Powerlink Queensland

Project Specification Consultation Report

8 May 2018

Addressing the secondary systems condition risks at Dan Gleeson 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.

Contents

Executive Summary

Aging and obsolete secondary systems at Dan Gleeson substation require Powerlink to take action

Located in south-west Townsville, Dan Gleeson Substation is a major injection point into the Ergon Energy distribution network. Planning studies have confirmed there is an enduring need for the substation to maintain the supply of electricity in the Townsville area.

Several secondary systems at the Dan Gleeson Substation are reaching the end of their technical life, and are increasingly at risk of failure. These secondary systems are also now 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 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.

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

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

Three credible options have been identified

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

A base option reflecting a minimal conventional approach has been identified to serve as the basis of comparison between the options. This base option reflects a targeted replacement of obsolete secondary systems components *in situ*, completed in two stages.

This option has then been compared with an option in which the entire secondary systems are replaced by the end of 2020, and a third option in which an entire replacement of the secondary systems is staged.

Table 1: Summary of potential credible options

Option	Description	Indicative capital cost ($million, 2017/18)	Indicative average annual operating and maintenance costs ($million, 2017/18)
Base option: Staged in-situ replacement	Staged replacement of obsolete secondary system components within existing panels. Stages would be completed by the end of 2020 and the end of 2025	5.6	0.017
Option 1: Full replacement (by end 2020)	Replace all secondary systems using a modular prefabricated building with new secondary systems installed. Beginning early 2019 and completed by the end of 2020	5.4	0.016
Option 2: Staged full replacement (by 2020 and 2025)	Staged replacement of secondary systems using a modular prefabricated building with new secondary systems installed	6.0	0.017

A base option reflecting a conventional approach to ensuring continued compliance with the secondary systems obligations in the Rules has been identified to serve as the basis of comparison between options. Under this base option, only those secondary system components that are obsolete would be replaced, within the existing panels. This replacement would occur in two stages: one completed in 2020 and a second in 2025.

This option has then been compared with options in which all of the secondary systems are replaced with new panels within a new prefabricated building, which is built off site and then installed at Dan Gleeson. Two options have been considered: one in which the replacement is undertaken all at once between 2019 and 2020, and the second where the replacement is staged and completed in 2020 and then 2025.

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 Dan Gleeson Substation provides Powerlink in meeting its reliability obligations on an enduring basis at a cost that is lower than the network options currently 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.

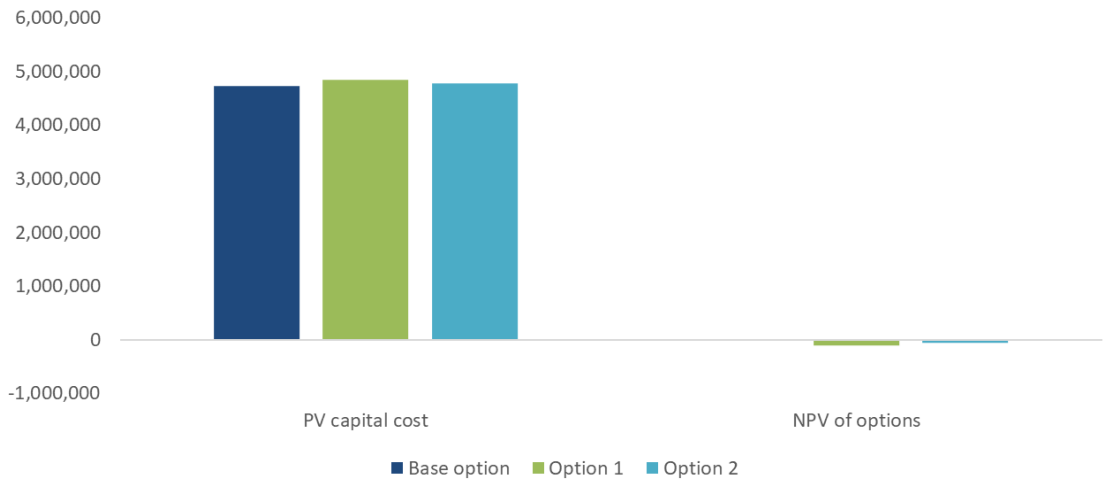
Notwithstanding, Powerlink welcomes submissions from potential proponents who consider that they could offer a credible non-network option that is both economically and technically feasible.

Option 1 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, which are similar across all options. This is supported by the NPV analysis.

Figure 1 shows the PV of capital costs compared with the NPV of Options 1 and 2 (relative to the base option).

Figure 1: PV of capital costs compared to NPV of options (NPV, $ 2017/18)



Powerlink has elected to recommend Option 1 based on the following qualitative characteristics:

- the opportunity to resolve health and safety issues by avoiding the continued use of the existing secondary systems corridor panels at Dan Gleeson, which would be required under the base option;
- simplified planning, design and implementation as there is no need to work within the constraints of legacy secondary systems, which would be required under the base option; and
- simplified project delivery, by avoiding multiple mobilisations of specialist resources for staged projects, which would be required under both the base option and Option 2.

