Powerlink Queensland

Project Assessment Conclusions Report

14 December 2018

Addressing the secondary systems condition risks at Tarong Substation

Document Purpose

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

1. The Rules require Powerlink to carry out forward planning to identify future reliability of supply requirements and consult with interested parties on the proposed solution as part of the Regulatory Investment Test for Transmission (RIT-T). This includes replacement of network assets in addition to augmentations of the transmission network.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. This document contains the results of this evaluation, and a final recommended solution to address the secondary system condition risks at Tarong Substation from December 2022.

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Executive Summary

Located approximately 130km north-west of Brisbane, Tarong Substation is a major part of the 275kV transmission backbone connecting generators to the major load centres in the south-east of the State. It also provides the major injection point for local, rural and bulk mining loads in south-west Queensland.

Several 275kV secondary systems at the Tarong Substation are reaching the end of their technical service life and are no longer supported by the manufacturer, with no spares available.

Secondary systems are the control, protection and communications equipment that are necessary to operate the transmission network and prevent damage to primary systems when adverse events occur. Under the National Electricity Rules ('the Rules'), Transmission Network Service Providers (TNSPs) are required to provide sufficient secondary systems, including redundancies, to ensure the transmission system is protected.

The deteriorated condition and obsolescence issues associated with the Tarong secondary systems presents Powerlink with operational and compliance issues, requiring resolution. Since consideration for this investment is driven by an obligation in the National Electricity Rules (the Rules), it is a 'reliability corrective action' under the Regulatory Investment Test for Transmission (RIT-T).

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

Credible options considered

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

Table 1: Summary of credible options

Option	Description	Indicative capital cost ($million, 2017/18)	Indicative average annual operating and maintenance costs ($million, 2017/18)
Base Option: Replace selected secondary systems in existing building by late 2022	Single stage replacement of selected secondary systems in free space of existing building	7.8	0.015
Option 1: Replace selected secondary systems using pre-fabricated building by late 2022	Single stage replacement of all obsolete secondary systems and associated panels, using a prefabricated building with new secondary systems equipment and wiring preinstalled. New yard cabling to bay marshalling kiosks	8.7	0.015

Evaluation and conclusion

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

In accordance with the expedited process for this RIT-T, the Project Specification Consultation Report (PSCR) made a draft recommendation to implement the Base Option, single stage replacement of selected secondary systems in the free space of the existing building by December 2022.

The estimated capital cost of the proposed preferred option is $7.8 million in 2017/18 prices. Powerlink is the proponent of the proposed network project.

There were no submissions received in response to the PSCR.

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

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process prescribed under the Rules undertaken by Powerlink to address the condition risks arising from the ageing and obsolete secondary systems at Tarong Substation. It follows the publication of the Project Specification Consultation Report (PSCR) published in August 2018 that adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature.

The Project Specification Consultation Report (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 specific RIT-T assessment are unlikely to be material
- identified the preferred option and that Powerlink was claiming an exemption from producing a Project Assessment Draft Report (PADR).

Powerlink identified the Base Option, single stage replacement in the existing building by December 2022 at an indicative capital cost of $7.8 million, in 2017/18 prices, as the preferred option to address the identified need.

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

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

There were no submissions received in response to the PSCR that closed on 30 November 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

As all of the conditions are now satisfied, Powerlink has not issued a PADR for this RIT-T and is now publishing this PACR, which:

