Powerlink Queensland

Project Specification Consultation Report

23 May 2019

Maintaining power transfer capability and reliability of supply at Lilyvale

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 the 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 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

The condition of primary plant at Lilyvale Substation requires Powerlink to take action

Lilyvale Substation, located approximately 50km from Emerald, plays a critical role in the supply of electricity to customers in Queensland's Central West region, as well as the Blackwater and Bowen Basin mining areas. Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services provided by Lilyvale Substation supporting a diverse range of customer needs in the area.

Commissioned over 38 years ago, much of the substation's primary plant, including two of the original three 132/66 kV transformers, are reaching the end of their technical service lives and are no longer supported by the manufacturer, with limited spares available to rectify a failure if one were to occur.

The increasing likelihood of faults arising from the condition of Lilyvale's ageing and obsolete primary plant and transformers remaining in service, 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 consequentially represented 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.

Two credible network options have been developed to address the identified need

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

The two credible network options, along with their net present values (NPVs) relative to the Base Case are summarised in Table 1. The absolute NPVs of the Base Case and the Options are shown graphically in Figure 1.

[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

Table 1: Summary of credible RIT-T network options

Option	Description	Total Cost ($m) 2018/19	NPV relative to Base Case ($m) 2018/19	Ranking
Option 1	Replacement of two 132/66kV 80MVA transformers with two 100MVA transformers and full-bay replacement of primary plant in selected bays by October 2022.	25.39*	35.65	**2**
	Replacement of remaining 80MVA transformer with 100MVA transformer by December 2027	8.13†		
	TOTAL	**33.52**		
Option 2	Replacement of two 132/66kV 80MVA transformers with two 160MVA transformers and full-bay replacement of primary plant in selected bays by October 2022.	26.27*	37.95	**1**
	Decommissioning of remaining 80MVA transformer by December 2027	1.96†		
	TOTAL	**28.23**		

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

It should be noted that the options described in Table 1 result in different substation configurations by 2027, with the existing three 132/66kV 80MVA transformers being replaced by three 100MVA transformers in Option 1 and by two 160 MVA transformers in Option 2. Both options and their resulting substation configurations, continue to provide the required services to the Lilyvale area.

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

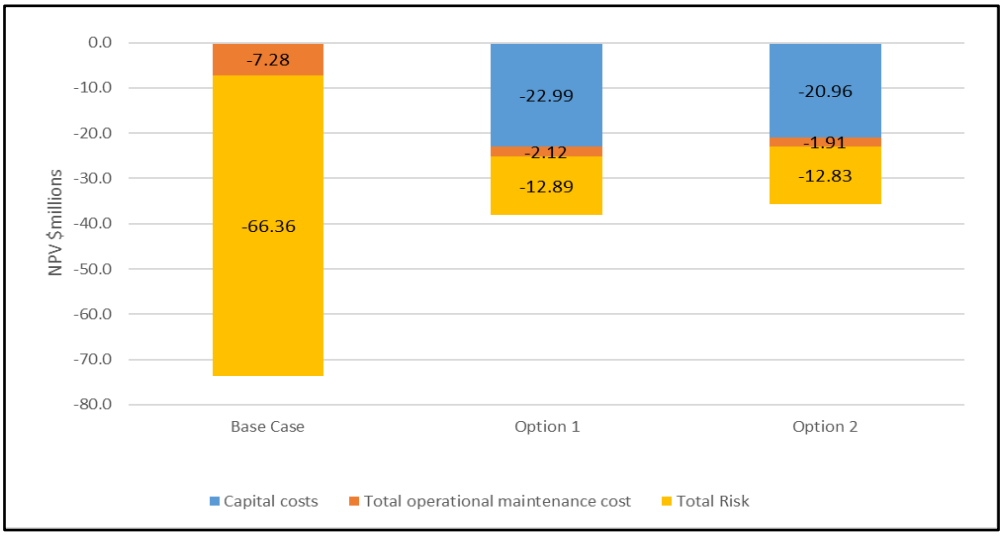

Figure 1 shows the breakdown of the absolute NPV of the Base Case and the two credible options. The Base Case and both options have a negative NPV. Both options reduce the total risks and maintenance costs arising from the ageing and obsolete assets at Lilyvale remaining in service (as in the Base Case) and hence reflect a net economic benefit when compared to the Base Case.

Taking into account capital, operational maintenance and risk costs, Option 2 delivers the greatest net economic benefit, providing a $37.95 million reduction in the overall costs in NPV terms when compared to the Base Case.

Option 2 has been identified as the preferred network option.