Under Option 1, 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 take place in 2020 with completion of the project in December 2020.

The indicative capital cost of this option is $5.4 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, 3 August 2018.

Please address submissions to:

Roger Smith
Manager Network and Alternate Solutions
Network Portfolio
Powerlink Queensland
PO Box 1193
VIRGINIA QLD 4014

(07) 3860 2328
networkassessments@powerlink.com.au

1. Introduction

1.1 Background

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, Ergon Energy and Essential Energy, 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.

Several secondary systems at the Dan Gleeson Substation are reaching the end of their technical life, and are increasingly at risk of failure. Secondary systems are the control, protection and communications equipment that are necessary to operate the transmission network and prevent damage to primary systems[2] 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:

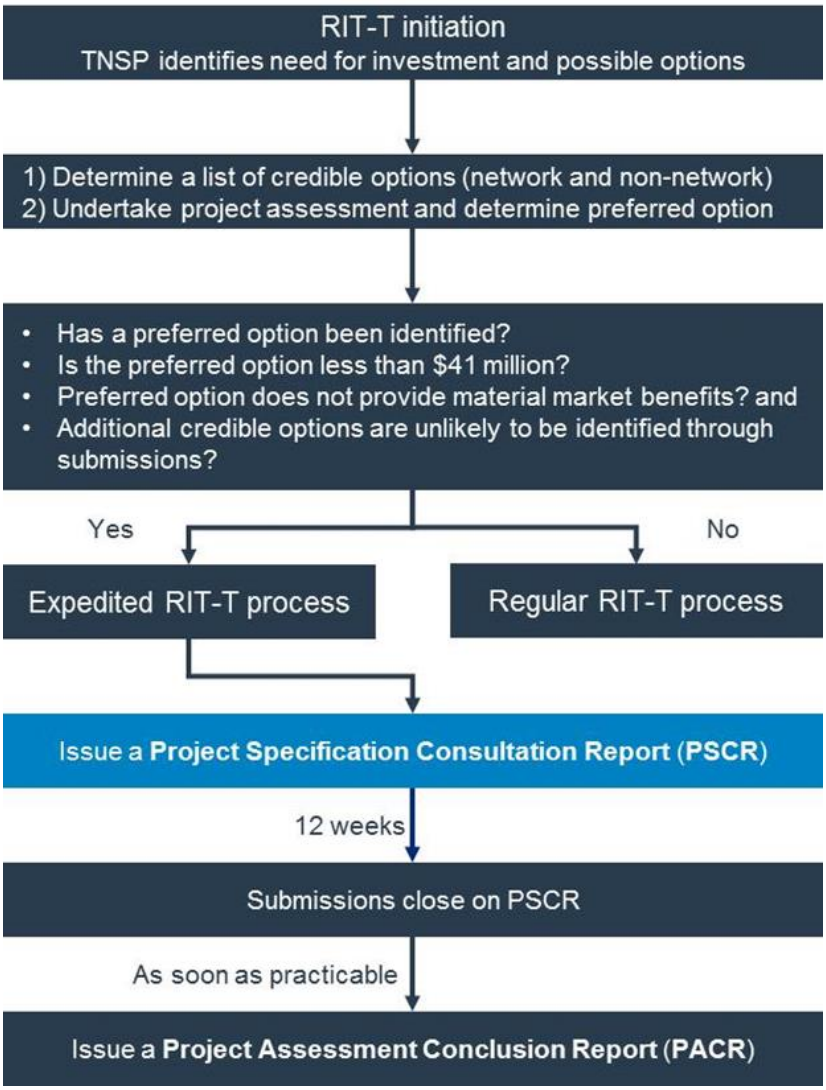
- describes the reasons why Powerlink has determined that investment is necessary (the 'identified need'), together with the assumptions used in identifying this need
- provides potential proponents of non-network options with information on the technical characteristics that a non-network solution would 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[3]
- 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
- 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 ISO31000:201809 *Risk Management Guidelines*.

[2] Primary systems include the switchgear at Dan Gleeson and the transmission lines connected to Dan Gleeson

[3] As required by clause 5.16.1(c)(iv) of the Rules.

Figure 1.1: This PSCR is the first report of the RIT-T process to address secondary systems condition risks at Dan Gleeson Substation



Powerlink has adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature.[4]

Specifically, Powerlink is proposing to publish a PACR following community 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)
- 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 systems replacement project.

However, Powerlink will 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.

