Powerlink Queensland

Project Assessment Conclusions Report

17 July 2019

Maintaining reliability of supply at Kamerunga Substation

Document Purpose

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

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

Contents

Executive Summary

Located approximately 10 kilometres north-west of Cairns, Kamerunga Substation, established in 1976, is a major injection point into the Ergon Energy (part of the Energy Queensland Group) distribution network. Planning studies have confirmed there is an enduring need for the substation to maintain the supply of electricity in the Cairns area.

Both the primary plant and secondary systems at Kamerunga Substation are nearing the end of their technical service lives with identified condition and obsolescence issues. The substation is also susceptible to major flooding events which could result in damage to equipment leading to loss of supply.

The condition of the primary plant and secondary systems at Kamerunga substation, along with the existing flood risk, exposes customers to the risks and consequences of an increasingly unreliable electricity supply.

Under the Electricity Act 1994, Powerlink is required to "operate, maintain (including repair and replace if necessary) and protect its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity"[1].

Powerlink must therefore address the emerging risks at Kamerunga Substation to ensure customers in the area continue to receive safe, reliable and cost effective electricity services into the future, as well as to meet reliability and service standards within Powerlink's Transmission Authority[2] and the National Electricity Rules (the Rules). The investment has been identified as a reliability corrective action.

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

Credible options considered

Powerlink published a Project Specification Consultation Report (PSCR) and a Project Assessment Draft Report (PADR) to Registered Participants, the Australian Energy Market Operator (AEMO) and interested parties in September 2018 and April 2019 respectively, regarding the reliability of supply at the Kamerunga Substation. The PSCR and PADR invited submissions particularly on credible options (network and non-network) to address the risks arising from the condition of the ageing primary plant and secondary systems at Kamerunga.

No submissions were received in response to the PSCR that closed on 21 December 2018 or the PADR that closed on 7 June 2019. As a result, no additional credible options have been identified as a part of this RIT-T consultation.

Powerlink proposed four credible network options to address the identified condition-based and flood risks at Kamerunga Substation.

A summary of the credible options is given in Table 1.

[1] The Electricity Act 1994 (Queensland), Chapter 2, Part 4, S34(1)(a)
[2] Transmission Authority No. TO1/98

Table 1: Summary of credible options

Option	Description	Capital cost ($m 2018/19)	Weighted NPV ($m 2018/19)	Ranking
Base Option	Single stage secondary system replacement. Staged AIS primary plant replacement. Flood operable by October 2028	26.70	-22.03	3
Option 1	Single stage secondary system replacement. Single stage AIS primary plant replacement. Flood operable by October 2022	23.20	-22.21	4
Option 2	Single stage secondary system replacement. Single stage GIS primary plant replacement including additional switching functionality. Flood operable by October 2022	24.62	-21.41	1
Option 3	Single stage secondary system replacement. Single stage AIS primary plant replacement including additional switching functionality. Flood operable by October 2022	23.75	-21.45	2

Evaluation and conclusion

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

In accordance with the RIT-T process, the PADR, published in April 2019, made a draft recommendation to implement Option 3 as it:

- satisfies the RIT-T based on the cost benefit analysis (i.e. equal lowest cost in NPV terms with consideration for estimating accuracy)
- utilises existing technology within the Powerlink network, removing the need to acquire new spares and undertake additional training for personnel (compared to Option 2)
- addresses the risk to electricity supply from flood inundation in a single construction phase at the current Kamerunga Substation site by October 2022
- provides increased security of supply through the inclusion of circuit breakers (CBs) on the Woree feeders

Option 3 involves replacing Kamerunga's current primary plant with new AIS (air insulated switchgear) equipment, installing additional circuit breakers for the Woree feeders and the full replacement of all secondary systems in a new building. All primary plant and secondary systems are to be located above the 1 in 200 year flood level. Design work would commence in early 2020, with preparatory construction activities occurring on-site in late 2020. All work would be completed by October 2022. The indicative capital cost of this option is $23.75 million in 2018/19 prices.

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

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process[3] prescribed under the National Electricity Rules (the Rules) undertaken by Powerlink to address the condition risks arising from the ageing primary plant and secondary systems at Kamerunga Substation. It follows the publication of the Project Specification Consultation Report (PSCR) and the Project Assessment Draft Report (PADR) in September 2018 and April 2019 respectively.

The Project Specification Consultation Report (PSCR):

- described the identified need that Powerlink is seeking to address, together with the assumptions used in identifying this need
- set out the technical characteristics that a non-network option would be required to deliver in order to address the identified need
- described the credible options that Powerlink considered may address the identified need
- discussed specific categories of market benefit that in the case of this RIT-T assessment are unlikely to be material.
- invited submissions and comments, in response to the PSCR and the credible options presented, from Registered Participants, The Australian Energy Market Operator (AEMO), potential non-network providers and any other interested parties.

