Powerlink Queensland

Project Assessment Conclusions Report

6 July 2020

Addressing the secondary systems condition risks in the Gladstone South 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.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. This document contains the results of this evaluation, and a final recommended solution to address the condition and obsolescence risks arising from the secondary systems at Gladstone South and QAL West Substations by April 2024.

Contents

Executive Summary

Gladstone South Substation, located approximately 5km southeast of the Gladstone CBD, was established in the early 1960s as a 132kV injection point for the 66kV regional distribution network owned by Ergon Energy (part of the Energy Queensland Group). A second interconnected 132kV substation was established on an adjacent site in 2002 to meet a growing demand for electricity in the local area.

The QAL West Substation, also established in 2002, is one of three injection points for the Queensland Aluminium (QAL) refinery in Gladstone.

Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services provided by Gladstone South and QAL West Substations to support a diverse range of customer needs in the area.

The secondary systems at Gladstone South and QAL West Substations broadly perform the functions of transmission element protection, data collection, remote (and local) control and monitoring. Commissioned almost 20 years ago, most of these systems are reaching the end of their technical service lives and are no longer supported by the manufacturer, with limited spares available. Increasing failure rates, along with the increased time to rectify the faults due to the obsolescence of the equipment significantly affects the availability and reliability of these systems and their ability to continue to meet the requirements of the National Electricity Rules (the Rules).

Powerlink must therefore address the emerging risks arising from the condition of the secondary systems at Gladstone South and QAL West Substations. As the identified need of the proposed investment is to meet reliability and service standards specified within Powerlink's Transmission Authority and guidelines and standards published by the Australian Energy Market Operator (AEMO), and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, it is classified as a 'reliability corrective action'[1].

This Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process prescribed under the Rules undertaken by Powerlink to address the condition risks arising from the secondary systems at Gladstone South and QAL West Substations. It contains the results of the planning investigation and the cost-benefit analysis of the credible option compared to a non-credible Base Case where the emerging risks are left to increase over time. In accordance with the RIT-T, the credible option that minimises the net present value (NPV) of costs is recommended as the preferred option.

Credible options considered

Powerlink developed two credible network options to maintain the existing electricity services, ensuring an ongoing reliable, safe and cost effective supply to customers in the area. The major difference between the credible options relates to the staging of the Gladstone South works.

By addressing the condition risks, both options allow Powerlink to meet the identified need and continue to meet the reliability and service standards specified within Powerlink's Transmission Authority, Schedule 5.1 of the Rules, AEMO guidelines and standards and applicable regulatory instruments.

Powerlink published a Project Specification Consultation Report (PSCR) in February 2020 to address the risks and obsolescence issues arising from the condition of the secondary systems at Gladstone South and QAL West Substations. No submissions were received in response to the PSCR that closed on 22 May 2020. As a result, no additional credible options have been identified as a part of this RIT-T consultation.

The two credible network options, along with their NPVs relative to the Base Case are summarised in Table 1. Both options have a negative NPV relative to the non-credible Base Case, as allowed for under the Rules for 'reliability corrective actions'. Of the two credible network options, Option 2 has the lowest cost in NPV terms.

[1] The Rules clause 5.10.2, Definitions, reliability corrective action.
NOTE. This RIT-T commenced under Version 132 of the Rules in February 2020.

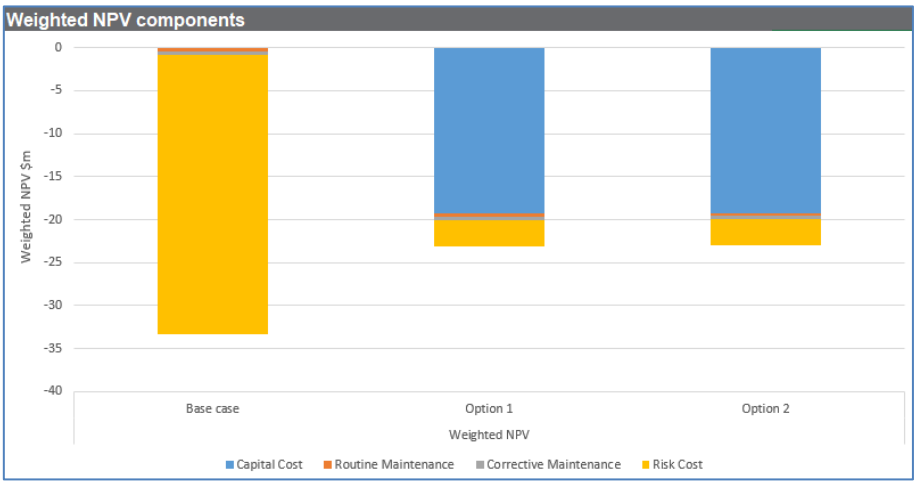
Table 1: Summary of credible network options

Option	Description	Capital costs ($m) 2019/20	Weighted NPV relative to Base Case ($m)	Ranking
1	**Gladstone South:** Partial replacement of secondary systems equipment using a new prefabricated building by April 2024*	15.9*	10.3	**2**
	Partial replacement of secondary systems equipment by October 2030†	2.3†		
	QAL West: Replace all secondary systems using existing building by April 2024*	6.8*		
2	**Gladstone South:** Full replacement of all secondary systems using a new prefabricated building by April 2024*	17.0*	10.4	**1**
	QAL West: Replace all secondary systems using existing building by April 2024*	6.8*		

* RIT-T Project
†Future modelled projects

Figure 1 shows the absolute NPVs of the Base Case and the credible network options. All credible options significantly reduce the total risks arising from the condition of the ageing and obsolete secondary systems at Gladstone South and QAL West Substations when compared to the Base Case. Option 2 has the highest NPV of the credible options.