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

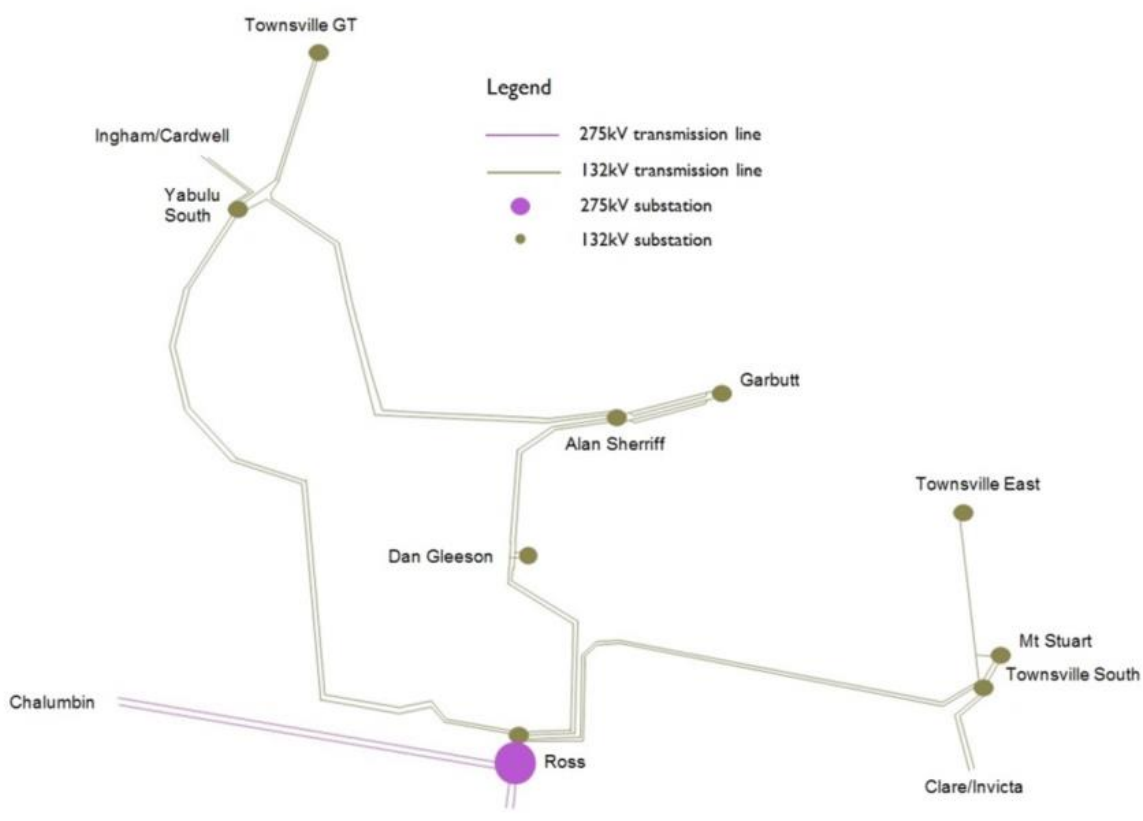
2. Identified need

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

2.1 Geographical and network overview

Dan Gleeson Substation is located in south-west Townsville. The Townsville area transmission network is shown in Figure 2.1.

Figure 2.1: Townsville area transmission network



Dan Gleeson Substation was built in 1998 to provide local supply to the south-western suburban area of Townsville.

The substation is a major injection point into the Ergon Energy (Ergon) distribution network. Planning studies undertaken by Powerlink have confirmed there is an enduring need for the substation to maintain electricity supply to the Townsville area.

The substation consists of a switchyard operating at 132kV and 66kV, with connections to Ergon's distribution network.[5] The switchyard is enclosed by the one perimeter fence that also encloses a single building that houses all secondary systems.

2.2 Description of identified need

Powerlink's assessment of the condition of the aging secondary systems assets at Dan Gleeson has highlighted that many of the assets are now obsolete, with limited or no support being provided by the manufacturers, and few remaining spare parts held by Powerlink.

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 risks associated with the obsolete and aging secondary system assets at Dan Gleeson Substation, to maintain compliance with the Rules.

[5] Dan Gleeson Substation is supplied by two feeders and there are two transformers located at the substation. Powerlink also owns two 66kV capacitor banks connected to Ergon's 66kV bus.

2.2.1 Assumptions underpinning the identified need

The need to invest arises from the risks associated with aging and increasingly obsolete secondary systems at Dan Gleeson Substation. 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 Dan Gleeson 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.

2.2.2 Description of asset obsolescence and risks

Secondary systems at Dan Gleeson broadly consist of five different groups of equipment. There are three groups of relays and control equipment associated with the primary systems; two 132kV feeder bays, two 132/66kV transformer bays and two capacitor bays. Additional secondary systems equipment includes electricity meters and non-bay secondary systems (primarily communications equipment).

The secondary systems equipment at Dan Gleeson ranges in age from 12 to 20 years. The original secondary systems equipment[6] is still in service and mounted in corridor type panels. Newer secondary systems equipment[7] was commissioned in 2005.

Many of the secondary system components are reaching the end of their technical lives, and therefore have an increasing risk of failure. 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.

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 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 secondary systems at Dan Gleeson is set out in Table 2.1.

[6] The 132kV equipment for feeder 7151 and transformer 1.
[7] Associated with transformer 2 and feeder F7144.