The Project Assessment Draft Report (PADR):

- described the identified need that Powerlink is seeking to address, together with the assumptions used in identifying this need
- described the credible options that Powerlink considered may address the identified need
- discussed why Powerlink does not expect market benefits to be material for this RIT-T[4]
- noted that no submissions were received in response to the PSCR
- presented the Net Present Value (NPV) economic assessment of each of the credible options (as well as the methodologies and assumptions underlying these results) and identified the preferred option.
- invited submissions and comments from Registered Participants, AEMO, potential non-network providers and other interested parties in response to the PADR.

Powerlink identified Option 3, involving the replacement of Kamerunga's current primary plant with new AIS equipment, installation of additional circuit breakers for the Woree feeders and the full replacement of all secondary systems in a new building by October 2022, as the preferred option to address the identified need. The indicative capital cost of this option is $23.75 million in 2018/19 prices.

There were no submissions received in response to the PSCR or the PADR that closed on 21 December 2018 and 7 June 2019 respectively. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. Powerlink is now undertaking the final stage of the RIT-T process and is publishing this PACR, which:

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

[3] This RIT-T consultation was commenced in September 2018 and has been prepared based on the following documents: *National Electricity Rules, Version 112*, 18 September 2018 and AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, September 2017.
[4] As required by clause 5.16.1(c)(iv) of the Rules.

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

2. Stakeholder engagement activities

Delivering electricity to almost four million Queenslanders, Powerlink recognises the importance of engaging with a diverse range of customers and stakeholders who have the potential to affect, or be affected by, Powerlink activities and/or investments.

2.1 Powerlink takes a proactive approach to engagement

Powerlink regularly hosts a range of engagement forums and webinars, sharing information with customer and stakeholders the broader community. These engagement activities help inform the future development of the transmission network and assist Powerlink in providing services that align with the long term interests of customers. Feedback from these activities is also incorporated into a number of publically available reports.

2.2 Working collaboratively with Powerlink's Customer Panel

Powerlink's Customer Panel provides a face-to-face opportunity for customers and consumer representative bodies to give their input and feedback about Powerlink's decision making, processes and methodologies. It also provides Powerlink with another avenue to keep customers and consumers better informed, and to receive feedback about topics of relevance, including RIT-Ts.

The Customer Panel is regularly advised on the publication of Powerlink's RIT-T documents and briefed quarterly on the status of current RIT-T consultations, as well as upcoming RIT-Ts, providing an ongoing opportunity for:

- the Customer Panel to ask questions and provide feedback to further inform RIT-Ts
- Powerlink to better understand the views of customers when undertaking the RIT-T consultation process.

The Customer Panel was advised of the RIT-T consultation for maintaining the reliability of supply at Kamerunga Substation in Panel meetings from April 2018.

Powerlink will continue providing updates to and request input from the Customer Panel throughout the RIT-T consultation process.

2.3 Transmission Annual Planning Report (TAPR) – the initial stage of public consultation

Powerlink identified in its TAPR from 2015 to 2019, an expectation that action would be required at Kamerunga Substation to maintain transfer capabilities and reliability of supply in the Far North transmission zone[5].

The 2018 TAPR also highlighted that Powerlink anticipated the commencement of a RIT-T within the next 12 months.

Members of Powerlink's Non-network Engagement Stakeholder Register (NNESR) were directly advised of the publication of the TAPR and the accompanying compendium of potential non-network solution opportunities (Appendix F), which set out the indicative non-network requirements to meet the identified need at Kamerunga Substation.

No submissions proposing credible and genuine non-network options have been received from prospective non-network solution providers in the normal course of business, in response to the publication of TAPRs or as a result of stakeholder engagement activities.

[5] This relates to the standard geographic definitions (zones) identified within the TAPR.