Figure 1: Weighted NPV of Base Case and Credible Network Options



Evaluation and Conclusion

The RIT-T requires that the proposed preferred option maximises the present value of net economic benefit, or minimises the net cost, to all those who produce, consume and transport electricity. The economic analysis demonstrates that Option 2 provides the lowest cost solution and is therefore the preferred option.

In accordance with the expedited process for the RIT-T, the PSCR made a draft recommendation to implement Option 2, the full replacement of all secondary systems at both Gladstone South and QAL West substations by April 2024. The indicative capital cost of this option is $23.8 million in 2019/20 prices. Powerlink is the proponent of this network option.

Design work will commence in 2020 and construction will commence in 2022. Installation and commissioning of the new secondary systems will be completed by April 2024.

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

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process[2] prescribed under the National Electricity Rules (the Rules) undertaken by Powerlink to address the condition risks and obsolescence issues arising from the secondary systems at Gladstone South and QAL West Substations . It follows the publication of the Project Specification Consultation Report (PSCR) in February 2020.

The Project Specification Consultation Report (PSCR):

- described the identified need that Powerlink is seeking to address, together with the assumptions used in identifying this need
- set out the technical characteristics that a non-network option would be required to deliver in order to address the identified need
- described the credible options that Powerlink considered may address the identified need
- discussed specific categories of market benefit that in the case of this RIT-T assessment are unlikely to be material
- presented the Net Present Value (NPV) economic assessment of each of the credible options (as well as the methodologies and assumptions underlying these results) and identified the preferred option and that Powerlink was claiming an exemption from producing a Project Assessment Draft Report (PADR)
- invited submissions and comments, in response to the PSCR and the credible options presented, from Registered Participants, the Australian Energy Market Operator (AEMO), potential non-network providers and any other interested parties.

Powerlink identified Option 2, involving the full replacement the secondary systems at both Gladstone South and QAL West Substations in new buildings by April 2024, as the preferred option to address the identified need. The indicative capital cost of this option is $23.8 million in 2019/20 prices.

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

- the estimated capital cost of the preferred option is less than $43 million
- the preferred option is identified in the PSCR noting exemption from publishing a PADR
- the preferred option, or other credible options, do not have a material market benefit, other than benefits associated with changes in involuntary load shedding[3]
- submissions to the PSCR did not identify additional credible options that could deliver a material market benefit.

There were no submissions received in response to the PSCR that closed for consultation on 22 May 2020. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. As the conditions for exemption are now satisfied, Powerlink has not issued a PADR for this RIT-T and is now publishing this PACR, which:

- describes the identified need and the credible options that Powerlink considers address the identified need
- discusses the consultation process followed for this RIT-T together with the reasons why Powerlink is exempt from producing a PADR
- provides a quantification of costs and reasons why specific classes of market benefit are not material for the purposes of this RIT-T assessment

[2] This RIT-T consultation was commenced in June 2019 and has been prepared based on the following documents: National Electricity Rules, Version 122, 30 May 2019 and AER, Application Guidelines Regulatory investment test for transmission, December 2018.
[3] Section 4.3 Project assessment draft report, Exemption from preparing a draft report, AER, Application guidelines, Regulatory investment test for transmission, December 2018

- provides the results of the net present value (NPV) analysis for each credible option assessed, together with accompanying explanatory statements
- identifies the preferred option for investment by Powerlink and details the technical characteristics and proposed commissioning date of the preferred option.

2. Customer and non-network 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 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 within 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 stakeholders 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. This provides an ongoing opportunity for the Customer Panel to ask questions and provide feedback to inform RIT-Ts, and for Powerlink to better understand the views of customers when undertaking the RIT-T consultation process.

2.3 Transmission Annual Planning Report (TAPR) – the initial stage of 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 reliability of supply in the Gladstone South area

Powerlink identified in its TAPRs 2018 to 2019, an expectation that action would be required at Gladstone South and QAL West Substations to address the secondary systems condition risks and maintain reliability of supply to customers in the Gladstone zone[4].

Powerlink advised members of its Non-network Engagement Stakeholder Register (NNESR) of the publication of the TAPR, TAPR templates 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.

No submissions proposing credible 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.

Taking into consideration the most recent analysis and understanding of the risks arising from the secondary systems at Gladstone South and QAL West, the proposed credible network options have been aligned to a common completion date of April 2024. While this completion date differs slightly from the December 2023 and December 2022 dates published in the 2019 TAPR, it better serves customers in the area by undertaking works at both sites in a similar timeframe.

[4] 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, stakeholders and non-network providers. Powerlink welcomes feedback from all stakeholders to further improve the RIT-T stakeholder engagement process.