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

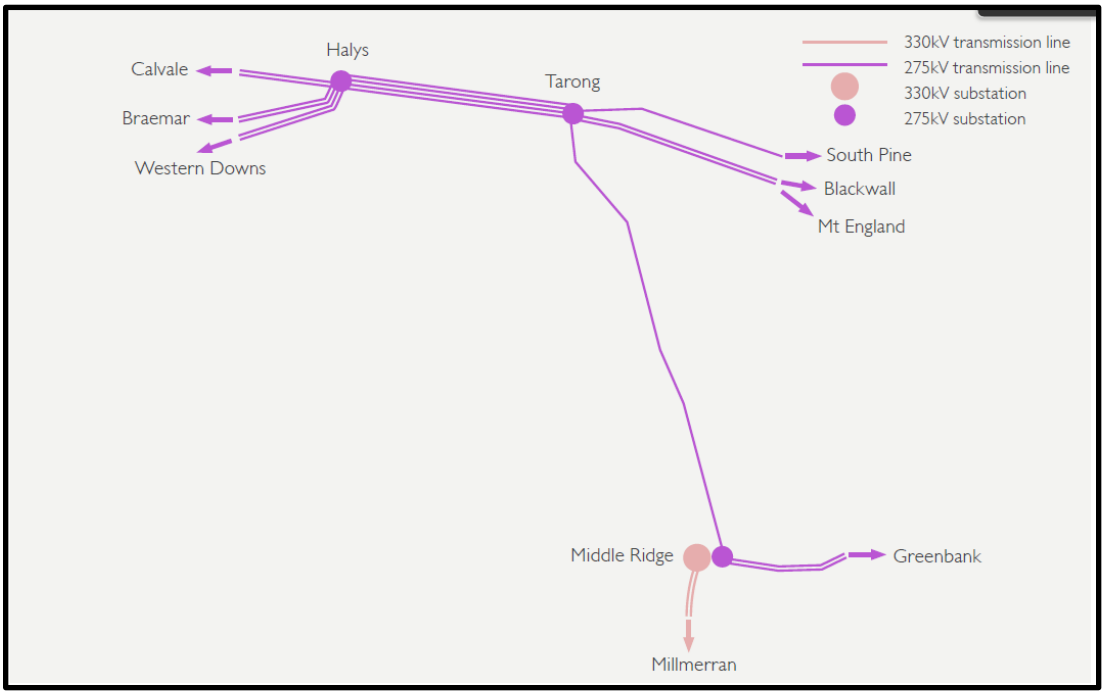
Since this investment is driven by an obligation in the Rules, it is a ‘reliability corrective action’ under the RIT-T.

2. Identified need

2.1 Geographical and network overview

Tarong substation is situated approximately 130km north-west of Brisbane and was first established in 1982 to connect Tarong Power Station to the transmission network. It now provides a 275kV switching function to five substations on the network, which has resulted in a variety of secondary system components ranging in age from 5 to 20 years, with the majority over 18 years old. The south-west transmission network is shown in Figure 2.1.

Figure 2.1: South-west transmission network



2.2 Description of identified need

Tarong plays a critical switching role for the Moreton, Bulli and Central West transmission zones and is the major injection point for the distribution network in south-west Queensland, where local connection loads are forecast to remain constant over the next 10 years.

Powerlink's condition assessment of the ageing 275kV secondary systems at Tarong Substation has highlighted that the majority of the assets are now obsolete and nearing the end of their technical service life.

Under the Rules, TNSPs are required to provide sufficient secondary systems, including redundancies, to ensure the transmission system is protected. This places an obligation on Powerlink to undertake actions that address the risks arising from the obsolete and ageing secondary system assets at Tarong Substation, to maintain compliance with the Rules.

2.3 Assumptions underpinning the identified need

The need to invest is driven by the risks arising from ageing and increasingly obsolete secondary systems at Tarong Substation for which Powerlink has a legal compliance obligation under the Rules. If not addressed, these risks can extend the time taken to recover (or even prevent recovery) from secondary systems faults, due to a lack of support from manufacturers and a lack of spare parts. Under the Rules, Powerlink would be required to disconnect the unprotected primary systems where a secondary systems fault lasts for more than eight hours (in the case of planned maintenance) or 24 hours (in the case of an unplanned outage).

Specifically, S5.1.9(c) of the Rules requires 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 type anywhere on its transmission system is automatically disconnected. This requirement extends to any communications facilities on which protection systems depend.

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 TNSP may need to take primary systems out of service if protection systems are not restored within the required eight hour timeframe for a planned outage. In the event of an unplanned outage, the Australian Energy Market Operator's (AEMO's) Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours.

