Powerlink Queensland

Project Assessment Conclusions Report

21 October 2019

Addressing the secondary systems condition risks at Kemmis

Document Purpose

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

1. The Rules require Powerlink to carry out forward planning to identify future reliability of supply requirements and consult with interested parties on the proposed solution as part of the Regulatory Investment Test for Transmission (RIT-T). This includes replacement of network assets in addition to augmentations of the transmission network.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. This document contains the results of this evaluation, and a final recommended solution to address the condition and obsolescence risks arising from the secondary systems at Kemmis Substation by June 2023.

Contents

Executive Summary

Kemmis Substation, located approximately 32km north west of Nebo, was established in 2002 to support the load growth arising from the expansion of mining in the northern Bowen Basin and to provide a bulk supply point for the regional distribution network owned by Ergon Energy (part of the Energy Queensland Group).

Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services provided by Kemmis Substation that support a diverse range of customer needs in the area.

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

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

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

Credible options considered

Powerlink has developed two credible network options to maintain the existing electricity services, ensuring an ongoing reliable, safe and cost effective supply to customers in the area. The major differences between the credible options relates to their capital costs and the timing of the replacement of the capacitor bank secondary systems.

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

Powerlink published a Project Specification Consultation Report (PSCR) in June 2019 to address the risks arising from the condition of the secondary systems at Kemmis Substation. No submissions were received in response to the PSCR that closed on 27 September 2019. As a result, no additional credible options have been identified as a part of this RIT-T consultation.

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

[1] The Rules clause 5.10.2, Definitions, reliability corrective action.

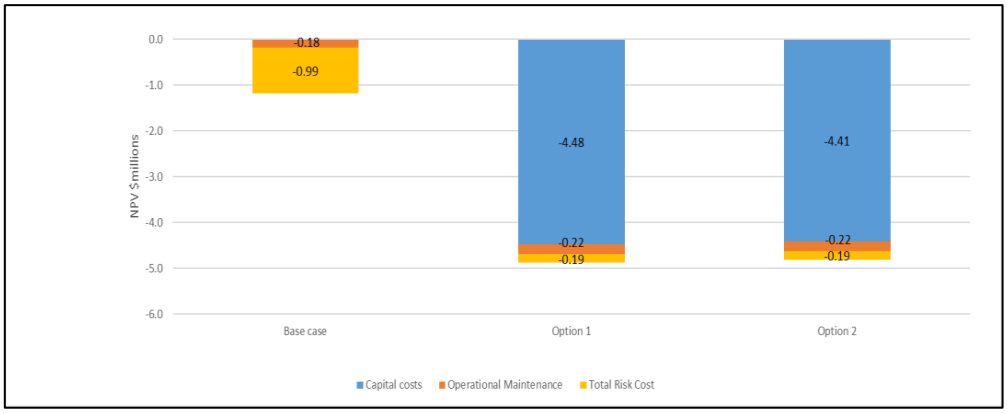
Table 1: Summary of credible network options

Option	Description	Total costs ($m) 2018/19	NPV relative to base case ($m) 2018/19	Ranking
1	Replacement of all secondary systems into a new building (excluding the capacitor bank secondary systems) by June 2023* Replacement of the capacitor bank secondary systems equipment by June 2028†	6.647* 0.494†	-3.710	**2**
2	Full replacement of all secondary systems into a new building by June 2023*	6.834*	-3.642	**1**

*RIT-T Project
†Future modelled projects

The absolute NPVs of the Base Case and the credible options are negative, shown graphically in Figure 1, with Option 2 being the least negative of the credible options. Both options significantly reduce the total risks arising from the condition of the ageing and obsolete secondary systems at Kemmis remaining in service. They also ensure ongoing compliance with Schedule 5.1 of the Rules and enable Powerlink to continue to meet the reliability and service standards specified within its Transmission Authority, as well as guidelines and standards published by the Australian Energy Market Operator (AEMO).

Figure 1: NPV of Base Case and Credible Network Options



Evaluation and Conclusion

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

In accordance with the expedited process for the RIT-T, the PSCR made a draft recommendation to implement Option 2, which involves the full replacement of all secondary systems at Kemmis, including the capacitor bank secondary system, by June 2023. The indicative capital cost of this option is $6.8 million in 2018/19 prices.

Under Option 2, design work will commence from mid-2020, and construction from 2021. Installation and commissioning of the new secondary system will be completed by June 2023. Powerlink is the proponent of the proposed network project.

