Powerlink Queensland

Project Specification Consultation Report

29 October 2018

Maintaining power transfer capability and reliability of supply at Bouldercombe Substation

Document Purpose

For the benefit of those not familiar with the National Electricity Rules (the Rules) and the National Electricity Market (NEM), Powerlink offers the following clarifications on the purpose and intent of this document:

1. The Rules require Powerlink to carry out forward planning to identify future reliability of supply requirements and consult with interested parties on the proposed solution as part of the Regulatory Investment Test for Transmission (RIT-T). This includes replacement of network assets in addition to augmentations of the transmission network.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. The main purpose of this document is to provide details of the identified need, credible options, technical characteristics of non-network options, and categories of market benefits addressed in the assessment. In particular, it seeks information from potential proponents of feasible non-network options to address the identified need.

Contents

Executive Summary

Located approximately 19 kilometres south-west of Rockhampton and established in 1975, Bouldercombe Substation is a major transmission node for Central Queensland, marshalling a number of 275kV circuits from Nebo and Broadsound to the north, Stanwell in the west and Raglan and Calliope River to the south.

It also provides the sole 132kV injection source for the area, supplying Ergon Energy at Rockhampton, Egans Hill and Pandoin, as well as Stanwell Power Station's auxiliary supply and customers directly connected to Powerlink's network.

Transformers 1 and 2, along with the original circuit breakers, disconnectors, earth switches and instrument transformers at Bouldercombe Substation are nearing the end of their technical service lives, with manufacturers no longer providing technical support or carrying spares for many of the items.

Powerlink's obligations as a Transmission Network Supply Provider (TNSP)[1] require it to maintain (including repair and replace if necessary) its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity, including the ability to meet peak demand if a major element of the network was to fail.

The increasing likelihood of faults arising from the ageing and obsolete plant at Bouldercombe Substation remaining in service, presents Powerlink with a range of operational and safety risks, as well as compliance issues, requiring resolution.

Powerlink is required to apply the RIT-T to this investment

This investment is driven by an obligation under the Rules, and is classified as a 'reliability corrective action' under the RIT-T.

Credible options

Powerlink has developed six credible options to address the identified need.

A Base Option reflecting a minimalist approach to ensuring continued compliance with Powerlink's reliability of supply obligations has been compared with five other options in which one of two transformers of differing capacity is paired with a range of primary plant replacement and life extension strategies.

Table 1: Summary of credible options

Option	Description	Indicative capital cost ($million, 2018/9)	Indicative annual O&M costs ($million, 2018/19)
Base Option Standard 250MVA transformer with staged replacement of primary plant by December 2031	Install a new 250MVA transformer Decommission Transformers 1 & 2 Life extend or replace selected primary plant by December 2021*	26.77*****	0.14
	Replace balance of ageing plant by December 2031†	16.96**†**	
Option 1 Standard 250MVA transformer with staged replacement of primary plant by December 2041	Install a new 250MVA transformer, decommission transformers 1 & 2, life extend or replace selected primary plant by December 2021*	26.98*****	0.14
	Replace balance of ageing plant by December 2041†	15.95†	

[1] Schedule 5.1a System Standards and 5.1.2 Network Reliability of the Rules, Electricity Act 1994 and Queensland Transmission Authority T01/98

Option	Description	Indicative capital cost ($million, 2018/9)	Indicative annual O&M costs ($million, 2018/19)
Option 2 Install standard 250MVA transformer with upfront replacement of all primary plant in selected bays by December 2021	Install a new 250MVA transformer, decommission transformers 1 & 2 and single stage replacement of all plant in selected bays by December 2021*	30.60*	0.12
Option 3 Standard 375MVA transformer with staged replacement of primary plant by December 2031	Install a new 375MVA transformer, decommission transformers 1 & 2 and life extend or replace selected primary plant by December 2021*	27.28*	0.14
	Replace balance of ageing plant by December 2031†	16.96†	
Option 4 Standard 375MVA transformer with staged replacement of primary plant by December 2041	Install a new 375MVA transformer, decommission transformers 1 & 2 and life extend or replace selected primary plant by December 2021*	27.49*	0.14
	Replace balance of ageing plant by December 2041†	15.95†	
Option 5 Standard 375MVA transformer with upfront replacement of all primary plant in selected bays by December 2021	Install a new 375MVA transformer, decommission transformers 1 & 2 and single stage replacement of all primary plant in selected bays by December 2021*	31.12*	0.12

*Proposed RIT-T project
†Modelled project

Powerlink has also considered whether non-network options could address the identified need. A non-network option that avoids replacement of the ageing primary plant would need to replicate the support that Bouldercombe Substation provides the Powerlink and Ergon Energy networks in meeting the Rule's reliability obligations on an enduring basis.

Powerlink welcomes submissions from potential proponents who consider that they could offer a credible non-network option that is both economically and technically feasible.

Option 2 has been identified as the preferred option

Option 2 has been identified as the preferred option for addressing the risks arising from the ageing transformers and primary plant at Bouldercombe Substation.

Due to the nature of the investment, none of the credible options considered, including the preferred option, are expected to give rise to material market benefits.

Table 2 shows the net present value (NPV) of all options.

Table 2: NPV of credible options (NPV, $m 2018/19)

Option	Weighted NPV	Ranking
Base Option	-35.2	5
Option 1	-30.8	3
Option 2	-29.0	1
Option 3	-35.7	6
Option 4	-31.3	4
Option 5	-29.4	2

Powerlink has identified Option 2 as the preferred option for the following reasons:

- lowest cost in NPV terms
- sufficient capacity for load growth
- minimum number of mobilisations to site of technical staff compared to staged options.

Under the preferred option, design work will commence in early 2020, with preparatory construction activities occurring on-site in late 2020. Completion of the work is scheduled for December 2021.

The indicative capital cost of this option is $30.6 million in 2018/19 prices.

Submissions

Powerlink welcomes written submissions on this *Project Specification Consultation Report*. Submissions are particularly sought on the credible options presented.

Submissions are due on or before Friday, 25 January 2019.

Please address submissions to:

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1. Introduction

Powerlink Queensland is a Transmission Network Service Provider (TNSP) in the National Electricity Market (NEM) that owns, develops, operates and maintains Queensland's high-voltage electricity transmission network. This network transfers bulk power from Queensland power stations to electricity distributors Energex and Ergon Energy (part of the Energy Queensland Group), and to a range of large industrial customers.

