 bay o =C07 – feeder/reactor 8811 bay and coupler 507 bay o =D04 – 132kV feeder 7161 • control system RTUs and Y protection relays =C03 feeder 8874 bay and =C05 feeder 871 bay

	• SCADA system interface with DNP over TCP/IP • installation of new batteries and distribution boards; and • SAP, CNDB, CMS and SPF updates as appropriate.
Estimated Cost	$7.4M
Basis of Cost	Indicative costs based on a Concept level estimate prepared for a similar project
Completion Date	October 2018 This timing takes into account: • the DC bus is over head and exposed and any work on site needs to be undertaken slowly to meet the level of caution required to mitigate the safety risk; and • mitigation of the more immediate risks associated with the RTUs is currently being addressed under OR.02027. The complexities in relation to generator customer outage availability and the associated detailed scheduling requirements do not form part of this Investment Options Paper and will be evaluated as part of project deliverability.
Key Assumptions	Safe work practices will be assessed and implemented as part of project delivery. This option assumes that there are no SDM interface issues on the bus zone and control system which are pre SDM8.
Risk Level Post Implementation of Option	Replacement of protection and control systems minimise the likelihood and consequences of failures which may occur due to malfunctions and protect assets. A moderate or significant residual risk could undermine the effectiveness of the controls required to maintain the overall secondary system functionality of Calvale Substation. Under option 1, the current moderate reliability and safety risk remains unchanged after implementation. This is due to the majority of aged equipment, brittle wiring and tunnel panels with exposed terminals remaining in service which will still be vulnerable to mis-operation during regular maintenance activities. This option carries the highest risk of reliability and failure compared to all other options.
Benefits of Option	Option 1 defers the requirement for a full secondary system replacement for five years.
Drawbacks of Option	As this option involves minimal relay replacement, overall reliability at the site is only marginally improved, due to the aged assets remaining in service. The DC bus is over-head and exposed. Work will be slow because of the additional level of caution that is required to mitigate the safety risk and may take longer than anticipated if unexpected situations arise.

Customer Impacts	Demand in the area is largely associated with industrial, commercial and residential loads. Customers, business and industry in the area may be detrimentally affected should an unplanned outage occur as a result of inadvertent contact with exposed terminals.
Operational Impacts	Option 1 has the highest effect on the network compared to Options 2, 3 and 4. Based on similar projects, it is estimated that outages of approximately two weeks per panel for construction and commissioning works will be required.
Delivery Risks & Constraints	Option 1 leaves the greatest dependence on the availability of MSP resources to respond to equipment failures or investigation post implementation compared to options 2, 3 and 4.

Option 2: Partial and in situ partial replacement by 2018

Option Overview	Option 2 is the full SDM9 replacement of 1988 secondary systems and in situ replacement of 1998 secondary systems, including: • Full replacement of secondary systems equipment and panels for the 275kV and 132kV bays: o 1 and 2 bus zone protection o =C03 – all bays o =C04 – all bays o =C05 – all bays o =D04 – 132kV feeder 7161 • In situ replacement of 1998 secondary systems equipment within existing panels for 275kV bays: o =C06 – feeder/reactor 8810 bay and coupler 506 bay o =C07 – feeder/reactor 8811 bay and coupler 507 bay • Full replacement of non-bay secondary systems equipment and panels: o Substation HMI o OpsWAN server o Callide B PS U1 and U2 interface RTUs • Integration of the replacement Callide B PS U1 and U2 interface RTU's and protocol converter RTU's with the replacement secondary systems • Integration of the existing CQ-SQ SPS scheme with the replacement secondary systems • Replacement of existing SCADA system interface with DNP over TCP/IP • Replacement of 125VDC and 50VDC batteries • SAP, CNDB, CMS and SPF updates as appropriate.
Estimated Cost	$14.21M
Basis of Cost	Indicative costs based on a Concept level estimate prepared for a similar project
Completion Date	October 2018