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

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the RIT-T process[2] prescribed under the National Electricity Rules (the Rules) undertaken by Powerlink to address the condition risks arising from the secondary systems at Kemmis Substation. It follows the publication of the Project Specification Consultation Report (PSCR) in June 2019.

The Project Specification Consultation Report (PSCR):

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

Powerlink identified Option 2, involving the replacement all secondary systems at Kemmis, including the capacitor bank secondary system, by June 2023, as the preferred option to address the identified need. The indicative capital cost of this option is $6.8 million in 2018/19 prices.

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

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

There were no submissions received in response to the PSCR which closed for consultation on 27 September 2019. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. As the conditions for exemption are now satisfied, Powerlink has not issued a PADR for this RIT-T and is now publishing this PACR, which:

- describes the identified need and the credible options that Powerlink considers address the identified need

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

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

2. Customer and non-network engagement

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

2.1 Powerlink takes a proactive approach to engagement

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

2.2 Working collaboratively with Powerlink's Customer Panel

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

The Customer Panel is regularly advised on the publication of Powerlink's RIT-T documents and briefed quarterly on the status of current RIT-T consultations, as well as upcoming RIT-Ts. This provides an ongoing opportunity for the Customer Panel to ask questions and provide feedback to further inform RIT-Ts, and for Powerlink to better understand the views of customers when undertaking the RIT-T consultation process.

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

Powerlink utilises the TAPR as a primary vehicle to engage and understand broader consumer, customer and industry views on key topics as part of the annual Transmission Network Forum (TNF) and to inform its business network and non-network planning objectives. TNF participants encompass a diverse range of stakeholders including customers, landholders, environmental groups, Traditional Owners, government agencies, and industry bodies.

2.3.1 Maintaining reliability of supply at Kemmis

Powerlink identified in its TAPRs 2017 to 2019, an expectation that action would be required at Kemmis Substation to address the secondary systems condition risks and maintain reliability of supply to customers in the North transmission zone[4].

Powerlink advised members of its Non-network Engagement Stakeholder Register (NNESR) 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 Kemmis Substation. Powerlink also advised the Customer Panel of the upcoming RIT-T consultation for Kemmis Substation in December 2018.

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

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.

2.4 Powerlink applies a consistent approach to the RIT-T stakeholder engagement process

Powerlink undertakes a considered and consistent approach to ensure an appropriate level of stakeholder engagement is undertaken for each individual RIT-T. Please visit Powerlink's website for detailed information on the types of engagement activities that may be undertaken during the consultation process. These activities focus on enhancing the value and outcomes of the RIT-T process for customers, stakeholders and non-network providers. Powerlink welcomes feedback from all stakeholders to further improve the RIT-T stakeholder engagement process.

3. Identified need

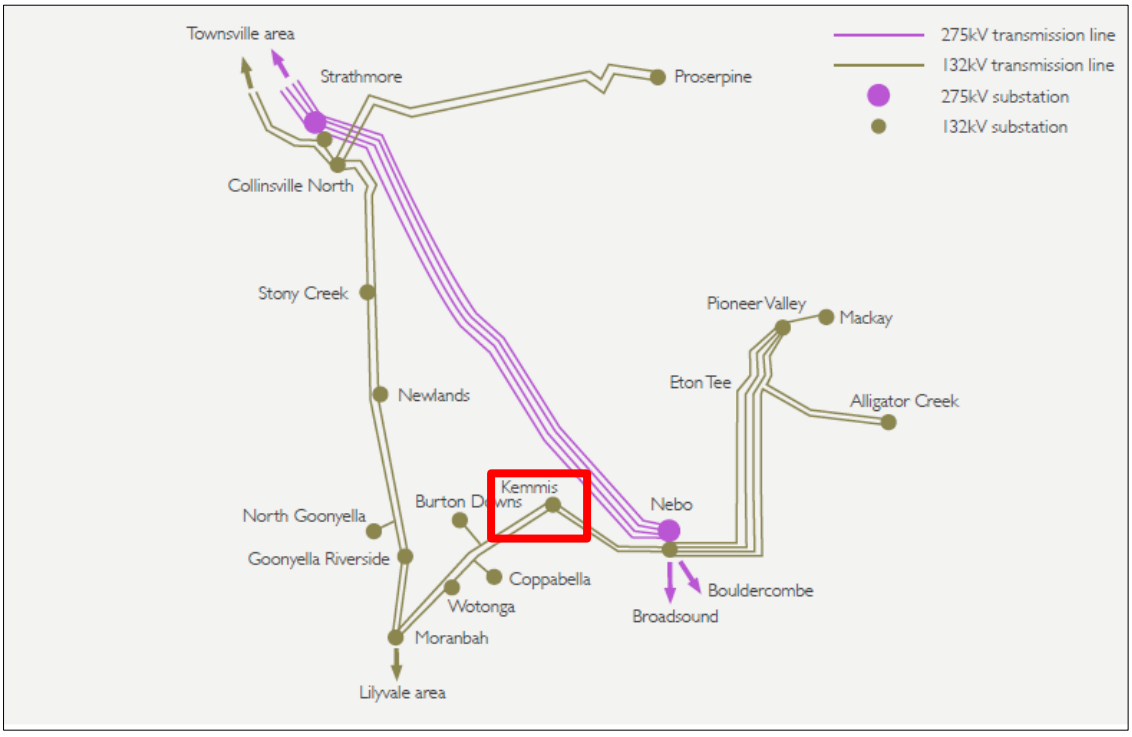
This section provides an overview of the existing arrangements at Kemmis Substation and describes the increasing risk to Powerlink of being unable to maintain compliance with relevant standards, applicable regulatory instruments and the Rules, which are designed to ensure Powerlink's customers continue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