Powerlink's approach to asset management includes a commitment to sustainable asset management practices that ensure Powerlink provides a valued transmission service to its customers by managing risk,[2] optimizing performance and efficiently managing assets through the whole of asset life cycle.[3]

Under the Electricity Act 1994, Powerlink is required to operate, maintain (including repair and replace if necessary) and protect its transmission grid to ensure adequate, economic, reliable and safe transmission of electricity. Transformers 1 and 2, along with the circuit breakers, disconnectors, earth switches and instrument transformers at Bouldercombe Substation are nearing the end of their respective technical service lives. This equipment is increasingly at risk of failure, with many items no longer supported by the manufacturers and having few or no spares available. Under the Rules, Powerlink must take action to address this risk within the RIT-T framework.

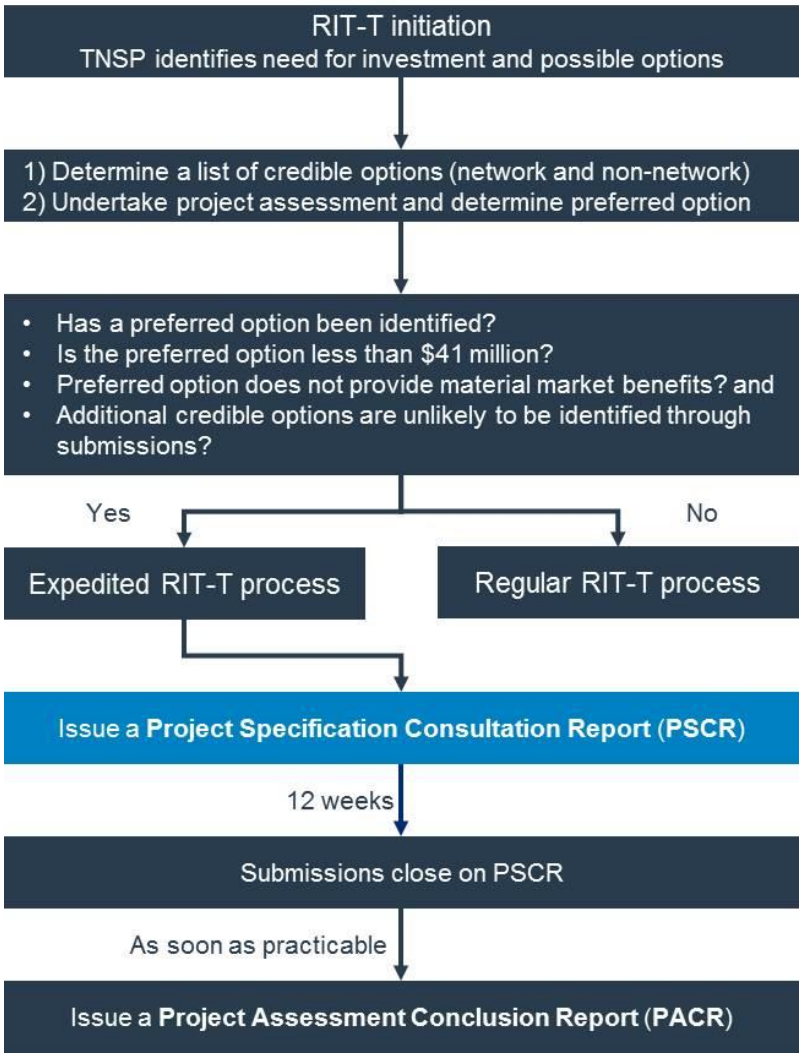
This Project Specification Consultation Report (PSCR) is the first step in the RIT-T process[4]. It:

- describes the reasons why Powerlink has determined that investment is necessary (the 'identified need'), together with the assumptions used in identifying this need
- provides potential proponents of non-network options with information on the technical characteristics that a non-network solution would need to deliver, in order to assist proponents in considering whether they could offer an alternative solution
- describes the credible options that Powerlink currently considers may address the identified need
- discusses why Powerlink does not expect market benefits to be material for this RIT-T[5]
- presents the NPV assessment of each of the credible options (as well as the methodologies and assumptions underlying these results)
- identifies and provides a detailed description of the credible option that satisfies the RIT-T, and is therefore the preferred option
- provides stakeholders with the opportunity to comment on this assessment so that Powerlink can refine the analysis (if required) as part of the Project Assessment Conclusions Report (PACR).

Figure 1.1 outlines the RIT-T process.

[2] Risk assessments are underpinned by Powerlink's corporate risk management framework and the application of a range of risk assessment methodologies set out in AS/NZS ISO31000:2018 *Risk Management Guidelines*.
[3] Powerlink aligns asset management processes and practices with AS ISO55000:2014 *Asset Management – Overview, principles and terminology* to ensure a consistent approach is applied throughout the life cycle of assets.
[4] This RIT-T consultation has been prepared based on the following documents: *National Electricity Rules, Version 113,* 5 October 2018 and AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* September 2017.
[5] As required by clause 5.16.1(c)(iv) of the Rules.

Figure 1.1: RIT-T process overview



Powerlink has adopted the expedited process for this RIT-T, as allowed for investments of this nature under the Rules. [6]

Specifically, Powerlink is proposing to publish a PACR following public consultation on this PSCR and apply the exemption from publishing a Project Assessment Draft Report (PADR) as:

- the preferred option has an estimated capital cost of less than $41 million
- none of the credible options have material market benefits
- Powerlink has identified its preferred option in this PSCR (together with the supporting quantitative cost benefit analysis)
- Powerlink does not envisage that additional credible options which could deliver material market benefits will be identified through the submission process, given the nature of this secondary system replacement project.

However, Powerlink will publish a PADR if submissions to this PSCR identify other credible options that have not yet been considered and which could provide a material market benefit.

[6] In accordance with clause 5.16.4(z1) of the Rules.

2. Identified need

This section provides an overview of the existing arrangements at Bouldercombe Substation and describes the increasing risk to reliability of supply in the Rockhampton area and more broadly into northern and central Queensland, due to the assessed deteriorated condition of selected primary plant assets at the substation.