	This timing takes into account: • the DC bus is over head and exposed and any work on site needs to be undertaken slowly to meet the level of caution required to mitigate the safety risk; and • mitigation of the more immediate risks associated with the RTUs is currently being addressed under OR.02027. The complexities in relation to generator customer outage availability and the associated detailed scheduling requirements do not form part of this Investment Options Paper and will be evaluated as part of project deliverability.
Key Assumptions	Safe work practices can be undertaken. This option assumes the existing cabling will be utilised and that there are no SDM interface issues on the bus zone and control system which are pre SDM8.
Risk Level Post Implementation of Option	Replacement of protection and control systems minimise the likelihood and consequences of failures which may occur due to malfunctions and protect assets. A moderate or significant residual risk could undermine the effectiveness of the controls required to maintain the overall secondary system functionality of Calvale Substation. Although slightly improved compared to Option 1, a moderate reliability and safety risk still remains after implementation of this option due to the aged equipment (from 1998) and tunnel panels with exposed terminals which will remain in service. This option carries the second highest risk of reliability and failure compared to options 1, 3 and 4.
Benefits of Option	Option 2 replaces the 1998 secondary systems equipment within existing panels and defers a full secondary system replacement by ten years.
Drawbacks of Option	Overall reliability at the site will remain problematic due to the risk associated with the RTUs and other aged assets remaining (e.g. existing cabling, old panels remaining in use for an additional ten years). As with Option 1, work will be need to be undertaken at a slow pace because of the additional level of caution that is required to mitigate the safety risk of tunnel panels with exposed terminals and work may take longer than anticipated if unexpected circumstances arise.
Customer Impacts	Demand in the area is largely associated with industrial, commercial and residential loads. Customers, business and industry in the area may be detrimentally affected should an unplanned outage occur as a result of inadvertent contact with exposed terminals.
Operational Impacts	Option 2 has the second highest effect on the network compared to

	Options 1, 3 and 4.
Delivery Risks & Constraints	Option 2 has the second greatest dependence on the availability of MSP resources to respond to equipment failures or investigation post implementation compared to options 1, 3 and 4.

Option 3: Majority full replacement by 2018

Option Overview	Option 3 includes: • Full SDM9 replacement of secondary systems equipment and panels for 275Kv and 132kV bays: o 1 and 2 bus zone protection o =C03 – all bays o =C04 – all bays o =C05 – all bays o =C06 – feeder/reactor 8810 bay and coupler 506 bay o =C07 – feeder/reactor 8811 bay and coupler 507 bay o =D04 – 132kV feeder 7161 • Full replacement of non-bay secondary systems equipment and panels: o Substation HMI o OpsWAN server o Callide B PS U1 and U2 interface RTUs • Integration of the existing CQ-SQ SPS scheme with the replacement secondary systems • Replacement of existing SCADA system interface with DNP over TCP/IP • Replacement of 125VDC and 50VDC batteries • SAP, CNDB, CMS and SPF updates as appropriate.
Estimated Cost	$16.06M
Basis of Cost	Indicative costs based on a Concept level estimate prepared for a similar project
Completion Date	October 2018 This timing takes into account: • the DC bus is over head and exposed and any work on site needs to be undertaken slowly to meet the level of caution required to mitigate the safety risk; and • mitigation of the more immediate risks associated with the RTUs is currently being addressed under OR.02027. The complexities in relation to generator customer outage availability and the associated detailed scheduling requirements do not form part of this Investment Options Paper and will be evaluated as part of project deliverability.
Key Assumptions	Design, installation and commissioning of the remote end protection relays for Callide B power station will not be carried out by

	Powerlink.
Risk Level Post Implementation of Option	Option 3 has the lowest overall level of risk compared to options 1, 2 and 4.
Benefits of Option	Option 3 has the lowest long run cost in the npv analysis. This option removes the safety risk associated with the exposed terminals and will have a lower effect on the network compared to Options 1 and 2. Dependence on MSP resources is significantly less than Options 1 and 2. FAT will be carried out before cut-over commences and as a result, cut-over works can be planned accurately as this option is not reliant on the existing condition of the secondary system. Option 3 meets the requirements of the National Electricity Rules.
Drawbacks of Option	N/A
Customer Impacts	Demand in the area is largely associated with industrial, commercial and residential loads. Customers, business and industry in the area may be detrimentally affected should an unplanned outage occur as a result of inadvertent contact with exposed terminals.
Operational Impacts	Based on similar projects, outages of approximately two weeks per panel for commissioning works will be required.
Delivery Risks & Constraints	There is a low dependence on the availability of MSP resources post implementation, however it is significantly less than Option 1, 2 and slightly lower than option 4 due to staging.

