Powerlink Queensland

Project Specification Consultation Report

30 May 2019

Maintaining reliability of supply in the Blackwater area

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. More information on the RIT-T process and how it is applied to ensure that safe, reliable and cost effective solutions are implemented to deliver better outcomes to customers is available on Powerlink's website.
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 customers.
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 encourages submissions from potential proponents of feasible non-network options to address the identified need.

Contents

Executive Summary

Ageing transformers at Blackwater Substation require Powerlink to take action

Blackwater Substation, established in 1969 and located approximately 68km east of Emerald, plays a critical role in the provision of electricity to customers in Queensland's Central West area, providing supply to residential, mining and rail traction loads. Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services provided by Blackwater Substation supporting the diverse range of customer needs in the area.

The substation's 132kV switchyard includes three 132/66/11kV transformers (2 x 80MVA and 1 x 160MVA) which provide connections to the Ergon Energy (part of the Energy Queensland Group) distribution network. The two 80MVA transformers were installed in 1978, and at over 40 years of age have significant condition and performance issues indicating that they are reaching the end of their technical service lives. The third transformer, rated at 160MVA, was installed in 2006 and is in good working condition.

The increasing likelihood of faults arising from the condition of the ageing 80MVA transformers at Blackwater remaining in service beyond June 2022, exposes customers to the risks and consequences of an increasingly unreliable electricity supply. There is a need for Powerlink to address this emerging risk under the reliability and service standards set out in its mandated jurisdictional and Rules' obligations.

This Project Specification Consultation Report (PSCR) discusses the potential credible network options, which incorporate cost effective measures over the long-term, to achieve the required service levels.

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

As the proposed investment is to meet reliability and service standards specified within applicable regulatory instruments, and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, it is classified as a 'reliability corrective action'[1].

The most expensive credible network option identified in this PSCR meets the capital expenditure cost threshold of $6 million, initiating public consultation under the Rules. Powerlink has adopted the expedited process for this RIT-T[2], as the preferred option is below $43 million and is unlikely to result in any material market benefits, other than those arising from a reduction in involuntary load shedding. The reduction in involuntary load shedding under the credible network options is catered for in the risk cost modelling and hence included in the economic analysis of the options.

A non-credible Base Case has been developed against which to compare credible options

Consistent with the RIT-T Application Guidelines[3] the assessment undertaken in this PSCR compares and ranks the net present value (NPV) of credible network options designed to address the emerging risks, relative to a Base Case. The Base Case is modelled as a non-credible option where the existing condition issues associated with an asset are managed via operational maintenance only, resulting in an increase in risk levels as the condition of the asset deteriorates over time. These increasing risk levels are assigned a monetary value and added to the ongoing maintenance costs to form the Base Case. The Base Case is then used as a benchmark against which to compare and rank the credible options designed to offset/mitigate the risks, and to ensure ongoing compliance with regulatory and jurisdictional obligations.

Three credible network options to address the identified need

Powerlink has developed three credible network options to maintain the existing electricity services, ensuring a safe, reliable and cost effective supply to customers in the area.

[1] The Rules clause 5.10.2, Definitions, reliability corrective action.

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

[3] AER, Application guidelines, Regulatory investment test for transmission, December 2018

The three credible network options, along with their net present values (NPVs) relative to the Base Case are summarised in Table 1 below. The absolute NPVs of the Base Case and the Options is shown graphically in Figure 1. All three credible options will address the identified need on an enduring basis. Table 1 shows that Option 2 is ranked first of the three credible options, with the highest NPV relative to the Base Case.

Table 1: Summary of credible network options

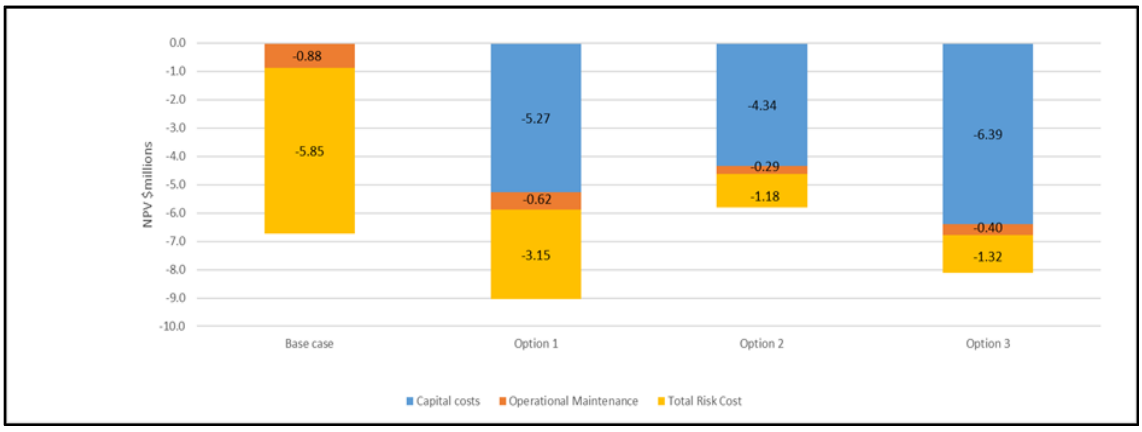
Option	Description	Total Cost ($m) 2018/19	NPV relative to Base Case ($m) 2018/19)	Ranking
1	Repair oil leaks and replace selected components on the two at-risk 80MVA transformers to address corrosion and emerging reliability issues by June 2022	3.50*	-2.31	3
	Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2027	6.16†		
2	Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2022	6.16*	+0.91	1
3	Replace both at-risk 80MVA 132/66/11kV transformers with two 100MVA 132/66/11kV transformers by June 2022	9.09*	-1.39	2

*RIT-T Project
†Future modelled projects (operational and capital).