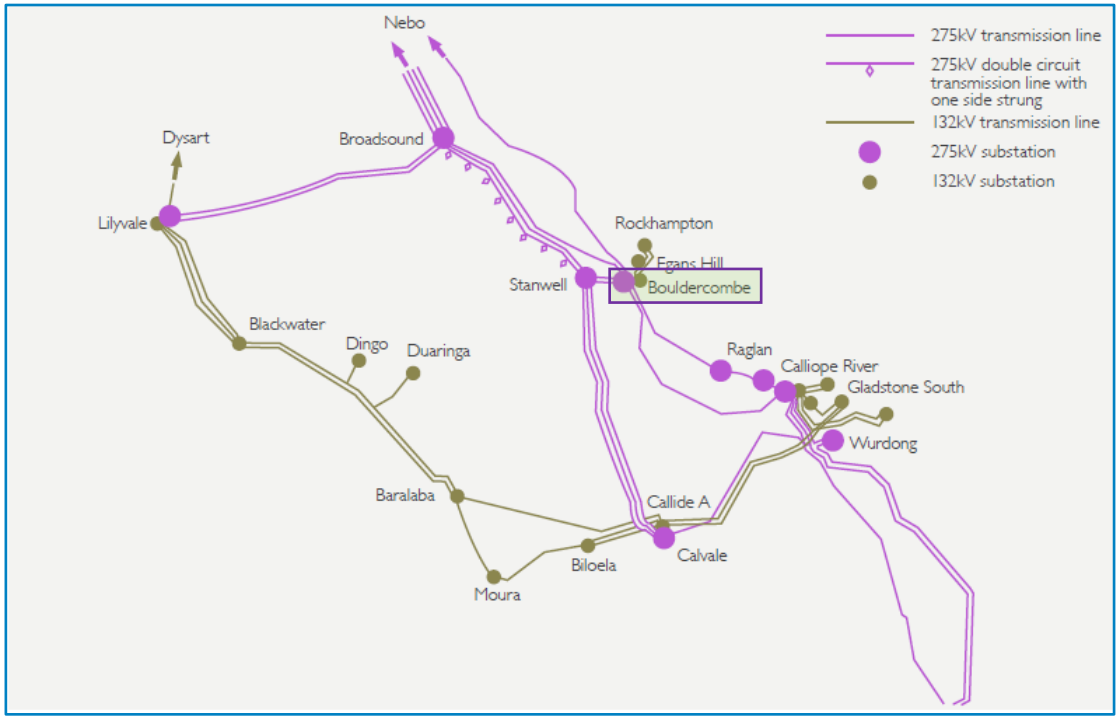
2.1 Geographical and network overview

Located approximately 19 kilometres south-west of Rockhampton and established in 1975, Bouldercombe Substation is a major transmission node for Central Queensland, marshalling a number of 275kV circuits from Nebo and Broadsound to the north, Stanwell to the west and Raglan and Calliope River to the south.

In addition, it provides the sole 132kV injection source for the Ergon Energy network in Rockhampton and surrounding areas, via Powerlink substations at Rockhampton, Egans Hill and Pandoin, while also providing the auxiliary supply to Stanwell Power Station and supply to customers directly connected to Powerlink's network.

Its location in the Central West and Gladstone Transmission Zone is shown in Figure 2.1.

Figure 2.1: Central West and Gladstone Transmission Zone[7]



2.2 Description of identified need

With peak demand in the Rockhampton area forecast to remain at or slightly above current levels[8], it is vital that Bouldercombe Substation has the ongoing capacity to satisfy these demands.

Powerlink's condition assessment of the ageing transformers and primary plant assets at Bouldercombe has highlighted that they are nearing the end of their technical service life, with an increasing likelihood of failure and in many cases limited or no spares and manufacturer support for repairs.

[7] This relates to the standard geographic definitions (zones) identified within the *Powerlink's Transmission Annual Planning Report*, which is published annually by 30 June.
[8] *Powerlink's Transmission Annual Planning Report* (TAPR)

2.3 Assumptions underpinning the identified need

The need to invest is driven by Powerlink's obligations to address the increasing risks to supply arising from ageing and obsolete assets remaining in service at Bouldercombe Substation. If not addressed, these risks will ultimately result in plant failure and extend the time taken to recover from faults, due to a lack of support from manufacturers and a lack of spare parts.

Powerlink's obligations as a TNSP[9] require it to maintain (including repair and replace if necessary) its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity, including the ability to meet peak demand if a major element of the network was to fail. For Bouldercombe, this includes ensuring the ongoing availability of its primary switchgear and power transformers in order to maintain a reliable supply of electricity to consumers.

It follows that the increasing likelihood of faults arising from the ageing assets and the subsequent increased return to service times due to obsolescence, compels Powerlink to undertake reliability corrective actions at Bouldercombe Substation if it is to continue meeting the standards for reliability of supply and public safety set out in the Rules and its jurisdictional responsibilities.

2.4 Description of asset condition and risks

Bouldercombe substation high voltage plant consists of 132kV and 275kV primary plant and three 275/132kV power transformers; Transformer 1 and Transformer 2 have a rating of 200MVA and were installed in 1977, while Transformer 3 has a 375MVA rating and was installed in 2012. Much of the primary plant, Transformer 1 and Transformer 2 are reaching the end of their technical service lives with details of their condition and the associated network and safety risks discussed below.

2.4.1 Transformers

Both Transformer 1 and Transformer 2 are over 40 years of age and are reaching the end of their technical service lives based on Powerlink's condition assessment. Protective galvanised coatings have begun to break down on several components including radiators, connecting pipework, control system cabinets, bushing mountings and flanges, resulting in significant corrosion. The sealing integrity of numerous joints and valves has also been compromised, resulting in an increased observation of oil leaks around the radiator cores, bushings and conservator tanks.

Transformer 2 has recently been electrically disconnected due to safety concerns resulting from the degradation of its insulation and bushings along with a lack of spares to affect a timely repair.

Transformer 1 has had minor refurbishment work to allow it to remain in service until 2021.

The in-service failure of a transformer would result in an extensive replacement timeframe, increasing the risk of loss of supply to the local area, and in extreme cases, can present a risk to the safety of personnel and members of the public. Transformers 1 and 2 require remedial action to be taken.

The 375MVA transformer, Transformer 3, is six years old and is in good condition.

2.4.2 Primary Plant

The majority of primary plant including circuit breakers, earth switches, disconnectors and surge arrestors date back to the late 1970s and mid-1980s and present an increasing risk of failure with very few or no spares available and no manufacturers' support for repairs.

Installed in the mid-1970s, the circuit breakers are experiencing an increasing number of age related deterioration issues including oil and gas leaks, corrosion and wear of components. This has resulted in performance degradation including false trip alarms and failure of the circuit breaker to operate, increasing the risk to plant and staff safety. With few or no spares available from the respective manufacturers, it is also becoming increasingly difficult for Powerlink to service this ageing and deteriorating population of breakers across the network.

[9] Schedule 5.1a System Standards and 5.1.2 Network Reliability of the Rules, Electricity Act 1994 and Queensland Transmission Authority T01/98

An increasing frequency of oil leaks and the onset of corrosion to bushings, terminals, gauges and switches have been observed in the substation's ageing voltage and current transformers, along with the presence of PCBs in the oil samples taken from the voltage transformers. Ageing porcelain housings on many of the voltage transformers also present an increasing risk to staff safety in the case of failure. The majority of the equipment is now obsolete, with insufficient spares to support ongoing operation.