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

Bay	Construction year	Health index (average)	Description
Feeder Bays 7144 7151	 2005 1997-2004	 6.0 7.0	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.
Transformer Bays 1T 2T	 1997 2005	 8.5 5.5	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.
Capacitor Bays 1 Cap 2 Cap	 1997 1997	 9.0 9.0	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.
Metering Equipment	1997-2005	8.0	Equipment does not meet current Rules requirements and is obsolete. Recommended action: replacement.
Non-bay secondary systems	1997-2005	8.5	All equipment is obsolete, with insufficient spares to support ongoing operation. Recommended action: replacement.

Deteriorating asset condition increases the risk of secondary system faults. Obsolescence can increase the time needed for Powerlink to address secondary system 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 can have 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 2017, an expectation that action would be required at Dan Gleeson Substation to maintain reliability of supply requirements in the Ross zone.[8]

Powerlink has consulted with Registered Participants and interested parties on the proposed investment at Dan Gleeson 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

Secondary systems are required for the operation of substations. Without secondary systems, a substation would not be able to function. A non-network option that avoids replacement of secondary systems would therefore need to replicate the functionality, capacity and reliability of the Dan Gleeson Substation on an enduring basis at a cost that is lower than the network options currently under consideration.

Consequently, any non-network option would need to provide injection or demand response at Dan Gleeson, or into the meshed Townsville network in the vicinity of Dan Gleeson, of up to 50MW capacity and up to approximately 850MWh of energy per day, based on the power transferred through the Dan Gleeson transformers in previous years, and accounting for steady demand in the future.

Powerlink has identified the following common criteria that must be satisfied if proposed network support services 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. However, the level of support is dependent on the location, type of network support and load forecasts.
- Due to the bulk nature of the transmission network, aggregation of sub 10MW non-network solutions will be the sole responsibility of the non-network provider.
- Notwithstanding the location of any solution, each proposal would require assessment in relation to technical constraints pertinent to the network connection, such as 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]
- 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.
- 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 Dan Gleeson 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 network options to address the identified need

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

- Base option: staged in-situ replacement of only those secondary system components that are obsolete, using the existing building and secondary system panels.
- Option 1: complete replacement of all secondary systems and associated panels, using a prefabricated building with new secondary systems equipment and wiring preinstalled.
- Option 2: staged replacement of all secondary systems and associated panels using a prefabricated building with new secondary systems equipment and wiring preinstalled. The first stage would occur be completed by the end of 2020, followed by completion of a second stage in 2025.

These credible options all address the identified need and are expected to be technically and commercially feasible, and to be 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]

Indicative costs for each credible option are presented in Table 4.1 and are based on Powerlink estimates.[11]

Table 4.1: Summary of credible network options

Option	Description	Indicative capital cost ($million, 2017/18)	Indicative average annual O&M costs ($million, 2017/18)
Base option: Staged in-situ replacement of obsolete components only	Staged replacement of obsolete secondary system components only, within existing panels. Stages would be completed by the end of 2020 and the end of 2025.	5.6	0.017
Option 1: Full replacement with prefabricated building	Replace all secondary systems by the end of 2020 using a modular, prefabricated secondary systems building with new systems pre-wired and installed.	5.4	0.016
Option 2: Staged full replacement with prefabricated building	Staged replacement of all secondary systems using a modular, prefabricated secondary systems building with new systems pre-wired and installed. Stages would be completed by the end of 2020 and the end of 2025.	6.0	0.017

Under all credible options, work would commence in early 2019, with completion either at the end of 2020, or (in the case of the staged options) at the end of 2020 followed for further works being completed by the end of 2025. This addresses the identified need in a timely manner and avoids a situation where corrective maintenance of obsolete secondary systems is no longer practical.

[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.
[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.

4.1 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 in situ, 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 Dan Gleeson Substation would not necessarily lead to unserved energy, given the requirement in the Rules to maintain redundancy in protection systems. However, whilst networks are 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.

The design of the Dan Gleeson Substation means that it is feasible to replace obsolete secondary systems on a component by component basis within the existing building, without replacing the entire panel on which the components are mounted. This approach has therefore been adopted as the appropriate base option for this RIT-T, and is discussed further below.

4.2 Base option – In situ replacement of obsolete secondary system components only

Powerlink is the proponent of this option.

The base option involves the staged in-situ replacement of only those secondary systems components that are obsolete, on a relay by relay basis and using the existing panels. This represents the conventional option under which the minimum number of obsolete components are replaced, using the existing building and secondary systems equipment panels at the substation.

Construction of the first stage would start early in 2019 and involves replacement of the majority of the obsolete secondary systems components at Dan Gleeson. Completion of the first stage would occur by the end of 2020. This first stage is estimated to cost $4.8 million (2017/18 prices).

The second stage completes the replacement of secondary system components at Dan Gleeson Substation to address the remaining obsolescence risk, and would be undertaken during 2024 and 2025. The cost of this second stage is estimated to cost approximately $0.8 million (2017/18 prices).

Table 4.2 sets out the secondary system components that would be modified or replaced in-situ under the base option.