3.1 Geographical and network need

Kemmis Substation, located approximately 32km north west of Nebo, was established in 2002 to support the load growth arising from the expansion of mining in the northern Bowen Basin and to provide a bulk supply point for the regional distribution network owned by Ergon Energy.

Planning studies have confirmed there is an enduring need for the supply of bulk electricity to the Northern Bowen Basin. The North zone transmission network is shown in Figure 3.1.

Figure 3.1: North zone transmission network



3.2 Description of identified need

With peak demand in the Northern Bowen Basin area forecast to remain at current levels[5], it is vital that electricity supply be maintained to address these demands and for Powerlink to meet its reliability of supply and service standard obligations under its Transmission Authority and Schedule 5.1 of the Rules.

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

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

Planning studies have confirmed that in order to continue to meet the reliability standard within Powerlink's Transmission Authority, the services currently provided by Kemmis 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[7]. Powerlink's condition assessment of the secondary systems at Kemmis Substation indicates that most are reaching the end of their technical service lives, are no longer supported by the manufacturer, and have limited spares available. Increasing failure rates, along with the increased time to rectify the faults due to equipment obsolescence, significantly affects the availability and reliability of these systems.

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

As the identified need of the proposed investment is to meet reliability and service standards specified within Powerlink's Transmission Authority and guidelines and standards published by the Australian Energy Market Operator (AEMO), and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules[8], it is classified as a 'reliability corrective action'[9].

A reliability corrective action differs from that of an increase in producer and consumer surplus (market benefit) driven need in that the preferred option may have a negative net economic outcome as it is required to meet an externally imposed obligation on the network business.

3.2.1 Assumptions and requirements underpinning the identified need

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

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

[5] Powerlink Transmission Annual Planning Report 2019
[6] Transmission Authority No. T01/98, section 6.2(c)
[7] The Rules Schedule 5.1.9(c)
[8] Specifically the protection requirements of Schedule 5.1.9 of the Rules
[9] The Rules clause 5.10.2, Definitions, reliability corrective action.

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

> *"Provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any fault type anywhere on its transmission system or distribution system is automatically disconnected"[10].*

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

> *"all protection systems for lines at a voltage above 66 kV, including associated intertripping, are well maintained so as to be available at all times other than for short periods (not greater than eight hours) while the maintenance of a protection system is being carried out"[11].*

As required by the Rules[12], AEMO has published the Power System Security Guidelines (PSS Guidelines) to clarify the Rules regarding unplanned outages of the protection systems. In the event of an unplanned outage of a secondary system, the PSS Guidelines require that the primary network assets be taken out of service if the fault cannot be rectified within 24 hours[13]. Both the Rules and the PSS Guidelines indicate that exceeding 24 hours to rectify a protection fault is not good practice, obligating Powerlink to take action to ensure the restoration period of unplanned outages of secondary systems does not reasonably exceed 24 hours.

Similar to protection requirements, AEMO's Power System Data Communication Standard specifies that the total period of critical outages over a 12 month period must not exceed 24 hours for remote control and monitoring functions[14]. This relates to both the reliability of the equipment (i.e. how often the device fails) and the repair time. It follows that the repair time for any single fault on this equipment must not exceed 24 hours if there are no other faults during the 12 month period.