It should be noted that Option 1 and 2 result in a changed substation configuration, with the final configuration consisting of two 132/66/11kV transformers (i.e. 2 x 160MVA transformers; one new and one existing transformer). Option 3 maintains the existing configuration consisting of three 132/66/11kV transformers (i.e. 2 x 100MVA new transformers and 1 x 160MVA existing transformer). All options and their resulting configurations continue to provide the required services to the Blackwater area.

From Figure 1 it can be seen that the Base Case and all options have negative absolute NPVs. All options reduce the total risks and maintenance costs arising from the ageing and obsolete assets at Blackwater remaining in service (as in the Base Case), with Option 2 having the largest reduction and reflecting a net economic benefit of $0.91 million when compared to the Base Case.

Figure 1: NPV of Base Case and Options ($m, 2018/19)



Option 2 has been identified as the preferred option.

Of the credible network options, Option 2 has been identified as the preferred option, providing the greatest benefit to customers.

The RIT-T project for Option 2 involves replacing the two 132/66/11kV 80MVA transformers with one 132/66/11 kV 160MVA transformer by June 2022. The indicative capital cost of the RIT-T project for the preferred option is $6.16 million in 2018/2019 prices.

Under Option 2, design work will commence in late 2019, with installation of the new transformer completed by June 2022.

Powerlink welcomes the potential for non-network options to form part or all of the solution

Powerlink welcomes submissions from proponents who consider that they could offer a credible non-network option that is both economically and technically feasible by June 2022, on an ongoing basis.

A non-network option that avoids the proposed replacement of the ageing transformers would need to replicate, in part or full, the support that Blackwater Substation delivers to customers in the area on a cost effective basis.

Lodging a submission with Powerlink

Powerlink is seeking written submissions on this Project Specification Consultation Report by Tuesday, 27 August 2019, particularly on the credible options presented[4].

Please address submissions to:

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[4] Powerlink's website has detailed information on the types of engagement activities, which may be undertaken during the consultation process. These activities focus on enhancing the value and outcomes of the RIT-T engagement process for customers and non-network providers.

1 Introduction

1.1 Powerlink Asset Management Obligations

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 generators to electricity distributors Energex and Ergon Energy (both 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 valued transmission services to its customers by managing risk[5] , optimizing performance and efficiently managing assets through the whole of asset life cycle.[6] .

Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services currently provided by Blackwater Substation to customers in Queensland's Central West, as well as the Blackwater and Bowen Basin mining areas.

Blackwater substation's 132kV switchyard includes three 132/66/11kV transformers (2 x 80MVA and 1 x 160MVA) which provide connections to the Ergon Energy distribution network. The two 80MVA transformers were installed in 1978, and at over 40 years of age are nearing the end of their technical service lives and are increasingly at-risk of failure due to their deteriorated condition. The 160MVA transformer was installed in 2006 and is in good working condition.

The proposed credible network options maintain current electricity services to customers in the area by addressing the increasing likelihood of faults arising from the condition of Blackwater Substation's ageing 80MVA transformers. When developing the credible options, Powerlink has focussed on implementing cost effective solutions that ensure a safe and reliable supply, delivering better outcomes for customers.

1.2 RIT-T Overview

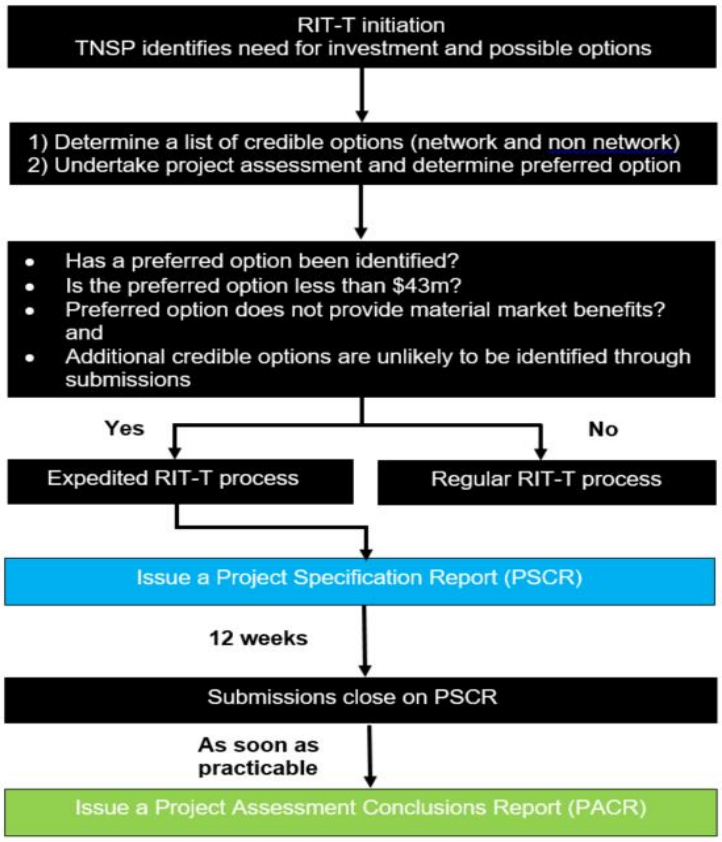
This Project Specification Consultation Report (PSCR) is the first step in the RIT-T process[7]. It:

- 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 address the identified need
- discusses why Powerlink does not expect specific categories of market benefit to be material for this RIT-T[8]
- presents the Net Present Value (NPV) assessment of each of the credible options compared to a Base Case (as well as the methodologies and assumptions underpinning these results)
- identifies and provides a detailed description of the credible option that satisfies the RIT-T, and is therefore the preferred option

[5] 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.
[6] 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
[7] This RIT-T consultation has been prepared based on the following documents: National Electricity Rules, Version 121, 2 May 2019 and AER Application guidelines, Regulatory investment test for transmission, December 2018.
[8] As required by Clause 5.16.1(c)(iv) of the Rules.