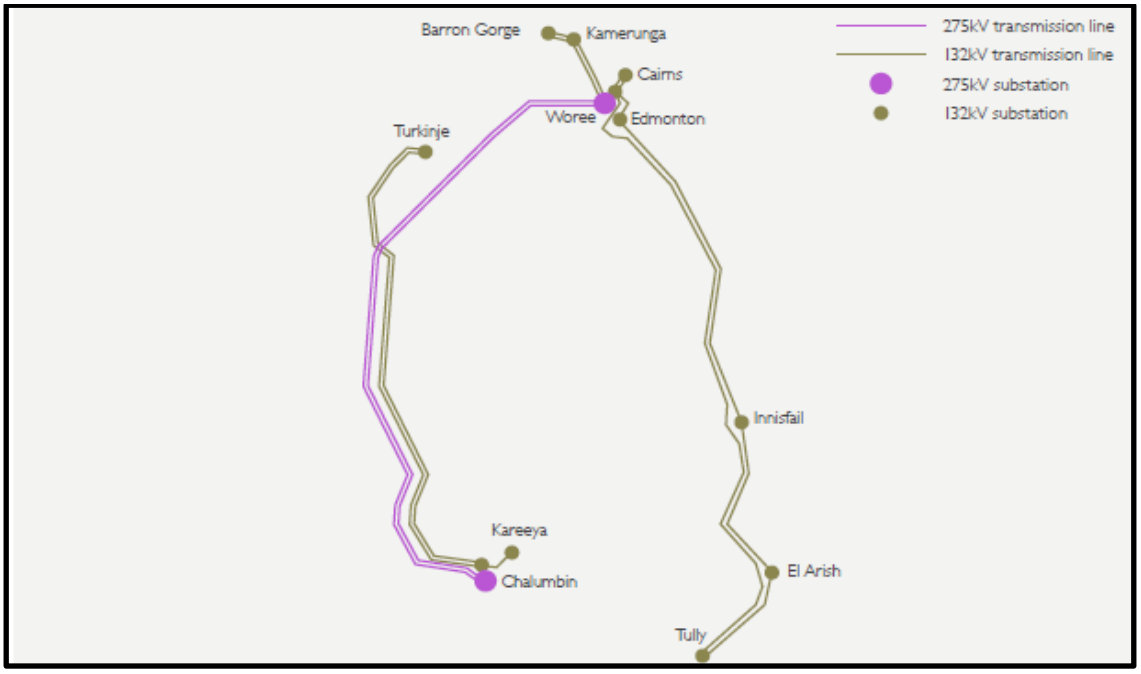
3. Identified need

This section provides an overview of the existing arrangements at Kamerunga Substation and describes the risk to supply from the assessed condition of the transmission assets.

3.1 Geographical and network overview

Kamerunga Substation, located approximately 10 kilometres north west of Cairns, was established in 1976 and consists of a switchyard operating at 132kV[6]. It provides the only injection point to the 22kV network in the Cairns Northern Beaches area, including Cairns Airport and connects the Barron Gorge Power Station to the transmission network. The Far North Queensland transmission network is shown in Figure 3.1.

Figure 3.1: Far North Queensland transmission network



3.2 Description of identified need

With peak demand in the Cairns area forecast to remain at or slightly above current levels, it is vital that electricity supply be maintained to satisfy these demands and for Powerlink to meet its reliability of supply and safety obligations under the *Electricity Act 1994, Electrical Safety Act* 2002 and Powerlink's Transmission Authority[7].

Under the Electricity Act 1994, Powerlink is required to "operate, maintain (including repair and replace if necessary) and protect its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity"[8].

Similarly, the Electrical Safety Act 2002 requires Powerlink to ensure that its works are electrically safe and operated in a way, which is electrically safe[9].

Powerlink's Transmission Authority requires it to plan and develop the transmission network "in accordance with good electricity industry practice, having regard to the value that end users of electricity place on the quality and reliability of electricity services".

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[6] Supplied by two 132kV feeders from Woree, Kamerunga Substation connects Barron Gorge Power Station to the network through two additional 132kV feeders. The two 132/22kV transformers are connected to Ergon Energy's network via a 22kV underground cable.
[7] Queensland Transmission Authority T01/98
[8] The Electricity Act 1994 (Queensland), Chapter 2, Part 4, S34(1)(a)
[9] The Electrical Safety Act 2002, Part 2, division 2, section 29

It allows load to be interrupted during a critical single network contingency, provided the maximum load and energy:

- will not exceed 50MW at any one time; or
- will not be more than 600MWh in aggregate[10].

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

Schedule 5.1 of the Rules sets minimum standards for network service providers on the availability and operation of protection systems. Schedule 5.1.9 (c) specifically requires Powerlink provide sufficient primary and back-up protection systems (including breaker-fail protection systems) to ensure that a fault is automatically disconnected[11]. Powerlink's condition assessment of the ageing assets at Kamerunga has highlighted that the majority are nearing the end of their technical service life with much of the substation's primary plant, protection, control and supervisory systems no longer supported by their respective manufacturers. Increasing failure rates, along with the increased time to rectify the faults due to equipment obsolescence, significantly affects the availability and reliability of these systems.

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

As the proposed investment is for meeting reliability and service standards arising from Powerlink's Transmission Authority and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, it is a 'reliability corrective action' under the Rules[12].

In addition to the risks posed by ageing assets, the substation also has a significant loss of supply risk in the case of a major flood event, as it is currently not constructed to withstand a 1 in 100 year or 1 in 200 year flood. The current configuration of the substation also poses a risk to the supply of electricity to the Cairns North area, and connection of the Barron Gorge Power Station to the network, should the Woree feeders trip for a fault on one of the feeders.

