Powerlink Queensland

Project Specification Consultation Report

21 August 2018

Addressing the secondary systems condition risks at Palmwoods 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. 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 seeks information from potential proponents of feasible non-network options to address the identified need

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Executive Summary

Located in Sunshine Coast hinterland, Palmwoods substation is approximately 18 kilometres west of Mooloolaba and is part of Powerlink's 275kV transmission network between generators and the main South East Queensland load centre. Palmwoods Substation also provides the major injection point into Energex's (part of the Energy Queensland Group) distribution network for the Sunshine Coast and north Caboolture areas.

Several secondary systems at the Palmwoods Substation are reaching the end of their technical service life and are facing obsolescence with manufacturer support and spares no longer available.

Secondary systems include the control, protection and communications equipment that operate the transmission network and prevent damage to primary systems during adverse events. 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 adequately protected.

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

This investment is driven by an obligation under the Rules, and is classified as a 'reliability corrective action' under the RIT-T.

Three credible options have been identified to address the identified need

Table 1: Summary of credible options

Option	Description	Indicative capital cost ($million, 2017/18)	Indicative annual O&M costs ($million, 2017/18)
Base Option: Staged replacement in existing building	Replace all obsolete secondary systems using new pre-wired panels installed in free space of the existing building in two stages between 2019 and 2024.	8.1	0.198
Option 1: Single stage replacement in existing building	Replace all secondary systems using new pre-wired panels installed in free space of the existing building by mid-2021	7.2	0.190
Option 2: Single stage replacement in prefabricated building	Replace all secondary systems using a modular prefabricated building with new secondary systems installed by mid-2021.	7.3	0.190

The base option reflects a conventional approach to ensuring continued compliance with the secondary systems obligations in the Rules and has been selected to serve as the basis of comparison between options. Replacement would occur in two stages in order to maximise asset life and defer investment: one completed in late 2020 and a second in late 2024.

This option has then been compared with an option in which all of the secondary systems are replaced with pre-wired panels within the existing building by mid-2021 and a third option where all of the secondary systems are replaced using a new prefabricated building, which is built off-site and then installed at Palmwoods, also by mid-2021.

Powerlink has also considered whether non-network options could address the identified need. A non-network option that avoids replacement of secondary systems would need to replicate the support that Palmwoods Substation provides Powerlink and Energex in meeting its reliability obligations on an enduring basis at a cost lower than the network options under consideration.

The nature of the underlying problem (i.e. aging and obsolete secondary systems) limits the number of possible solutions that can be adopted. Powerlink is not currently aware of other credible network or non-network options that could be adopted.

Notwithstanding this, Powerlink welcomes submissions from potential proponents who consider that they could offer a credible non-network option that is both economically and technically feasible.

Option 2 has been identified as the preferred option

Due to the nature of the investment, none of the options considered, including the preferred option, are expected to give rise to market benefits. The difference between the options relates primarily to differences in capital costs and timing that in combination have no material impact on rankings. This is supported by the NPV analysis that demonstrates only marginal variances between the options. (Refer to Table 2)

Table 2: NPV of credible options (NPV, $m 2017/18)

Option	Central scenario	Ranking
Base option	-5.6	3
Option 1	-5.5	1
Option 2	-5.5	2

Powerlink recommends Option 2 based on the following:

- The opportunity to resolve health and safety risks by avoiding the continued use of the existing secondary systems corridor panels at Palmwoods beyond 2021 that would be required under the Base Option;
- Simplified planning, design and implementation as there is no need to work within the constraints of legacy designs and architecture, required under the Base Option and Option 1; and
- Simplified project delivery, by reducing the travel time of specialist resources to site, which would be required under the Base Option.

Under Option 2, work on prefabricating the secondary systems building will commence off-site in late 2019, with preparatory construction activities occurring on-site in mid-2020. Installation of the prefabricated secondary systems building on site will take place in late 2020 with full commissioning by mid-2021.

The indicative capital cost of this option is $7.3 million in 2017/18 prices.

Submissions

Powerlink welcomes written submissions on this *Project Specification Consultation Report*. Submissions are particularly sought on the credible options presented.

Submissions are due on or before Friday, 16 November 2018.

Please address submissions to:

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1. Introduction

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 power stations 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 a valued transmission service to its customers by managing risk,[1] optimizing performance and efficiently managing assets through the whole of asset life cycle.[2]

Several secondary systems at the Palmwoods Substation are reaching the end of their technical service life and are facing obsolescence (i.e. they are no longer supported by the manufacturer and have 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[3] when adverse events occur. These secondary systems are also now facing obsolescence (i.e. they are no longer supported by the manufacturer and have no spares available).