Table 4.2: Secondary systems equipment to be modified or installed under the base option

System		Type
Stage 1	Protection and control systems	2x 132kV feeder systems 1x 132/66kV transformer systems (1T) 2x 66kV capacitor bank systems 2x 132kV bus system
	Telecommunications systems	1x multiplexor systems
	Metering systems	2x 66kV metering systems
	Ancillary systems	1x OpsWAN server/network system 1x local control & SCADA interface systems 2x redundant battery DC voltage supply & distribution systems 2x AC voltage supply & distribution system
	Remote end substation protection systems	2x remote end feeder protection systems
Stage 2	Protection and control systems	1x 132/66kV transformer systems (2T)

While the base option may have the least number of physical changes to the secondary systems at Dan Gleeson, it is the most technically difficult because:

- The design, installation, integration and testing of new components with existing secondary systems cabling and panels is a complex and a time-consuming process, involving extensive rewiring of existing panels requiring specialist technicians.
- Space constraints inside the existing secondary systems building make the in situ replacement of components difficult and introduce additional safety risks.

In addition to being technically difficult, limiting the replacement to currently obsolete secondary systems components only does not future-proof other secondary systems components at the substation that are not yet obsolete but may become obsolete in the near future. Further, the in-situ replacement of equipment in the existing secondary systems building at the substation fails to resolve health and safety issues associated with the existing corridor panel arrangement.

Powerlink also notes that an in-situ replacement approach is only practical if its application across the network is limited. The integration of new secondary systems components into legacy systems is labour intensive and technically complex, requiring specialist engineering resources. These specialist resources are scarce within the market and would be easily exhausted if an in-situ replacement approach was adopted network wide. 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. While this staged approach might be sensible for a single project considered in isolation, applying the staged approach on multiple projects across the transmission network would strain Powerlink's capacity to deliver capital projects effectively and efficiently.

At a total cost of $5.6 million (2017/18 prices), the in-situ replacement base option costs more than Option 1 but less than Option 2. The base option is also the most expensive per component as only the minimum number of obsolete components are replaced under this option.

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	New secondary systems (protection and control) at Dan Gleeson	3,125	Construction on-site: 2019 and 2020 Completion: 2020
	New and modified secondary systems (telecommunications) at Dan Gleeson	260	
	Modification of secondary systems at adjacent substations	554	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	831	
Subtotal		**4,770**	
Stage 2	New secondary systems (protection and control) at Dan Gleeson	555	Construction on-site: 2024 and 2025 Completion: 2025
	New and modified secondary systems (telecommunications) at Dan Gleeson	112	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	141	
Subtotal		**808**	
Total		**5,578**	

Once the replacement components are in place, planned and corrective maintenance for the base option is estimated to be $17,000 (2017/18 prices) per annum. This is slightly higher than for Option 1, and reflects the 5 year delay in replacing some of the secondary systems components due to the staged nature of this option.

4.3 Option 1 – Full replacement in a new modular building in 2019

Powerlink is the proponent of this option.

Option 1 involves a full replacement of all secondary systems at Dan Gleeson Substation, within a new, demountable secondary systems building.

Option 1 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 Dan Gleeson site. This method adopts a modular approach to secondary systems replacement that reduces project risk and simplifies the replacement process.

The use of prefabricated building under Option 1 will address health and safety issues associated with the existing corridor panel arrangement as use of the existing secondary systems building at Dan Gleeson would be avoided.

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 take place in 2020 with completion of the

project in December 2020. Option 1 is a one stage project, which simplifies logistics by requiring only one mobilisation of specialist resources compared to two mobilisations under the base option and Option 2.

Table 4.4 summarises the secondary systems equipment that will be installed under Option 1.

Table 4.4: Secondary system panels installed under Option 1

System	Type
Protection and control systems	2x 132kV feeder systems 2x 132/66kV transformer systems 2x 66kV capacitor bank systems 2x 132kV bus system
Telecommunications systems	1x multiplexor systems
Metering systems	2x 66kV metering systems
Ancillary systems	1x OpsWAN server/network system 1x local control & SCADA interface systems 2x redundant battery DC voltage supply & distribution systems 2x AC voltage supply & distribution system
Remote end substation protection systems	2x remote end feeder protection systems

Planning, design and implementation under this approach will be simplified as there is no need to work within the constraints of legacy secondary systems. Staging of the works and cutovers is also simplified, with reduced risk to network reliability because there is no ongoing installation activity within operational substation panels as with the base option.

The indicative capital cost of this option is $5.4 million in 2017/18 prices. Major cost components are illustrated in Table 4.5.

Table 4.5: Main project components for Option 1

Components	Cost ($k, real 2017/18)	Construction timetable and completion date
New secondary systems (protection and control) at Dan Gleeson	3,667	Construction off and on site would commence early 2019. Completion of project in December 2020
New and modified secondary systems (telecommunications) at Dan Gleeson	316	
Modification of secondary systems at adjacent substations	791	
Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	585	
Total	**5,360**	

Once the replacement components are in place, planned and corrective maintenance for Option 1 is estimated to be $16,000 (2017/18) per annum. This is slightly lower when compared to the base option, and a consequence of the reduced probability of a future fault occurring as all secondary systems components are replaced upfront with this option.