3. Identified need

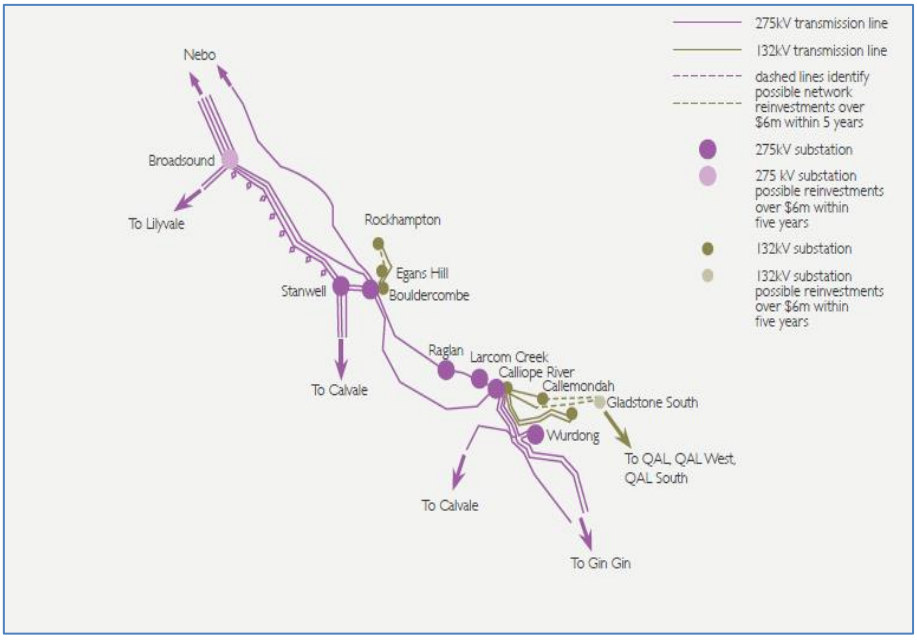
This section provides an overview of the existing arrangements at Gladstone South and QAL West substations and describes the increasing risk to Powerlink of being unable to maintain compliance with relevant standards, applicable regulatory instruments and the Rules, which are designed to ensure Powerlink's customers continue to receive safe, reliable and cost effective electricity services.

3.1 Geographical and network need

Gladstone South Substation, located approximately 5km south east of Gladstone CBD, was established in the early 1960s to provide a bulk supply point for the regional distribution network owned by Ergon Energy (part of the Energy Queensland Group) and support the load growth arising from Queensland Aluminium (QAL). In 2002, the site was expanded and upgraded with the addition of an interconnected substation on an adjacent site. The QAL West Substation, also established in 2002, is one of three injection points for the QAL refinery in Gladstone.

The Gladstone zone transmission network is shown in Figure 3.1.

Figure 3.1: Gladstone zone transmission network



3.2 Description of identified need

With peak demand in the Gladstone area forecast to remain at current levels[5], it is vital that electricity supply be maintained to address these demands. The 2019 TAPR highlights the need to address the condition-based risks of the secondary systems at the two substations.

[5] *Powerlink's Transmission Annual Planning Report* 2019

Powerlink's Transmission Authority requires it to plan and develop the transmission network "in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services". It allows load to be interrupted during a critical single network contingency, provided the maximum load and energy:

- will not exceed 50MW at any one time; or
- will not be more than 600MWh in aggregate[6].

Planning studies have confirmed that in order to continue to meet the reliability standard within Powerlink's Transmission Authority, the services currently provided by Gladstone South and QAL Substations are required for the foreseeable future to meet ongoing customer requirements.

Schedule 5.1 of the Rules sets minimum standards for network service providers on the availability and operation of protection systems, whilst Schedule 5.1.9 (c) specifically requires Powerlink provide protection systems to ensure that a fault is automatically disconnected[7]. Powerlink's condition assessment of the secondary systems at Gladstone South and QAL West Substations indicates that most are reaching the end of their technical service lives, they are no longer supported by the manufacturer and there are limited spares available. Increasing failure rates, along with the increased time to rectify the faults due to equipment obsolescence, significantly affects the availability and reliability of these systems.

There is a need for Powerlink to address this emerging risk to ensure ongoing compliance with Schedule 5.1 of the Rules, relevant standards and applicable regulatory instruments, which are designed to ensure Powerlink's customers continue to receive safe, reliable and cost effective electricity services.

As the proposed investment is for meeting reliability and service standards arising from Powerlink's Transmission Authority and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, it is a 'reliability corrective action' under the Rules[8]. 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 as it is required to meet an externally imposed obligation on the network business.

3.3 Assumptions and requirements underpinning the identified need

The secondary systems at Gladstone South and QAL West broadly perform the functions of transmission element protection, data collection, remote (and local) control and monitoring. In performing these functions secondary systems:

- protect the public, the environment, the transmission network and substation primary plant from damage due to faults or mal-operation
- allow remote and local automatic or manual control of primary plant
- enable the remote and local monitoring of primary and secondary plant and equipment

The Rules place specific requirements on Powerlink as a Transmission Network Service Provider (TNSP) to:

> *"Provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any fault type anywhere on its transmission system or distribution system is automatically disconnected"[9].*

The importance of protection systems is further reinforced in the Rules, which require TNSPs to ensure:

> *"all protection systems for lines at a voltage above 66 kV, including associated intertripping, are well maintained so as to be available at all times other than for short periods (not greater than eight hours) while the maintenance of a protection system is being carried out"[10].*

[6] Transmission Authority No. T01/98, section 6.2(c)
[7] The Rules Schedule 5.1.9(c)
[8] The Rules clause 5.10.2 ,Definitions, reliability corrective action
[9] The Rules clause S5.1.9(c)
[10] The Rules clause S5.1.2.1 (d)

As required by the Rules[11], AEMO has published the Power System Security Guidelines (PSS Guidelines) to clarify the Rules regarding unplanned outages of the protection systems. In the event of an unplanned outage of a secondary system, the PSS Guidelines require that the primary network assets be taken out of service if the fault cannot be rectified within 24 hours[12]. Both the Rules and the PSS Guidelines indicate that exceeding 24 hours to rectify a protection fault is not good practice, obligating Powerlink to take action to ensure the restoration period of unplanned outages of secondary systems does not reasonably exceed 24 hours.

Similar to protection requirements, AEMO's Power System Data Communication Standard specifies that the total period of critical outages over a 12 month period must not exceed 24 hours for remote control and monitoring functions[13]. This relates to both the reliability of the equipment (i.e. how often the device fails) and the repair time. It follows that the repair time for any single fault on this equipment must not exceed 24 hours if there are no other faults during the 12 month period.