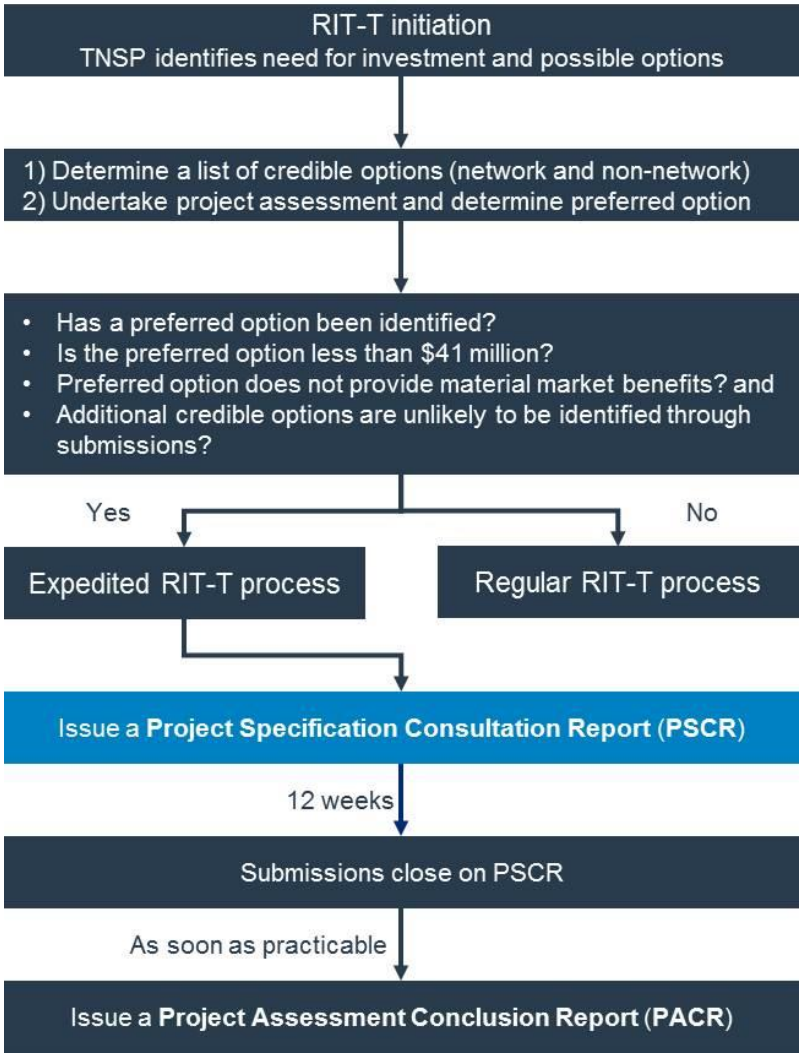
This Project Specification Consultation Report (PSCR) is the first step in the RIT-T process. It:

- 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 may address the identified need;
- Discusses why Powerlink does not expect market benefits to be material for this RIT-T[4];
- Presents the NPV assessment of each of the credible options (as well as the methodologies and assumptions underlying these results);
- Identifies and provides a detailed description of the credible option that satisfies the RIT-T, and is therefore the preferred option; and
- Provides stakeholders with the opportunity to comment on this assessment so that Powerlink can refine the analysis (if required) as part of the Project Assessment Conclusions Report (PACR).

[1] 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*.
[2] 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
[3] Primary systems include the switchgear at Palmwoods and the transmission lines connected to Palmwoods
[4] As required by clause 5.16.1(c)(iv) of the Rules.

Figure 1-1 outlines the RIT-T process.

Figure 1-1: RIT-T process overview



Powerlink has adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature.[5]

Specifically, Powerlink is proposing to publish a 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 $41 million;
- None of the credible options have material market benefits;
- Powerlink has identified its preferred option in this PSCR (together with the supporting quantitative cost benefit analysis); and
- 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 secondary system 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 material market benefit.

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

2. Identified need

This section provides an overview of the supply arrangements around Palmwoods Substation. It then describes the Rules' obligations relating to secondary systems and summarises the asset condition and risks relating to 275kV secondary systems equipment at Palmwoods Substation.