3.3 Assumptions underpinning the identified need

The need to invest is driven by Powerlink's obligations to address the increasing risks to supply arising from the condition of ageing and increasingly obsolete assets as well as the potential for flood inundation at Kamerunga Substation. If not addressed, these risks can extend the time taken to recover (or even prevent recovery) from faults, due to a lack of support from manufacturers and a lack of spare parts.

Powerlink's obligations as a TNSP[13] require it to maintain (including repair and replace if necessary) its transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity, including the ability to meet peak demand if a major element of the network was to fail. For Kamerunga, this includes ensuring the ongoing availability of its primary switchgear and instrument transformers to ensure the ongoing reliable supply of electricity to customers.

Under the Rules, Powerlink is also required to provide sufficient primary protection systems and back-up protection systems to ensure that a fault of any type anywhere on its transmission system is automatically disconnected[14]. In the event of an unplanned outage, the Power System Security Guidelines published by AEMO, require that the primary network assets must be taken out of service within 24 hours[15].

[10] Transmission Authority No. T01/98, section 6.2(c)
[11] The Rules Schedule 5.1.9(c)
[12] The Rules clause 5.10.2 ,Definitions, reliability corrective action
[13] Schedule 5.1a System Standards and 5.1.2 Network Reliability of the Rules, and Queensland Transmission Authority T01/98
[14] Clause S5.1.9(c) of the Rules requires that faults are automatically disconnected in accordance with clause S5.1.9 (e) or clause S5.1.9(f)
[15] AEMO Power System Operating Procedure SO_OP_3715 – *Power System Security Guidelines* (the Rules require AEMO to develop and publish Power System Operating Procedures pursuant to clause 4.10.1(b) of the Rules, which Powerlink must comply with per clause 4.10.2(b)).

It follows that the increasing likelihood of faults arising from the condition of ageing assets and their obsolescence compels Powerlink to undertake reliability corrective actions at Kamerunga Substation if it is to continue meeting the standards for reliability of supply and comply with the obligations for protection system availability, as set out in the Rules.

The State Planning Policy[16] also requires Powerlink design, locate and operate its substations to avoid adverse impacts on the community during and immediately following a 1 in 200 year flood event.

3.4 Description of asset obsolescence and risks

Kamerunga Substation consists of two 132/22kV power transformers and associated 132kV bays, four 132kV feeder bays, and associated secondary systems. It was established in 1976 with the two transformers being replaced in 1990 and 1996 respectively.

The majority of primary plant including circuit breakers, earth switches, disconnectors, bus bars and surge arrestors date back to the late 1970s, and present an increasing risk of failure with very few spares available and no manufacturers' support for repairs. The circuit breakers in both transformer bays are of particular concern given their age, condition and consequences of failure.

The circuit breakers in transformer bay 1 were manufactured in 1981 and installed on site in 1984. These circuit breakers have had increased failure rates due to frequent issues with the air compressors. The circuit breakers in transformer bay 2 have been in service since 1976 and are showing significant age related degradation resulting in slower clearance times and an increased risk of failure to operate. In both cases, these circuit breakers are no longer supported by their manufacturers.

The increasing risk to the reliability of the primary plant has the potential to directly impact supply, while the lack of spares and manufacturer support increases significantly the timeframe to rectify such failures and restore the network to a resilient state.

Furthermore, the absence of any dedicated circuit breakers on the Woree feeders means a trip to either of these results in maintenance crews having to be despatched to site to manually isolate the faulted line.

Due to the age of the site, there are inherent design issues. The switchyard was not designed to meet current electrical clearance distances, which is managed on site through temporary earthworks, and the control building at Kamerunga has only a single 125V DC supply, impacting the reliability and security of the secondary systems.

The majority of the secondary system equipment at Kamerunga Substation was installed over 20 years ago and is now at or reaching the end of its technical service life. The equipment is no longer supported by the respective manufacturers and spare parts are no longer available. Consequently, these secondary systems are maintained with an increasingly limited stock of spare parts and without manufacturer support for repairs.

The lack of manufacturer support and spare equipment, and the reliability of the ageing equipment are becoming an unacceptable risk to ongoing reliable supply of electricity to the local community. Additionally, most devices are located in corridor type panels that present space constraints and potential safety issues during maintenance activities.

Powerlink uses an asset health index rating to categorise at-risk secondary systems equipment, based upon the equipment functional failure rate (i.e. failure to operate as intended), the environmental condition where the assets are installed and the 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 Kamerunga is set out in Table 3.1.

