Powerlink Queensland

Project Assessment Conclusions Report

4 March 2019

Maintaining reliability of supply at Townsville South 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. This document contains the results of this evaluation, and a final recommended solution to address the primary plant condition risks at Townsville South Substation from December 2022.

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Executive Summary

Located approximately 11 kilometres south east of the Townsville CBD, Townsville South Substation is a major injection point into the Ergon Energy distribution network for southern and eastern Townsville, as well as a transfer point for enabling the flow of electricity between Clare to the south and Townsville to the north. Planning studies have confirmed there is an enduring need for the substation to maintain the supply of electricity in the Townsville area.

At over 40 years of age, much of the substation's primary plant is reaching the end of its technical service life and is no longer supported by the manufacturer, with few spares available.

The increasing likelihood of faults arising from the condition of Townsville South's ageing and obsolete primary plant remaining in service, places the network at risk of being unable to meet current and forecast energy demands.

Powerlink's obligations as a Transmission Network Service Provider (TNSP) 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.

This increased likelihood of faults combined with its TNSP obligations present Powerlink with a range of operational and safety risks, as well as compliance issues requiring resolution. Since consideration for this investment is driven by an obligation in the National Electricity Rules (the Rules), it is a 'reliability corrective action' under the Regulatory Investment Test for Transmission (RIT-T).

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process prescribed under the Rules undertaken by Powerlink to address the condition risks arising from ageing primary plant at Townsville South Substation. It contains the results of the planning investigation and cost-benefit analysis of credible options. In accordance with the RIT-T, the credible option that maximises the present value of net economic benefits is recommended for implementation.

Credible options considered

Powerlink identified three credible network options to address the identified need, as presented in Table 1.

Table1: Summary of credible primary plant options

Option	Description	Indicative capital cost ($million, 2018/19)	Indicative annual O&M costs* ($million, 2018/19)
Base Option Staged replacement utilising live tank circuit breakers completed by 2045	Staged replacement of selected equipment in existing bays utilising live tank circuit breakers by: • December 2022* • December 2030† • December 2045†	 4.94* 0.99† 4.14†	0.101
Option 1 Staged replacement utilising dead tank circuit breakers completed by 2045	Staged replacement of selected equipment in existing bays utilising dead tank circuit breakers by: • December 2022* • December 2030† • December 2045†	 7.77* 1.09† 4.86†	0.084
Option 2 Upfront, single stage replacement utilising dead tank circuit breakers completed by 2022	Upfront, single stage replacement of selected equipment including all equipment in 7 bays utilising dead tank circuit breakers by December 2022*	10.96*	0.076

*Proposed RIT-T projects
†Modelled projects

Evaluation and conclusion

The RIT-T requires that the proposed preferred option maximises the present value of net economic benefit, or minimises the net cost, to all those who produce, consume and transport electricity in the market.

In accordance with the expedited process for this RIT-T, the Project Specification Consultation Report (PSCR), published in October 2018, made a draft recommendation to implement the Base Option, staged replacement of selected primary plant using live tank circuit breakers. The RIT-T project for the Base Option, involves the installation and commissioning of new plant by December 2022 and has an estimated capital cost of $4.94 million in 2018/19 prices. Powerlink is the proponent of the proposed network project.

There were no submissions received in response to the PSCR.

As the outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR, the draft recommendation has been adopted without change as the final recommendation, and will now be implemented.

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process[1] prescribed under the Rules undertaken by Powerlink to address the condition risks arising from the ageing primary plant at Townsville South Substation. It follows the publication of the Project Specification Consultation Report (PSCR) published in October 2018 that adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature. The Project Specification Consultation Report:

- described the identified need that Powerlink is seeking to address, together with the assumptions used in identifying this need
- set out the technical characteristics that a non-network option would be required to deliver in order to address the identified need
- described the credible options that Powerlink considered may address the identified need
- discussed specific categories of market benefit that in the case of this specific RIT-T assessment are unlikely to be material
- identified the preferred option and that Powerlink was claiming an exemption from producing a Project Assessment Draft Report (PADR).