- describes how customers and stakeholders have been engaged regarding the identified need
- provides stakeholders with the opportunity to comment on this assessment so that Powerlink can refine the analysis (if required)

Figure 1.1: RIT-T Process Overview



Powerlink has adopted the expedited process for this RIT-T, as allowed for under the National Electricity Rules (the Rules) for investments of this nature[9]. Specifically, Powerlink will publish a Project Assessment Conclusions Report (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 $43 million
- none of the credible options have material market benefits, other than benefits associated with changes in involuntary load shedding[10]
- 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 transformer replacement project.

Powerlink will however publish a PADR if submissions to this PSCR identify other credible options that have not yet been considered and which could provide a more cost efficient outcome for customers.

[9] In accordance with clause 5.16.4(z1) of the Rules
[10] Section 4.3 Project assessment draft report, Exemption from preparing a draft report, AER, Application guidelines, Regulatory investment test for transmission, December 2018

2 Customer and stakeholder engagement

Delivering electricity to almost four million Queenslanders, Powerlink recognises the importance of engaging with a diverse range of customers and stakeholders who have the potential to affect, or be affected by, Powerlink's activities and/or investments.

2.1 Powerlink takes a proactive approach to engagement

Powerlink regularly hosts a range of engagement forums and webinars, sharing information with customers and stakeholders in the broader community. These engagement activities help inform the future development of the transmission network and assist Powerlink in providing services that align with the long term interests of customers. Feedback from these activities is also incorporated into a number of publicly available reports.

2.2 Working collaboratively with Powerlink's Customer Panel

Powerlink's Customer Panel provides a face-to-face opportunity for customers and consumer representative bodies to give their input and feedback about Powerlink's decision making, processes and methodologies. It also provides Powerlink with a valuable avenue to keep customers better informed, and to receive feedback about topics of relevance, including RIT-Ts.

The Customer Panel is regularly advised on the publication of Powerlink's RIT-T documents and briefed quarterly on the status of current RIT-T consultations, as well as upcoming RIT-Ts, providing an ongoing opportunity for:

- the Customer Panel to ask questions and provide feedback to further inform RIT-Ts
- Powerlink to better understand the views of customers when undertaking the RIT-T consultation process.

Powerlink will continue providing updates to and request input from the Customer Panel throughout the RIT-T consultation process.

2.3 Transmission Annual Planning Report (TAPR) – the initial stage of formal public consultation

Powerlink utilises the TAPR as a primary vehicle to engage and understand broader consumer, customer and industry views on key topics as part of the annual Transmission Network Forum (TNF) and to inform its business network and non-network planning objectives. TNF participants encompass a diverse range of stakeholders including customers, landholders, environmental groups, Traditional Owners, government agencies, and industry bodies.

2.3.1 Maintaining transfer capabilities and reliability of supply at Blackwater

- Powerlink identified in its TAPR from 2016, an expectation that action would be required at Blackwater Substation to maintain transfer capabilities and reliability of supply in the Central West transmission zone[11].
- The 2018 TAPR also highlighted that Powerlink anticipated the commencement of a RIT-T within the next 12 months.
- Members of Powerlink's Non-network Engagement Stakeholder Register (NNESR) were directly advised of the publication of the TAPR and the accompanying compendium of potential non-network solution opportunities (Appendix F), which set out the indicative non-network requirements to meet the identified need at Blackwater Substation.
- The Customer Panel was advised of the upcoming RIT-T consultation for Blackwater Substation in December 2018.
- No submissions proposing credible and genuine non-network options have been received from prospective non-network solution providers in the normal course of business, in response to the publication of TAPRs or as a result of stakeholder engagement activities.

[11] This relates to the standard geographic definitions (zones) identified within the TAPR.

2.4 Powerlink applies a consistent approach to the RIT-T stakeholder engagement process

Powerlink undertakes a considered and consistent approach to ensure an appropriate level of stakeholder engagement is undertaken for each individual RIT-T. Please visit Powerlink's website for detailed information on the types of engagement activities, which may be undertaken during the consultation process. These activities focus on enhancing the value and outcomes of the RIT-T engagement process for customers and non-network providers. Powerlink welcomes feedback from all stakeholders to improve the RIT-T stakeholder engagement process.

3 Identified need

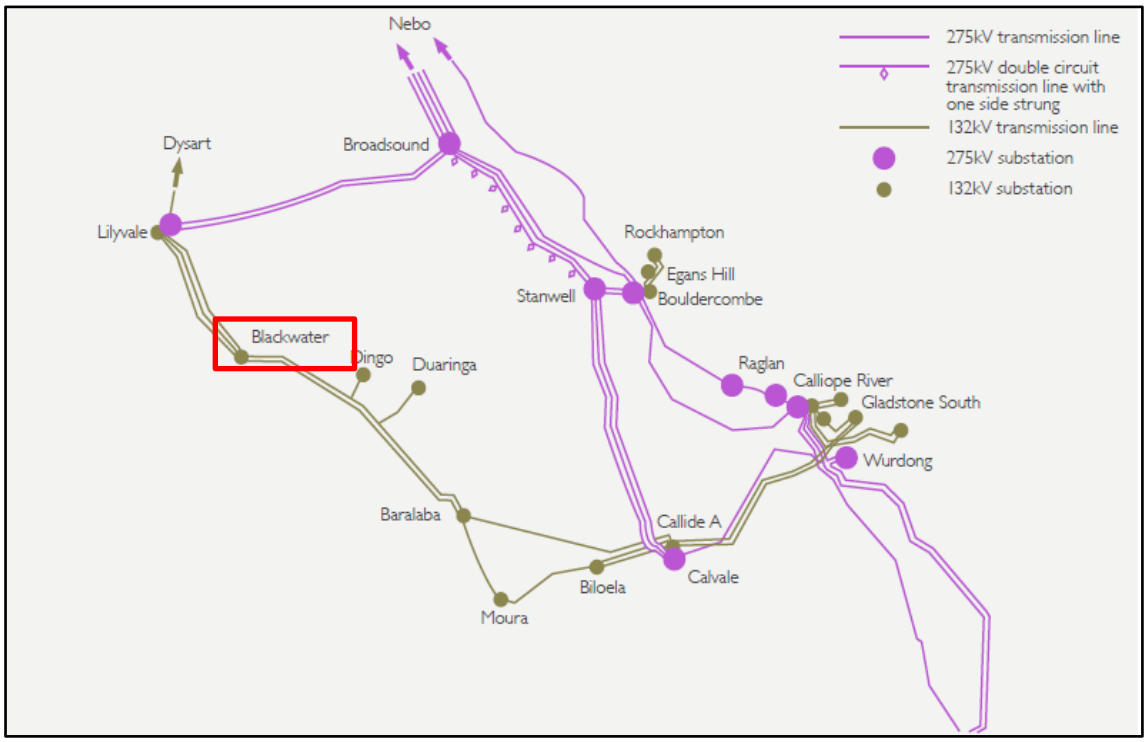
This section provides an overview of the existing arrangements at Blackwater Substation and describes the increasing risk to reliability of supply in the Central West area due to the assessed deteriorated condition of the ageing 80MVA transformers at the substation.