2.1 Geographical and network overview

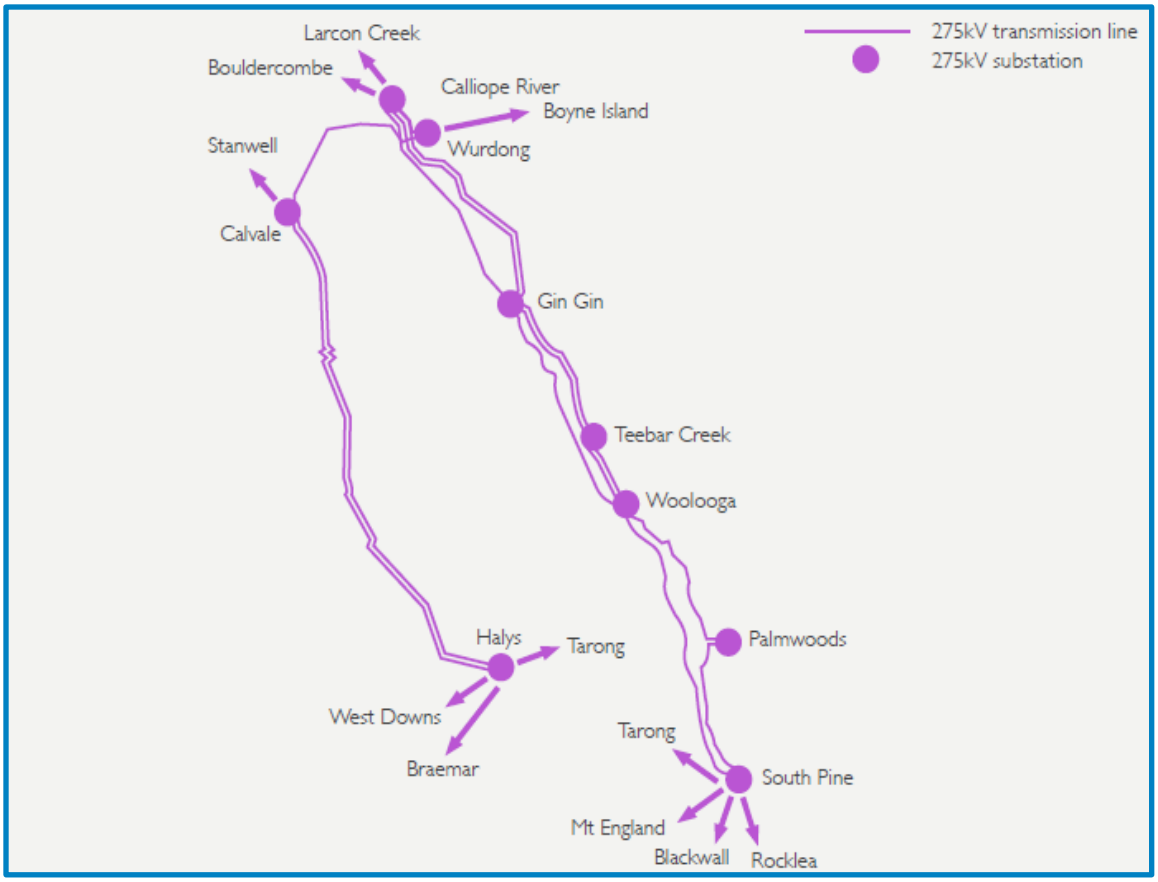
Palmwoods Substation is located approximately 18 kilometres west of the Mooloolaba in the Sunshine Coast hinterland. The 132kV switchyard was first established in 1978, with a 275kV switchyard established in 1993 to meet a growing demand.

It is the major HV injection point for the Sunshine Coast and Norther Caboolture areas and forms an integral part of the 275kV network in the Wide Bay Zone that connects the generators in Central Queensland to the greater Moreton area. [6]

The original two 132kV transformers and their associated bay equipment were replaced between 2009 and 2013.

The relevant transmission network is shown in Figure 2-1

Figure 2-1: Wide Bay Transmission Zone



[6] Palmwoods is connected to the transmission network via two 275kV feeders and supplies energy into the Sunshine Coast and Caboolture region by 132kV and 110kV connections to Energex Queensland substations at Mooloolaba, Beerwah, Nambour, Cooroy and Caboolture

2.2 Description of identified need

Powerlink's planning studies have identified a forecast increase for 132kV loads at Palmwoods Substation from 363MW in 2019/20 to 391 MW in 2026/27, confirming an enduring network need to retain the substation for the next 7 years[7].