Powerlink identified the Base Option, staged replacement of selected primary plant using live tank circuit breakers, as the preferred option to address the identified need. The RIT-T project for the Base Option, involves the installation and commissioning of new plant by December 2022 and has an estimated capital cost of $4.94 million in 2018/19 prices.

NER clause 5.16.4(z1) provides for a Transmission Network Service Provider (TNSP) to claim exemption from producing a PADR for a particular RIT-T application if all the following conditions are met:

- the estimated capital cost of the preferred option is less than $41 million
- the preferred option has been identified in the PSCR noting exemption from publishing a PADR
- the preferred option, or other credible options, do not have a material market benefit
- submissions to the PSCR did not identify additional credible options that could deliver a material market benefit.

There were no submissions received in response to the PSCR that closed on 25 January 2019. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. As all of the conditions are now satisfied, Powerlink has not issued a PADR for this RIT-T and is now publishing this PACR, which:

- describes the identified need and the credible options that Powerlink considers may address the identified need
- provides a quantification of costs and reasons why specific classes of market benefit are not material for the purposes of this RIT-T assessment
- provides the results of the net present value (NPV) analysis for each credible option assessed, together with accompanying explanatory statements
- identifies the preferred option for investment by Powerlink and details the technical characteristics and estimated commissioning date of the preferred option
- describes the consultation process followed for this RIT-T together with the reasons why Powerlink is exempt from producing a PADR.

Since this investment is driven by an obligation in the Rules, it is a 'reliability corrective action' under the RIT-T.

[1] 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.