2.4 Description of asset condition and risks

Many of the 275kV secondary systems at Tarong Substation are approaching the end of their technical service life, while the technology embodied in these systems has also become (or is becoming) obsolete. Consequently, these secondary systems are maintained with an increasingly limited stock of spare parts and without manufacturer support for repairs. This places an obligation on Powerlink to address the risk of system unavailability arising from these ageing and obsolete assets remaining in service.

Powerlink uses an asset health index rating method that describes asset conditions by reference to:

- equipment functional failure rate (failure to operate as intended)
- environmental condition where the assets are installed
- equipment physical and effective age.

Health indices are modelled in the range from zero (0) to ten (10), where zero represents new assets and ten indicates the asset requires immediate action to address its increasing risk of failure. The impact of equipment obsolescence on availability is also considered when determining the recommended action.

A summary of health index scores and recommended actions for each group of obsolete 275kV secondary systems at Tarong is set out in Table 2.1.

Table 2.1: Summary of secondary system health index scores at Tarong Substation

Bay	Construction year	Health index (average)	Description
8 x Feeder Bays Protection & Control Equipment	1999-2013	3.4-8.2 (7.1)	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required.
5 x Coupler Bays Protection & Control Equipment	1999-2002	6.8-8.2 (7.5)	All RTUs rank above 8. Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required.
OpsWAN	1999-2010	6.5-9.4 (8.1)	The majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required.

Technology upgrades are also required for the SCADA, metering and high speed monitoring systems to align them with current network standards of operation. The design and condition of the AC & DC distribution boards and cable termination racks in Building 1 present potential safety issues during work activities, and also need to be replaced.

Deteriorating asset condition increases the risk of secondary system faults, while obsolescence increases the time needed for Powerlink to address these faults, potentially up to several weeks as panel wiring and test plans are needed on an individual basis. The inability to repair, replace, or otherwise resolve secondary system faults in a timely manner can have operational consequences, as this reduces the overall resilience of the transmission network to subsequent forced outages.

3. Submissions received

Powerlink published a PSCR in August 2018 calling for submissions from Registered Participants, the Australian Energy Market Operator (AEMO) and interested parties on the credible options presented, including alternative credible non-network options that could address the risks arising from the ageing and obsolete secondary systems at Tarong Substation.

There were no submissions received in response to the PSCR that was open for consultation until 30 November 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

4. Credible options assessed in this RIT-T

Powerlink has considered two credible network options as part of this PSCR:

- Base Option: Single stage replacement of obsolete secondary system components using new secondary system panels established within the existing building
- Option 1: Single stage replacement of all obsolete secondary systems and associated panels, using a prefabricated building with new secondary systems equipment and wiring preinstalled. Installation of new yard cabling to bay marshalling kiosks.

The components listed in Table 4.1 are to be replaced.

Table 4.1: Summary of systems to be replaced

System/Location	Type
Protection and control systems	8x 275kV feeder system replacements – Tarong & remote ends 5x 275kV coupler system replacements
High Speed Monitoring	4x 275kV feeder high speed monitoring upgrades
Metering	4x 275kV feeder A & B Revenue Meter replacements
Ancillary systems	1x SCADA system 1x OpsWAN system, including 2x new Site Infrastructure panels 1x AC & DC distribution boards in existing +1 Building 1x Blade 150 workstation 1x Timing system in +1 Building 5x VT marshalling kiosks in 5 diameter panels 6x Termination racks – *Base Option only* 5x Bay marshalling kiosks – *plus associated cabling in 5 diameters for Option 1 only* 1x Dual fibre interface between new building and +1 Building – *Option 1 only*
Telecommunications	Tarong & remote end multiplexers

Both credible options to address the identified need, are technically and economically feasible and able to be implemented in sufficient time. Neither of these options has been discussed by AEMO in its most recent National Transmission Network Development Plan (NTNDP).[1]

Indicative costs for each credible option are presented in Table 4.2, and are based on Powerlink estimates.[2]

Table 4.2: Summary of credible network options

Option	Indicative capital cost ($million, 2017/18)	Indicative average annual operating and maintenance costs ($million, 2017/18)
Base option:	7.8	0.015
Option 1:	8.7	0.015

Under both options, work would commence in 2019, with completion by December 2022. This addresses the identified need in a timely manner and avoids a situation where corrective maintenance of obsolete and ageing assets is no longer practical.