4.4 Option 2 – Full replacement in a new modular building, completed in two stages

Powerlink is the proponent of this option.

Option 2 involves the full replacement of all secondary systems within a new, demountable secondary systems building, the same as for Option 1. The difference between the options relates solely to the construction approach, with the new secondary systems in Option 2 being constructed and installed in two stages rather than one. The majority of secondary systems are replaced in stage 1 with the remaining to be replaced during stage 2.

Stage 1 utilises a prefabricated building with protection, control, communications, and other ancillary equipment wired and installed off site within a controlled environment. The complete prefabricated building will then be transported to the Dan Gleeson site. Stage 2 works will subsequently involve wiring new panels off-site and installation within the demountable building established during stage 1 works.

The use of prefabricated building under Option 2 will address health and safety issues associated with the existing corridor panel arrangement as use of the existing secondary systems building at Dan Gleeson would be avoided.

Construction of the first stage will start in early 2019, with a new prefabricated building housing new panels for the identified secondary systems being wired off-site and then transported to Dan Gleeson. Completion of this first stage would occur by the end of 2020. This first stage is estimated to cost $4.3 million (2017/18 prices).

The second stage completes the full replacement of secondary systems at Dan Gleeson Substation to address the remaining obsolescence risk, and would be undertaken during 2024 and 2025. The cost of this second stage is estimated to cost $1.7 million (2017/18 prices).

The staged nature of Option 2 means that multiple mobilisations of specialist resources would be required to complete the project. While this staged approach might be sensible for a single project considered in isolation, applying the staged approach on multiple projects across the transmission network would strain Powerlink's capacity to deliver capital projects effectively and efficiently without significant escalation of operational expenditure.

The secondary systems equipment ultimately installed or modified under Option 2 is the same as that for the Base Option (and is presented in Table 4.2).

Again, planning, design and implementation under this approach will be simplified as there is no need to work within the constraints of legacy secondary systems and there is reduced risk to network reliability because there is no ongoing installation activity within operational substation panels as with the base option.

The indicative capital cost of this option is $6.0 million in 2017/18 prices. Major project components are illustrated in Table 4.6.

Table 4.6: Main project components for Option 2

Components		Cost ($k, real 2017/18)	Construction timetable and completion date
Stage 1	New secondary systems (protection and control) at Dan Gleeson	3,193	Construction off- and on-site: 2019 and 2020 Completion: 2020
	New and modified secondary systems (telecommunications) at Dan Gleeson	260	
	Modification of secondary systems at adjacent substations	396	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	466	
Subtotal		**4,315**	
Stage 2	New secondary systems (protection and control) at Dan Gleeson	984	Construction off- and on-site: 2024 and 2025 Completion: 2025
	New and modified secondary systems (telecommunications) at Dan Gleeson	112	
	Modification of secondary systems at adjacent substations	396	
	Other *- this includes project management, commissioning coordination, network operations, compliance management and statutory costs (Qleave)*	223	
Subtotal		**1,715**	
Total		**6,029**	

Planned and corrective maintenance for Option 2 is estimated to be $17,000 (2017/18 prices) per annum. This is the same as for the base option reflecting the 5 year delay in replacing some of the obsolete secondary systems components due to the staged nature of this and the base case options.

4.5 Options considered but not progressed

Powerlink has considered whether there are other credible options that would meet the identified need. However, the identified need to address the risks associated with obsolete secondary systems at Dan Gleeson Substation does not lend itself to other technically and economically feasible solutions other than to replace those secondary systems.

Consequently, Powerlink has not considered or progressed options other than those discussed in this section.

4.6 Material inter-regional 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 Dan Gleeson 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 Dan Gleeson. A discussion of each market benefit under the RIT-T is provided below.

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 associated with 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 and expected life of replacement secondary systems.

Works on secondary systems replacement under each credible option is expected to begin in 2019, with Option 2 also having a second stage commencing in 2024. As secondary systems have a technical life of 15 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 NPV of costs and benefits of credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 7.04 per cent[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 per cent[15] and an upper bound discount rate of 10.61 per cent (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 only the discount rate affects option rankings. Powerlink has therefore adopted three scenarios based on high, low and central estimates of the discount rate.

Table 6.1: Reasonable scenarios adopted

Key variable/parameter	Central scenario	Low discount rate scenario	High discount rate scenario
Discount rate	7.04%	3.47%	10.61%

Powerlink does not have any basis to weight one scenario more heavily over another. Consequently, Powerlink has weighted each scenario equally.

[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

The table below summaries the NPV for each credible option, which is the sum of capital and operating costs, all in present value terms, across each of the three discount rate scenarios.

The table also shows the overall weighted outcome of the assessment, where each scenario has been weighted equally.