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

Analysis has shown that operating a secondary system beyond 20 years of effective age significantly impacts its ability to perform within acceptable limits[15]. Delaying replacement of secondary system assets beyond this optimal 20 year timeframe places the network at risk due to the limited supply of suitable spares, which prolongs the duration of any emergency corrective maintenance associated with replacing failed components beyond the 24 hour limit. In the case of protection systems, extended outages beyond 24 hours will result in the need to switch out network assets, placing the supply of electricity to customers at risk[16].

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

3.3 Description of asset condition and risks

Powerlink has undertaken a comprehensive condition assessment of the secondary systems at Kemmis Substation using an asset health index modelled from zero to ten, where zero represents new assets and ten indicates that the asset requires urgent action to address the increasing risk of unavailability and unreliable operation. This has identified that a significant

[10] The Rules clause S5.1.9(c)
[11] The Rules clause S5.1.2.1 (d)
[12] The Rules clause 4.11.2 (c)
[13] AEMO, Power System Operating Procedure SO_OP_3715, Power System Security Guidelines, V94, 23 April 2019 (the Rules require AEMO to develop and publish Power System Operating Procedures pursuant to clause 4.10.1(b) of the Rules, which Powerlink must comply with per clause 4.10.2(b)).
[14] AEMO, Power System Data Communication Standard, Section 3 Reliability and Section 6 Maintenance. (This standard has been made by AEMO under clause 4.11.2(c) of the Rules and incorporates the standards and protocols referred to in clause 4.11.1)
[15] Cigre, Study Committee B3, Paper B3_205_2018, "Modelling Substation Control and Protection Asset Condition for Optimal Reinvestment Decision Based on Risk, Cost and Performance" by T. Vu, M. Pelevin, D. Gibbs, J. Horan, C. Zhang (Powerlink Queensland)
[16] AEMO, Power System Operating Procedure SO_OP_3715, Power System Security Guidelines, V94, 23 April 2019

amount of secondary system equipment at Kemmis is reaching the end of its technical service life.

The condition of the at-risk secondary systems at Kemmis Substation is summarised in Table 3.1.

Table 3.1: Kemmis at-risk secondary systems

Bay	Construction year	Health index range (average)
2x Feeder Bays Protection and Control	2002 - 2016	2.1 – 8.3 (6.9)
2x Transformer Bays Protection and Control	2003 - 2005	5.3 – 8.2 (7.3)
1x Capacitor Bay Protection and Control	2010	4.2 – 6.0 (4.7)
1x Bus Coupler Protection	2002 - 2003	8.0 - 8.2 (8.1)
2x Transformers Metering Equipment	1999-2002	8.4 – 10.0 (8.6)
Non-bay secondary systems (includes OpsWAN, SCADA, fire protection, AC board, DC battery systems	2002-2015	5.1 – 10. 0 (8.2)

Most of the secondary systems at Kemmis were installed in 2002 or 2003 as part of the original installation, except for those associated with the capacitor bank installation, which occurred in 2010. There have also been a number of selective secondary system component installations in later years due to capital works at remote substation ends, or the replacement of failed components, thereby reducing the average health index, meaning the majority of equipment has a health index higher than the average given in Table 3.1.

The impact of equipment obsolescence is an important consideration when determining if remedial action is required. Currently, over 65% of the secondary systems equipment (excluding those associated with the capacitor bank) is obsolete. This is expected to increase to an unsupportable level beyond June 2023.

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

3.4 Consequences of failure in an obsolete system

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

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

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

Given the specific nature of the Rules' obligations and the AEMO requirements relating to protection, control and monitoring systems, accepted good industry practice is often to replace the current ageing and obsolete secondary systems when they reach the end of their technical service lives, rather than letting them run to failure. Due to the condition and obsolescence issues with the secondary systems at Kemmis, there is a significant risk of breaching the mandated obligations and requirements if the secondary systems (excluding those associated with the capacitor bank) are left to operate beyond June 2023.

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

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

Equipment	Condition/Issue	Potential consequence of failure
Protection and Control for High Voltage Bay	• Obsolescence and limited availability of spares; no longer supported by the manufacturer • Increasing failure rates due to ageing electronic components	• Failure to operate or slow clearance resulting in Rules violation, plant damage, safety and supply risks • Prolonged outages of equipment placing load at risk and resulting in less reliable supply to customers • Unable to comply with Power System Data Communication Standard • Unable to comply with the Power System Security Guidelines • Increased failures resulting in less reliable supply to customers
Metering Equipment	• Obsolescence and limited availability of spares; no longer supported by the manufacturer • Increasing failure rates due to ageing electronic component	• Unable to restore metering installation upon malfunction within the 2 business day requirement of the Rules[17]
SCADA System	• Obsolescence and limited availability of spares; no longer supported by the manufacturer • Increasing failure rates due to ageing electronic components	• Unable to comply with Power System Data Communication Standard • Increased failures resulting in less reliable supply to customers

3.4.1 Fleet-wide implications of obsolescence

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

[17] The Rules, clause 7.8.10 Metering installation malfunctions

4. Submissions received

There were no submissions received in response to the PSCR that was open for consultation until the 27 September 2019[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.