4.1 Base Option: Replace selected secondary systems in existing building by December 2022

The Base Option involves the replacement of all ageing and obsolete 275kV secondary systems with new panels installed in the current building, retaining the infrastructure within the existing building. This minimises the amount of work required in the switchyard by retaining the existing cabling. It also avoids the need to run new fibre paths between the current building and the new pre-fabricated building that are required under Option 1.

As part of this option, the termination racks inside the current building will be replaced. Decommissioning will be slightly more complex as the work must be carried out in a space occupied by two sets of secondary system panels (old and new) as opposed to just one set under the alternative option. Major cost components are shown in Table 4.3

Table 4.3: Main project components for the Base Option

Components	Cost ($k, real 2017/18)	Construction timetable & completion date
Replacement of obsolete protection and control systems within existing building at Tarong	5,406	Design and procurement: 2019 Completion: December 2022
Modification of secondary systems at adjacent substations	830	
Telecommunication works at Tarong & remote ends	354	
Other *Includes project management, design & commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,238	
TOTAL	**7,828**	

[1] Clause 5.16.4(b)(4) of the Rules requires Powerlink to advise whether the identified need and or solutions are included in the most recent NTNDP. The 2016 NTNDP is currently the most recent NTNDP.
[2] Powerlink has a robust estimating process that takes into consideration construction costs of recently completed projects, exchange rates on equipment and current labor market trends.

4.2 Option 1: Replace selected secondary systems in pre-fabricated building by December 2022

Powerlink is the proponent of this option.

Option 1 involves the replacement of all ageing and obsolete 275kV secondary systems within a prefabricated building. The building is constructed, fitted out and tested off-site, before being relocated to the substation for commissioning.

This approach provides for a more efficient layout and installation of panels compared to the Base Option. The panels can be tested at Powerlink by internal staff and any issues addressed before the building is shipped to site. It also results in a common start-up date for the panels, internal cabling and DC supplies, making it easier to schedule and carry out maintenance.

The installation of a new building will however require on-site civil works and provision of AC supplies, while new switchyard cabling will also be needed under this Option.

Major cost components are shown in Table 4.4

Table 4.4: Main project components for Option 1

Components	Cost ($k, real 2017/18)	Construction timetable & completion date
Replacement of obsolete protection and control systems within new prefabricated building at Tarong	6,212	Design and procurement: 2019 Completion: December 2022
Modification of secondary systems at adjacent substations	830	
Telecommunication works at Tarong & remote ends	387	
Other *Includes project management, design & commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,264	
TOTAL	**8,693**	

4.3 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.[3]

5. Materiality of Market Benefits

Powerlink does not consider that the replacement of secondary systems at Tarong Substation will provide any market benefits due to the nature of the project.

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

None of the replacement options will have an impact on wholesale market outcomes. The Australian Energy Regulator (AER) has recognised that if the proposed investment will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment[4].

Consequently, no market benefits have been estimated as part of this RIT-T. More information on consideration of individual classes of market benefits can be found in the PSCR.

[3] 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.
[4] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* September 2017, version 2, page 13.

6. General modelling approach adopted to assess net benefits

6.1 Analysis period

The RIT-T analysis has been undertaken over a 15-year period, from 2020 to 2034. A 15-year period takes into account the size and complexity of the secondary systems.

Works on the secondary systems replacement under both options are expected to begin in 2019 and to be completed by December 2022. As the new secondary system has a technical service life of 20 years, there will be some remaining asset life by 2034 under each option, at which point a terminal value is calculated to correctly account for capital costs under each credible option.