[16] Queensland Government,Department of Infrastructure, Local Government and Planning – State Planning Policy – state interest guidelines, Natural hazards, risks and resilience, April 2016

Table 3.1: Summary of secondary-system health index scores at Kamerunga Substation

Bay	Construction year	Health index range (average)	Description
22kV Earthing Transformers	1990-2010	3.0-10.0 (7.7)	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
Transformer Bays	1990-2002	6.7 – 10 (8.7)	50% of equipment has a health index of 10, and is subject to increasing failure rates. Majority is obsolete, with insufficient spares to support ongoing operation. Remedial action required
Feeder Bays	1998 and 2006	4.9 – 8.6 (6.6)	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required
Metering Bays	1999-2014	3.3-8.2 (6.0)	Interface switches are obsolete. Equipment is located in constrained corridor panels. Remedial action required
Non-bay secondary systems(incl SCADA & OpsWAN)	1997-2005	6.8-10 (8.9)	Majority of equipment is obsolete, with insufficient spares to support ongoing operation. Remedial action required

Poor asset condition increases the risk of secondary system faults, while obsolescence increases the time needed by Powerlink to rectify the 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.

The Kamerunga Substation site is also susceptible to flooding events and was originally designed with insufficient drainage. The substation is located in low-lying terrain, in tropical North Queensland, which is subject to heavy rainfall and cyclonic events. Studies have shown that the substation would be inundated with 1.25 metres of water during a 1 in 100 year flood event and 1.6 metres for a 1 in 200 year event, resulting in extensive damage it its protection and control systems and loss of supply. The current risk of inundation at the substation also leaves Powerlink operating Kamerunga Substation outside the recommendations of the State Planning Policy guidelines[17].

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

4. Submissions received

There were no submissions received in response to the PSCR or the PADR that were open for consultation until the 21 December 2018 and 7 June 2019 respectively[18]. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

[17] Queensland Government, Department of Infrastructure, Local Government and Planning – State Planning Policy – state interest guidelines, Natural hazards, risks and resilience, April 2016
[18] Members of Powerlink's Non-network Engagement Stakeholder Register were also advised of the PSCR and PADR publications.

5. Credible options assessed in this RIT-T

Powerlink considered four credible network options to address the identified need for maintaining the reliability of supply at Kamerunga Substation, which are outlined in Table 5.1.

Table 5.1: Credible Options

Option	Description	Indicative capital cost ($million, 2018/19)	Indicative annual O&M costs ($million, 2018/19)
Base Option	Full secondary systems replacement with prefabricated building and partial AIS primary plant replacement on existing foundations and structures. Primary plant established at current flood level. Commission by October 2021 Replace Barron Gorge 132kV feeder circuit breakers. Commission by October 2024 Replace remaining AIS primary plant using new foundations and raised structures. Fit new foundations and raised structures to primary plant installed in 2021. All primary plant established to comply with 1 in 200 year flood level. Flood operable by October 2028. Commission by October 2028	26.70	0.20
Option 1	Single stage secondary system replacement. Single stage AIS primary plant replacement. Flood operable by October 2022. Commission by October 2022	23.20	0.19
Option 2	Single stage secondary system replacement. Single stage GIS primary plant replacement including additional switching functionality. Flood operable by October 2022. Commission by October 2022	24.63	0.08
Option 3	Single stage secondary system replacement. Single stage AIS primary plant replacement including additional switching functionality. Flood operable by October 2022. Commission by October 2022	23.75	0.12

All credible options address the risks arising from the condition of the ageing secondary systems and primary plant, as well as the risk of flood inundation, to allow Powerlink to meet its reliability of supply obligations under its Transmission Authority and the Electricity Act 1994 by the replacement of the deteriorated primary plant and secondary systems. Options 1, 2 and 3 address flood operability by 2022, while the Base Option results in the substation becoming flood operable by 2028. Both the Base Option and Option 1 retain the current switching capabilities in that they do not include circuit breakers (CBs) on the Woree feeders.

None of these options has been discussed by the Australian Energy Market Operator (AEMO) in its most recent National Transmission Network Development Plan (NTNDP).[19]

[19] 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. At the time of commencement of this RIT-T in September 2016, the 2016 NTNDP was the most recent published version.

Additional options that have been considered but not progressed, due to not being either economically or technically feasible, were identified in the PSCR.

Any recovered primary plant with a remaining technical service life will be retained as spares for the network.

5.1 Material inter-network impact

Powerlink does not consider that any of the credible options being considered will have a material inter-network impact, based on AEMO's screening criteria[20].

6. Materiality of Market Benefits

Powerlink does not consider the proposed works at Kamerunga Substation will provide any market benefits, due to the nature of the project.

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[21].

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

None of the replacement options will have an impact on wholesale market outcomes. The Australian Energy Regulator (AER) has recognised that if the proposed investment will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment[22]. Consequently, no market benefits have been estimated as part of this RIT-T.