Option 4: Staged Replacement - 1988 secondary systems by 2018 and 1998 secondary systems by 2023

Option Overview	Option 4 includes the same scope of works as option 3 with the works being delivered over two stages with a five year deferral period. Stage 1 works are the same as Option 3 with the exception of the full replacement of secondary systems equipment and panels for 275kV bays =C06 and =C07 which were established in 1998 (Stage 2).
Estimated Cost	$13.42
Basis of Cost	Indicative costs based on a Concept level estimate prepared for a similar project
Completion Date	Stage 1 October 2018 This timing takes into account: • the DC bus is over head and exposed and any work on site needs to be undertaken slowly to meet the level of caution required to mitigate the safety risk; and • mitigation of the more immediate risks associated with the

	RTUs is currently being addressed under OR.02027. Stage 2 October 2023 The complexities in relation to generator customer outage availability and the associated detailed scheduling requirements do not form part of this Investment Options Paper and will be evaluated as part of project deliverability.
Key Assumptions	Design, installation and commissioning of the remote end protection relays for Callide B power station will not be carried out by Powerlink.
Risk Level Post Implementation of Option	Option 4 has a similar level of risk compared to option 3, however there remains some minor risk associated with those aged assets which will not be replaced until the completion of Stage 2 in 2023.
Benefits of Option	Option 4 has the second highest long run cost in the npv analysis, however is a similar cost to Option 2. This option removes the safety risk associated with the exposed terminals and will have a lower effect on the network compared to Options 1 and 2. FAT will be carried out before cut-over commences and as a result, cut-over works can be planned accurately as this option is not reliant on the existing condition of the secondary system.
Drawbacks of Option	Due to the five year deferral for completion of works, critical staff may be required to respond to equipment failures or investigation above the usual requirements for maintenance practices due to the aged 1998 secondary systems equipment and panels remaining in service until 2023.
Customer Impacts	Demand in the area is largely associated with industrial, commercial and residential loads. Customers, business and industry in the area may be detrimentally affected should an unplanned outage occur as a result of inadvertent contact with exposed terminals.
Operational Impacts	Based on similar projects, outages of approximately two weeks per panel for commissioning works will be required.
Delivery Risks & Constraints	There is some dependence on the availability of MSP resources post implementation, however it is significantly less than Option 1 and 2 but higher than Option 3 due to the staging of works.

Economic Assessment of Options

NPV Parameters

Discount Cash Flow Rate	Period of NPV Assessment
8.61%	25 years

NPV Components of Option 1: *Minimal relay replacement in situ by October 2018*

Action	Date	Value
Minimal relay replacement	2018	$7.4M
Full secondary systems replacement	2023	$16.06

NPV Components of Option 2: *Partial and in situ replacement by October 2018*

Action	Date	Value
Partial and in situ replacement	2018	$14.21M
Remainder of secondary systems replacement	2028	$5.4M

NPV Components of Option 3: *Majority replacement by October 2018*

Action	Date	Value
Majority secondary systems replacement	2018	$16.06M

NPV Components of Option 4: *Staged majority replacement by October 2023*

Action	Date	Value
Stage 1 majority secondary systems replacement	2018	$13.42M
Stage 2 =C06 and =C07 275kV secondary systems replacement	2023	$5.72M

NPV Results

		Present Value	Rank
Option 1	In situ minimal replacement	$14.16M	4
Option 2	In situ partial replacement	$12.16M	2
Option 3	Majority replacement	$11.15M	1
Option 4	Staged majority replacement	$12.53M	3

The information above and financial analysis shows that Option 3 offers the lowest cost solution in NPV terms.