3.1 Geographical and network need

Blackwater Substation was established in 1969 to service the growing residential, mining and rail needs of Central West Queensland. The substation consists of 132kV (Powerlink) and 66kV (Ergon Energy) switchyards and hosts three 132/66/11kV transformers (2 x 80MVA and 1 x 160MVA) supplying the Ergon Energy load. It also facilitates the connection of seven 132kV feeders.

The Central West and Gladstone transmission zones are shown in Figure 2.1.

Figure 2.1: Central West and Gladstone transmission zones



3.2 Description of identified need

With peak demand in the Blackwater area forecast to remain at or slightly above current levels[12], it is vital that electricity supply be maintained to address these demands and for Powerlink to meet its reliability of supply and safety obligations under the *Electricity Act 1994, Electrical Safety Act* 2002 and Transmission Authority[13].

Powerlink's condition assessment of the ageing 80MVA transformers at Blackwater Substation has highlighted that they are operating in a deteriorated condition and are nearing the end of their technical service lives.

As the proposed investment is to meet reliability and service standards specified within applicable regulatory instruments, and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, it is classified as a "reliability corrective action", under the RIT-T[14].

A reliability corrective action differs from that of an increase in producer and consumer surplus (market-benefit) driven need in that the preferred option may have a negative net economic outcome because it is required to meet an externally imposed obligation on the network business.

3.2.1 Assumptions and requirements underpinning the identified need

The need to invest is driven by Powerlink's obligations to address the increasing risks to supply, safety and property arising from the condition of the ageing 80MVA transformers at Blackwater Substation. If not addressed, these risks can lead to failures and extend the time taken to recover from faults, due to the time taken to relocate and install a spare transformer in the event of an irreparable failure.

Under the *Electricity Act 1994*, Powerlink is required to "operate, maintain (including repair and replace if necessary) and protect its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity"[15].

The *Electrical Safety Act* 2002 also requires Powerlink to operate its network in a manner that ensures electrical risk to a person or property has been eliminated, so far as is reasonably practicable; or if it is not reasonably practicable to eliminate electrical risk to the person or property, the risk has been minimised so far as is reasonably practicable[16].

Powerlink's must also plan, design, maintain and operate its network to meet the power quality standards and reliability obligations set out in the Rules and in its Transmission Authority[17].

It follows that the increasing likelihood of faults arising from the deteriorated condition of the 80MVA transformers remaining in service at Blackwater 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 National Electricity Rules.

3.2.2 Description of asset condition and risks

Powerlink has undertaken a comprehensive condition assessment of the transformers at Blackwater Substation.

Commissioned over 40 years ago, the two original 132/66/11kV transformers are exhibiting signs of age-related deterioration, particularly in the performance of their oil impregnated insulating paper and main tank bushing seals, as well as the corrosion of external fittings. Protective galvanised coatings have begun to break down on several components including radiators, connecting pipework, control system cabinets, bushing mountings and flanges.

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[12] Powerlink's Transmission Annual Planning Report 2018

[13] Queensland Government Transmission Authority T01/98

[14] The Rules clause 5.10.2, Definitions, reliability corrective action.

[15] S34(1)a, Electricity Act 1994

[16] S29 of the Electrical Safety Act

[17] Schedule 5.1a System Standards and 5.1.2 Network Reliability of the Rules, and Section 6 Transmission Authority Number T01/98, as amended 30 June 2014

The sealing integrity of numerous joints and valves has been compromised, resulting in an increased observation of oil leaks at radiators, bushings and conservator tanks. Analysis has also shown the transformers' winding paper insulation has deteriorated and is nearing the end of its technical service life, with approximately 3 to 5 years of reliable operation remaining.

The design of the winding clamping mechanism used in these older transformers also results in a loss of residual clamping pressure over time as the paper deteriorates, reducing the overall resilience of the transformers to future through faults. A failure of transformer insulation during a through fault can have major consequences to reliability of supply, safety and the environment because of the potential for oil loss and fire.

The transformers' porcelain bushings have also reached or exceeded their manufacturers predicted design service life, increasing their likelihood of failure and presenting Powerlink with an unacceptable level of safety and network risks.

With only limited spares available, the manufacturer no longer supports many of the transformers' mechanical parts; hence, obsolescence has also become an issue with ongoing maintenance of the transformers.

As the consequences of a major failure of a power transformer are high, the asset management strategy employed is to plan and execute reinvestment before an actual failure occurs, given an ongoing future need to supply electricity in the area.