Powerlink's condition assessment of the aging secondary systems assets at Palmwoods has highlighted that the majority are now obsolete and nearing the end of their technical service life. The majority of the substation's protection, control and supervisory systems are no longer supported by their respective manufacturers nor do they hold spare replacement units.

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

2.3 Assumptions underpinning the identified need

The need to invest arises from the risks associated with aging and increasingly obsolete secondary systems at Palmwoods Substation for which Powerlink has legal compliance obligations under the Rules. If not addressed, these risks can extend the time taken to recover (or even prevent recovery) from secondary system 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 system 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 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, AEMO's Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours.

It follows that the increasing likelihood of faults associated with the aging secondary systems and their obsolescence compels Powerlink to undertake reliability corrective actions at Palmwoods Substation if it is to continue to meet the standards for protection system availability set out in the Rules, and to avoid the impacts of taking primary systems out of service.

2.3.1 Description of asset obsolescence and risks

Palmwoods Substation consists of one 275kV switchyard and one 132kV/110kV switchyard.

The 275kV switchyard was built in 1993 and expanded between 2000 and 2004, while the original 1978 132kV yard was updated between 2009 and 2013.

The majority of components in the 275kV secondary systems are approaching the end of technical service life. Many critical protection and control items are no longer supported by the manufacturers and have been superseded by new technologies. The diminishing availability of spares and the lack of manufactures' support for repairs place an obligation on Powerlink to address the obsolescence risks arising from these aging assets remaining in service.

[7] Powerlink Transmission Annual Planning Report 2017

Powerlink undertakes a comprehensive condition assessment of the at-risk equipment using an asset health index that evaluates:

- Equipment functional failure rates (failure to operate as intended);
- Environmental conditions where the assets are installed; and
- 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 that the asset requires immediate action to address its increasing risk of unreliable operation. The impact of equipment obsolescence is also considered when determining the recommended action.

A summary of health index scores and recommended actions for each group of 275kV secondary systems at Palmwoods is set out in Table 2-1.

Table 2-1: Summary of secondary system health index scores at Palmwoods Substation

Bay	Construction year	Health index range (average)	Description
Transformer Bays	1993 -2003	*3.8 – 10 (7.3)*	40% of equipment has a health index of 10. The majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.
Feeder bays	1993 - 2003	*3.4 – 10 (5.9)*	25% of equipment has a health index of 10. The majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.
Coupler Bays		*3.8-10 (7.9)*	60% has a health index of 10. Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement
Bus		*9.35*	Transducers Health index indicates that the asset requires replacement. Recommended action: replacement
Capacitor Bank		*6.02*	Relays Recommended action: replacement
Non-bay secondary systems. *(Includes supervisory RTUs, cameras, Ethernet switches & server ports)*	2002 - 2009	*3.8-10 (6.4)*	Condition of equipment is fair. Equipment is not compliant with current Rules requirements and is obsolete. Recommended action: replacement; functionality provided by replacement devices.

NOTE: The assessed condition of metering devices and circuits are not considered to pose a threat to the reliability of the Substation.

Obsolescence increases the time needed by Powerlink to address system faults, potentially up to several weeks as panel wiring and test plans are needed on an individual basis. The inabilities to repair, replace, or otherwise resolve secondary system faults in a timely manner has operational consequences, as this reduces the overall resilience of the transmission network to subsequent forced outages.

3. 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 (TAPR) 2015 to 2018, an expectation that action would be required at Palmwoods Substation to maintain reliability of supply requirements in the Wide Bay and Moreton zones.[8]

Powerlink has consulted with Registered Participants and interested parties on the proposed investment at Palmwoods Substation and potential non-network options as part of the TAPR publication process. 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.

This PSCR provides a further opportunity for providers of feasible non-network options to submit details of their proposals for consideration.

3.1 Criteria for proposed network support services

A Non-network solution that avoids replacement of the 275kV secondary systems at Palmwoods Substation would need to replicate the functionality, capacity and reliability of the substation on an enduring basis at a cost that is lower than the network options currently under consideration.

Any non-network solution to supply the entire load at Palmwoods would require injection to the 132/110kV network at Palmwoods of up to 363MW peak in 2019/2020, climbing to 391MW peak in 2026/2027.

Powerlink has identified the following common criteria that must be satisfied if any proposed non-network solutions are to meet supply requirements:

Size and location:

- Proposed solutions must be large enough, individually or collectively, to provide the size of injection or demand response set out above from the end of 2020. The level of support is however 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; and
- Notwithstanding the location of any solution, each proposal would require assessment in relation to technical constraints pertinent to the network connection, such as other intra-regional transfer limits, fault level or quality of supply impacts of operation.