Recommended Option

Having taking into consideration

- the NPV results which identify Option 3 as the most economic option;
- removal of the safety risk from exposed terminals and constrained space;
- greater reliability benefits compared to option 1 and 2 which are still dependent upon aging equipment in order to operate post implementation; and
- operational capability in accordance with the National Electricity Rules

Option 3, majority bay replacement by October 2018, is the preferred option for implementation.

It is recommended that approvals be sought in line with current financial delegations to progress Option 3 by October 2018. The estimated cost of these works is $16.06M ($15/16).

CAPITAL PROJECT ENDORSEMENT SHEET

Project: **CP.01151**	Description: **Calvale and Callide B Power Station Secondary Systems Replacement**

In order to ensure that all the issues associated with network capital works are addressed, it is desirable to have all relevant Managers within Powerlink Queensland endorse project approval submissions prior to financial approval being received.

Endorsement by responsible parties ensures that the proposed project scope achieves Powerlink's requirements. The following parties endorse this project and recommend its approval, specifically:

1. there is an ongoing need for the project and the project scope is consistent with the intended objective of the project;

2. the project scope (including the timing) and associated estimate are consistent, and appropriate budget has been identified for the required works to ensure a deliverable outcome;

3. there is sufficient budget provision to undertake this capital project and the project is allowed for within the overall portfolio of works; and

4. the proposed scope is technically acceptable and complies with all current plant strategies.

[redacted]
Senior Project Sponsor

[redacted]
Portfolio Manager Portfolio & Business Mangement

[redacted]

[redacted]

Signature

Date

INVESTMENT & PLANNING

BUSINESS CASE

CP.01151 Calvale & Callide B PS Secondary Systems Replacement

13 November 2015

Document Control

Issue Date	Responsible Person	Objective Document Name	Background
13 Nov 2015	[redacted]	Business Case CP.01151 Calvale & Callide B PS Secondary Systems Replacement	Initial issue

CONTENTS

SUMMARY

This report sets out a business case to justify a capital project for replacement of secondary systems at the Calvale Substation and Callide B Power Station. It discusses the reasons for replacement of the assets and also recommends the proposed scope as the preferred option that addresses the issues associated with the secondary systems at Calvale Substation and Callide B Power Station.

It is recommended that approval be sought for Option 3 the majority full replacement of secondary systems at Calvale Substation and Callide B Power Station. The estimated capital expenditure required is $21.79 million escalated to completion ($19.8 million plus 10% contingency), which comprises of $18.9 million for Prescribed Transmission Services assets [redacted] The works are to be completed by June 2021.

As a result of this project, it is also recommended that $2,535,819 of accelerated depreciation be applied to the existing assets being replaced.

1. INTRODUCTION

As a transmission network service provider, Powerlink undertakes works to meet its obligations contained in the *National Electricity Rules* (the Rules) to plan, design, operate and maintain the transmission network to allow the efficient transfer of electrical energy from producers to users. In addition, under its *Transmission Authority* obligations set out in the *Electricity Act*, Powerlink must make appropriate investments to ensure continuity of supply (refer Attachment 1).

These obligations give rise to a program of capital expenditure to develop the network to ensure efficient transfer of electrical energy and to replace assets to maintain reliability of supply. This business case describes a capital project to replace the secondary systems equipment at Calvale Substation and Callide B Power Station to address the reliability and obsolescence issues.

2. BACKGROUND

Calvale 275/132kV substation which is located in Central Queensland was established in 1988 and is a key switching point for the region with power flowing to the north and east of the state as well as beyond to southern Queensland. Originally the substation was established to connect to Callide A and B power stations.