Of the credible network options, Option 2 has been identified as the preferred option.

The RIT-T project for Option 2 involves the replacement of two 132/66kV 80MVA transformers with two 160MVA transformers and the full bay replacement of primary plant in selected bays by October 2022. The indicative capital cost of the RIT-T project for the preferred option is $26.27 million in 2018/19 prices.

Under Option 2, design work would commence in 2020 with the installation of the new transformers and selected primary plant completed by October 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 October 2022, on an ongoing basis.

A non-network option that avoids the proposed replacement of ageing primary plant and transformers would need to replicate, in part or full, the support that Lilyvale 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 Wednesday, 21 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 and 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 (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 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 Lilyvale Substation to customers in Queensland's Central West region, as well as the Blackwater and Bowen Basin mining areas.

The primary plant and transformers at Lilyvale Substation are nearing the end of their technical service lives and are increasingly at risk of failure due to deteriorated condition, with many items of equipment no longer supported by the manufacturers and limited spares available.

The proposed credible network options maintain the current electricity services to customers in the area by addressing the increasing likelihood of faults arising from the condition of Lilyvale Substation's ageing and obsolete primary plant and transformers. When developing the credible options, Powerlink has focussed on implementing cost effective solutions that ensure a reliable and safe 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 best satisfies the RIT-T, and is therefore the preferred option
- 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).

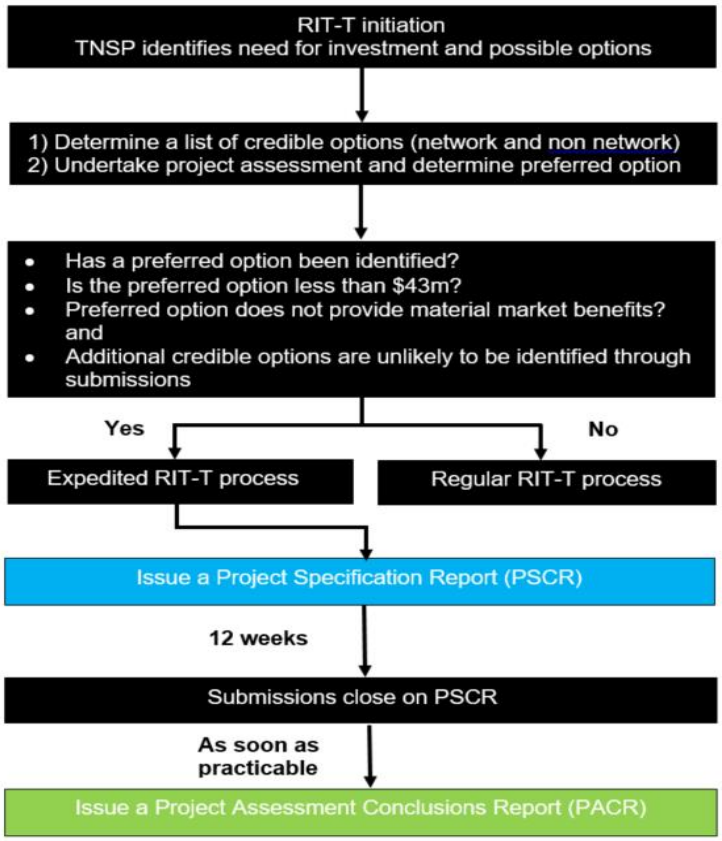
[5] Risk assessments are underpinned by Powerlink's corporate risk management framework and the application of a range of risk assessment methodologies set out in AS/NZS ISO31000:2018 *Risk Management Guidelines*.

[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.

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 primary plant 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 and consumers 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 Lilyvale

- Powerlink identified in its TAPRs from 2015 to 2018, an expectation that action would be required at Lilyvale 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 Lilyvale Substation.
- The Customer Panel was advised of the upcoming RIT-T consultation for Lilyvale 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 that may be undertaken during the consultation process. These activities focus on enhancing the value and outcomes of the RIT-T process for customers, consumers, and non-network providers. Powerlink welcomes feedback from all stakeholders to further improve the RIT-T stakeholder engagement process.