3.3 Consequences of Blackwater transformer failures

The main condition-based risks of the transformers are summarised in Table 3.1.

Table 3.1: Blackwater transformer risks and consequences

Equipment	Condition/Issue	Consequence of failure
Power Transformers	• Degraded oil and paper insulation • Deteriorated cooling fans and radiators • Significant oil leaks. • Reduced clamping pressure due to clamp design • Loss of insulating paper strength • Limited availability of spares	• Increased susceptibility to power transformer failure during through faults leading to loss of supply with long return to service time. • Increased risk of fire and environmental damage.

Notwithstanding the assessed condition of the asset, Powerlink's ongoing operational maintenance practices are designed to monitor plant condition and ensure emerging safety and environmental risks are proactively managed.

3.4 Rules, Jurisdictional and Legislative Compliance

The consequences of Blackwater's at-risk transformers remaining in service beyond 2022, without corrective action, would result in Powerlink being exposed to an unacceptable risk of breaching a number of its jurisdictional network, safety, environmental and Rules' obligations - resulting in poor customer, safety and environmental outcomes.

By addressing the risks arising from the condition of the ageing transformers at Blackwater, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to its customers in the Blackwater area into the future.

4 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 Reports (TAPRs), from 2016 onwards, an expectation that action would be required at Blackwater Substation to maintain reliability of supply requirements in the Central West transmission zone[18]. Powerlink has considered the operation of the existing embedded generation in the area in establishing this requirement.

Powerlink has consulted with Registered Participants, Powerlink's Non-Network Engagement Stakeholder Register and interested parties on the proposed investment at this 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, but will 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.

4.1 Criteria for proposed network support services

A non-network option that assists in minimising the overall investment could provide either a full solution that supports the decommissioning of both 132/66/11KV 80MVA transformers, or a partial solution that provides support to replace one of the two transformers at-risk, by June 2022.

A full non-network option would provide support for the replacement of both 132/66/11kV 80MVA transformers from June 2022. Indicative support requirements for this arrangement to comply with Powerlink's reliability obligations are provided in Table 4.1. The capacity requirement is provided as the MW requirement, along with the maximum likely daily energy requirement.

The exact requirements are in addition to existing embedded generation that operates in the area, and is dependent on the nature of the network support, including how quickly any response can be initiated, and the ability of the network support to respond to (and operate with) the highly variable nature of the load at Blackwater. A non-network option must also maintain/restore fault level (system strength) and voltage control.

Table 4.1: Support requirements to replace both 132/66/11kV transformers

Non-network support requirements (Medium forecast)	
MW	MWh/day
105	2,500

A partial non-network solution would provide support for the replacement of one of the two at-risk 80MVA transformers from June 2022. Indicative support requirements for this arrangement to comply with Powerlink's reliability obligations are provided in Table 4.2.

Table 4.2: Support requirements to replace one 132/66/11kV transformer

Non-network support requirements (Medium forecast)	
MW	MWh/day
10	175

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

Powerlink has identified the following common criteria that must be satisfied if proposed network support services are to meet supply requirements[19].

Size and location

- Proposed solutions must be large enough, individually or collectively, to provide the size of injection or demand response set out above. However, the level of support is 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 impacts on intra-regional transfer limits, fault level, system strength, maintaining network operability and quality of supply.

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 market price[20].
- 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.
- Where there are network costs associated with a proposed non-network option, including asset decommissioning, these costs will form part of the option economic assessment

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 condition risks at Blackwater 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.

[19] Powerlink's Network Support Contracting Framework also provides a general guidance to potential non-network solution providers. This framework outlines the key contracting principles that are likely to appear in any non- agreement.
[20] The National Electricity Rules prevent a generator that is providing network support from setting the market price.

5 Potential credible network options to address the identified need

Powerlink has developed three credible network options to address the identified need for maintaining reliability of supply in the Blackwater area.

All three options are designed to mitigate the risks to supply before the transformers reach the end of their technical service lives.

- Option 1: Life extension of the two at-risk 80MVA transformers by June 2022, followed by the replacement of both at-risk transformers with a single 160MVA transformer by June 2027. The RIT-T portion of this option would be completed by June 2022 at a cost of $3.50 million in 2018/19 prices.
- Option 2: Replacement of both at-risk 80MVA transformers with a single 160MVA transformer by June 2022, at a cost of $6.11 million in 2018/19 prices.
- Option 3: Replacement of both at-risk 80MVA transformers with two 100MVA transformers by June 2022, at a cost of $9.09 million in 2018/19 prices

Table 4.1: Summary of credible options

Option	Description	Indicative project costs ($million, 2018/19)	Indicative annual average O&M costs ($million, 2018/19)
1	Repair oil leaks and replace selected components on the two at-risk 80MVA 132/66/11kV transformers to address corrosion and emerging reliability issues by June 2022	3.50*	0.04
	Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2027	6.16†	
2	Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2022	6.16*	0.02
3	Replace both at-risk 80MVA 132/66/11kV transformers with two 100MVA 132/66/11kV transformers by June 2022	9.09*	0.03

*RIT-T Project
†Future modelled projects (operational and capital).

All credible network options address the major risks resulting from the deteriorated condition of ageing transformers at Blackwater Substation. None of these options has been discussed by the Australian Energy Market Operator (AEMO) in its most recent National Transmission Network Development Plan (NTNDP)[21].

Additional options that have been considered but not progressed, for technical or economic reasons, are listed in Appendix 1.

[21] 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 2018 NTNDP is currently the most recent NTNDP.

5.1 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[22].

6 Materiality of market benefits

The Rules require that all categories of market benefits identified in relation to a RIT-T be quantified, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material.