Calvale substation was extended to connect to Callide C Power Station and Tarong in 1998 and further expanded in 2013 as part of the Calvale to Stanwell augmentation to meet increased demand in the region. The substation layout has seven 275kV diameters which include:

- four 275kV generator connections (two Callide B, two Callide C)
- six 275kV feeders (to Halys, Wurdong and Stanwell)
- one 275/132kV transformer bay
- one 132kV feeder bay
- one 275kV spare transformer bay

The substation has a mixture of secondary systems equipment ranging in age from two to twenty-seven years old.

In addition, there is secondary systems equipment from the original installation at Callide B Power Station to provide an interface with Calvale Substation.

3. NEED

The original secondary systems equipment for five diameters at the Calvale Substation is now over seventeen years old, with some equipment up to twenty-seven years old. Similarly, secondary systems equipment at Callide B Power Station is now over twenty-seven years old.

A condition assessment of the secondary systems equipment at the Calvale Substation and Callide B Power Station was undertaken, which identified that the equipment installed prior to 2000 requires replacement due to:

- maintainability issues arising from obsolete technology, such as lack of availability for spare parts and manufacturer support, as well as design deficiencies;
- defective and unserviceable equipment condition resulting in decreased reliability in the short term; and
- tunnel-entry type panel layout which brings about safety and network security concerns.

Calvale Substation is an essential component of the transmission network supplying central and southern Queensland. In the event of failure of the secondary systems, Powerlink's ability to maintain reliability of supply to northern and central Queensland would be reduced and potentially leave load at risk until the faulty equipment is replaced. As a result, corrective action is considered necessary.

The replacement works would take until 2021 to complete due to the need to align with the four-yearly cycle of generator maintenance outages (i.e. one of four units is taken out for maintenance each year). Further deferral would result in the associated equipment not being replaced until the mid-2020s to align with next cycle of generator unit outages. Considering the deteriorated condition of the equipment, deferral is not considered an acceptable solution.

4. PROPOSED SOLUTION

4.1. Options Considered

Four options were considered to address the identified issues, and are summarised in the following sections.

- Option 1 - Minimal relay replacement in the existing panels;
- Option 2 - Partial secondary systems replacement in the existing control building;
- Option 3 - Replacement of the majority of secondary systems equipment in the existing building; and
- Option 4 - Staged replacement of the majority of the secondary systems equipment in the existing control building.

Additional information is available from the associated Investment Options Paper (A2119630) which is included in Attachment 4.

4.1.1. Option 1 - Minimal In Situ Replacement

Option 1 involves the in situ replacement of obsolete equipment in the existing tunnel panels and includes upgrading the SCADA system interface to current standards and installation of new batteries, distribution boards and selected marshalling kiosks.

The key benefit of this option is that it defers the requirement for a major secondary systems replacement for five years.

The key risks of this option are:

- The current moderate reliability and safety risk remains unchanged after implementation due to a residual majority of aged equipment, brittle wiring and tunnel panels with exposed terminals remaining in-service, which would continue to be vulnerable to mal-operation during regular maintenance activities.

- The implementation for this option in comparison to the others, poses the most risk for network operations and would be the most intrusive due to the extended outages required to effect installation and cutover of new secondary systems within the existing in-service equipment panels. Works would need to be undertaken at a cautious pace because of the additional care required to mitigate the safety risk of tunnel panels with exposed terminals.

The NPV assessment for this option includes provision for the cost of a major secondary systems replacement five years after the in situ replacement is completed. This option has the highest long run cost in the NPV analysis.

Option 1 would address the condition issues in the short term.

4.1.2. Option 2 - Partial and In Situ Replacement

Option 2 involves full replacement of the 1988 secondary systems equipment and panels, and in situ replacement of 1998 equipment.

This option comprises full replacement of the 275kV bus zone protection, and the secondary systems for three 275kV diameters and one 132kV feeder bay. Also included is the replacement of secondary systems within existing panels for two 275kV diameters, as well as upgrading the SCADA system interface to current standards, installation of new batteries, distribution boards and selected marshalling kiosks.

The key benefit of this option is that it defers the requirement for a secondary systems replacement for ten years.