Powerlink must therefore plan (have systems and processes in place) to safely resolve all protection, remote control and monitoring system problems and defects within 24 hours.

Analysis has shown that operating a secondary system beyond 20 years of effective age significantly impacts its ability to perform within acceptable limits[14]. Delaying replacement of secondary system assets beyond this optimal 20 year timeframe places the network at risk due to the limited supply of suitable spares, which prolongs the duration of any emergency corrective maintenance associated with replacing failed components beyond the 24 hour limit. In the case of protection systems, extended outages beyond 24 hours will result in the need to switch out network assets, placing the supply of electricity to customers at risk[15].

With an increasing likelihood of faults arising from ageing secondary systems remaining in service at Gladstone South and QAL West Substations and limited supply of suitable spares, Powerlink must undertake reliability corrective action if it is to continue to meet its jurisdictional obligations and the standards for reliability of supply set out by AEMO and the Rules.

3.4 Description of asset condition and risks

Powerlink has undertaken a comprehensive condition assessment of the secondary systems at Gladstone South and QAL West using an asset health index modelled from zero to ten, where zero represents new assets and ten indicates that the asset requires urgent action to address the increasing risk of unavailability and unreliable operation. This has identified that a significant amount of secondary system equipment is reaching the end of its technical service life.

The condition of the at-risk secondary systems at Gladstone South and QAL West substations is summarised in Table 3.1.

[11] The Rules clause 4.11.2 (c)
[12] AEMO, Power System Operating Procedure SO_OP_3715, Power System Security Guidelines, V95, 23 September 2019 (the Rules require AEMO to develop and publish Power System Operating Procedures pursuant to clause 4.10.1(b) of the Rules, which Powerlink must comply with per clause 4.10.2(b)).
[13] AEMO, Power System Data Communication Standard, Section 3 Reliability and Section 6 Maintenance. (This standard has been made by AEMO under clause 4.11.2(c) of the Rules and incorporates the standards and protocols referred to in clause 4.11.1)
[14] Cigre, Study Committee B3, Paper B3_205_2018, "Modelling Substation Control and Protection Asset Condition for Optimal Reinvestment Decision Based on Risk, Cost and Performance" by T. Vu, M. Pelevin, D. Gibbs, J. Horan, C. Zhang (Powerlink Queensland)
[15] AEMO, Power System Operating Procedure SO_OP_3715, Power System Security Guidelines, V95, 23 September 2019

Table 3.1: Gladstone South and QAL at-risk secondary systems

Bay	Construction year	Health index average
4x Bus Zones Protection and Control	2003	8.1
3x Bus Couplers Protection and Control	2003	8.1
8x Feeder Bays Protection and Control	2002 - 2012	8.0
4x Transformers Bays Protection and Control	2002-2003	8.3
1x Capacitor Bay Protection and Control*	2006	6.2
1x Harmonic Filter Protection and Control*	2010	3.8
4x Feeder Metering	2003	8.1
Non-bay secondary systems (includes OpsWAN, SCADA, GPS timing system, 125VDC battery chargers)	2002– 2010	8.5

*Gladstone South Substation only

Most of the secondary systems at Gladstone South were installed in 2002/03 as part of the establishment of the second interconnected substation. The secondary systems associated with the harmonic filter were established in 2010 and the capacitor bank in 2006. The systems at QAL West were installed in 2002, when the substation was first commissioned. There have also been a number of selective secondary system component installations in later years due to capital works at remote substation ends, or the replacement of failed components. This has reduced the average health index, whilst the majority of equipment has a health index higher than the average given in Table 3.1.

The impact of equipment obsolescence is an important consideration when determining if remedial action is required. Currently, over 60% of the secondary systems equipment is obsolete. This is expected to increase to an unsupportable level beyond April 2024.

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

3.5 Consequences of failure in an obsolete system

The duration of a fault is not only dependent on the nature and location of the fault, but also on the availability of a like for like replacement of the failed component. If a like for like replacement is available (i.e. same hardware and firmware as the failed device), then the replacement is often not complex and can generally be rectified within the timeframes specified by AEMO. If a like for like replacement is not available, then replacement is operationally and technically more complex due to:

- physical differences with the mounting and installation
- development and testing of new configurations and settings
- cabling, connectivity and protocol differences
- interoperability between other devices on site, and with remote ends (if applicable)
- non-standard settings / configuration requirements
- legislative requirements for professional engineering certification

All of the above complexities add time to fault resolution, typically resulting in a fault duration well in excess of 24 hours.

Given the specific nature of the Rules' obligations and the AEMO requirements relating to protection, control and monitoring systems, accepted good industry practice is often to replace the current ageing and obsolete secondary systems when they reach the end of their technical service lives, rather than letting them run to failure. Due to the condition and obsolescence issues with the secondary systems at Gladstone South, there is a significant risk of breaching the mandated obligations and requirements if the secondary systems (excluding those associated with the capacitor bank) are left to operate beyond April 2024.

A summary of the equipment condition issues and associated possible consequences of failure of the equipment is given in Table 3.2.