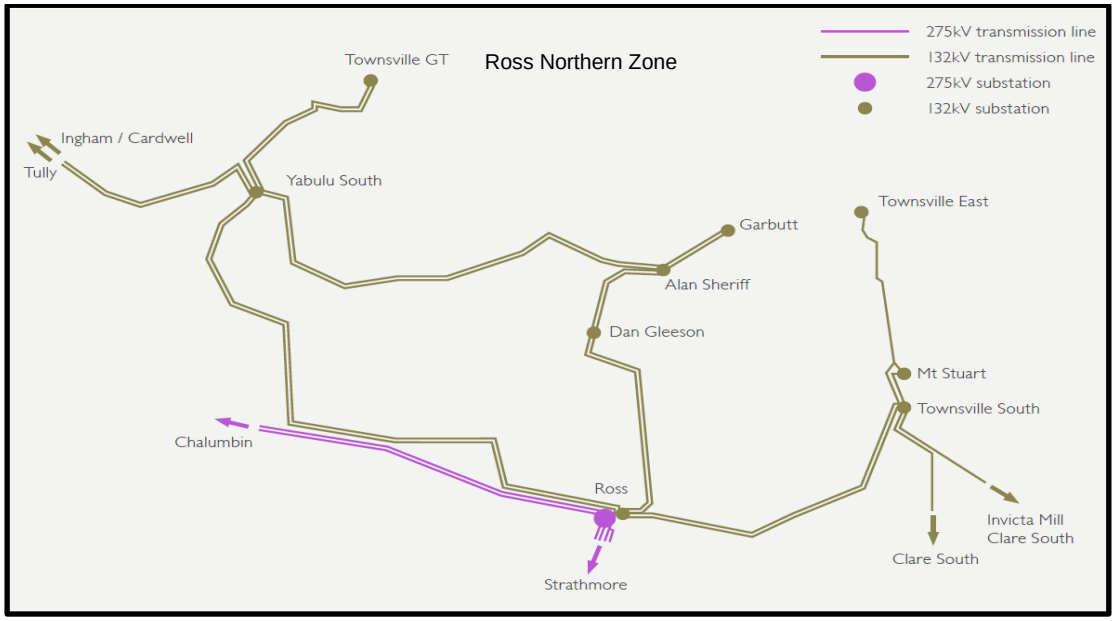
2. Identified need

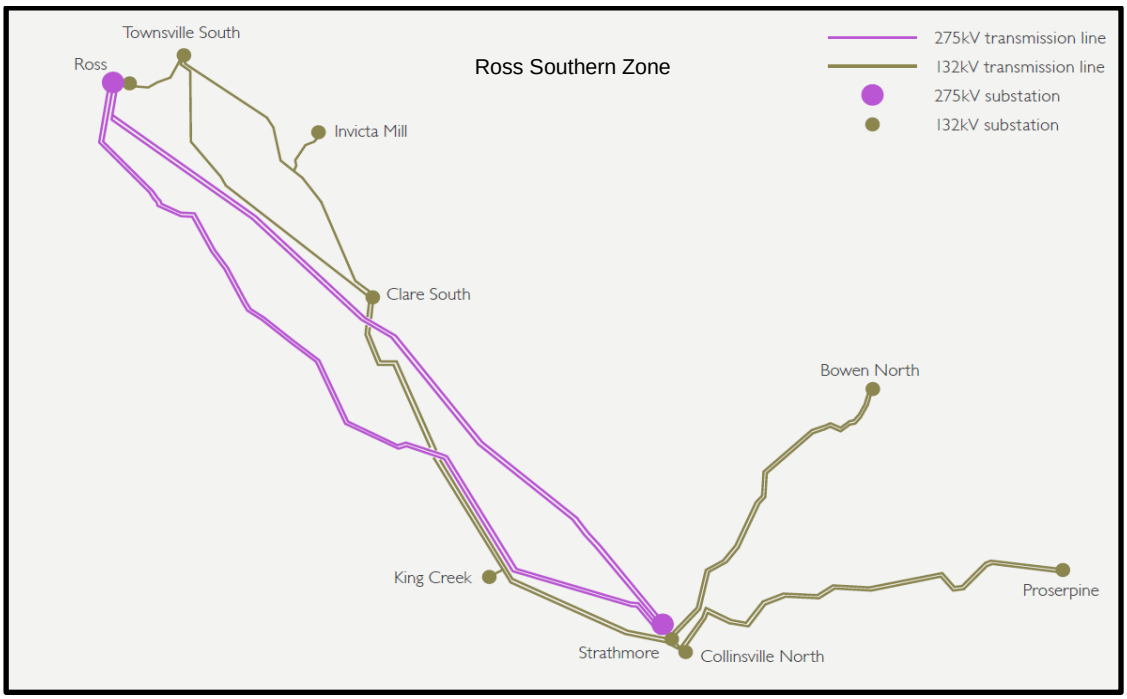
This section provides an overview of the existing arrangements at Townsville South Substation and describes the increasing risk to reliability of supply in the Townsville area and more broadly into north Queensland, due to the assessed deteriorated condition of selected primary plant assets at the substation.

2.1 Geographical and network overview

Townsville South Substation is located approximately 11 kilometres south-east of Townsville in north Queensland and is part of the Ross transmission zone. Established in 1977, it is a 132/66kV substation with multiple functions. It provides the major injection point to the Ergon 66kV network in the southern and eastern suburbs of Townsville, enables transfer of electricity between Clare to the south and North Queensland (Townsville) and connects several direct customers to the transmission network. The Ross transmission zone is shown in Figure 2.1.

Figure 2.1: Ross transmission zone





2.2 Description of identified need

With peak demand in the Townsville area forecast to remain at or slightly above current levels[2], it is vital that the electricity supply is maintained to satisfy these demands and for Powerlink to meet its reliability of supply obligations.

Powerlink's condition assessment of the ageing primary plant assets at Townsville South has highlighted that many are nearing the end of their technical service life. The majority of the substation's original primary equipment, including circuit breakers, is no longer supported by their respective manufacturers, with little or no spares available.