The key risks of this option are:

- Although improved compared to Option 1, a moderate reliability and safety risk remains after implementation due to a residual population of aged equipment, brittle wiring and tunnel panels with exposed terminals. This option has the second highest risk of equipment reliability and failure when compared to options 1, 3 and 4.

- The implementation for this option poses risk to network operations requiring extended outages to effect the in situ installation and cutover of new secondary systems within the existing in-service equipment panels.

- As with Option 1, the works would need to be undertaken at a cautious pace because of the additional care required to mitigate the safety risk of tunnel panels with exposed terminals.

The NPV assessment for this option includes provision for the cost of a secondary systems replacement ten years after the in situ replacement is completed. This option has the second lowest long run cost in the NPV analysis.

This option would address the condition issues in the short to medium term.

4.1.3. Option 3 - Majority Full Replacement

Option 3 involves full replacement of the 1988 and 1998 secondary systems equipment and panels.

This option comprises full replacement of the 275kV bus zone protection, and the secondary systems for five 275kV diameters and one 132kV feeder bay. Also included is upgrading the SCADA system interface to current standards, installation of new batteries, distribution boards and selected marshalling kiosks.

The safety risk associated with the exposed terminals is removed with this option as well as having a lesser impact on the network compared to options 1 and 2. As the scope of this option involves progressive cut-overs to pre-FAT tested SDM9 panels, there would be reduced risk of unplanned forced outages.

The secondary systems for the transmission circuits and one generator connection would be replaced by 2018 with commissioning of the last generator bays to occur in 2020. Decommissioning and removal of redundant equipment would extend into 2021. The generator bays would be commissioned during the programed four-yearly generator maintenance outages between 2017 and 2020.

Dependence on MSP resources is considerably less than options 1 and 2.

Option 3 would address the condition issues, and has the lowest long run cost in the NPV analysis.

4.1.4. Option 4 - Staged Full Replacement

Option 4 includes the same scope works as Option 3 with the works delivered over two stages. Stage 1 involves full replacement of the 1988

secondary systems equipment and panels, and under stage 2 five years subsequent is the full replacement of the 1998 panels.

Option 4 has similar risk level compared to option 3 however there remains some minor risk associated with aged assets which would not be replaced until the completion of stage 2.

There is some dependence on the availability of MSP resources post implementation, however it is considerably less than options 1 and 2, but higher than Option 3 due to the staging of the works.

This option would address the condition issues and has the second highest long run cost in the NPV analysis.

4.2. Recommended Solution

The recommended option is Option 3, majority replacement of secondary systems in one stage at the Calvale Substation and Callide B Power Station.

An economic assessment has been undertaken to evaluate the present value of the options, the results of which are summarised in Table 1 below.

Table 1 - Summary of NPV Financial Analysis

		Present Value	Rank
Option 1	Minimal In Situ Replacement	$ 14.158M	4
Option 2	Partial and In Situ Replacement	$ 12.157M	2
Option 3	Majority Full Replacement	$ 11.151M	1
Option 4	Staged Full Replacement	$ 12.530M	3

Option 3 is the lowest overall cost and in comparison to the other options:

- has the lowest operational and implementation risks;
- addresses all of the technical matters requiring rectification as identified in the Condition Assessment Report;
- resolves reliability issues which will remain problematic and potentially costly (financially and in relation to MSP resources) due to the aged assets remaining in service for an additional five to ten years; and
- removes the safety risk associated with the exposed terminals.

On balance, in light of the financial analysis and having weighed the risks and benefits of each option, it is recommended that Option 3 - Majority Secondary Systems Replacement – represents the most prudent and efficient option. The estimated cost of these works is $19.8 million escalated to completion.

[redacted]

5. STRATEGIC FIT

The replacement of secondary systems at the Calvale Substation and Callide B Power Station is consistent with long term electricity infrastructure requirements in the central Queensland area. The new secondary systems comply with the current Powerlink Digital Technology Asset Management Methodology (refer AM-STR-0167).

6. PROJECT SCOPE

The project scope is outlined in the project scope report, refer Attachment 2.