3 Identified need

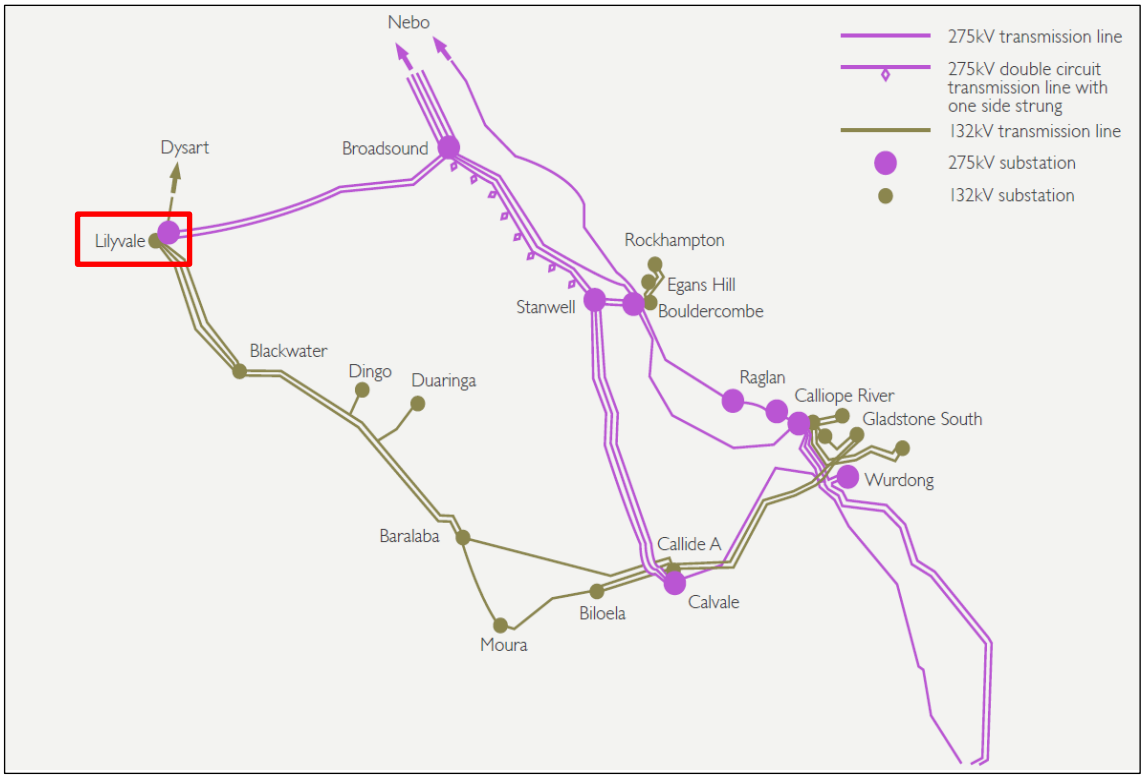
This section provides an overview of the existing arrangements at Lilyvale Substation and describes the increasing risk to reliability of supply to customers in the Central West transmission zone due to the assessed deteriorated condition of selected primary plant assets at the substation.

3.1 Geographical and network need

Lilyvale Substation was established in 1980 to supply the mining load in the Bowen Basin and Blackwater Regions of Central Queensland. It connects the generation points in Central Queensland to the Blackwater and Bowen Basin mining regions, providing the main 275kV injection into western Central Queensland. This region of the network, in which Lilyvale is an integral node, also hosts a significant quantity of generation including levels of renewable and embedded generation.

Lilyvale substation operates as a major transmission connection point supplying the Central Queensland distribution region owned and operated by Ergon Energy, mining and rail traction loads. The 66kV network fed from Lilyvale also supplies several direct connect mining customers that operate large draglines resulting in significant load fluctuations. The Central West transmission zone is shown in Figure 3.1.

Figure 3.1: Central West transmission zone



3.2 Description of identified need

With peak demand in the Lilyvale 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 primary plant assets at Lilyvale Substation has highlighted that many assets are operating in a deteriorated condition and are nearing the end of their technical service lives. In addition, the majority of the original primary plant, particularly circuit breakers, are no longer supported by their respective manufacturers and have only limited spares available.

As the proposed investment is to meet reliability and service standards specified within applicable regulatory instruments, and 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 ageing and obsolete primary plant assets at Lilyvale 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 the plant no longer being supported by manufacturers, with limited spare parts available.

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 obligations as a TNSP[17] 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 Lilyvale 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.

3.3 Description of asset condition and risks

Powerlink has undertaken a comprehensive condition assessment of the primary plant and transformers at Lilyvale Substation. This has identified that a significant amount of equipment is exhibiting age-related deterioration issues and reaching the end of its technical service life, with an increasing risk of failure.

This deteriorated primary plant is requiring additional maintenance and displaying reduced performance due to increased failures and an increased number of outages for repairs. The time taken for repairs is increasing significantly, as much of this plant is no longer supported by the manufacturer, with only limited spares available.