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 pool price[9]; and
- 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.

[8] This relates to the standard geographic definitions (zones) identified within the *Powerlink's Transmission Annual Planning Report*,, which is published annually by 30 June.
[9] The National Electricity Rules prevent a generator that is providing network support from setting the market price.

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; and
- Powerlink has obligations under the National Electricity Rules, its Transmission Authority and connection agreements to ensure supply reliability is maintained to its customers. Failure to meet these obligations may give rise to liability. Proponents of non-network options must also be willing to accept any liability that may arise from its contribution to a reliability of supply failure.

Timeframe and certainty:

- Proposed services must be able to be implemented in sufficient time to meet the identified need using proven technology and, where not already in operation, provision of information in relation to development status such as financial funding and development timeline to support delivery within the required timeframe must be provided.

Duration:

- The agreement duration for any proposed service will provide sufficient flexibility to ensure that Powerlink is pursuing the most economic long run investment to address the secondary systems condition risks at Palmwoods 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.

4. Potential credible options to address the identified need

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

- Base Option: staged replacement of all obsolete 275kV secondary system panels within the existing control building, Stage 1 (Corridor Panels) completed by late 2020, Stage 2 (Swing Frame Panels) completed by late 2024;
- Option 1: single stage replacement of all 275kV secondary systems and associated panels for all secondary systems, with new secondary systems panels and equipment in free space of the existing control building, completed by mid-2021; and
- Option 2: complete replacement of all 275kV secondary systems and associated panels for all identified secondary systems, using a new prefabricated building with new secondary systems equipment and wiring preinstalled, completed by mid-2021.

The following systems are to be replaced or upgraded under all three options.

Table 4-1: Summary of systems to be replaced

System	Type
Protection and control systems	2x 275/132kV transformer systems 2x 275kV feeder 1x 275kV coupler system 2x 275kV bus system 1x 275kV capacitor bank system
Ancillary systems	1x network system 2x station infrastructure systems 2x battery DC voltage supply & distribution systems 1x SCADA system 1x OpsWAN system
Remote end substation protection systems	2x remote end feeder protection systems

All of the credible options address the identified need and are expected to be technically and economically feasible, and able to be implemented in sufficient time. None of these options has been discussed by the Australian Energy Market Operator (AEMO) in its most recent National Transmission Network Development Plan (NTNDP).[10]

[10] 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.

Indicative costs for each credible option are presented in Table 4-2, and are based on Powerlink estimates.[11]

Table 4-2: Summary of credible network options

Option	Description	Indicative capital cost ($million, 2017/18)	Indicative annual O&M costs ($million, 2017/18)
Base Option: Staged replacement in existing building	Replace all obsolete secondary systems using new pre-wired panels installed in free space of the existing building in 2 stages between 2019 and 2024.	8.1	0.198
Option 1: Single stage replacement in existing building	Replace all secondary systems using new pre-wired panels installed in free space of the existing building by mid-2021	7.2	0.190
Option 2: Single stage replacement in prefabricated building	Replace all secondary systems using a modular prefabricated building with new secondary systems installed by mid-2021.	7.3	0.190

Under all credible options, work would commence in early 2019, with completion either in mid-2021, or in the case of the Base Option at the end of 2024. This addresses the identified need in a timely manner and avoids a situation where corrective maintenance of obsolete and aging assets is no longer practical.

4.1 Selection of a base option

Powerlink has undertaken this RIT-T assessment using a base case that reflects the conventional option that would otherwise be implemented by Powerlink to ensure ongoing compliance with the Rules' obligations to maintain operational protection systems.

Given the specific nature of the Rules' obligations relating to protection systems, the conventional option reflects the replacement of the current aging and obsolete secondary systems as and when they reach the end of technical service life, rather than an option in which the current systems are run to failure with an escalating risk of unserved energy and reactive maintenance costs.

The failure of any individual secondary system at the Palmwoods Substation would not necessarily lead to unserved energy, given the requirement in the Rules to maintain redundancy in protection systems. While networks are however typically resilient to isolated faults, the assumption of running a fleet of secondary systems to failure leads to a higher likelihood of multiple concurrent systemic faults. This could result in substantial unserved energy and overwhelm Powerlink's capacity to undertake corrective maintenance or replacement projects.