7. PROJECT COMPLETION

The planned completion date for the project is June 2021.

The planned completion date is significantly influenced by power station generator outage opportunity. The majority of the Calvale Substation secondary systems is planned to be replaced by 2018 including one Callide B Power Station generator connection bay. The balance of generator bays will be commissioned during the programed generator maintenance outages from 2018 through 2020.

8. DEPENDENCIES

This project is dependent upon the timely completion of project *CP.01546 - Callide A Substation Replacement* for the establishment of new digital telecommunications infrastructure in the Calvale Callide area.

There are no projects dependent upon the timely completion of this project.

9. COSTS

The project quotation is enclosed; refer Project Proposal - Attachment 3, and summarised in the table below

Table 2 - Summary Project Proposal

Description	**Estimate 2015/16 $k**	**Escalated to Completion $k**
Preliminary Costs (I&P, Project Concept & Definition)	[redacted]	[redacted]
Q Leave	[redacted]	[redacted]
Project Management	[redacted]	[redacted]
Design Support	[redacted]	[redacted]
Calvale Sec Sys Replacement	[redacted]	[redacted]
Callide B PS Sec Sys Replacement	[redacted]	[redacted]
Commissioning Coordination	[redacted]	[redacted]
Network Switching	[redacted]	[redacted]
Total	**18,492**	**19,805**

The projected cash flows based on an annual escalation 4.1% are set out below.

Table 3 - Project Cash Flow

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Basis of Cost	**2015/16 $k**	**2016/17 $k**	**2017/18 $k**	**2018/19 $k**	**2019/20 $k**	**2020/21 $k**	**Total $k**
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
At Completion (Prescribed)	2,275	8,722	3,168	21	540	2,452	**17,178**
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

A contingency amount of 10% should be included to allow for unforeseen scope changes. This brings the total amount to be approved to [redacted] ($18.9 million for Prescribed Transmission Service assets [redacted]

As a result of this project, it is also recommended that accelerated depreciation be applied to the existing secondary systems at Calvale and Callide B Power Station. The written down value of assets to be replaced by this project is estimated to be $2,535,819 at 30 June 2016.

10. FUNDING

The capital expenditure of this project has been reviewed in relation to the financial forecasts and borrowing requirements. Funding of this project is considered appropriate and can be accommodated within the current approved capital budget and as such within Powerlink's borrowing requirements.

11. RETURN ON INVESTMENT

The replacement of Non-Regulated Transmission Service assets at Calvale will require a capital investment of $2.89 million. Whilst there is no additional customer connection charge, the current post-tax nominal WACC for a 30 year Connection and Access Agreement is [redacted] in accordance with the non-regulated and negotiated transmission services pricing policy.

The actual return on Calvale non-regulated investment associated with the Callide C (Callide Power Plant) connection is now estimated to reduce from [redacted] to [redacted]

To support Powerlink's capital expenditure associated with Prescribed Transmission Service assets at Calvale and Callide B Power Station, and to meet its regulatory obligations, the following matters have been considered for the proposed investment:

- the expenditure is demonstrated to be cost effective;
- the requirement for the assets does not diminish in future (i.e. asset stranding does not occur);
- the proposed capital expenditure relative to the allowance in the AER's current Transmission Determination for Powerlink; and
- appropriate consultation and approvals processes are undertaken.

Each of these issues is discussed in turn below.

11.1. Cost Effective Solution

This report discusses the need for replacement of the secondary systems at Calvale and Callide B Power Station. The recommended option is the lowest cost solution to address the condition and obsolescence issues and has prudent regard for long term business requirements.

The works to be undertaken are also in accordance with Powerlink's Procurement Policy and existing procurement arrangements to ensure effective pricing competition. The expenditure is therefore considered to be cost effective.

11.2. Stranding Risk

The Calvale Substation is required for the foreseeable future to provide an essential switching and bulk supply point for the Callide area in Central Queensland. The stranding risk associated with this proposed investment is therefore not considered to be significantly different to that of Powerlink's other typical prescribed investments.