Table 7.1: Net present values for each credible option (NPV, $m 2017/18)[17]

Option	Central scenario	Low discount rate scenario	High discount rate scenario	Weighted scenario	Ranking
Base option	-4.7	-5.0	-4.5	-4.7	=1
Option 1: Full replacement	-4.8	-5.1	-4.6	-4.8	=1
Option 2: Staged replacement	-4.8	-5.1	-4.5	-4.8	=1

The magnitude of the NPV difference between the options is immaterial in comparison to the capital cost of the options, indicating that all options are essentially ranked equally under the RIT-T. The largest difference between credible options is only $143,000 (between the base option and Option 1 under the high discount rate scenario). This represents only around 2% of the capital expenditure estimates (of between $4.7 million and $4.8 million in NPV terms), which is well within the expected margin of accuracy of those estimates (of around 25%).

The figure below shows the PV of capital costs compared with the NPV of Options 1 and 2 (relative to the base case), illustrating that the NPV of options are essentially equivalent to each other.

Figure 7.1: PV of capital costs compared to NPV of options (NPV, $ 2017/18)

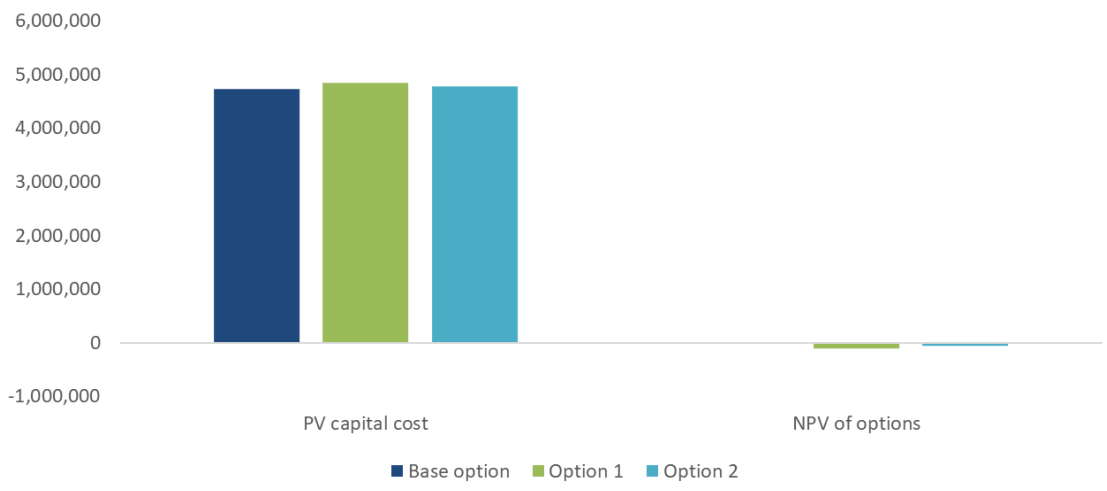


Table 7.2 sets out the net present values for Option 1 and Option 2 relative to the base option under each of the scenarios considered.

[17] Negative numbers denote an overall net cost.

Table 7.2: Net present values for Option 1 and Option 2 relative to the base option (NPV, $k 2017/18)

Option	Central scenario	Low discount rate scenario	High discount rate scenario	Weighted scenario	
	NPV	NPV	NPV	NPV	Ranking
Option 1: Full replacement	-108	-76	-143	-109	=1
Option 2: Staged replacement	-52	-95	-7	-51	=1

Both Option 1 and Option 2 have slightly negative weighted NPVs when compared to the base option. However, the difference in NPVs is so small between the base option and the other two credible options that they are effectively the same in NPV terms.

Figure 7.2 sets out the breakdown of capital costs and operating costs (i.e. routine maintenance and corrective maintenance) for each option in NPV terms, and highlights that operating costs form only a very small component of the overall differences between the base option and the two credible options.

Figure 7.2: Net present values for each credible option relative to the base option (NPV, $ 2017/18)