In a worst-case scenario, running fleets of secondary systems to failure could lead to cascading blackouts across the network. Powerlink does not therefore consider that this would be a credible base case against which to conduct the RIT-T assessment, as it is far removed from appropriate practice.

[11] 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 Base option: Replacement of all secondary system panels in two stages

Powerlink is the proponent of this option.

The Base Option involves the staged replacement of all 275kV secondary systems components within the existing control building. This represents the conventional approach under which the minimum amount of infrastructure is replaced at any one time and the technical service life of all systems is optimised.

Construction of the first stage would start early in 2019 with commissioning scheduled for late 2020. The second stage completes the full replacement of the obsolete secondary systems and would be undertaken during 2023 and 2024.

Limiting the replacement to currently obsolete secondary systems components does not resolve the health and safety issues associated with the existing corridor panel arrangement.

The integration of new secondary systems components into legacy systems is also labour intensive and technically complex, placing a significant demand on scarce specialist engineering resources. Powerlink considers an expanded resource approach would not be economically viable, as it would incur significant increases in operating expenditure.

Furthermore, the staged nature of the Base Option means that multiple mobilisations of specialist resources would be required to complete the project and would impact Powerlink's capacity to deliver capital projects effectively and efficiently.

At a total cost of $8.1 million (2017/18 prices), this option costs more than Options 1 and 2 and.

Major cost components are shown in Table 4-3 below.

Table 4-3: Main project components for the Base Option

Components		Cost ($k, real 2017/18)	Construction timetable and completion date
Stage 1	Replacement of obsolete protection and control systems mounted in Corridor Panels at Palmwoods	3,717	Construction on-site: 2019 Completion: late-2020
	Modification of secondary systems at remote end substations and telecom works	551	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	852	
Subtotal		**5,120**	
Stage 2	Replacement of remaining of protection and control systems at Palmwoods.	2,271	Construction on-site: 2023 Completion: late-2024
	Modification of secondary systems at remote end substations and telecom works	297	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	458	
Subtotal		**3,026**	
TOTAL		**8,146**	

Once the replacement components are in place, planned and corrective maintenance for the Base Option is estimated to be $19,800 (2017/18 prices) per annum. This is slightly higher than Options 1 and 2, and reflects the five year delay in replacing some of the secondary systems components due to the staged nature of this option.

4.3 Option 1 – Full replacement with new panels in existing building by 2021

Powerlink is the proponent of this option.

Option 1 involves the replacement of all secondary systems in a single stage implementation using new pre-wired protection and control panels tested off-site and installed in the free space of the existing building.

This modular approach reduces project risk and simplifies the replacement process. While this option requires an extended level of intra-panel wiring on-site, it ensures consistent technology is maintained across the replacement systems.

Work on prefabricating the secondary systems panels would commence off-site in early 2019, with preparatory construction activities occurring on-site in 2020. Installation of the prefabricated secondary systems panels will take place in late 2020 – mid 2021.

This is a single stage project that simplifies logistics by requiring only one mobilisation of specialist resources to site compared to two mobilisations under the Base Option.

Major cost components are shown in Table 4-4

Table 4-4: Main project components for Option 1

Components	Costs ($k, real 2017/18)	Construction timetable and completion date
Installation of prewired protection and control panels at Palmwoods	5,365	Construction off-site: 2019 Completion: mid-2021
Modification of secondary systems at remote end substations	578	
Telecommunication upgrades for Palmwoods and remote end substations	249	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,041	
TOTAL	**7,233**	

4.4 Option 2 – Full replacement in pre-fabricated building by 2021

Powerlink is the proponent of this option.

Option 2 involves a full replacement of all 275kV secondary systems at Palmwoods Substation, within a new, demountable secondary systems building.

Option 2 will utilise a prefabricated building with protection, control, communications, and other ancillary equipment wired and installed off-site within a controlled environment. This allows for more efficient utilisation of resources in the fit-out which almost entirely offsets the cost of the new building. The complete prefabricated building will then be transported to the Palmwoods site. This method adopts a modular approach to secondary systems replacement that reduces project risk and simplifies the replacement process.

Work on prefabricating the secondary systems building will commence off-site in early 2019, with preparatory construction activities occurring on-site later in 2019. Installation of the prefabricated secondary systems building on site will commence in 2020 with completion of the project in mid-2021.

This is a single stage project, which simplifies logistics by requiring only one mobilisation of specialist resources to site compared to two mobilisations under the Base Option.