Those disconnectors and earth switches installed in the late 1970s and early 1980s are also nearing 40 years of age and showing signs of advanced corrosion to supporting structures, spacer plates, joint palms, nuts and bolts. This equipment is facing obsolescence issues with few spares available and no manufacturer support for repairs.

Corrosion is becoming an issue on the support insulators of the surge arrestors with a number of arrestors also having become deformed.

Poor asset condition increases the risk of faults, while obsolescence increases the time needed for Powerlink to remedy them, potentially up to several weeks. The inability to repair, replace, or otherwise resolve primary plant faults in a timely manner can have operational consequences, as this reduces the overall resilience of the transmission network to subsequent forced outages, resulting in loss of supply to consumers.

Taking into consideration the most recent analysis and understanding of the risks arising from the primary plant at Bouldercombe Substation, the proposed credible network solutions have been brought forward by 12 months from the possible commissioning date of December 2022 as advised in the 2018 TAPR to December 2021.

3. Required technical characteristics for non-network options

The information provided in this section is intended to enable interested parties to formulate and propose genuine and practicable non-network solutions such as, but not limited to, local generation and Demand Side Management (DSM) initiatives.

Powerlink identified in its Transmission Annual Planning Report (TAPR) 2016 to 2018, an expectation that action would be required at Bouldercombe Substation to maintain power transfer and reliability of supply requirements in the Central West and Gladstone Transmission Zone.[10]

Powerlink has consulted with Registered Participants, Powerlink's Non-network Engagement Stakeholder Register and interested parties on the proposed investment at Bouldercombe Substation as part of the TAPR publication and associated engagement activities. No submissions proposing credible and genuine non-network options were received from prospective solution providers in the normal course of business or in response to the TAPRs. As a result, Powerlink is currently not aware of any non-network options that could be adopted and will continue to investigate the feasibility of any potential non-network option proposed or otherwise identified.

This PSCR provides a further opportunity for providers of feasible non-network options to submit details of their proposals for consideration.

3.1 Criteria for proposed network support services

A non-network option that avoids replacement of the ageing primary plant would need to replicate the functionality, capacity and reliability of the Bouldercombe Substation on an enduring basis at a cost that is lower than the network options currently under consideration.

Consequently, any non-network option would need to provide injection or demand response into the Rockhampton area of over 200MW at peak (summer medium growth forecast for Ergon Energy and Powerlink customers connected to Bouldercombe).

Bouldercombe Substation also facilitates bulk transfer between Central and North Queensland. Any non-network solution seeking to defer or offset investment into the Bouldercombe 275kV primary plant must take account of the impact of reduced transfer limits that may potentially arise.

Powerlink has identified the following common criteria that must be satisfied if any proposed non-network solutions are to meet supply requirements[11]:

Size and location

- Proposed solutions must be large enough, individually or collectively, to provide the size of injection or demand response set out above. The level of support is however dependent on the location, type of network support and load forecasts
- Due to the bulk nature of the transmission network, aggregation of sub 10MW non-network solutions will be the sole responsibility of the non-network provider
- Notwithstanding the location of any solution, each proposal would require assessment in relation to technical constraints pertinent to the network connection, such as other intra-regional transfer limits, fault level or quality of supply impacts of operation.

[10] This relates to the standard geographic definitions (zones) identified within the *Powerlink's Transmission Annual Planning Report*, which is published annually by 30 June.

[11] Powerlink's Network Support Contracting Framework has been developed as a general guide to assist potential non-network solution providers. This framework outlines the key contracting principles that are likely to appear in any Powerlink non-network support agreement.

Operation

- A non-network option would need to be capable of operating continuously 24 hours per day over a period of years
- If a generation service is proposed (either standalone or in conjunction with other services), such operation will be required regardless of the pool price[12]
- Proponents of generation services are advised that network support payments are intended for output that can be demonstrated to be additional to the plant's normal operation in the NEM.

Reliability

- Proposed services must be capable of reliably meeting electricity demand under a range of conditions and, if a generator must meet all relevant National Electricity Rules requirements related to grid connection
- Powerlink has obligations under the National Electricity Rules, its Transmission Authority and connection agreements to ensure supply reliability is maintained to its customers. Failure to meet these obligations may give rise to liability. Proponents of non-network options must also be willing to accept any liability that may arise from its contribution to a reliability of supply failure.

Timeframe and certainty

- Proposed services must be able to be implemented in sufficient time to meet the identified need using proven technology and, where not already in operation, provision of information in relation to development status such as financial funding and development timeline to support delivery within the required timeframe must be provided.

Duration

- The agreement duration for any proposed service will provide sufficient flexibility to ensure that Powerlink is pursuing the most economic long run investment to address the primary plant condition risks at Bouldercombe Substation.

Powerlink welcomes submissions from potential proponents who consider that they could offer a credible non-network option that is both economically and technically feasible.

[12] The National Electricity Rules prevent a generator that is providing network support from setting the market price.

4. Potential credible options to address the identified need

Powerlink has considered six credible network options as part of this PSCR.

The Base Option involves the replacement of the two aged 200MVA transformers with a single 250MVA transformer, along with minimal primary plant replacement coupled with life extension work in 2021 to defer replacement of aged 132kV and 275kV primary plant by 10 years until 2031. In 2031, the remaining aged primary plant is replaced.

Option 1 combines the replacement of the two aged 200MVA transformers with a single 250MVA transformer, with a more comprehensive primary plant replacement and life extension strategy to achieve a 20 year life extension. In 2041, the remaining aged primary plant is replaced.

Option 2 combines the replacement of the two aged 200MVA transformers with a single 250MVA transformer, with the complete replacement of all primary plant in the affected bays by December 2021.

Options 3 to 5 are based upon replacement of the two aged 200MVA transformers with a 375MVA transformer in combination with the same range of primary plant strategies as employed in the Base Option, Option 1 and Option 2 respectively.

Details and costings of the options are summarised in Table 4.1.