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

[13] Queensland 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*

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

Power Transformers

Commissioned over 38 years ago, the original 132/66kV transformers are all exhibiting signs of age-related deterioration, particularly by the condition of their oil and paper insulation, main tank and bushing seals as well as the corrosion of external fittings. Transformers 3 and 4 are assessed to be in a more deteriorated condition than Transformer 7 and provide an emerging risk to the reliable and safe supply of electricity at Lilyvale, and more broadly into the central west transmission zone.

Protective galvanised coatings have begun to break down on several components including radiators, connecting pipework, control system cabinets, bushing mountings and flanges. The sealing integrity of numerous joints and valves has been compromised, resulting in an increased observation of oil leaks at radiators, bushings and conservator tank.

Analysis has also shown the transformers' winding paper insulation has deteriorated and is nearing the end of its technical service life, with approximately three years of reliable operation remaining for Transformers 3 and 4. Whilst Transformer 7 has experienced some insulating paper degradation, the measurements indicate there are approximately eight years before it will reach the end of its technical service life.

The design of the winding clamping mechanism used in these older transformers also results in a loss of residual clamping pressure as the paper deteriorates, reducing the overall resilience of the transformers to through faults. The 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.

A number of components on Transformers 3 and 4 have been repaired and/or replaced due to numerous failures. With only limited spares available and the manufacturer no longer providing support for many of the transformers' mechanical parts, obsolescence has now become an issue for ongoing maintenance.

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.

Primary Plant

At-risk primary plant comprises circuit breakers, current and voltage transformers, isolators, earth switches and surge arrestors.

Circuit Breakers

Installed in the 1980s, the substation's ageing circuit breakers are no longer supported by their manufacturers and sourcing spare parts has become a major issue. Low air pressure in the breakers' compressor systems has resulted in a number of outages, while the wiring inside several mechanism boxes has cracked due to UV penetration through the boxes' sight glasses. SF6 gas leaks have also become a major issue on four circuit breakers procured in 1985, with the supplier no longer manufacturing HV circuit breakers.

The deteriorated state of these original circuit breakers has resulted in an increasing frequency of unplanned outages and prolonged repair times due to the lack of spares and no manufacturer support. These circuit breakers also contain friable asbestos that requires additional safety precautions when working on the units.

With limited spares available from the manufacturers, it is becoming increasingly difficult for Powerlink to service this ageing population of circuit breakers more broadly across the Powerlink transmission network.

Current and Voltage Transformers

Insulation breakdown and oil leaks pose the biggest risk to the ongoing operation of the ageing current and voltage transformers at Lilyvale Substation. The ageing process has the most significant impact on the integrity of the various seals. The deteriorated state of the aged seals has led to moisture ingress into the insulating oil causing it to breakdown. As the transformer's

insulating oil breaks down it releases a combination of combustible gases and loses its insulating properties.

The moisture migrates into the paper insulation causing its rapid degradation. The insulating paper degradation combined with continuing degradation of the oil ultimately results in the occurrence of partial discharges across insulation, which can result in arcing in the presence of highly combustible gases, leading to an increased probability of catastrophic failure. The oil is contained within porcelain housings, which can rupture when failure occurs, resulting in safety risks, reliability of supply impacts, and potential damage to adjacent equipment and plant requiring repairs and incurring financial costs.

3.4 Consequences of Lilyvale primary plant and transformer failures

Poor asset condition increases the risk and frequency of faults, while obsolescence increases the time needed for Powerlink to undertake any necessary repairs prolonging the return to service time. The potential in-service failure of ageing and obsolete primary plant and transformers at Lilyvale presents Powerlink with a range of unacceptable safety, network and financial risks, and the inability to meet legislative obligations and customer service standards.

The condition and consequences of failure of the main at-risk items of equipment is summarised in Table 3.1.

Table 3.1: Lilyvale at-risk assets and consequences of failure

Equipment	Condition/Issue	Consequence of failure
Circuit Breakers	• Loss of pneumatic pressure • Release of SF6 gas into the atmosphere • Frequent maintenance required to add SF6 to ensure the CB remains functional • Limited availability of spares	• Failure to operate or slow clearance times resulting in safety and supply risks • Extended time to restore supply to customers due to a limited availability of spares • Potential environmental impacts • Increased maintenance resulting in less reliable and more costly supply to customers
Current Transformers	• Degraded oil and paper insulation inside porcelain housings • Oil leaks.	• Significant safety, financial, environmental and loss of supply risks • Potential for explosive failure modes leading to damage of other equipment and extended loss of supply
Voltage Transformers	• Degraded oil and paper insulation inside porcelain housings • Oil leaks and overheating	• Significant safety, financial, environmental and loss of supply risks • Potential for explosive failure modes leading to damage of other equipment and loss of supply • Loss of protection signals resulting in disconnection of supply • Breach of metering requirements[18]

[18] Chapter 7, Part D, Metering Installation and Schedule 7.2 Metering Provider, AER

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 of power transformer failure during through faults leading to loss of supply with long return to service time. • 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 any emerging safety risks are proactively managed.