6.1 Market benefits that are material for this RIT-T assessment

Powerlink considers that changes in involuntary load shedding (i.e. the reduction in expected unserved energy) between the options, set out in this PSCR, may impact the ranking of the credible options under consideration and that this class of market benefit could be material. These benefits have been quantified and included within the cost benefit and risk cost analysis as network risk.

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

The AER has recognised a number of classes of market benefits may not be material in the RIT-T assessment, and so do not need to be estimated[23].

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

- **changes patterns of generation dispatch**: replacement under the credible options does not by itself affect transmission network constraints or affect transmission flows that would change patterns of generation dispatch. It follows that changes in patterns of generation dispatch are not material to the outcome of the RIT-T assessment
- **changes in voluntary load curtailment**: replacement under the credible options does not by itself 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 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

[22] 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.
[23] AER, Application guidelines, Regulatory investment test for transmission, December 2018

- **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.

6.3 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 will 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 will assess the materiality of market benefits associated with these options. Where the market benefits are material, these will be quantified as part of the RIT-T assessment of these options.

7 Base Case

7.1 Modelling a Base Case under the RIT-T

Consistent with the RIT-T Application Guidelines, the assessment undertaken in this PSCR compares the costs and benefits of credible options to address the risks arising from an identified need with a Base Case[24].

As characterised in the RIT-T Application Guidelines, the Base Case itself is not a credible option to meet the identified need. Specifically, the Base Case reflects a state of the world in which the condition of the ageing asset is only addressed through standard operational activities, with escalating safety, financial, environmental and network risks.

To develop the Base Case, the existing condition issues associated with an asset are managed by undertaking operational maintenance only, which results in an increase in risk levels as the condition of the asset deteriorates over time. These increasing risk levels are assigned a monetary value that is used to evaluate the credible options designed to offset or mitigate these risk costs.

The Base Case therefore includes the costs of work associated with operational maintenance (i.e. routine, condition-based and corrective maintenance) and the risk costs associated with the irreparable failure of the asset. The costs associated with irreparable failures are modelled in the risk cost analysis and are not included in the corrective maintenance costs.

The Base Case acts as a benchmark and provides a clear reference point in the cost benefit analysis to compare and rank the credible options against each other over the same timeframe.

7.2 Blackwater 80MVA transformer Base Case risk costs

Powerlink has developed a risk modelling framework consistent with the RIT-T Application Guidelines. An overview of the framework is available on Powerlink's website[25] and has been used to calculate the risk costs of the Base Case for the two 80MVA Blackwater transformers. The framework includes the modelling methodology and general assumptions underpinning the analysis.

7.2.1 Base Case assumptions

In calculating the potential unserved energy (USE) arising from a failure of the two ageing 132/66/11kV 80MVA transformers at Blackwater, the following modelling assumptions specific to the Blackwater network configuration have been made:

- A suitable spare transformer is available as an emergency replacement in the event of non-repairable failure of one of the aged transformers.

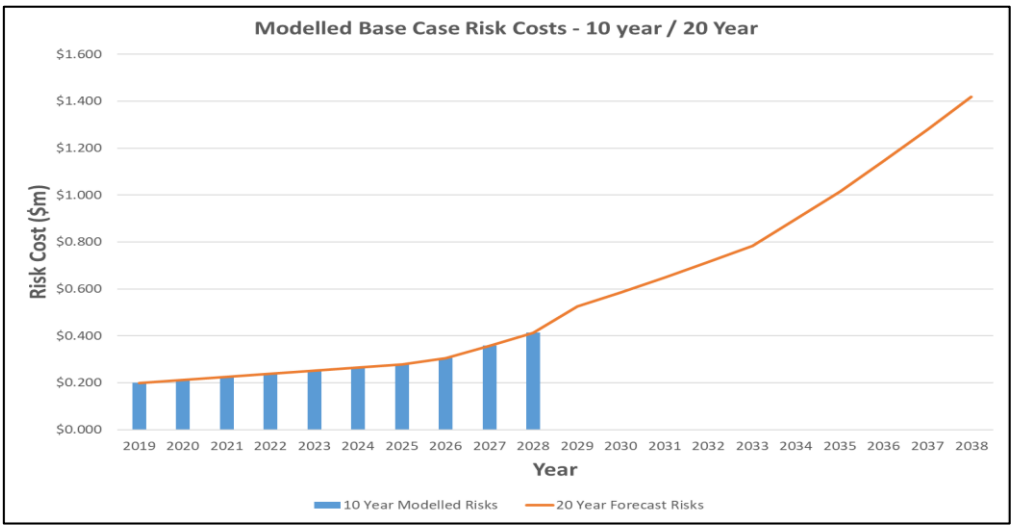
[24] AER, Final Regulatory investment test for transmission application guidelines, December 2018
[25] The risk costs are calculated using the principles set out in the Powerlink document, Overview of Asset Risk Cost Methodology, May 2019

- The downstream Ergon Energy 66kV distribution network supplying the greater Lilyvale and Blackwater area is available to provide a level of backup supply in the event of equipment failure.
- Embedded generation within the area operates whilst Blackwater substation remains energised to reduce the impacts of unserved energy in the event of equipment failures.
- Historical load profiles and embedded generation patterns have been used when assessing the likelihood of unserved energy under concurrent failure events.
- Peak demand for the greater Blackwater load area consistent with medium demand forecasts published within Powerlink's 2018 Transmission Annual Planning Report have been used.
- Unserved energy generally accrues under concurrent failure events, and consideration has been given to potential feeder trip events within the wider Blackwater area.
- The Blackwater Substation load comprises of a mix of load types, including open cut mining, underground mining, traction loads, and residential township. The network risk cost models have used the Queensland regional Value of Customer Reliability (VCR) published within AEMO 2014 Value of Customer Reliability Review Final Report ($39,710/MWh).
- Powerlink's business response to mitigating unserved energy under prolonged supply outage events has been incorporated within the risk cost modelling.