Major cost components are shown in Table 4-5

Table 4-5: Main project components for Option 2

Components	Cost ($k, real 2017/18)	Construction timetable and completion date
New secondary systems (protection and control) at Palmwoods	5,415	Construction off and on site would commence late 2019. Completion of project in mid-2021
Modification of secondary systems at remote end substations	578	
Telecommunication upgrades for Palmwoods and remote end substations	262	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	1,045	
Total	**7,300**	

4.5 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[12].

[12] In accordance with Rules clause 5.16.4(b)(6)(ii). AEMO has published guidelines for assessing whether a credible option is expected to have a material inter-network impact.

5. Materiality of market benefits

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

While there may be an absence of market benefits, there is an expectation of a modest degree of avoided cost benefits, where it is assumed that new secondary systems would require less maintenance than would be incurred under the base option that retains some of the existing secondary systems currently in service at Palmwoods. A discussion of each market benefit under the RIT-T is discussed in Section 5.1.

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

None of the secondary systems replacement options will have an impact on wholesale market outcomes. The 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, and so do not need to be estimated.[13]

- **Changes patterns of generation dispatch**: replacement of secondary systems by itself does not affect transmission network constraints or affect transmission flows that would change patterns of generation dispatch. It follows that changes patterns of generation dispatch are not material to the outcome of the RIT-T assessment;
- **Changes in voluntary load curtailment**: a secondary system fault by itself does not affect prices in the wholesale electricity market. It follows that changes voluntary load curtailment will not be material for the purposes of this RIT-T;
- **Changes in involuntary load shedding**: as discussed above, secondary system faults by themselves do not necessarily lead to unserved energy as redundancies are built into secondary systems and the transmission network at a broader level. These redundancies mitigate the risk of involuntary load shedding in the event of secondary system faults to a negligible level;
- **Changes in costs for other parties**: the effect of replacing secondary systems 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 secondary system replacement do not affect the capacity of transmission network assets, the way they operate, or transmission flows. Accordingly, differences in the timing of expenditure of unrelated transmission investments are unlikely to be affected;
- **Changes in network losses**: credible options are not expected to provide any changes in network losses as replacing secondary systems do not affect the characteristics of primary transmission assets;
- **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; and
- **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.

[13] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* June 2010, version 1, page 15.

5.2 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 may 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 intends on assessing the materiality of market benefits arising from these options. Where the market benefits are considered to be material, these will be quantified as part of the RIT-T assessment of these options.

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 2019 to 2033. A 15-year period takes into account the size, complexity of the secondary system.

Works on secondary systems replacement under options 1 and 2 is expected to begin in 2019 and to be completed by mid-2021. As the new secondary system has a technical service life of 20 years, there will be some remaining asset life by 2033 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%[14] 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%[15] 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[16]:

- 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 scenario assumed

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

[14] 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.
[15] 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.
[16] AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 16, p. 7

7. Cost benefit analysis and identification of the preferred option

7.1 Net present values

Table 7-1 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: Staged replacement in existing building	-5.6	3
Option 1: Single stage replacement in the existing building	-5.5	1
Option 2: Single stage replacement with prefabricated building	-5.5	2

Table 7-2 sets out the net present values of Options 1 and 2 relative to the Base Option under each of the scenarios considered.

Table 7-2: NPV for Options 1 and 2 relative to the Base Option (NPV, $k 2017/2018)

Option	Central scenario NPV	Ranking
Option 1:	143	1
Option 2:	93	2

The above table shows that Option 1 and Option 2 are expected to cost $143,000 and $93,000 less in relative NPV terms than the Base Option, which demonstrates only marginal variances between the options. Overall, the difference in absolute NPV terms is minor considering the magnitude of the project.

7.2 Sensitivity analysis

Powerlink has investigated the impact on the NPV assessment of assuming a 25% increase/decrease in capital costs.

The sensitivity analysis for each credible option is set out in Table 7-3.

Table 7-3 Sensitivities for each credible option relative to base option (NPV $k, 2017/18)

Sensitivity	Option 1 NPV	Option 2 NPV
High capital cost	174	112
Low capital cost	112	74

The magnitude of difference between the options is minor in relation to the overall capital costs and estimating accuracy, with no material impact on rankings and is consistent with the marginal variances between the options.

7.3 Conclusion

The result of the cost benefit analysis indicates that the NPVs for each credible option considered are very similar. While Option 1 is less costly than the Base Option and Option 2 in capital terms, the NPV differences between them are minor given the magnitude of the capital cost and the accuracy in estimating costs.