Table 4.1: Credible Options

Option	Description	Indicative capital cost ($million, 2018/9)	Indicative annual O&M costs ($million, 2018/19)
Base Option Standard 250MVA transformer with staged replacement of primary plant by December 2031	Install a new 250MVA transformer Decommission Transformers 1 & 2 Life extend or replace selected primary plant by December 2021*	26.77*	0.14
	Replace balance of ageing plant by December 2031†	16.96†	
Option 1 Standard 250MVA transformer with staged replacement of primary plant by December 2041	Install a new 250MVA transformer, decommission transformers 1 & 2, life extend or replace selected primary plant by December 2021*	26.98*	0.14
	Replace balance of ageing plant by December 2041†	15.95†	
Option 2 Install standard 250MVA transformer with upfront replacement of all primary plant in selected bays by December 2021	Install a new 250MVA transformer, decommission transformers 1 & 2 and single stage replacement of all plant in selected bays by December 2021*	30.60*	0.12
Option 3 Standard 375MVA transformer with staged replacement of primary plant by December 2031	Install a new 375MVA transformer, decommission transformers 1 & 2 and life extend or replace selected primary plant by December 2021*	27.28*	0.14
	Replace balance of ageing plant by December 2031†	16.96†	

Option	Description	Indicative capital cost ($million, 2018/9)	Indicative annual O&M costs ($million, 2018/19)
Option 4 Standard 375MVA transformer with staged replacement of primary plant by December 2041	Install a new 375MVA transformer, decommission transformers 1 & 2 and life extend or replace selected primary plant by December 2021*	27.49*	0.14
	Replace balance of ageing plant by December 2041†	15.95†	
Option 5 Standard 375MVA transformer with upfront replacement of all primary plant in selected bays by December 2021	Install a new 375MVA transformer, decommission transformers 1 & 2 and single stage replacement of all primary plant in selected bays by December 2021*	31.12*	0.12

*Proposed RIT-T Project
†Model Project

All credible options address the risks arising from the ageing transformers and primary plant at Bouldercombe Substation. Any recovered primary plant with a remaining technical service life will be retained as spares for the network.

None of these options has been discussed by the Australian Energy Market Operator (AEMO) in its most recent National Transmission Network Development Plan (NTNDP).[13]

Additional options that have been considered but not progressed, due to not being either economically or technically feasible, are listed in Appendix 1.

The primary plant to be installed or life extended under the proposed RIT-T projects for each option is summarised in Table 4.2.

Table 4.2: Primary plant to be replaced (R) or life extended (LE) under each network option by 2021

Options	Circuit Breakers		Current Transformers		Voltage Transformers		Surge Arrestors		Isolators		Earth Switches	
	R	LE	R	LE	R	LE	R	LE	R	LE	R	LE
Base Option & Option 3*	16	-	-	-	40	-	3	6	-	46	-	51
Option 1 & Option 4♦	16	-	3	-	40	-	3	6	29	17	37	14
Option 2 & Option 5	16	-	15	-	50	-	30	-	46	-	51	-

*All life extended items under the Base Option and Option 3 will be replaced in 2031
♦All life extended items under Options 1 and 4 will be replaced in 2041

[13] Clause 5.16.4(b)(4) of the Rules requires Powerlink to advise whether the identified need and or solutions are included in the most recent NTNDP. The 2016 NTNDP is currently the most recent NTNDP.

4.1 Selection of a Base Option

Powerlink has undertaken this RIT-T assessment using a Base Option that reflects the conventional option that would otherwise be implemented by Powerlink to ensure ongoing compliance with the Rules. The initial work seeks to replace the minimal amount of at risk plant while extending the technical service life of the remaining at risk primary plant items by 10 years in 2021, before replacing these at risk assets in 2031.

This Base Option provides a benchmark against which to assess other credible options.

4.2 Base Option: Standard 250MVA transformer with staged replacement by December 2031

Powerlink is the proponent of this option.

The two existing 200MVA transformers are replaced with a single 250MVA transformer, along with selected primary plant by December 2021. The balance of at risk primary plant is life extended to obtain a 10 year deferral of its replacement until December 2031.

Table 4.3: Main project components for the Base Option

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Life extend and replace selected items of primary plant	14,249	Completion: December 2021*
Replace transformers with single 250MVA unit	6,561	
Replace selected secondary systems and communications equipment	3,306	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,654	
Sub Total	**26,770***	
Replace balance of primary plant	12,081	Completion: December 2031†
Replace balance of secondary systems and communications equipment	2,969	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,910	
Sub Total	**16,962†**	
Total	**43,732**	

*Proposed RIT-T Project
†Modelled Project

4.3 Option 1: Standard 250MVA transformer with staged replacement by December 2041

Powerlink is the proponent of this option.

The two existing 200MVA transformers are replaced with a single 250MVA transformer, along with selected primary plant by December 2021. The balance of at risk primary plant is life extended to obtain a 20 year deferral of its replacement until December 2041.

Table 4.4: Main project components for Option 1

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Replace or life extend selected items of primary plant	14,398	Completion: December 2021*
Replace transformers with single 250MVA unit	6,561	
Replace selected secondary systems and communications equipment	3,361	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,656	
Sub Total	**26,976***	
Replace balance of primary plant	11,066	Completion: December 2041†
Replace balance of secondary systems and communications equipment	2,969	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,910	
Sub Total	**15,945†**	
Total	**42,922**	

*Proposed RIT-T Project
†Modelled Project

4.4 Option 2: Standard 250MVA transformer with upfront replacement by December 2021

Powerlink is the proponent of this option.

The two existing 200MVA transformers are replaced with a single 250MVA transformer, along with all primary plant in selected bays by December 2021.

Table 4.5: Main project components for Option 2

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Replace primary plant	17,829	Completion: December 2021
Replace transformers with single 250MVA unit	6,561	
Secondary systems and telecommunications work	3,463	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,750	
Total	**30,604**	

4.5 Option 3: Standard 375MVA transformer with staged replacement by December 2031

Powerlink is the proponent of this option

The two existing 200MVA transformers are replaced with a single 375MVA transformer, along with selected primary plant by December 2021. The balance of at risk primary plant is life extended to obtain a 10 year deferral of its replacement until December 2031.

Table 4.6: Main project components for Option 3

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Replace or life extend selected items of primary plant	14,249	Completion: December 2021*
Replace transformer with single 375MVA unit	7,061	
Replace selected secondary systems and communications equipment	3,306	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,667	
Sub Total	**27,284***	
Replace balance of primary plant	12,081	Completion: December 2031†
Replace balance of secondary systems and communications equipment	2,969	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,910	
Sub Total	**16,962†**	
Total	**44,245**	

***Proposed RIT-T Project**
†Modelled Project

4.6 Option 4: Standard 375MVA transformer with staged replacement by December 2041

Powerlink is the proponent of this option

The two existing 200MVA transformers are replaced with a single 375MVA transformer, along with selected primary plant by December 2021. The balance of at risk primary plant is life extended to obtain a 20 year deferral of its replacement in December 2041.