Table 3.2: Summary of equipment condition issues and potential consequences of failure

Equipment	Condition/Issue	Potential consequence of failure
Protection and Control for High Voltage Bay	Obsolescence and limited availability of spares; no longer supported by the manufacturer Increasing failure rates due to ageing electronic components	Failure to operate or slow clearance resulting in Rules violation, plant damage, safety and supply risks Prolonged outages of equipment placing load at risk and resulting in less reliable supply to customers Unable to comply with Power System Data Communication Standard Unable to comply with the Power System Security Guidelines Increased failures resulting in less reliable supply to customers
Metering Equipment	Obsolescence and limited availability of spares; no longer supported by the manufacturer Increasing failure rates due to ageing electronic component	Unable to restore metering installation upon malfunction within the 2 business day requirement of the Rules[16]
SCADA System	Obsolescence and limited availability of spares; no longer supported by the manufacturer Increasing failure rates due to ageing electronic components	Unable to comply with Power System Data Communication Standard Increased failures resulting in less reliable supply to customers

3.5.1 Fleet-wide implications of obsolescence

In addition to the site specific impacts of obsolescence at Gladstone South and QAL West, it is also important to note the compounding impact of equipment obsolescence occurring across the fleet of secondary systems assets installed in the Powerlink network. When a particular equipment type or model is no longer supported by the manufacturer, and limited spares are available to service the fleet of assets, running multiple secondary systems to failure across the network increases the likelihood of concurrent systemic faults that would overwhelm Powerlink's capacity to undertake corrective maintenance or replacement projects. This would leave Powerlink in breach of the Rules, the AEMO standards and its jurisdictional obligations.

4. Submissions received

There were no submissions received in response to the PSCR that was open for consultation until the 22 May 2020[17]. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

[16] The Rules, clause 7.8.10 Metering installation malfunctions
[17] Members of Powerlink's Non-network Engagement Stakeholder Register were also advised of the PSCR publication.

5. Credible options assessed in this RIT-T

Powerlink has developed two credible network options to address the secondary system condition risks and compliance obligations at Gladstone South Substation and QAL West substations. A summary of these options is given in Table 5.1.

Table 5.1: Summary of credible options

Option	Description	Capital costs ($m) 2019/20	Indicative average O&M Costs ($m p.a.) 2019/20
1	**Gladstone South:** Partial replacement of secondary systems equipment using a new prefabricated building by April 2024*	15.9*	0.063
	Partial replacement of secondary systems equipment by October 2030†	2.3†	
	QAL West: Replace all secondary systems using existing building by April 2024*	6.8*	
2	**Gladstone South:** Full replacement of all secondary systems using a new prefabricated building by April 2024*	17.0*	0.060
	QAL West: Replace all secondary systems using existing building by April 2024*	6.8*	

*Proposed RIT-T project
†Modelled capital project

All credible options address the major risks resulting from the deteriorating condition of ageing and obsolete secondary systems at Gladstone South and QAL West substations. Addressing these risks will allow Powerlink to meet its reliability of supply and safety obligations under the Rules, its Transmission Authority, the Electricity Act 1994 and other applicable regulatory instruments, by the replacement of the deteriorated protection systems and associated equipment.

The proposed network options have not been discussed by AEMO in its most recent National Transmission Network Development Plan (NTNDP)[18] or the draft 2020 Integrated System Plan (ISP) published in December 2019.

An additional option considered but not progressed due to economic reasons is listed in Appendix 1.

5.1 Option 1: Two stage replacement of the secondary systems by April 2024 and October 2030

This option seeks to optimise the service life of the systems by replacing those secondary systems identified in table 3.1, excluding the secondary systems associated with the capacitor bank and harmonic filter at Gladstone South, by April 2024. The capacitor bank and harmonic filter secondary systems are replaced in a second stage by October 2030.

Powerlink is the proponent of this option.

[18] 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 the most recent NTNDP.

Table 5.2: Main project components for the Option 1

Option 1	Works	Indicative cost ($million, 2019/20)
RIT - Project		
Replace selected Gladstone South secondary systems by April 2024	Replacement of the following protection, control and monitoring systems in a new building: • 4x bus zones • 3x bus coupler bays • 8x feeder bays • 4x transformer bays • Selected metering equipment • Selected non-bay equipment	15.9
Replace QAL West Secondary System by April 2024	Replace QAL West Secondary System	6.8
Modelled Capital Project		
Replace capacitor bank and harmonic filter secondary systems by October 2030	Replacement of the following protection, control and monitoring systems in the new building: • 1x capacitor bank bay • 1x harmonic filter	2.3
TOTAL		**25.0**

5.2 Option 2: Single stage replacement of all secondary systems by April 2024

This option seeks to minimise mobilisation costs by replacing all secondary systems identified in Table 3.1 by April 2024.

Table 5.4: Main project components for Option 2

Option 2	Works	Indicative cost ($million, 2019/20)
RIT - Project		
Replace all Gladstone South secondary systems by April 2024	Replacement of the following protection, control and monitoring systems in a new building: • 4x bus zones • 3x bus coupler bays • 8x feeder bays • 4x transformer bays • 1x capacitor bank bay • 1x harmonic filter • Selected metering equipment • Selected non-bay equipment	17.0
Replace QAL West Secondary System by April 2024	Replace QAL West Secondary System	6.8
TOTAL		**23.8**

5.3 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[19].

[19] 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.

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 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 options and the Base Case, set out in this PACR, may impact the ranking of the credible options under consideration, or the relativity of the credible options to the Base Case, 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[20]. Other than market benefits associated with involuntary load shedding, Powerlink does not consider any other category of market benefits to be material, and had not estimated them as part of this RIT-T.

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

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 PACR[21] compares the costs and benefits of credible options to address the risks arising from an identified need, with a Base Case[22].

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 and obsolescence issues arising from the ageing assets are only addressed through standard operational activities, with escalating safety, financial, environmental and network risks.

To develop the Base Case, the existing condition and obsolescence issues are managed by undertaking operational maintenance only, which results in an increase in risk levels as the condition and availability 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 for Gladstone South and QAL West secondary systems therefore includes the costs of work associated with operational maintenance and the risk costs associated with the failure of the assets. The costs associated with equipment failures are modelled in the risk cost analysis and are not included in the operational 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 Gladstone South QAL West Case risk costs

Powerlink has developed a risk modelling methodology consistent with the RIT-T Application Guidelines and the AER Industry practice application note for asset replacement planning[23]. A document giving an overview of the methodology is available on Powerlink's website[24] and the principles of the methodology have been used to calculate the risk costs of the Gladstone South QAL Base Case. The document includes the modelling methodology and general assumptions underpinning the analysis.