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

7. General modelling approach adopted to assess net benefits

7.1 Analysis period

The RIT-T analysis has been undertaken over a 35-year period, from 2020 to 2054. A 35-year period takes into account the size and complexity of the primary plant and secondary systems.

As the replacement plant will have different residual values by 2054 under each option, terminal values have been calculated to offset these variations.

7.2 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 5.90%[23] 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%[24] and an upper bound discount rate of 8.33%.

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[20] 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.
[21] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* September 2017, version 2, page 13.
[22] AER, *Final Regulatory Investment Test for Transmission Application Guidelines,* September 2017, version 2, page 13.
[23] The indicative commercial discount rate is calculated on the assumption that a private investment in the electricity sector would hold an investment grade credit rating, a return on equity and a debt gearing ratio equal to an average firm on the Australian stock exchange.
[24] A discount rate of 3.47 per cent is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0 per cent and forecast inflation of 2.45 per cent that implies a real discount rate of 3.47 per cent. See AER, *Final Decision: Powerlink transmission determination 2017-2022* | *Attachment 3 – Rate of return*, April 2017, p 9.

7.3 Description of reasonable scenarios

The RIT-T analysis is required to incorporate different reasonable scenarios to estimate market benefits. The scenarios must be appropriate to the credible options under consideration.

The choice of reasonable scenarios must reflect any variables or parameters that[25]:

- are likely to affect the ranking of the credible options, where the identified need is reliability corrective action
- 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.

As all cash flows being discounted relate to regulated network costs and there are no material market benefits identified, Powerlink has applied weightings to the final NPV ranking that reflect that the low discount rate scenario is the most appropriate for the discounting of costs.

Full modelling parameters are outlined in Table 7.1

Table 7.1: Modelling Parameters

	High	Central	Low
Discount rate	8.33%	5.90%	3.47%
Weighted	0.33	0.33	0.33
Operational Risk	Operational risk costs due to absence of Woree circuit breakers modelled as follows: • Base Option and Option 1 – entire analysis period • Options 2 and 3 – until 2022		
Flood Risk	Flood risk recovery costs included in Base Option until 2028		

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

8.1 Net present values

Table 8.1 summaries the NPVs for each credible option under high, central and low discount rates scenarios.

Table 8.1 NPV ($m) for scenarios

Option	High	Central	Low
Base Option	-19.46	-21.93	-24.68
Option 1	-20.43	-22.14	-24.05
Option 2	-21.33	-21.52	-22.39
Option 3	-20.05	-21.46	-22.85

The Base Option is ranked first in NPV terms (i.e. least negative NPV) under the high discount rate, while Options 2 and 3 rank first under the low and central discount rate respectively. Option 3 is the most consistently high ranking option in that it ranks either first or second across all scenarios considered.

Table 8.2 shows more detail on the comparison of the NPVs under the weighted discount rate scenario.

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

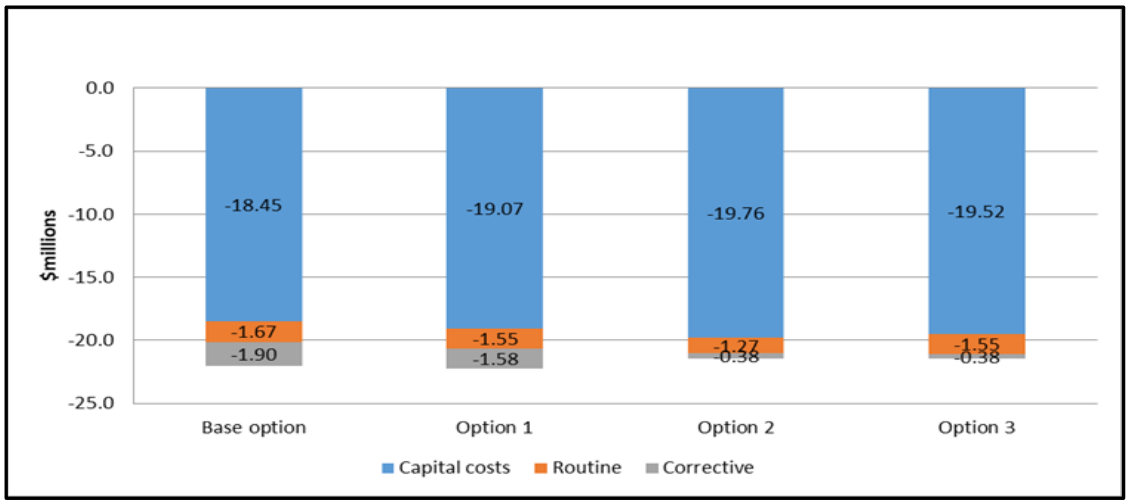
Table 8.2: Weighted NPV, NPV relative to Base Option ($m) and Ranking

Option	Weighted NPV ($m)	Weighted relative NPV ($m)	Ranking
Base Option	-22.03	-	3
Option 1	-22.21	-0.178	4
Option 2	-21.41	0.612	1
Option 3	-21.45	0.573	2

Under the weighted scenario, Option 2 is ranked first in NPV terms, followed closely by Option 3. The economic analysis shows only $0.04 million difference between the NPV of Options 2 and 3, which represents less than 0.2% of the capital expenditure estimates for these options, well within the expected margin of accuracy. Given this, Options 2 and 3 are considered equal as the highest ranking options under the weighted scenario.