Table 4.7 Main project components for Option 4

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Replace or life extend selected items of primary plant	14,398	Completion: December 2021*
Replace transformers with single 375MVA unit	7,061	
Replace selected secondary systems and communications equipment	3,362	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,669	
Sub Total	**27,489***	
Replace balance of primary plant	11,066	Completion: December 2041†
Replace balance of secondary systems and communications equipment	2,969	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,910	
Sub Total	**15,945†**	
Total	**43,435**	

***Proposed RIT-T Project**
†Modelled Project

4.7 Option 5: Standard 375MVA transformer with upfront replacement by December 2021

Powerlink is the proponent of this option

The two existing 200MVA transformers are replaced with a single 375MVA transformer, along with all primary plant in selected bays by December 2021.

Table 4.7 Main project components for Option 5

Components	Cost ($k, real 2018/19)	Construction timetable and commissioning date
Replace primary plant	17,829	Completion: December 2021
Replace transformers with single 350MVA unit	7,061	
Secondary systems and telecommunications work	3,463	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	2,763	
Total	**31,117**	

4.8 Material inter-network impact

Powerlink does not consider that any of the credible options being considered will have a material inter-network impact, based on AEMO's screening criteria.[14]

[14] In accordance with Rules clause 5.16.4(b)(6)(ii). AEMO has published guidelines for assessing whether a credible option is expected to have a material inter-network impact.

5. Materiality of market benefits

Powerlink does not consider the proposed works at Bouldercombe Substation will provide any material market benefits, due to the nature of the project.

The AER has recognised that if the proposed investment will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated[15].

5.1 Market benefits that are not material for this RIT-T assessment

A discussion of each market benefit under the RIT-T is discussed below:

- **changes in patterns of generation dispatch**: replacement of existing assets by itself does not affect transmission network constraints or affect transmission flows that would change patterns of generation dispatch. It follows that changes patterns of generation dispatch are not material to the outcome of the RIT-T assessment
- **changes in voluntary load curtailment**: replacement of existing assets by itself does not affect prices in the wholesale electricity market. It follows that changes in voluntary load curtailment will not be material for the purposes of this RIT-T
- **changes in involuntary load shedding**: the credible options under consideration will not lead to unserved energy so it follows that changes in involuntary load shedding are not material to the outcome of the RIT-T assessment
- **changes in costs for other parties**: the effect of replacing the ageing assets under the credible options considered are localised to the substation they are located at and do not affect the capacity of transmission network assets and therefore is unlikely to change generation investment patterns (which are captured under the RIT-T category of 'costs for other parties')
- **differences in the timing of expenditure**: credible options for asset replacement do not affect the capacity of transmission network assets, the way they operate, or transmission flows. Accordingly, differences in the timing of expenditure of unrelated transmission investments are unlikely to be affected
- **changes in network losses**: credible options are not expected to provide any changes in network losses as replacing the ageing assets has no material effect on the characteristics of the asset
- **changes in ancillary services cost**: there is no expected change to the costs of Frequency Control Ancillary Services (FCAS), Network Control Ancillary Services (NCAS), or System Restart Ancillary Services (SRAS) due to credible options under consideration. These costs are therefore not material to the outcome of the RIT-T assessment
- **competition benefits:** Powerlink does not consider that any of the credible options will materially affect competition between generators, and generators' bidding behaviour and, consequently, considers that the techniques required to capture any changes in such behaviour would involve a disproportionate level of effort compared to the additional insight it would provide
- **option value**: Powerlink does not consider that the identified need for the options considered in this RIT-T is affected by uncertain factors about which there may be more clarity in future. As a consequence, option value is not a relevant consideration for this RIT-T

[15] AER, *Regulatory investment test for transmission application guidelines,* September 2017, version 2, pp13-14

5.2 Consideration of market benefits for non-network options

Powerlink notes that non-network options may impact the wholesale electricity market (for example by displacing generation output). Accordingly, it is possible that several of the above classes of market benefits may be material where there are credible non-network options, depending on the specific form of the option.

Where credible non-network options are identified as part of the consultation process on this PSCR, Powerlink intends on assessing the materiality of market benefits arising from these options. Where the market benefits are considered to be material, these will be quantified as part of the RIT-T assessment of these options.

6. General modelling approach adopted to assess net benefits

6.1 Analysis period

The RIT-T analysis has been undertaken over a 35-year period, from 2019 to 2053. A 35-year period takes into account the size and complexity of the primary plant and transformer replacements.

As the replacement plant will have differing residual values by 2053 under each option, terminal values have been calculated to offset these variations.

6.2 Discount rate

Under the RIT-T, a commercial discount rate is applied to calculate the net present value (NPV) of costs and benefits of credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 7.04%[16] as the central assumption for the NPV analysis presented in this report.

Powerlink has tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound discount rate of 3.47%[17] and an upper bound discount rate of 10.61% (i.e. a symmetrical upwards adjustment).

6.3 Description of reasonable scenarios

The RIT-T analysis is required to incorporate different reasonable scenarios to estimate market benefits. The scenarios must be appropriate to the credible options under consideration.

The choice of reasonable scenarios must reflect any variables or parameters that are likely to affect the ranking of the credible options, where the identified need is reliability corrective action[18].

Powerlink has considered capital costs and discount rate sensitivities individually and in combination and found that only the discount rate affects option rankings. Powerlink has therefore adopted three scenarios based on high, low and central estimates of the discount rate.

As all cashflows being discounted relate to regulated network costs and there are no material market benefits identified, Powerlink has applied weightings to the final NPV ranking that reflect that the low discount rate scenario is the most appropriate for the discounting of costs. Notwithstanding this, any credible non-network options identified during the PSCR consultation process will be modelled accordingly and weightings amended as necessary.

Table 6.1: Reasonable scenarios adopted

Key variable/parameter	Low discount rate scenario	Central discount rate scenario	High discount rate scenario
Discount rate	3.47%	7.04%	10.61%
NPV Weighting	0.6	0.3	0.1

[16] The indicative commercial discount rate is calculated on the assumption that a private investment in the electricity sector would hold an investment grade credit rating, a return on equity and a debt gearing ratio equal to an average firm on the Australian stock exchange.
[17] A discount rate of 3.47 per cent is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0 per cent and forecast inflation of 2.45 per cent that implies a real discount rate of 3.47 per cent. See AER, *Final Decision: Powerlink transmission determination 2017-2022 | Attachment 3 – Rate of return*, April 2017, p 9.
[18] AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 16, p. 7

7. Cost benefit analysis and identification of the preferred option

7.1 Net present values

Table 7.1 outlines the NPV for each credible option. The table also shows the corresponding ranking of each option, illustrating that the NPV of Option 2 is the lowest cost preferred option.