[20] AER, Application guidelines, Regulatory investment test for transmission, December 2018
[21] The economic assessment was also presented in the PSCR.
[22] AER, Application Guidelines, Regulatory Investment Test for Transmission, December 2018
[23] AER, Industry practice application note, Asset replacement planning, January 2019
[24] The risk costs are calculated using the principles set out in the Powerlink document, Overview of Asset Risk Cost Methodology, May 2019

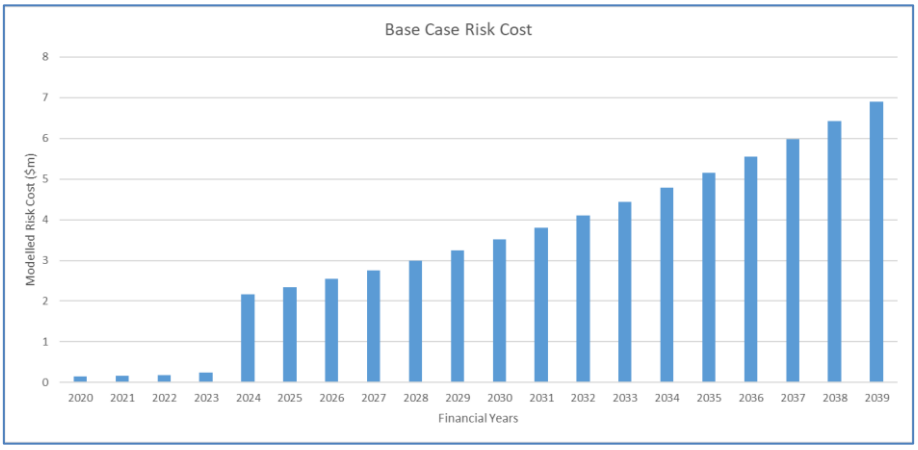
7.3 Base Case assumptions

In calculating the potential unserved energy (USE) arising from a failure of the ageing and obsolete secondary systems at Gladstone South and QAL West substations, the following modelling assumptions have been made:

- spares for secondary system items have been assumed to be available prior to the point of expected spares depletion, as after this point, the cost and time to return the secondary system back to service increases significantly
- historical load profiles have been used when assessing the likelihood of unserved energy under concurrent failure events
- unserved energy generally accrues under concurrent failure events, and consideration has been given to potential feeder trip events within the wider area
- the network risk cost model has used the VCR values as published in the AER 2019 Value of Customer Reliability Review Final Report.[25]

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 secondary systems at Gladstone South and QAL West, the risk costs are projected to increase from $0.16 million in 2020 to $6.90 million in 2039. The main areas of risk cost are network risks that involve reliability of supply through the failure of deteriorated secondary systems modelled as probability weighted unserved energy[26], and financial risk costs associated mostly with the replacement of failed assets in an emergency. These risks increase over time as the condition of equipment further deteriorates, more equipment becomes obsolete and the likelihood of failure rises.

7.4 Modelling of Risk in Options

Each option is scoped to mitigate the key risks arising in the Base Case and to maintain compliance with all statutory requirements, the Rules and AEMO standards. 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.

[25] AER - Values of Customer Reliability Review - Final Report - December 2019.
[26] As the analysis for this RIT commenced before the December 2019 VCR update, Unserved Energy is modelled using a Value of Customer Reliability (VCR) consistent with that published by AER in their *Value of Customer Reliability Review, Final Report*, 2014.

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 2020 to 2039. A 20 year period takes into account the size and complexity of the secondary system replacement options. There will be remaining asset life by 2039, 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%[27] 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%[28] 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, and they 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[29].

Powerlink has considered discount rate, capital cost and risk cost sensitivities individually and in combination and found that the discount rate parameter has an impact on the ranking of results. Powerlink has developed three reasonable scenarios and applied weighting to the NPVs calculated under the high, central and low scenarios, as illustrated in Table 8.1.

Table 8.1: Reasonable scenario assumed

Key parameter	High Scenario	Central scenario	Low scenario
Capital cost	100% of base capital cost estimate	100% of base capital cost estimate	100% of base capital cost estimate
Discount rate	8.33%	5.90%	3.47%
Weighting	1/3	1/3	1/3

[27] 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.
[28] 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.
[29] 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 shows the NPV and the corresponding ranking of each credible option relative to the Base Case.

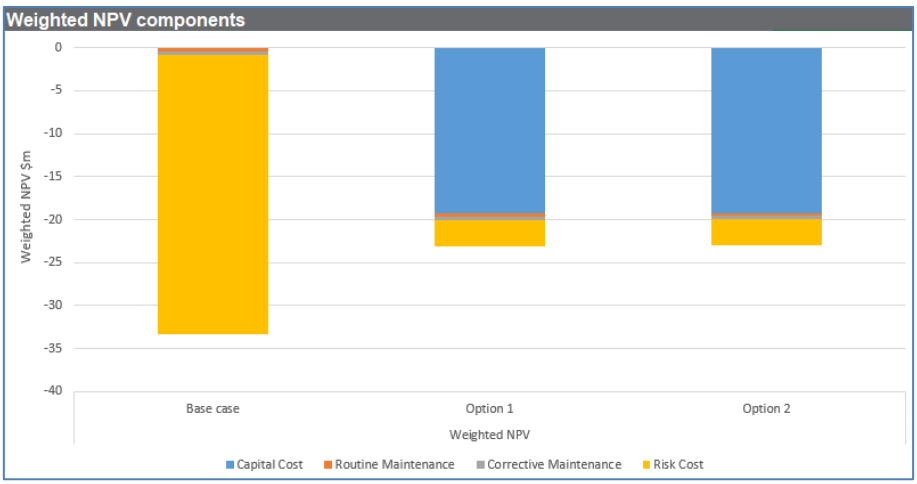
Table 9.1: NPV of credible options relative to base case ($m, 2019/20)