Sensitivity testing shows the analysis is robust to variations in the capital cost and the discount rate assumptions.

8. 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 arising from the aging and obsolete 275kV secondary systems at Palmwoods Substation.

Powerlink is recommending Option 2 to be the preferred option based on qualitative characteristics given that the NPV analysis indicates the credible options considered are essentially the same in NPV terms.

Option 2 involves replacing all secondary systems at Palmwoods with new secondary systems using a modular prefabricated building.

By adopting a prefabricated building approach, Option 2 considerably simplifies the scope of wiring and installation works compared to the Base Option and Option 1, as most of the works can take place off-site in a controlled environment. This reduces the number of variables that need to be managed and any potentially negative impacts resulting from escalating input costs over time.

The use of a prefabricated building under Option 2 also allows the health and safety risks arising from the existing corridor panels at Palmwoods to be more effectively addressed than either of the other credible options.

Logistics are also simplified under Option 2, as there are fewer mobilisations of contractors and specialised equipment to undertake work at a remote site. It follows that this more simplified approach avoids multiple mobilisation of contractors and specialised equipment for a single project that, if applied across the network on multiple projects, would impact Powerlink's capacity to deliver capital projects at a network wide level without significant and expensive escalation of operational expenditure.

Consequently, Powerlink considers the single-stage Option 2 to be a preferable option compared to the Base Option and Option 1.

Overall, the simplified scope enables Powerlink to deliver Option 2 at only a marginally higher capital cost in NPV terms compared to the other options. The estimated capital cost is $7.3m million (2017/18). Powerlink is the proponent of this proposed option.

Construction activities would be expected to commence off-site in early 2019 and on site later in 2019, with completion of the project in mid-2021.

9. Submissions requirements

Powerlink invites submissions and comments in response to this PSCR from Registered Participants, AEMO, potential non-network providers and any other interested parties.

Submissions should be presented in a written form and should clearly identify the author of the submission, including contact details for subsequent follow-up if required. If parties prefer, they may request to meet with Powerlink ahead of providing a written response.

9.1 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 AER RIT-T 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; and
- Other material that would be relevant in the assessment of the proposed service.

As the submissions may 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.

9.2 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 (including PADR exemption)	21 August 2018
	Submissions due on the PSCR Have your say on the credible options and potential non-network options.	16 November 2018
Part 2	Publication of the PACR Responding to any submissions received and making a final recommendation on the preferred option for implementation.	21 December 2018

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).

10. Appendix 1: Options considered but not progressed

Option description	Reason for not progressing option
In-situ replacement of secondary systems components: replacement of individual obsolete components in existing panels.	Replacement of individual secondary system components within existing panels is not technically feasible due to safety requirements and space constraints in the corridor panel layout currently used at Palmwoods. This option is also not economically feasible as much of the old wiring is “set” and any disturbance would likely damage the insulation, resulting in the need to replace the wiring, and/or rewire the components. This option would therefore have substantially higher costs, but would not provide additional benefits.
Reconfigure Palmwoods as a transformer ended 275kV connection	Transformer ending connection option can abolish the need of 275kV bus zone protection, but it does not remove the need to replace the 275kV secondary systems at Palmwoods substation. This configuration of 275kV connection would result in an unequal loading of the 275/132kV transformers, and thermal overloads due to back-feed under contingency conditions. This option will impact negatively on the transfer capability and reliability of supply to customers in the Wide Bay and Moreton zones. Reconfiguring the 275kV yard is not expected to result in a significant decrease in the secondary systems requirement. There would still be a requirement for two 275kV feeder bays and two 275kV transformer bays, as well as much of the associated equipment. This option was therefore not considered further as it would reduce the functionality and/or equipment of the existing primary plant and secondary systems at Palmwoods substation in the near future, and would provide only minimal cost savings over the option to maintain the network topology as is.
Rebuild Palmwoods at a nearby site	Palmwoods Substation is located in the northern part of Moreton zone. This is a key 275kV substation in the wider interconnected network supplying power into South East Queensland. It is also an essential bulk supply substation to supply Energex loads. Therefore the important role of this substation must be retained. Replacement of this substation by rebuilding it at a nearby site is unlikely to present a cost effective solution due to the high cost of replacing or relocating primary plant for the new substation. Additionally, acquisition of a new site near the existing Palmwoods substation suitable for such an establishment is likely to be unachievable given the required delivery timeframe. Therefore, this alternative option is unachievable and not economically feasible to address the identified issues.

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