3.5 Rules, Jurisdictional and Legislative Compliance

The consequences of Lilyvale's at-risk primary plant and transformers 3 and 4 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.

The failure of the circuit breakers to operate or clear faults in sufficient time to avoid damage to the power system may leave Powerlink unable to meet its public safety and supply obligations to its customers. Corrective action is also required to prevent the failure of deteriorated current and voltage transformers, in order to ensure the safety of personnel and that the plant operates as designed in accordance with the requirements of the *Electrical Safety Regulations 2013 Part 1 Section 3 and Part 9 Section 198*.

Allowing the ageing and obsolete transformers to remain in service without corrective action increases the potential risk of catastrophic failure. This would lead to a breach of Powerlink's obligations under the *Electrical Safety Act and Regulations, Work Health and Safety Act* and *Environmental Protection Act*, as well as its service standards under the *Electricity Act* and *Regulations and its Queensland Transmission Authority*[19].

By addressing the risks arising from the condition of ageing and obsolete assets at Lilyvale, Powerlink is seeking to ensure it can safely deliver an adequate, economic, and reliable supply of electricity to its customers 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) 2015 to 2018, an expectation that action would be required at Lilyvale Substation to maintain reliability of supply requirements in the Central West transmission zone[20]. Powerlink has considered the operation of the existing embedded generation in the region 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.

[19] *Section 29, Electrical Safety Act 2002*; P*art 1, Section 3, and Part 9, Section 198, Electrical Safety Regulations 2013; Section 19, Work Health and Safety Act 2011*; *Chapter 7, Part 1, Division1 Section 319(1), Environmental Protection Act 1994*; *Section 34 (1)a Electricity Act 1994*; Queensland Transmission Authority T01/98

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

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 replicates the functionality of the primary plant and the three 132/66kV transformers, or a partial solution that provides support to replace one or two of the transformers at risk.

A full non-network option that avoids replacement of ageing primary plant and all three 132/66kV transformers would need to provide injection or demand response at Lilyvale of over 200MW[21] at peak, as well as providing switching for a number of connections in the region from October 2022.

A partial non-network solution could provide support for the replacement of one of the two at risk transformers (Transformers 3 and 4) from as early as June 2021[22], retaining the third transformer (Transformer 7) for approximately six additional years. Indicative support requirements for this arrangement to comply with Powerlink's reliability obligations are provided below in Table 4.1. The capacity requirement is provided as the MW requirement, along with the maximum likely daily energy requirement.

Table 4.1: Lilyvale support requirements

Non-network support requirements (Medium forecast)	
MW	MWh/day
12	170

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 Lilyvale. A non-network solution must also maintain/restore fault level (system strength) and voltage control.

Powerlink has identified the following common criteria that must be satisfied if proposed network support services are to meet supply requirements[23].

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.

[21] Delivered Lilyvale and Blackwater forecast from Table A.2 Powerlink's Transmission Annual Planning Report 2018 adjusted for the existing embedded generation in the area.

[22] The June 2021 date for a partial non-network solution, replacing one transformer, facilitates the staging of the network portion of the solution to be implemented by October 2022.

[23] 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 non- 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 market price[24].
- 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 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 Lilyvale 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.

5 Potential credible network options to address the identified need

Powerlink has developed two credible network options to address the identified need for maintaining power transfer capabilities and reliability of supply at Lilyvale Substation. In both options, work commences for the RIT-T project in 2020, with commissioning in October 2022[25].

- Option 1: Replacement of two 132/66kV 80MVA transformers with 100MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Replacement of the remaining 80MVA transformer with a 100MVA transformer by December 2027. The RIT-T portion of this option would be completed by October 2022 at a cost of $25.39 million in 2018/19 prices.

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

[25] The most recent analysis of the risks arising from the asset condition, in conjunction with the scheduling of the works within the proposed Options allows for a final commissioning date of their RIT-T projects of October 2022 as opposed to June 2021 (advised in the 2018 TAPR).

- Option 2: Replacement of two 132/66kV 80MVA transformers with two 160MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Decommissioning of the remaining 80MVA transformer by December 2027. The RIT-T project component portion of this option would be completed by October 2022 at a cost of $26.27 million in 2018/19 prices.