6.2 Discount rate

Under the RIT-T, a commercial discount rate is applied to calculate the net present value (NPV) of costs and benefits of credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 7.04%[5] 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%[6] and an upper bound discount rate of 10.61% (i.e. a symmetrical upwards adjustment).

6.3 Description of reasonable scenarios

The RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration.

The choice of reasonable scenarios must reflect any variables or parameters that[7]:

- are likely to affect the ranking of the credible options, where the identified need is reliability corrective action; and
- are likely to affect the ranking of the credible options, or the sign of the net economic benefits of any of the credible options, for all other identified needs.

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

Table 6.1: Reasonable scenarios adopted

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

[5] 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.
[6] A discount rate of 3.47 per cent is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0 per cent and forecast inflation of 2.45 per cent that implies a real discount rate of 3.47 per cent. See AER, *Final Decision: Powerlink transmission determination 2017-2022 | Attachment 3 – Rate of return*, April 2017, p 9.
[7] AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 16, p. 7

7. Cost-benefit analysis and identification of the preferred option

Table 7.1 summarises the NPV for each credible option. The table also shows that differences between the options are only minor.

Table 7.1: Net present values for each credible option (NPV, $m 2017/2018)

Option	Central Scenario NPV	Ranking
Base Option	-5.6	1
Option 1	-6.2	2

When directly comparing Option 1 to the Base Option, Option 1 is $604,000 more expensive in net present terms.

7.1 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

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

Given that the only difference between the options relates to the difference in their capital costs, these sensitivity tests show that the Base Option is the preferred option under all sensitivities (both considered individually and in combination).

7.2 Preferred option

Based on the conclusions drawn from the NPV analysis and the Rules' requirements relating to the proposed replacement of transmission network assets, it is recommended that the Base Option be implemented to address the risks arising from the ageing and obsolete secondary systems at Tarong Substation.

The Base Option involves replacing selected secondary systems within the free space of the existing building by December 2022.

Sensitivity testing shows the analysis is robust to variations in the capital cost and the discount rate assumptions. The Base Option is therefore considered to satisfy the requirements the RIT-T and is the preferred option.

8. Conclusions

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

- Powerlink has identified condition risks arising from ageing and obsolete secondary systems at Tarong Substation 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 risks arising from the condition of ageing secondary systems and their obsolescence compels Powerlink to undertake reliability corrective actions at Tarong Substation to ensure ongoing compliance with NER standards for protection system availability and avoid the impacts of taking primary systems out of service.
- Studies were undertaken to evaluate two credible options. Both credible options were evaluated in accordance with the AER's RIT-T.

- Powerlink published a PSCR in August 2018 requesting submissions from Registered Participants and interested parties on the credible options presented, including alternative credible non-network options which could address the secondary systems condition risks at Tarong Substation.
- The PSCR also identified the preferred option and that Powerlink was adopting the expedited process for this RIT-T, claiming exemption from producing a PADR as allowed for under NER clause 5.16.4(z1) for investments of this nature.
- There were no submissions received in response to the PSCR which was open for consultation until 30 November 2018. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. The conditions specified under the Rules for exemption have now been fulfilled.
- The result of the cost-benefit analysis under the RIT-T identified that the Base Option is the highest net benefit solution over the 15-year analysis period. Sensitivity testing showed the analysis is robust to variations in the capital cost and the discount rate assumption. As a result the Base Option is considered to satisfy the RIT-T.
- The outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR. Consequently, the draft recommendation has been adopted without change as the final recommendation and will now be implemented.

9. Final Recommendation

Based on the conclusions drawn from the NPV analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that the Base Option be implemented to address the condition risks arising from ageing and obsolete secondary systems at Tarong Substation.

The Base Option involves replacing selected secondary systems at Tarong Substation with new secondary systems installed in the free space of the existing building. The estimated capital cost is $7.8 million (2017/18 prices).

Powerlink is the proponent of this proposed option.

Construction activities would be expected to commence off-site in late 2019, with final commissioning on-site by December 2022.

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

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