A number of age-related issues are also impacting the performance and safety of several voltage transformers and surge arrestors.

2.2.1 Assumptions underpinning the identified need

The need to invest is driven by Powerlink's obligations to address the increasing risks to supply arising from the condition of the ageing and obsolete primary plant assets at Townsville South Substation. If not addressed, these risks can lead to plant failures and extend the time taken to recover (or even prevent recovery) from faults, due to a lack of support from manufacturers and a lack of spare parts.

Powerlink's obligations as a TNSP[3] 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.

It follows that the increasing likelihood of faults arising from ageing assets remaining in service at Townsville South Substation compels Powerlink to undertake reliability corrective actions if it is to continue to meet its jurisdictional obligations and the standards for reliability of supply set out in the Rules.

2.2.2 Description of asset condition and risks

Townsville South Substation was established in 1977 to replace the ageing 132kV equipment at Stuart Substation. While a number of primary plant additions and replacements were undertaken between 1998 and 2006, the majority of the original equipment is still in service and being maintained with an increasingly limited stock of spare parts and without manufacturer support for repairs.

Powerlink has undertaken a comprehensive condition assessment of the primary plant at Townsville South Substation. This has identified that due to age related deterioration there is a significant amount of equipment reaching the end of its technical service life with an increasing risk of failure. The primary plant at Townsville South Substation that has been identified as requiring remedial action consists primarily of circuit breakers, surge arrestors, earth switches, voltage transformers and capacitor cans located in various bays within the substation.

At almost 40 years of age, the circuit breakers are experiencing significant age-related performance degradation and component failures. Issues being experienced (dependent upon model) include SF6 gas leaks, corrosion, age related degradation and wear of components, and oil leaks. These condition issues have also resulted in performance degradation including slower fault clearance times and, in some cases, failure of the circuit breaker to operate correctly, which could increase the risk to plant and staff safety.

Several of the circuit breakers are also under-rated for the expected fault levels within the next five years. With few or no spares available from the respective manufacturers, it is also becoming increasingly difficult for Powerlink to service this ageing population of circuit breakers across the network.

The disconnectors and earth switches that were installed in the late 1970s and early 1980s are also nearing 40 years of age and facing obsolescence issues. They too will become under-rated for the expected fault levels within the next five years, resulting in an increased safety risk at the site if the situation is not addressed.

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[2] *Powerlink's Transmission Annual Planning Report* 2018

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

The aged voltage transformers and earth switches are experiencing obsolescence issues with insufficient spares to support ongoing operation. There is also an increasing frequency of oil leaks and a safety risk associated with the ageing porcelain housings of the voltage transformers. The capacitor banks were installed in the late 1970s with the capacitor cans showing signs of advanced corrosion.

Poor asset condition increases the risk of faults, while obsolescence increases the time needed for Powerlink to undertake any necessary repairs. The potential in-service failure of ageing and obsolete primary plant at Townsville South Substation would present Powerlink with an increasing risk to personnel safety and risk of unserved energy beyond those specified in its jurisdictional obligations.[4]

3. Submissions received

Powerlink published a PSCR in October 2018 calling for submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options that could address the risks arising from the ageing primary plant at Townsville South Substation. Members of Powerlink's Non-network Engagement Stakeholder Register were also advised of the PSCR publication.

There were no submissions received in response to the PSCR that was open for consultation until 25 January 2019. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

4. Credible options assessed in this RIT-T

Powerlink has developed three credible network options to address the identified need for maintaining the reliability of supply at Townsville South Substation. The options consist of similar works over the longer term, but consider alternative staging of these works.

These options are summarised in Table 4.1.