Due to the higher rating of the new transformers installed under Option 2, Transformer 7 will not be replaced at the end of its technical service life in 2027, resulting in a configuration consisting of two, 160MVA 132/66kV transformers at Lilyvale instead of three. Option 1 however will result in a substation configuration consisting of three 132/66kV 100MVA transformers in 2027.

Table 5.1: Summary of credible options

Option	Description	Indicative project costs ($million, 2018/19)	Indicative annual average O&M costs ($million, 2018/19)
Option 1 Replacement of two 132/66kV 80MVA transformers with two 100MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Replacement of remaining 80MVA transformer with 100MVA transformer by December 2027	Replacement of 3 and 4 power transformers with two 100MVA transformers and full replacement of 132kV and 275kV primary plant in selected bays by October 2022*	25.39*	0.16
	Replacement of 7 transformer with a third 100MVA transformer and full replacement of primary plant in associated bays by December 2027†	8.13†	
Option 2 Replacement of two 132/66kV 80MVA transformers with two 160MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Decommissioning of remaining 80MVA transformer by December 2027	Replacement of 3 and 4 power transformers with two 160MVA transformers and full replacement of 132kV and 275kV primary plant in selected bays by October 2022*	26.27*	0.14
	Decommissioning of transformer 7 by December 2027†	1.96†	

*Proposed RIT-T project
†Future modelled projects (operational and capital)

All credible options address the major risks resulting from the deteriorated condition of ageing primary plant at Lilyvale 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)[26].

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

[26] 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[27].

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. Consequently, 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[28].

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 materially 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 materially provide any changes in network losses
- **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

[27] 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.
[28] 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[29].

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 Lilyvale 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[30] and this has been used to calculate the risk costs of the Lilyvale Base Case. 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 ageing and obsolete primary plant and transformers at Lilyvale, the following modelling assumptions specific to the Lilyvale 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.

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

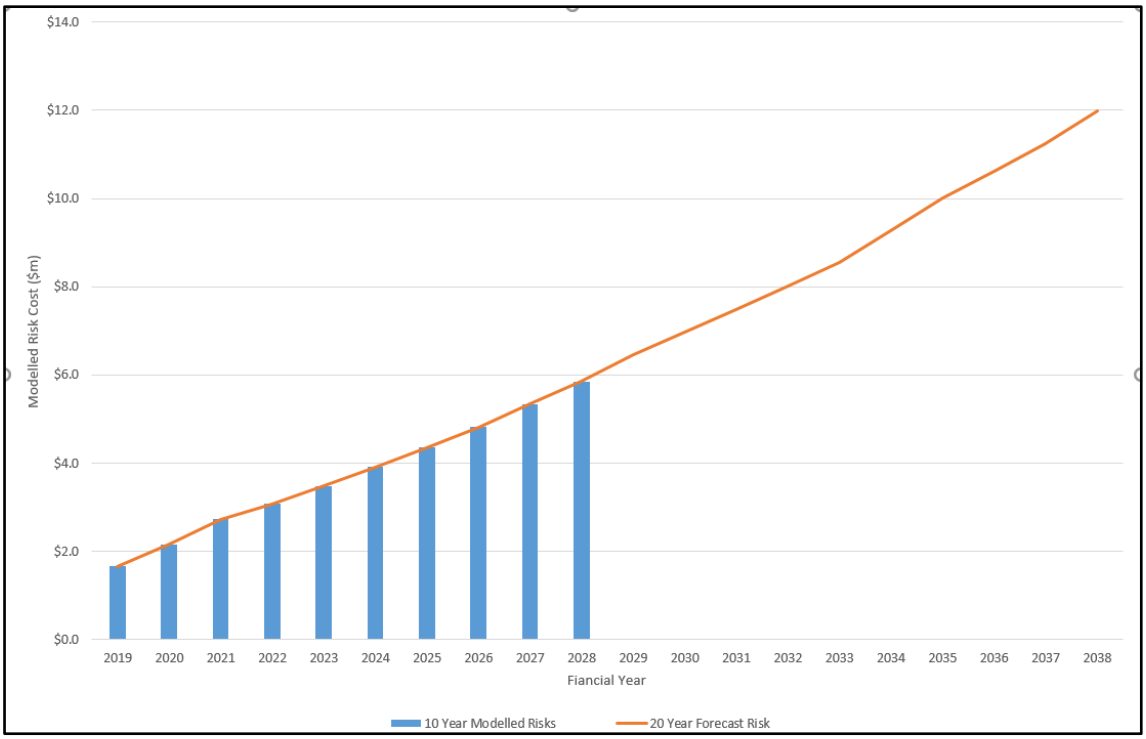
[30] The risk costs are calculated using the principles set out in the Powerlink document, Overview of Asset Risk Cost Methodology, May 2019