11.3. Capital Expenditure Allowance

The replacement of the secondary systems equipment associated with Prescribed Transmission Service assets at Calvale and Callide B Power Station will incur capital expenditure and result in an increase in the value of assets in the regulated asset base.

For the regulatory period of 2012/13 to 2016/17 the revenue regulation arrangements include an ex-ante capex allowance. Powerlink will receive a full regulated return on, and of, the expenditure, provided the investment required to meet Powerlink's obligations over the five year period is prudent and efficient, and within the capital expenditure allowances in the AER's Transmission Determination for Powerlink.

This project is included in the current capital budget forecast and, therefore, the capital expenditure associated with Prescribed Transmission Service assets in this project is within the ex-ante capital expenditure allowance.

11.4. Approval and Consultation

The AER requires that all new assets to be rolled into the regulated asset base at the end of the 2012/13 to 2016/17 regulatory period be subjected to the appropriate consultation and approvals processes.

At the time of writing there are no Rules requirements for approvals, public or participant consultation on the replacement of assets such as secondary systems included in this project. However, this project is subject to Powerlink's capital governance process.

In line with the *Queensland GOC Investment Guideline*, as the works are greater than $20 million, Shareholding Ministers will be notified following the Board approval.

12. RECOMMENDATION

It is recommended that approval be sought for replacement of the majority of the secondary systems at Calvale and Callide Power Station as described in Option 3. The estimated cost is [redacted] escalated to completion [redacted] which is comprised of $18.9 million for Prescribed Transmission Service assets a[redacted] The works are to be completed by June 2021.

As a result of this project, it is also recommended that accelerated depreciation be applied to the existing Calvale and Callide B Power Station secondary systems equipment that is to be replaced. The written down value of assets to be replaced by this project is estimated to be $2,535,819 as at 30 June 2016.

13. REFERENCES

1. Condition Assessment Report - A2334966
2. Project Scope Report - A2187050
3. Project Proposal - A2202358
4. Investment Options Paper - A2119630

ATTACHMENT 1 – PLANNING OBLIGATIONS

As a transmission network service provider (TNSP), Powerlink is obliged to meet the requirements of Schedule 5.1 of the *National Electricity Rules* (the Rules) and in particular, clause S 5.1.2.1:

> *"Network Service Providers must plan, design, maintain and operate their transmission network… to allow the transfer of power from generating units to Customers with all facilities or equipment associated with the power system in service and may be required by a Registered Participant under a connection agreement to continue to allow the transfer of power with certain facilities or plant associated with the power system out of service, whether or not accompanied by the occurrence of certain faults (called "credible contingency events").*
>
> *The following credible contingency events and practices must be used by Network Service Providers for planning and operation of transmission networks….*
>
> *The credible contingency events must include the disconnection of any single generating unit or transmission line, with or without the application of a single circuit two-phase-to-ground solid fault on lines operating at or above 220 kV".*
>
> *The voltage stability criteria outlined in Clause S5.1.8 of the National Electricity Rules requires 'that an adequate reactive power margin must be maintained at every connection point in a network with respect to the voltage stability limit as determined from the voltage/reactive load characteristic at that connection point'. In line with this requirement, a reactive margin of 1% of the maximum fault level (in MVA) at each connection point is required.*

Powerlink's transmission authority also includes a responsibility on Powerlink to:

> *"…..plan and develop its transmission grid in accordance with good electricity industry practice such that:*
>
> *…*
>
> *(b) if the power quality standards do not specify different obligations during normal and other operating conditions – the power quality standards will also be met by the transmission entity even during the most critical single network element outage; and*
>
> *(c) the power transfer available through the power system will be such that the forecast of electricity that is not able to be supplied during the most critical single network element outage will not exceed:*
>
> *(i) 50 megawatts at any one time; or*
>
> *(ii) 600 megawatt-hours in aggregate....." (Electricity Act 1994).*

These obligations give rise to an ongoing program of capital expenditure to develop the grid and to replace aged assets.