[4] S 34(1), Electricity Act 1994; Division 2 Duties of care, Electrical Safety Act 2002; Queensland Transmission Authority T01/98

Table 4.1: Credible Options

Option	Description	Indicative capital cost ($million, 2018/19)	Indicative annual O&M costs* ($million, 2018/19)
Base Option Staged replacement utilising live tank circuit breakers completed by 2045	Staged replacement of selected equipment in existing bays utilising live tank circuit breakers by: • December 2022* • December 2030† • December 2045†	 4.94* 0.99† 4.14†	0.101
Option 1 Staged replacement utilising dead tank circuit breakers completed by 2045	Staged replacement of selected equipment in existing bays utilising dead tank circuit breakers by: • December 2022* • December 2030† • December 2045†	 7.77* 1.09† 4.86†	0.084
Option 2 Upfront single stage replacement utilising dead tank circuit breakers completed by 2022	Upfront single stage replacement of selected equipment including all equipment in 7 bays utilising dead tank circuit breakers by December 2022*	10.96*	0.076

*Proposed RIT-T project
†Modelled projects

All credible options address the risks arising from the deteriorated condition of ageing primary plant at Townsville South Substation. The Base Option and Option 1 seek to optimise plant life, while Option 2 seeks to minimise mobilisation costs and outages.

None of these options has been discussed by the Australian Energy Market Operator (AEMO) in its most recent National Transmission Network Development Plan (NTNDP).[5] Additional options that have been considered but not progressed, due to not being either economically or technically feasible, are listed in Appendix 1 of the PSCR.

The primary plant to be installed under the initial stage of each option is outlined in Table 4.2.

Table 4.2: Primary plant to be installed under initial stage of each credible network option

HV Primary Plant	Base Option	Option 1	Option 2
132kV Circuit Breakers	7 (Live tank)	7 (Dead tank)*	8 (Dead tank)*
Voltage Transformers	9	9	18
Disconnectors	10	10	12
Earth Switches	2	2	5
Surge Arrestors	6	6	21
Capacitor Bank 'Cans'	2	2	2

* Dead tank circuit breakers incorporate current transformers within the unit hence the current transformers are replaced at the same time as the circuit breakers.

[5] 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 Base Option: Staged replacement using live tank circuit breakers, completed by 2045

Powerlink is the proponent of this option.

The initial stage of the works under this option would consist of the replacement of the existing live tank circuit breakers with modern equivalent live tank circuit breakers, along with selected disconnectors, voltage transformers, earth switches, surge arrestors and capacitor bank 'cans' by December 2022.

The remainder of the primary plant would be replaced in two subsequent stages in 2030 and 2045, as part of modelled projects under this option. These modelled projects include the replacement of a hybrid circuit breaker, selected voltage transformers, and the existing current transformers along with the balance of aged disconnectors, voltage transformers, earth switches and surge arrestors.

Table 4.3: Main project components for the Base Option

Base Option	Description	Indicative capital cost ($million, 2018/19)
Staged replacement by December 2022*	Live tank circuit breakers, selected disconnectors, voltage transformers, earth switches and surge arrestors and capacitor bank 'cans'	4.94
Staged replacement by December 2030†	Selected voltage transformers and PASS hybrid circuit breaker module	0.99
Staged replacement by December 2045†	Current transformers and balance of aged disconnectors, voltage transformers, earth switches and surge arrestors.	4.14
TOTAL		**10.07**

*Proposed RIT-T project
†Modelled projects

4.2 Option 1: Staged replacement using dead tank circuit breakers, completed by 2045

Powerlink is the proponent of this option.

The initial stage of the works under this option would consist of the replacement of the existing live tank circuit breakers and associated current transformers with dead tank circuit breakers, which incorporate current transformers by December 2022. Selected disconnectors, voltage transformers, earth switches, surge arrestors and capacitor bank 'cans' would also be replaced at this time.

The remainder of the primary plant would be replaced in two subsequent stages in 2030 and 2045, as part of modelled projects under this option. These modelled projects include the replacement of a hybrid circuit breaker, selected voltage transformers, and the balance of aged disconnectors, voltage transformers, earth switches and surge arrestors.