- 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 Lilyvale 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 Lilyvale 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 Lilyvale area.
- The Lilyvale 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 primary plant and transformers at Lilyvale, the total risk costs are projected to increase from $1.67 million in 2019 to $11.9 million in 2038. The main areas of risk cost are network risks that involve reliability of supply through the failure of deteriorated primary plant modelled as probability weighted unserved energy[31], financial risk costs associated mostly with the replacement of failed assets in an emergency and safety risks. These risks increase over time as the condition of plant further deteriorates and the likelihood of failure rises.

[31] Unserved Energy is modelled using a Value of Customer Reliability (VCR) consistent with that published by AEMO in their *Value of Customer Reliability Review, Final Report*, September 2014.

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 replacement primary plant and transformer investment.

Due to the nature of the options, there will be 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 credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 5.90%[32] 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%[33] 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 likely to affect the ranking of the credible options, where the identified need is reliability corrective action[34].

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 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%

[32] 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.

[33] A discount rate of 3.47% is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0% and forecast inflation of 2.45% that implies a real discount rate of 3.47%. See AER, *Final Decision: Powerlink transmission determination 2017-2022 | Attachment 3 – Rate of return*, April 2017, p 9.

[34] 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 net present value for each credible option and the corresponding ranking of each credible option, relative to the Base Case.

Table 9.1: NPV of credible options ($m, 2018/19)

Option	Central Scenario NPV relative to Base Case ($m)	Ranking
Option 1 Replacement of two 132/66kV 80MVA transformers with two 100MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Replacement of remaining 80MVA transformer with 100MVA transformer by December 2027	35.65	2
Option 2 Replacement of two 132/66kV 80MVA transformers with two 160MVA transformers and full-bay replacement of primary plant in selected bays by October 2022. Decommissioning of remaining 80MVA transformer by December 2027	37.95	1

Both credible options will address the identified need on an enduring basis. Option 2 is ranked first, with Option 1 being $2.3 million more expensive compared to Option 2 in NPV terms.

Option 2 is identified as the preferred option as it maximises the net economic benefit relative to the Base Case.

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 non-credible Base Case consists of operational maintenance and total risk costs and does not include any capital expenditure.

Figure 9.1: NPV of Base Case and Options ($m, 2018/19)

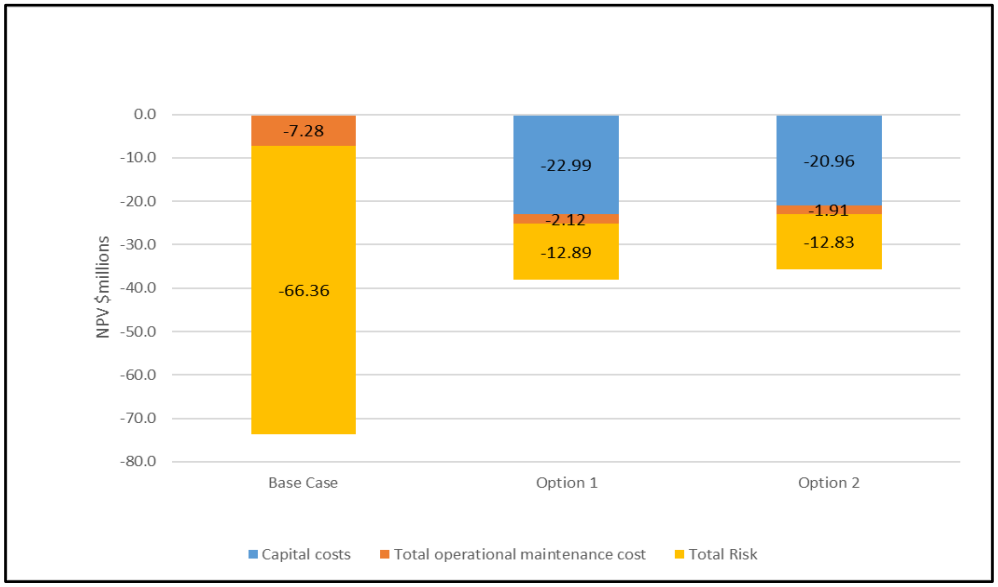


Figure 9.1 illustrates that the capital investment for the two credible options that address risks associated with the primary plant and transformers at Lilyvale Substation will result in benefits from a reduction in risk costs, as well as a reduction in operational maintenance costs when compared to the Base Case.