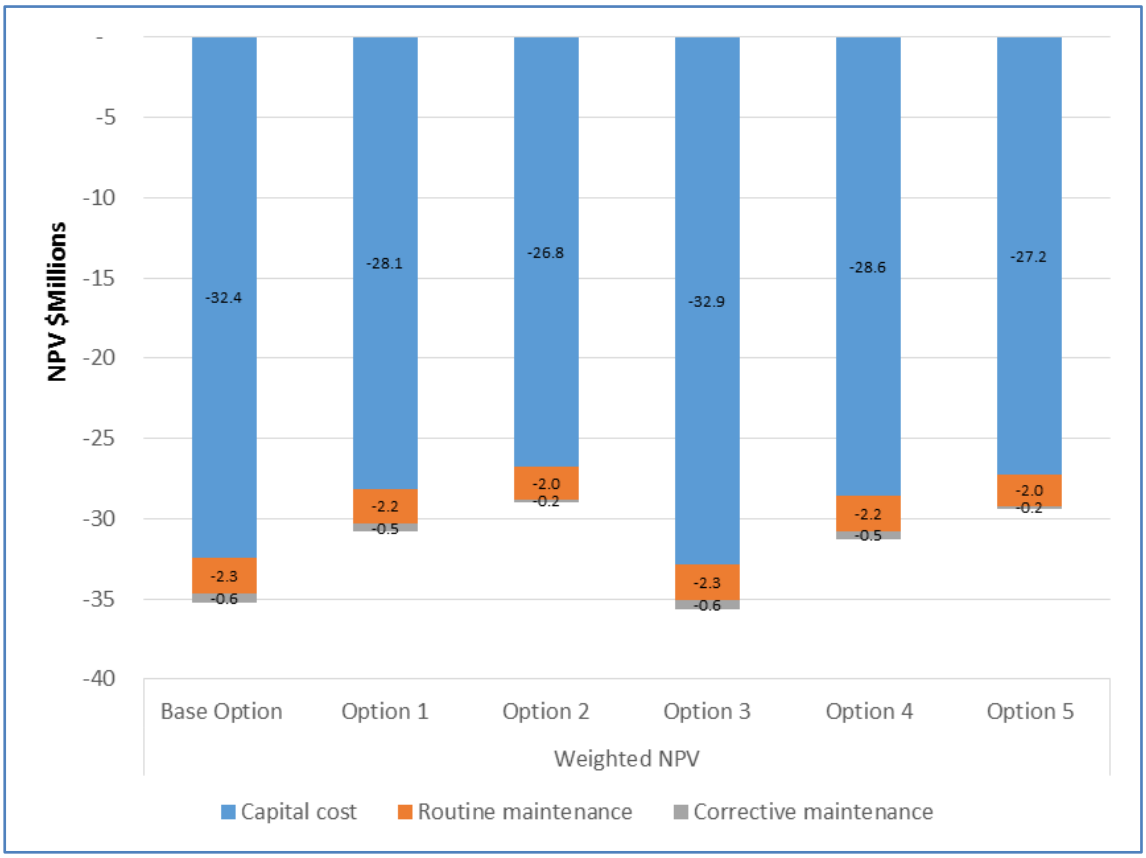
Table 7.1: Weighted NPV for each credible option with consideration of flood risk ($m, 2018/19)

Option	Description	Weighted NPV ($m)	Ranking
Base Option	Install a standard 250MVA transformer Staged replacement of aged primary plant by December 2031	-35.2	**5**
Option 1	Install a standard 250MVA transformer Staged replacement of aged primary plant by December 2041	-30.8	**3**
Option 2	Install a standard 250MVA transformer Replace all primary plant in selected bays by December 2021	-29.0	**1**
Option 3	Install a standard 375MVA transformer Staged replacement of aged primary plant by December 2031	-35.7	**6**
Option 4	Install a standard 375MVA transformer Staged replacement of aged primary plant by December 2041	-31.3	**4**
Option 5	Install a standard 375MVA transformer Replace all primary plant in selected bays by December 2021	-29.4	**2**

Option 2 is ranked as the lowest cost option in NPV terms.

Figure 7.1 provides a breakdown of capital and maintenance costs for each scenario.

Figure 7.1: Weighted NPV component for each credible option (NPV $m, 2018/19)



A comparison of the weighted NPVs for each option relative to the Base Option is shown in Table 7.2

Table 7.2: Weighted NPV for each credible option relative to the Base Option (NPV $m, 2018/19)

Option	Description	Weighted NPV relative to Base Option ($m)
Option 1	Install standard 250MVA transformer Staged replacement of aged primary plant by December 2041	4.4
Option 2	Install standard 250MVA transformer Replace all primary plant in selected bays by December 2021	6.3
Option 3	Install standard 375MVA transformer Staged replacement of aged primary plant by December 2031	-0.4
Option 4	Install standard 375MVA transformer Staged replacement of aged primary plant by December 2041	4.0
Option 5	Install standard 375MVA transformer Replace all primary plant in selected bays by December 2021	5.8

7.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a lower discount rate of 3.47% as well as a higher rate of 10.61%
- a 25% increase/decrease in capital costs.

Sensitivity analysis for the NPV relative to the Base Option shows that varying the discount rate impacts the ranking, whereas varying the capital cost has no impact on the preferred option.

For a discount rate of less than 7.7%, Option 2 is identified as the best ranked option. For discount rates greater than 7.7%, Option 1 is identified as the best ranked option. Overall, Option 2 maximises the present value of net economic benefit across the range of scenarios modelled under this RIT-T.