Figure 9.1 provides a breakdown of capital and maintenance costs (i.e. routine and corrective maintenance) for the weighted scenario and highlights the similarity in NPV terms of Options 2 and 3.

Figure 8.1: Weighted NPV component for each credible option (NPV $m, 2018/19)



8.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a lower discount rate of 3.47% as well as a higher rate of 8.33%
- a 25% increase/decrease in capital costs using a central discount rate.

As illustrated in Figures 8.2 and 8.3, the sensitivity analysis for the NPV of the options relative to the Base Option shows that varying the discount rate and the capital cost impacts the ranking.

As shown previously in Table 8.1, Figure 8.2 identifies that Option 3 delivers the lowest net cost under central discount rates, while Option 2 and the Base Option deliver the lowest net cost under low and high discount rates respectively (with Option 3 ranked second in both these cases).

Figure 8.2 Sensitivity Analysis for Discount Rate

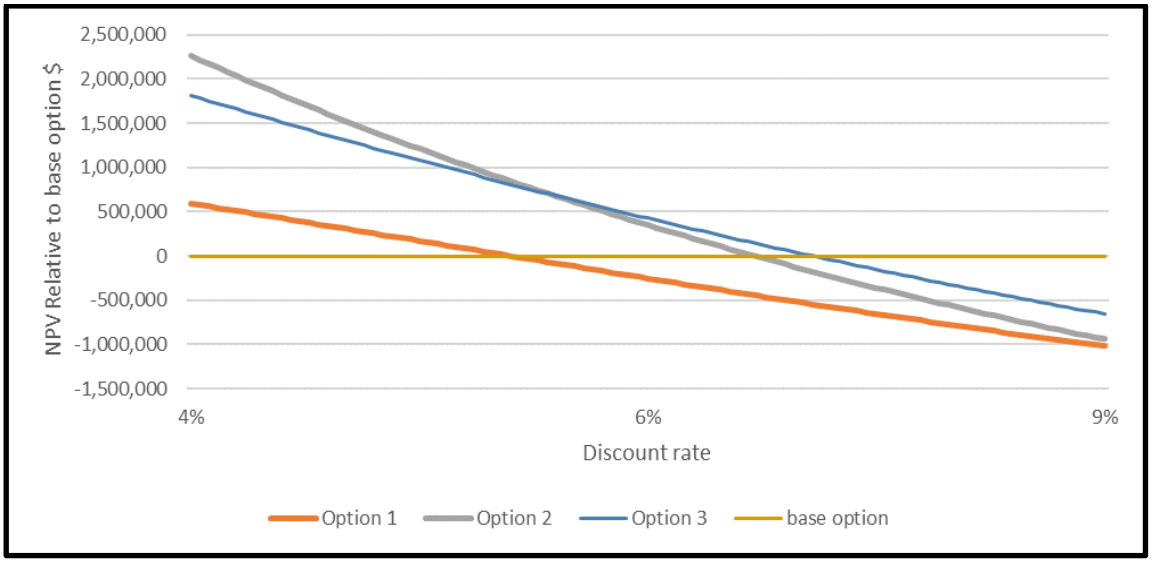
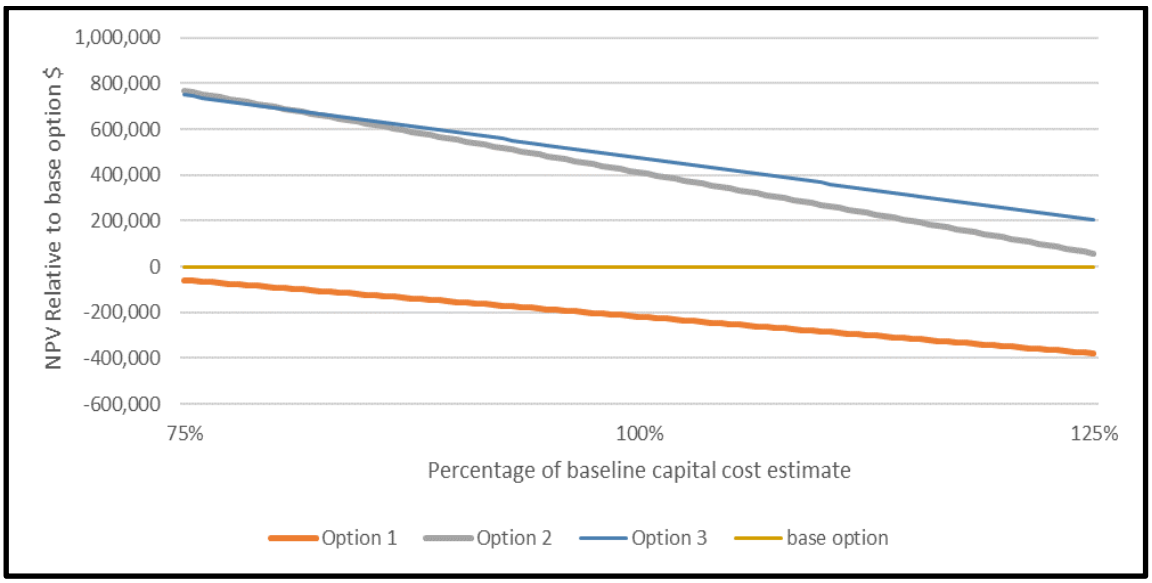