Table 4.4: Main project components for Option 1

Option 1	Description	Indicative capital cost ($million, 2018/19)
Staged replacement by December 2022*	Dead tank circuit breakers, selected disconnectors, voltage transformers, earth switches, surge arrestors and capacitor bank 'cans'	7.77
Staged replacement by December 2030†	Selected voltage transformers and PASS hybrid circuit breaker module	1.09
Staged replacement by December 2045†	Balance of aged disconnectors, voltage transformers, earth switches and surge arrestors	4.86
TOTAL		**13.72**

*Proposed RIT-T project
†Modelled projects

4.3 Option 2: Replacement using dead tank circuit breakers, completed by December 2022

Powerlink is the proponent of this option.

Under this option selected primary plant would be replaced in a single stage, including all primary plant in seven 132kV bays where existing live tank circuit breakers would be replaced with dead tank circuit breakers incorporating new current transformers.

Table 4.5: Main project components for Option 2

Option 2	Description	Indicative capital cost ($million, 2018/19)
Upfront singe stage replacement by December 2022	Dead tank circuit breakers, disconnectors, voltage transformers, earth switches, surge arrestors and capacitor bank 'cans'	10.96
TOTAL		**10.96**

4.4 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.[6]

5. Materiality of Market Benefits

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

[6] 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.

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

None of the replacement options will have an impact on wholesale market outcomes. The Australian Energy Regulator (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[7]. Consequently, no market benefits have been estimated as part of this RIT-T.

More information on consideration of individual classes of market benefits can be found in the PSCR.

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 2021 to 2055. A 35-year period takes into account the size and complexity of the primary plant. Due to the staged nature of the options, there will remaining asset life by 2055, at which point a terminal value is calculated to correctly account for capital costs under each credible option.

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%[8] 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%[9] 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 a number of different reasonable scenarios, which are used to estimate market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration. The choice of reasonable scenarios must reflect any variables or parameters that[10] are likely to affect the ranking of the credible options, where the identified need is reliability corrective action.

Powerlink has considered capital costs and discount rate sensitivities individually and in combination and found that these variables do not affect the relative rankings of credible options or identification of the preferred option. As sensitivities (both individually and in combination) do not affect ranking results, Powerlink has elected to present one central scenario in Table 6.1.

Table 6.1: Reasonable scenario assumed

Key variable/parameter	Central scenario
Capital costs	100% of central capital cost estimate
Discount rate	7.04%

[7] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* September 2017, version 2, page 13.
[8] This indicative commercial discount rate has been calculated on the assumptions that a private investment in the electricity sector would hold an investment grade credit rating and have a return on equity equal to an average firm on the Australian stock exchange, as well as a debt gearing ratio equal to an average firm on the Australian stock exchange.
[9] 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.
[10] 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 net present value and the corresponding ranking of each credible option.

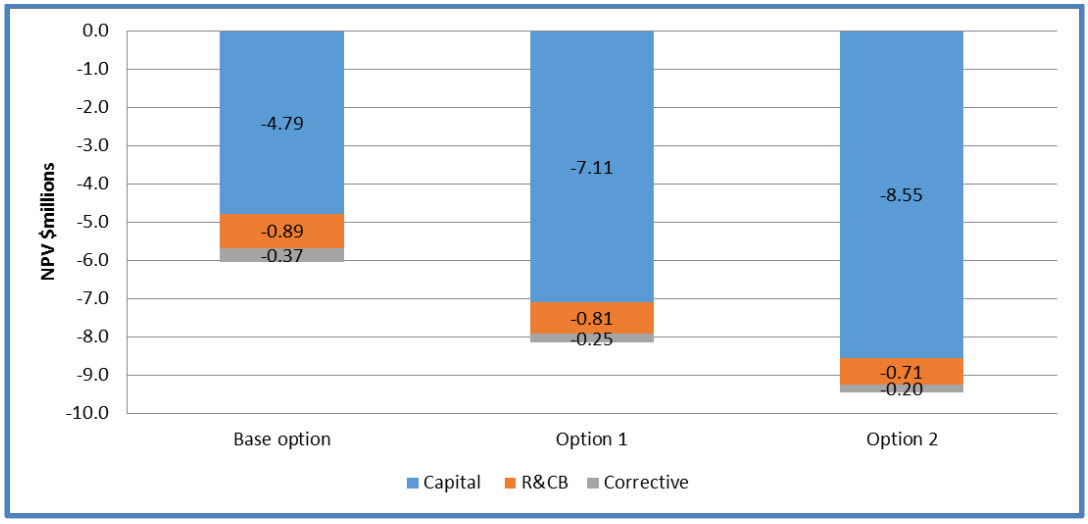
Table 7.1: NPV for each credible option ($m, 2018/19)