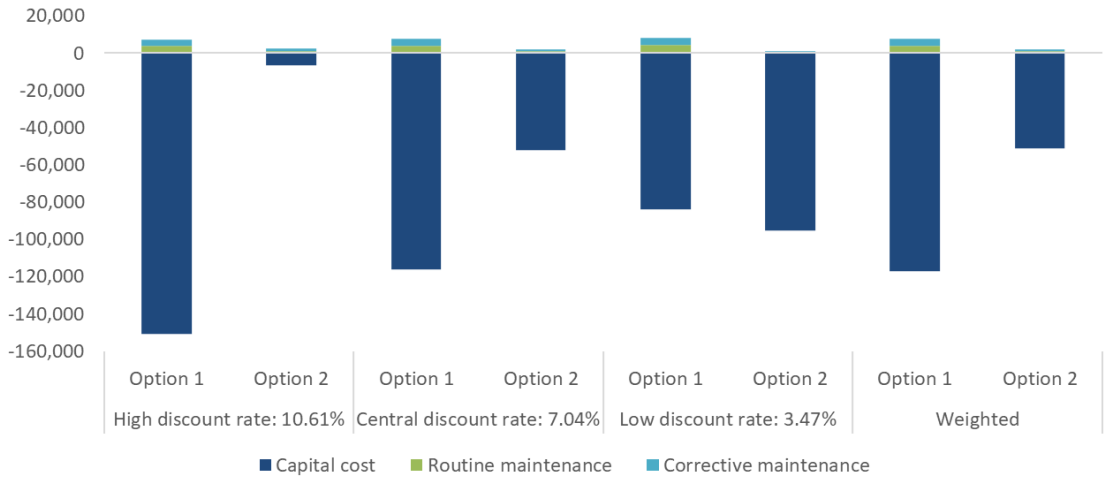


Table 7.3 sets out the NPV for Options 1 and 2 relative to the base option, and shows that Option 1 and Option 2 are expected to cost around $109,000 and $51,000 more respectively in NPV terms compared with the base option.

Table 7.3: NPV for each credible option relative to the base option (NPV $k, 2017/18)

Option	Description	Weighted NPV	Ranking
Option 1: Full replacement with prefabricated building	Replace all secondary systems using a modular prefabricated building. Completion at the end of 2020.	-109	=1
Option 2: Staged full replacement with prefabricated building	Replace all secondary systems using a modular prefabricated building. Completion in two stages: 2020 and 2025.	-51	=1

Comparing weighted NPVs for each option set out in Table 7.3 to the present value of capital expenditure shows that the negative NPV is only 2% of the proposed capital expenditure under Option 1 and 1% under Option 2. This is well within the margin of accuracy in estimating capital costs and is an immaterial difference in practical terms, considering the magnitude of the project. It follows that the weighted NPVs for the credible options are essentially equal to each other, with all options being ranked equally under the RIT-T.

7.2 Sensitivity analysis

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

Table 7.4 sets out the results of this sensitivity for each credible option.

Table 7.4: Sensitivities for each credible option relative to the base option (NPV $k, 2017/18)

Sensitivity	Option 1	Option 2
High capital cost	-137	**-65**
Low capital cost	-79	**-39**

Again, the difference in NPV between Option 1 and Option 2, and the comparison with the base option, indicates that the options are essentially all ranked equally, considering the magnitude of capital costs and the expected estimating accuracy.

7.3 Conclusion

The result of the cost benefit analysis under the RIT-T indicates that the NPVs for each credible option considered are essentially equivalent to each other. While the base option is less negative than the other two credible options, the NPV differences between them are immaterial considering the magnitude of the capital costs and the accuracy in estimating costs.

8. Draft recommendation

Based on the conclusions drawn from the NPV analysis, the Rules requirements relating to the proposed replacement of transmission network assets and the qualitative characteristics of the credible options considered, it is recommended that Option 1 be implemented to address the risks associated with the aging and obsolete secondary systems at Dan Gleeson Substation.

Powerlink is recommending Option 1 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 1 involves replacing all secondary systems at Dan Gleeson with new secondary systems using a modular prefabricated building (with replacement of all secondary systems as listed in Table 8.1).

Table 8.1: New secondary system equipment under Option 1

Type	Model
Protection and control systems	2x 132kV feeder systems 2x 132/66kV transformer systems 2x 66kV capacitor bank systems 2x 132kV bus system
Telecommunications systems	1x multiplexor systems
Metering systems	2x 66kV metering systems
Ancillary systems	1x OpsWAN server/network system 1x local control & SCADA interface systems 2x redundant battery DC voltage supply & distribution systems 2x AC voltage supply & distribution system
Remote end substation protection systems	2x remote end feeder protection systems

By adopting a prefabricated building approach, Option 1 considerably simplifies the scope of wiring and installation works compared to the in-situ base option, as most of the works can take place off site in a controlled environment. The use of a prefabricated building under Option 1 will also address health and safety issues with the existing secondary systems corridor panels at Dan Gleeson. The opportunity to resolve the health and safety issues leads Powerlink to consider Option 1 to be preferable over the base option.

Logistics are also simplified under Option 1, as there are fewer times that Powerlink would need to mobilise 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 strain 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 1 to be a superior option compared to the base option and Option 2, which each have two stages.

Overall, the simplified scope enables Powerlink to deliver Option 1 at only a marginally higher capital cost in NPV terms compared to the base option. The estimated capital cost is $5.4 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 December 2020.

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
- 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)	8 May 2018
	Submissions due on the PSCR Have your say on the credible options and potential non-network options.	3 August 2018
Part 2	Publication of the PACR Responding to any submissions received and making a final recommendation on the preferred option for implementation.	September 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).

Contact us

Registered office	33 Harold St Virginia Queensland 4014 Australia
Postal address:	GPO Box 1193 Virginia Queensland 4014 Australia
Contact:	Roger Smith Manager Network and Alternate Solutions
Telephone	(+617) 3860 2328 (during business hours)
Email	networkassessments@powerlink.com.au
Internet	www.powerlink.com.au