The reduction in operational maintenance costs is similar for both Option 1 and Option 2, though there is a greater reduction in Option 2, as the ultimate configuration for Option 2 results in only two 132/66kV transformers from 2027 instead of three as for Option 1.

Similarly, the reduction in risk costs is comparable between the options, resulting in a slightly greater reduction in Option 2; mostly due to less financial and safety risks associated with the ultimate two 132/66 kV transformer configuration.

9.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a range from 3.47% to 8.33% for discount rate
- a range from 75% to 125% for capital expenditure estimates
- a range from 75% to 125% for operational maintenance expenditure estimates
- a range from 75% to 125% for 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 option rank, and hence which is the preferred option.

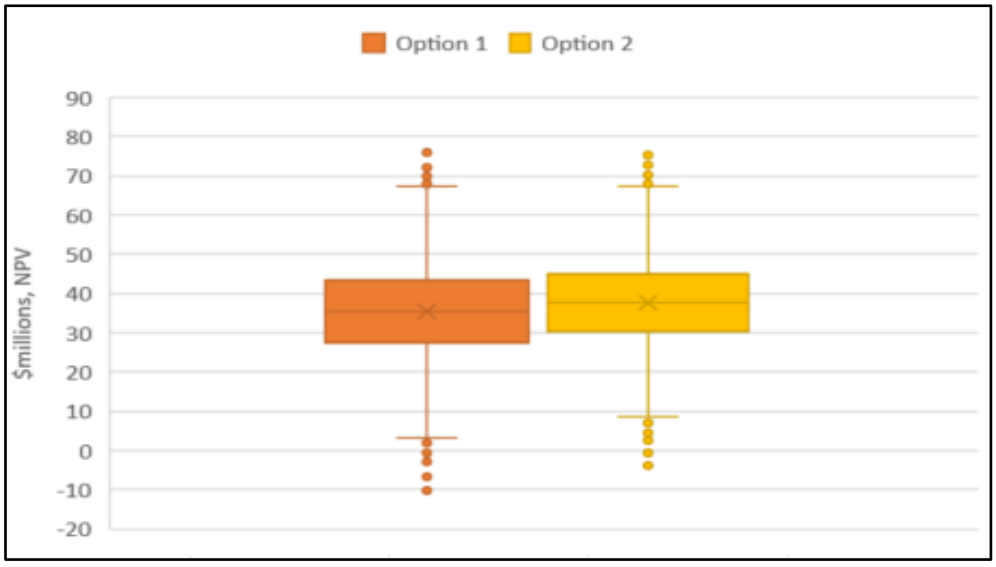
9.2.1 Sensitivity to multiple key assumptions

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 variable from the probability function.

The output is presented as a distribution of possible NPVs for each option, as illustrated in the boxplot. (See Figure 9.2)

It can be seen that the preferred option, Option 2, has slightly less statistical dispersion in comparison with Option 1 and its mean and median is the higher of the two options. 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 requirement 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 ageing primary plant and transformers at Lilyvale Substation.

Option 2 involves replacing two of the three ageing 132/66kV 80MVA transformers with two 160MVA transformers and selected full bay primary plant replacement by October 2022. Due to the higher rating of the new transformers installed under this option, Transformer 7 will not be replaced at the end of its technical service life in 2027, resulting in a configuration consisting of two 132/66 kV transformers at Lilyvale instead of three. This option minimises the number of outages and mobilisation costs and reduces the overall operational maintenance costs, as there is less primary plant to maintain in the final substation configuration.

The indicative capital cost of the RIT-T project for Option 2 is $26.27 million in 2018/19 prices.

Design and procurement activities will commence in 2020, with onsite work to be completed by October 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 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	23 May 2019
Part 2	Submissions due on the PSCR Have your say on the credible options and propose potential non-network options.	21 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).

Appendices

Appendix 1: Options considered but not progressed

Powerlink considered two further network options that have not been progressed. These options are described in Table A1.

Table A1: Options considered but not progressed

Option description	Reason for not progressing option
Two stage replacement of existing 80MVA transformers with three 100MVA transformers and in-situ replacement of selected primary plant by 2027	While technically feasible, the in-situ replacement of primary plant adds a degree of complexity to the scheduling of the required work, such that the work would be unable to be completed before the identified end of technical service life for the at-risk assets. Due to the complexity of the project staging, these options were also estimated to be less economical than those presented in the body of the report.
Two stage replacement of existing 80MVA transformers with two 160MVA transformers and in-situ replacement of selected primary plant by 2027	

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