Option	Description	NPV ($m)	Ranking
Base Option	Staged replacement utilising live tank circuit breakers completed by 2045	-6.0	1
Option 1	Staged replacement utilising dead tank circuit breakers completed by 2045	-8.2	2
Option 2	Upfront single stage replacement utilising dead tank circuit breakers completed by 2022	-9.5	3

When compared to the Base Option, Option 1 and Option 2 are $2.2 million and $3.5 million more expensive in NPV terms respectively.

Figure 7.1 sets out the breakdown of capital cost and operating costs for each option in NPV terms under the central scenario, highlighting the relatively small contribution of operating costs to the overall NPV and the impact of capital costs on the final outcome.

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



7.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

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

These sensitivity tests show that the Base Option is the preferred option under all sensitivities (both considered together and in combination).

7.3 Preferred option

The result of the cost benefit analysis indicates that the Base Option is the highest net benefit solution (lowest cost in NPV terms) over the 35-year analysis period. Sensitivity testing shows the economic analysis is robust to variations in the capital cost and the discount rate assumptions. The Base Option is therefore considered to satisfy the requirement of the RIT-T and is the preferred option.

8. Conclusions

The following conclusions have been drawn from the analysis presented in this report:

- Powerlink has identified condition risks arising from ageing primary plant at Townsville South Substation requiring action.
- TNSPs must maintain (including repair and replace if necessary) their transmission network 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 condition of ageing primary plant compels Powerlink to undertake reliability corrective actions at Townsville South Substation if it is to continue meeting the reliability standards set out in the Rules.
- Studies were undertaken to evaluate three credible options. All three credible options were evaluated in accordance with the AER's RIT-T.
- Powerlink published a PSCR in October 2018 requesting submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options which could address the primary plant condition risks at Townsville South Substation.
- The PSCR also identified the preferred option and that Powerlink was adopting the expedited process for this RIT-T, claiming exemption from producing a PADR as allowed for under NER clause 5.16.4(z1) for investments of this nature.
- There were no submissions received in response to the PSCR which was open for consultation until 25 January 2019. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.
- The conditions specified under the Rules for exemption have now been fulfilled.
- The result of the cost-benefit analysis under the RIT-T identified that the Base Option is the highest net benefit solution over the 35-year analysis period. Sensitivity testing showed the analysis is robust to variations in the capital cost and discount rate assumptions. As a result, the Base Option is considered to satisfy the RIT-T.
- The outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR. Consequently, the draft recommendation has been adopted without change as the final recommendation and will now be implemented.

9. Final 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 the Base Option be implemented to address the condition risks arising from ageing primary plant at Townsville South Substation. The Base Option provides for a staged approach to replacing selected primary plant and utilises live tank circuit breakers.

The RIT-T project for the Base Option, involves the installation and commissioning of new plant by December 2022 and has an estimated capital cost of $4.94 million in 2018/19 prices.

Powerlink is the proponent of the proposed network project.

Powerlink will now proceed with the necessary processes to implement this recommendation.

Contact us

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