Option	Weighted NPV relative to Base Case ($m)	Ranking
Option 1 Two stage replacement of secondary systems by April 2024 and October 2030	10.264	**2**
Option 2: Single stage replacement of all secondary systems by April 2024	10.367	**1**

Both credible network options address the identified need on an enduring basis. Option 2 has the highest weighted NPV relative to the Base Case and is ranked first.

Figure 9.1 sets out the weighted NPV component of capital cost, maintenance cost and risk cost for the Base Case and each credible option. Option 2 has lower capital cost and maintenance cost components compared to Option 1, resulting in overall higher weighted net present value. Note that the non-credible Base Case consists of maintenance cost and risk cost and does not include any capital expenditure.

Figure 9.1: NPV of the Base Case and each credible option (NPV $m, 2019/20)



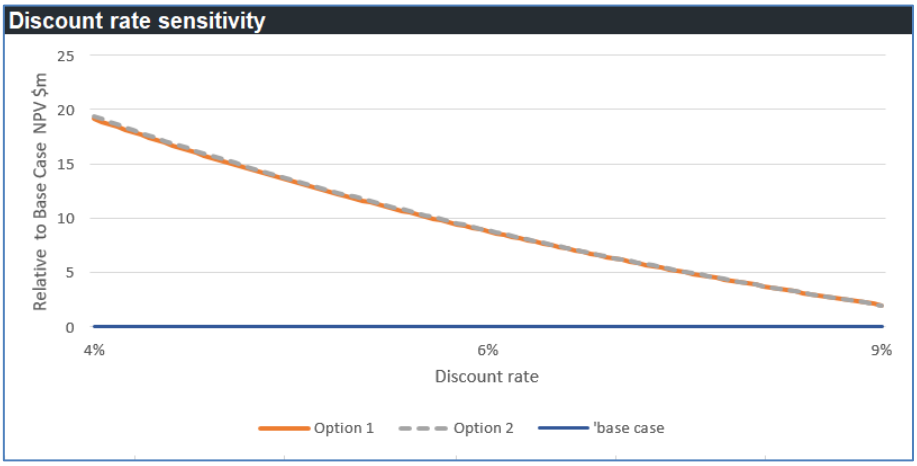
9.2 Sensitivity analysis

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 base risk cost estimates

Option 2 is preferred for discount rates below 8.2% while Option 1 is preferred for discount rate greater than 8.2%. In the calculation of weighted NPV, Option 2 results in higher NPV compared Option 1.

Figure 9.2.1 Discount rate sensitivity



Sensitivity analysis of the NPVs relative to the Base Case shows that when varying capital expenditure and risk costs, there is no material change between the option rankings.

Figure 9.2.2 Capital cost sensitivity

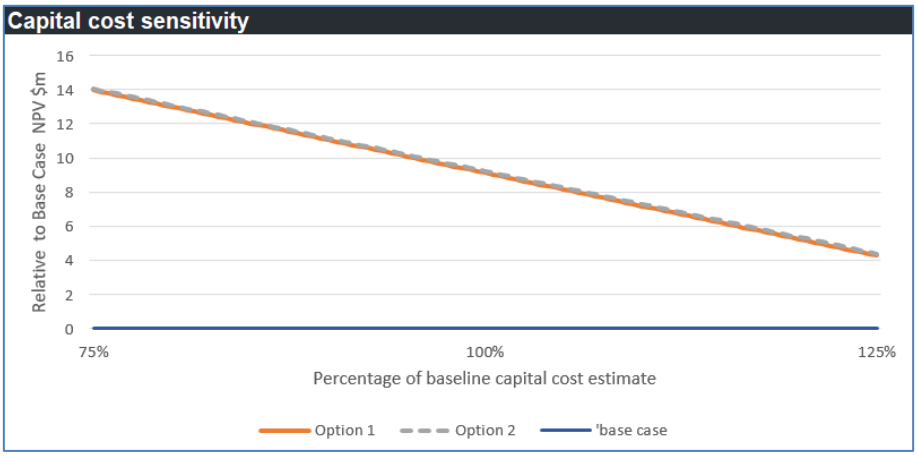
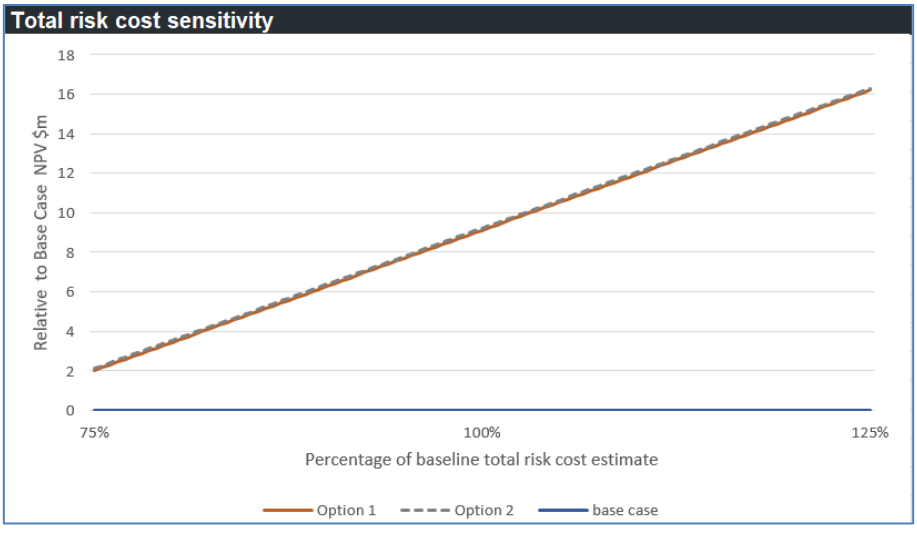