Figure 7.2: Sensitivity Analysis for Discount Rate

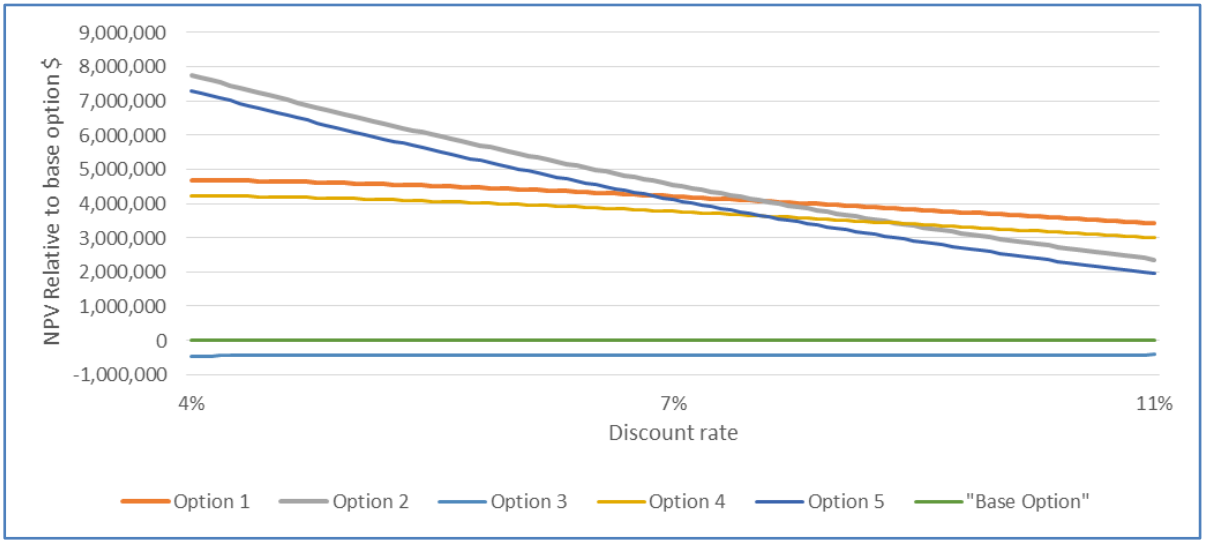
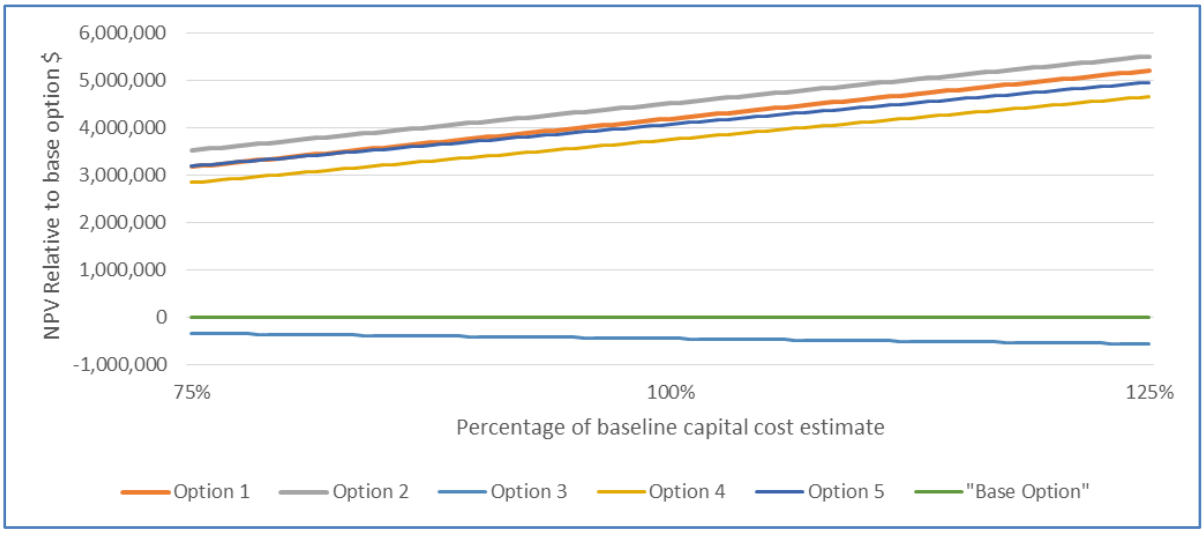


Figure 7.3: Sensitivity Analysis for Capital Cost



7.3 Conclusion

The result of the cost benefit analysis indicates that Option 2 (installation of standard 250MVA transformer and replacement of all primary plant in selected bays) is the highest net benefit solution (lowest cost in NPV terms) over the 35 year period of analysis.

Option 2 is therefore considered to satisfy the requirement of the RIT-T and is the proposed preferred option.

8. Draft recommendation.

Based on the conclusions drawn from the NPV analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 2 be implemented to address the risks associated with ageing infrastructure at Bouldercombe Substation.

Option 2 involves the full replacement of primary plant in selected bays at Bouldercombe Substation and the installation of a new standard 250MVA transformer to replace the existing two, 200MVA transformers**.**

Under this preferred option, design work will commence in early 2020, with preparatory construction activities occurring on-site in late 2020. Completion of the work is scheduled for December 2021.

The indicative capital cost of this option is $30.6 million in 2018/19 prices.

9. Submissions requirements

Powerlink invites submissions and comments in response to this PSCR from Registered Participants, AEMO, potential non-network providers and any other interested parties.

Submissions should be presented in a written form and should clearly identify the author of the submission, including contact details for subsequent follow-up if required. If parties prefer, they may request to meet with Powerlink ahead of providing a written response.

9.1 Submissions from non-network providers

This is not a tender process – submissions are requested so that Powerlink can fulfil its regulatory obligations to analyse non-network options. In the event that a non-network option appears to be a genuine and practicable alternative that could satisfy the RIT-T, Powerlink will engage with that proponent or proponents to clarify cost inputs and commercial terms.

Submissions from potential non-network providers should contain the following information:

- details of the party making the submission (or proposing the service)
- technical details of the project (capacity, proposed connection point if relevant, etc.) to allow an assessment of the likely impacts on future supply capability
- sufficient information to allow the costs and benefits of the proposed service to be incorporated in a comparison in accordance with AER RIT-T guidelines
- an assessment of the ability of the proposed service to meet the technical requirements of the Rules
- timing of the availability of the proposed service
- other material that would be relevant in the assessment of the proposed service.

As the submissions will be made public, any commercially sensitive material, or material that the party making the submission does not want to be made public, should be clearly identified.

It should be noted that Powerlink is required to publish the outcomes of the RIT-T analysis. If parties making submissions elect not to provide specific project cost data for commercial-in-confidence reasons, Powerlink may rely on cost estimates from independent specialist sources.

9.2 Assessment and decision process

Powerlink intends to carry out the following process to assess what action, if any, should be taken to address future supply requirements:

Part 1	PSCR Publication	29 October 2018
	Submissions due on the PSCR Have your say on the credible options and propose potential non-network options.	25 January 2019
Part 2	Publication of the PACR Powerlink's response to any further submissions received and final recommendation on the preferred option for implementation.	February 2019

Powerlink reserves the right to amend the timetable at any time. Amendments to the timetable will be made available on the Powerlink website (www.powerlink.com.au).

10. Appendix 1: Options considered but not progressed

Table A1: Options considered but not progressed

Option description	Reason for not progressing option
Like for like replacement or life extension of Transformers 1 and 2.	Technically feasible but economically not viable as a single new 250MVA transformer will provide sufficient capacity at considerably less cost compared with refurbishing or replacing the existing two 200MVA transformers.
Single non-standard 250MVA transformer	Modification of the standard 250MVA transformer would allow better impedance matching with the existing 375MVA transformer and a more even sharing of load between the two. Benefits were considered to be of marginal value only and the introduction of nonstandard equipment would result in higher maintenance costs and the need to carry an additional spare transformer.

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