Figure 8.3 shows that varying the sensitivity of the options to capital costs results in Option 3 delivering the lowest net cost should the capital cost of the options vary between approximately 80% and 125%, while Option 2 is only marginally better than Option 3 if the capital costs are less than 80% of their estimated values.

Figure 8.3 Sensitivity Analysis for Capital Cost



9. Preferred option

Based on the conclusions drawn from the NPV analysis and the rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 3 be implemented to address the risks associated with the condition of the ageing infrastructure at Kamerunga Substation. Option 3 ranks first or second in all NPV scenarios, and when the sensitivity analysis for capital costs and discount rates is taken into account, making it the most consistent high ranking option.

Option 3:

- satisfies the RIT-T based on the cost benefit analysis (i.e. equal lowest cost in NPV terms under the weighted discount rate scenario with consideration of estimating accuracy, and lowest cost in NPV terms under the central discount rate)
- utilises existing technology within the Powerlink network, removing the need to acquire and store new spares, and to undertake additional training for personnel (compared to Option 2)
- addresses the risk to electricity supply from flood inundation in a single construction phase at the current Kamerunga Substation site by October 2022
- provides increased security of supply through the inclusion of circuit breakers on the Woree feeders.

Option 3 is therefore considered to satisfy the requirements of the RIT-T and is the preferred option.

10. Conclusions

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

- Powerlink has identified condition risks arising from the ageing primary plant and secondary systems equipment at Kamerunga Substation requiring action.
- TNSPs must maintain (including repair and replace if necessary) their transmission grid to ensure the adequate, economic, reliable and safe transmission of electricity, including the ability to meet peak demand if a major element of the network was to fail[26].
- S5.1.9(c) of the Rules requires a TNSP to provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.
- TNSPs must also ensure that all protection systems for lines at a voltage above 66kV are well maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of a protection system is being carried out.
- The increasing likelihood of faults associated with the condition of the ageing primary plant and secondary systems equipment at Kamerunga Substation compels Powerlink to undertake reliability corrective actions if it is to continue meeting the reliability standards set out in its Transmission Authority and the Rules.
- Studies were undertaken to evaluate four credible options; all four credible options were evaluated in accordance with the AER's RIT-T.
- Powerlink published a PSCR in September 2018 requesting submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options, which could address the condition risks at Kamerunga Substation.
- There were no submissions received in response to the PSCR, which was open for consultation until 21 December 2018.
- Similarly, Powerlink published a PADR in April 2019, which was open for consultation until 7 June 2019. There were no submissions received in response to the PADR.
- As a result of receiving no submissions to the PSCR or PADR, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.
- Option 3 satisfies the RIT-T based on the cost benefit analysis. Option 3 ranks first or second in all NPV scenarios and when the sensitivity analysis for capital costs and discount rates is taken into account, making it the most consistent high ranking option.

[26] Electricity Act 1994 (Queensland), Chapter 2, Part 4, S34(1)(a)

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

11. Final Recommendation

Based on the conclusions drawn from the NPV analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 3 be implemented to address the risks associated with the condition of the ageing infrastructure at Kamerunga Substation.

Option 3 involves replacing Kamerunga's current primary plant with new AIS equipment, installing additional circuit breakers for the Woree feeders and the full replacement of all secondary systems in a new building. All primary plant and secondary systems are to be located above the 1 in 200 year flood level.

The estimated capital cost is $23.75 million (2018/19 prices).

Powerlink is the proponent of the proposed network project.

Design and construction activities would be expected to commence in early 2020, with completion of the project in October 2022.

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