Figure 9.2.3 Risk cost sensitivity



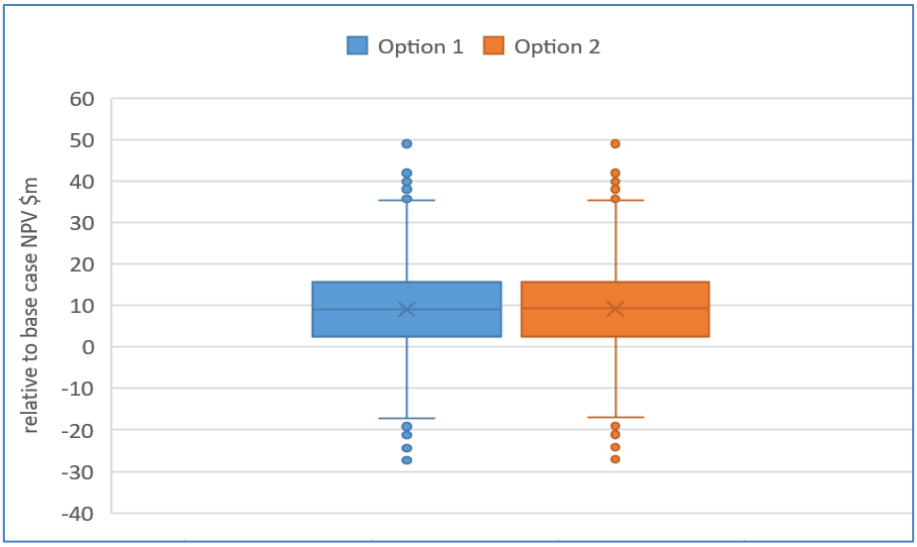
9.3 Sensitivity to multiple parameters

A Monte Carlo simulation was performed with multiple input parameters (including capital cost, discount rate and risk cost) generated for the calculation of the 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 9.3.

The Monte Carlo simulation results identify that Option 2 has similar statistical dispersion in comparison to Option 1 and has a higher mean compared to Option 1. This confirms that the preferred option, Option 2, is robust over a range of input parameters in combination.

Figure 9.3 NPV sensitivity analysis of multiple key assumptions relative to the Base Case



10. Preferred option

Based on the conclusions drawn from the economic 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 aged and obsolete secondary systems at Gladstone South and QAL West substations. Implementing this option will also ensure ongoing compliance with relevant standards, applicable regulatory instruments and the Rules.

Option 2 involves the full replacement of both the Gladstone South and QAL West secondary systems at an indicative capital cost of $23.8 million in 2019/20 prices. Powerlink is the proponent of this network option.

Under Option 2, design work will commence in 2020, and construction from 2022. Installation and commissioning of the new secondary systems will be completed by April 2024.

11. Conclusions

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

- Powerlink has identified condition risks arising from the ageing and obsolete secondary systems equipment at Gladstone South and QAL West Substations as requiring action.
- S5.1.9(c) of the Rules requires a TNSP to provide sufficient primary protection systems and back-up protection systems (including breaker-fail protection systems) to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.
- TNSPs must also ensure that all protection systems for lines at a voltage above 66kV are well maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of a protection system is being carried out.
- The increasing likelihood of faults arising from the condition and obsolescence of the ageing secondary systems at Gladstone South and QAL Substations compels Powerlink to undertake reliability corrective action to meet the reliability standards set out in its Transmission Authority and ensure ongoing compliance with the Rules' standards for protection system availability.

- Studies were undertaken to evaluate two credible options. Both options were evaluated in accordance with the AER's RIT-T.
- Powerlink published a PSCR in February 2020 requesting submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options, which could address the secondary systems condition risks and obsolescence issues at Gladstone South and QAL West Substations.
- The PSCR also identified the preferred option and that Powerlink was adopting the expedited process for this RIT-T, claiming exemption from producing a PADR as allowed for under the Rules Clause 5.16.4(z1) for investments of this nature.
- There were no submissions received in response to the PSCR, which was open for consultation until 22 May 2020. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. The conditions specified under the Rules for exemption have now been fulfilled.
- The result of the cost-benefit analysis under the RIT-T identified that Option 2 is the least cost solution over the 15 year analysis period. Sensitivity testing showed the analysis is robust to variations in discount rate, capital expenditure, operational maintenance expenditure and risk costs assumptions. As a result, Option 2 is considered to satisfy the RIT-T.
- The outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR. Consequently, the draft recommendation has been adopted without change as the final recommendation and will now be implemented.

12. Final Recommendation

Based on the conclusions drawn from the NPV analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 2 be implemented to address the risks arising from the condition of the ageing and obsolete secondary systems at Gladstone South and QAL West Substations. Option 2 allows Powerlink to continue to maintain compliance with relevant AEMO standards, Powerlink's Transmission Authority and Schedule 5.1 of the Rules. Powerlink is the proponent of this option.

Option 2 involves the replacement of the secondary systems at Gladstone South and QAL West Substations in a new building by April 2024 at an indicative capital cost of $23.8 million in 2018/19 prices. Design and procurement activities will commence in late 2020 and construction in 2022.

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

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