7.2.2 Base Case risk costs

The 20-year forecast of risk costs for the Base Case is shown in Figure 7.1.

Figure 7.1: Modelled Base Case risk costs



Based upon the assessed condition of the ageing 80MVA transformers at Blackwater, total risk costs are projected to increase from $0.2 million in 2019 to $1.4 million in 2038.

The main areas of risk cost are associated with network risks that involve reliability of supply through failure of the aged transformers modelled as probability weighted unserved energy and financial risk costs associated mostly with the replacement of failed assets in an emergency situation. Both of these risks increase over time as the condition of plant further deteriorates and the likelihood of failure rises.

7.3 Modelling of Risk in Options

Each option is specifically scoped to mitigate the major risks arising in the Base Case in order to maintain compliance with all statutory requirements. The residual risk is calculated for each option based upon the individual implementation strategy of the option. This is included with the capital and operational maintenance cost of each option to develop the NPV inputs.

8 General modelling approach adopted for net benefit analysis

8.1 Analysis period

The RIT-T analysis has been undertaken over a 20 year period, from 2019 to 2038. A 20-year period takes into account the size and complexity of the primary plant.

For all options, there will remaining asset life by 2038, at which point a terminal value is calculated to correctly account for capital costs under each credible option.

8.2 Discount rate

Under the RIT-T, a commercial discount rate is applied to calculate the NPV of costs and benefits of the credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 5.90%[26] 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%[27] and an upper bound discount rate of 8.33% (i.e. a symmetrical upwards adjustment).

8.3 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 are likely to affect the ranking of the credible options, where the identified need is reliability corrective action[28].

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 the ranking of the preferred option, Powerlink has elected to present one central scenario in Table 8.1.

Table 8.1: Reasonable scenario assumed

Key variable/parameter	Central scenario
Capital costs	100% of central capital cost estimate
Discount rate	5.90%

[26] 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.
[27] 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.
[28] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 16, p. 7

9 Cost benefit analysis and identification of the preferred option

9.1 NPV Analysis

Table 9.1 outlines the NPV and the corresponding ranking of each credible option relative to the Base Case.

Table 9.1: NPV for each credible option ($m, 2018/19)

Option	Description	Central Scenario NPV relative to Base Case ($m)	Ranking
1	Repair oil leaks and replace selected components on the two at-risk 80MVA 132/66/11kV transformers to address corrosion and emerging reliability issues by June 2022 Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2027	-2.31	3
2	Replace both at-risk 80MVA 132/66/11kV transformers with a single 160MVA 132/66/11kV transformer by June 2022	+0.91	1
3	Replace both at-risk 80MVA 132/66/11kV transformers with two 100MVA 132/66/11kV transformers by June 2022	-1.39	2

All three credible options will address the identified need on an enduring basis. Option 2 is ranked first of the three credible options, with the highest NPV relative to the Base Case. When compared to other credible options, Option 3 is $2.30 million and Option 1 is $3.22 million more expensive than Option 2 in NPV terms.

Figure 9.1 sets out the breakdown of capital cost, operational maintenance cost and total risk cost for each option in NPV terms under the central scenario. Note that the Base Case consists of operational maintenance and total risk costs and does not include any capital expenditure.

Figure 9.1: Central Scenario NPV component for each credible option (NPV $m, 2018/19)

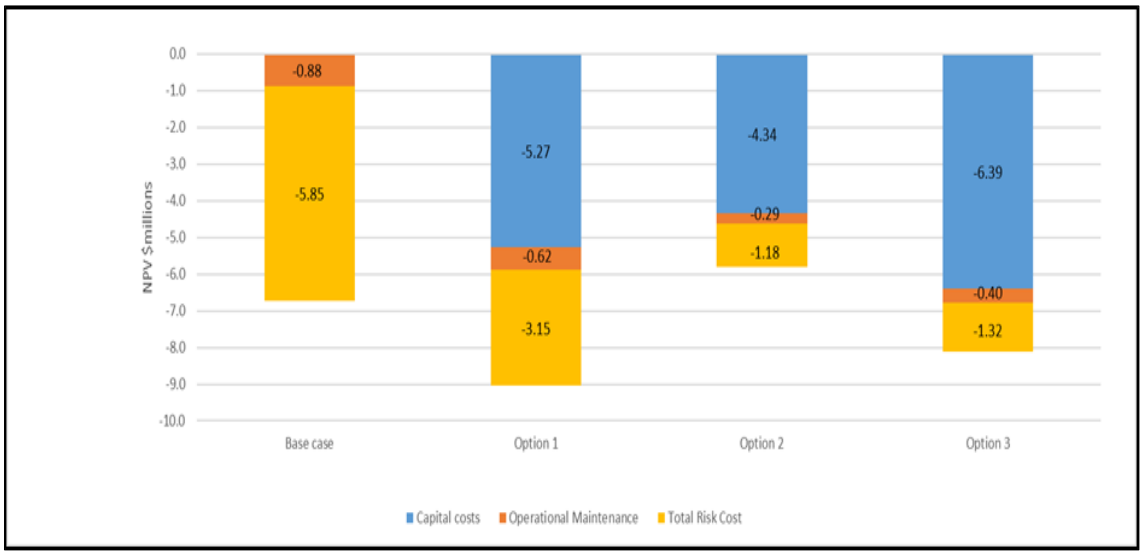


Figure 9.1 illustrates that all credible options will reduce the total risk cost and operational maintenance cost compared to the Base Case. Option 2 has the highest cost reduction benefit of the three credible options when compared with the Base Case.

Option 2 has the largest reduction in operational maintenance costs as the ultimate configuration consists of two 132/66/11kV transformers (1 new and 1 existing 160MVA transformer) at Blackwater from 2022.

Option 2 also has the largest reduction in total risk costs. This is due to the lower financial, network and safety risks associated with the ultimate two 132/66/11 kV transformer configuration to be commissioned from June 2022. Option 1 reaches the two transformer configuration at a later date in June 2027, while Option 3 retains the current three transformer configuration and has the highest residual total risk cost.

9.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a range from 3.47% to 8.33% discount rate.
- a range from 75% to 125% of base capital expenditure estimates.
- a range from 75% to 125% of operational maintenance expenditure estimates.
- a range from 75% to 125% of total risk cost estimates.

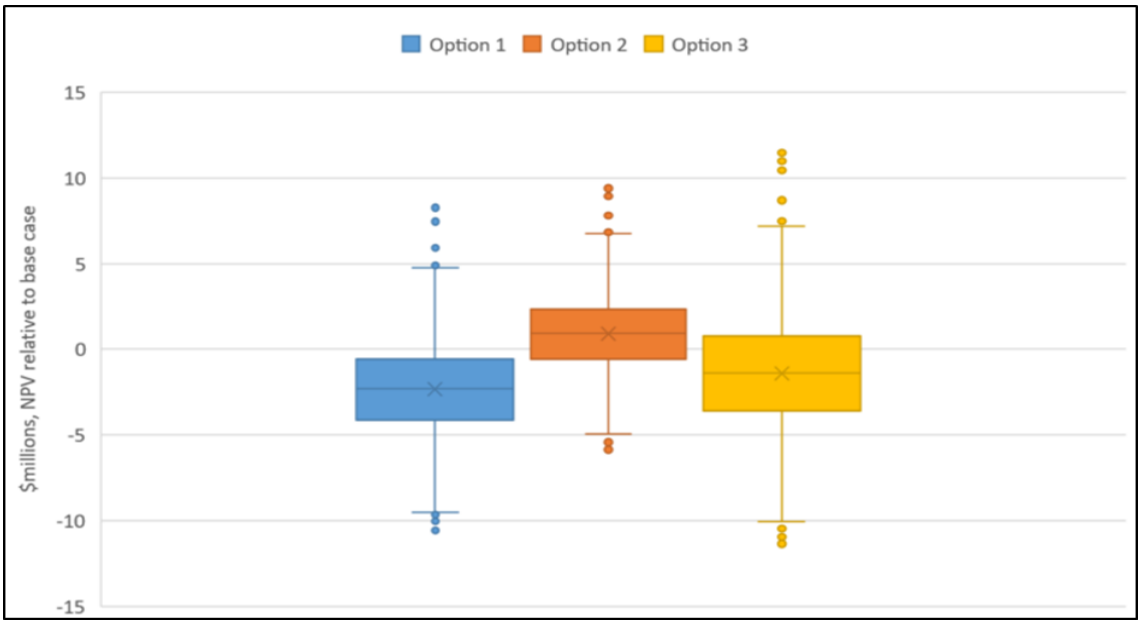
Sensitivity analysis for the NPV relative to the Base Case shows that varying the discount rate, capital expenditure, operational maintenance expenditure and total risk costs has no impact on the option rank and the identification of the preferred option.

9.2.1 Sensitivity to multiple parameters

A Monte Carlo simulation was performed with multiple input parameters (including capital cost, discount rate, operational maintenance cost, corrective maintenance cost and total risk costs) generated for the calculation of NPV for each option. This process is repeated over 5000 iterations, each time using a different set of random variables from the probability function. The sensitivity analysis output is presented as a distribution of possible NPVs for each option, as illustrated in Figure 9.2.

The Monte Carlo simulation results, identifies that Option 2 has the highest mean and median compared to the other credible options, while also exhibiting less statistical dispersion. This confirms that the preferred option is robust over a range of input parameters in combination.

Figure 9.2 NPV sensitivity analysis of multiple key assumptions relative to the Base Case



9.3 Conclusion

The result of the cost benefit analysis indicates that Option 2 has the highest net economic benefit over the 20-year analysis period. Sensitivity testing shows that the analysis is robust to variations in the capital cost, operational maintenance cost, discount rate and risk cost assumptions.

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

10 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 the deteriorated condition of the two ageing 132/66/11kV 80MVA transformers at Blackwater Substation. Implementing this option will provide an ongoing safe and reliable electricity supply to customers in the area and ensure continued compliance with applicable regulatory instruments and the Rules.

Option 2 involves replacing both 132/66/11kV 80MVA transformers with one new 160MVA transformer by June 2022. This option minimises the number of outages and mobilisation costs, and reduces the overall future operational maintenance costs, as there are less transformers to maintain in the final substation configuration.

The indicative capital cost of the RIT-T project for Option 2 is $6.16 million in 2018/19 prices.

Design and procurement activities will commence in late 2019, with the RIT-T project works to be completed by June 2022.

11 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.

11.1 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 RIT-T Application 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.

11.2 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	30 May 2019
Part 2	Submissions due on the PSCR Have your say on the credible options and propose potential non-network options.	27 August 2019
Part 3	Publication of the PACR Powerlink's response to any further submissions received and final recommendation on the preferred option for implementation.	October 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).

Appendix 1: Options considered but not progressed

Powerlink considered one further network option that has not been progressed. This option is described in Table A1.

Table A1: Options considered but not progressed

Option description	Reason for not progressing option
Like for like replacement of the existing two 132/66/11kV 80MVA transformers	Powerlink optimises operational maintenance and capital expenditure on transformers through standardising on transformer sizes. This allows for minimisation of spares holdings, and standardised designs and procurement contracts. Powerlink has currently standardised on 100MVA and 160MVA 132/66kV transformers. As a result of the savings associated with standardisation, replacing the existing 80MVA transformers at Blackwater with 100MVA transformers is more economic than replacing them with 80MVA transformers. The like for like replacement of the transformers with 80MVA units was therefore not progressed in favour of progressing the option using two 100MVA transformers.

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