5. Credible options assessed in this RIT-T

Powerlink has developed two credible network options to address the secondary system condition risks and compliance obligations at Kemmis Substation:

- Option 1: Two staged replacement of the secondary systems by June 2023 and June 2028.
- Option 2: Single stage replacement of the secondary systems by June 2023.

A summary of these options is given in Table 5.1.

Table 5.1: Summary of credible options

Option	Description	Indicative project costs ($m, 2018/19)	Indicative annual average O&M costs ($m, 2018/19)
1	Replacement of all secondary systems into a new building (excluding capacitor bank secondary systems) by June 2023*	6.647*	0.033
	Replacement of capacitor bank secondary systems equipment by June 2028†	0.494*	
2	Full replacement of all secondary systems into a new building by June 2023*	6.834*	0.032

*Proposed RIT-T project
†Modelled capital project

All credible options address the major risks resulting from the deteriorating condition of ageing and obsolete secondary systems at Kemmis Substation and allow Powerlink to continue to maintain compliance with its Transmission Authority, AEMO Standards and Schedule 5.1 of the Rules, by the replacement of the deteriorated protection systems and associated equipment.

Option 1 seeks to optimise the technical service life of existing secondary systems, by delaying the replacement of the capacitor bank secondary systems, while Option 2 seeks to minimise mobilisation costs and outages, by replacing all secondary systems in one stage. None of these options has been discussed by AEMO in its most recent National Transmission Network Development Plan (NTNDP)[19].

5.1 Option 1: Two stage replacement of secondary systems by June 2028

This option involves replacing the secondary systems at Kemmis Substation, excluding the secondary systems associated with the capacitor bank, by June 2023. The capacitor bank secondary systems are replaced in a second stage by June 2028.

Powerlink is the proponent of this option.

[18] Members of Powerlink's Non-network Engagement Stakeholder Register were also advised of the PSCR publication.
[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. The 2018 NTNDP is the most recent NTNDP.

Table 5.2: Main project components for the Option 1

Option 1	Description	Indicative cost ($million, 2018/19)
RIT - Project		
Replacement of all secondary systems (excluding capacitor bank secondary systems) by June 2023	Replacement of the following protection, control and monitoring systems in a new building: • 2x feeder bays • 2x transformer bays • 1x bus coupler bay • All metering equipment • All non-bay equipment	6.647
Modelled Capital Project		
Replacement of capacitor bank secondary systems by 2028	Replacement of the following protection, control and monitoring systems in an existing building: • 1x capacitor bank bay	0.494
TOTAL		**7.141**

5.2 Option 2: Single stage replacement secondary systems by June 2023

Option 2 involves replacing all secondary systems at Kemmis Substation, including the capacitor bank secondary systems, by June 2023.

Powerlink is the proponent of this option.

Table 5.3: Main project components for Option 2

Option 2	Description	Indicative cost ($million, 2018/19)
RIT - Project		
Full replacement of all secondary systems by June 2023	Replacement of the following protection, control and monitoring systems in a new building: • 2x feeder bays • 2x transformer bays • 1x bus coupler bay • 1x capacitor bank bay • All metering equipment • All non-bay equipment	6.834
TOTAL		**6.834**

5.3 Material inter-network impact

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

[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.

6. Materiality of Market Benefits

The rules require that all categories of market benefits identified in relation to a RIT-T be quantified, unless the TNSP can demonstrate that a specific category is unlikely to be material.

6.1 Market benefits that are material for this RIT-T assessment

Powerlink considers that changes in involuntary load shedding (i.e. the reduction in expected unserved energy) between options and the Base Case, set out in this PACR, may impact the ranking of the credible options under consideration, or the relativity of the credible options to the Base Case, and that this class of market benefit could be material. These benefits have been quantified and included within the cost benefit and risk cost analysis as network risk.

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

The AER has recognised a number of classes of market benefits may not be material in the RIT-T assessment and so do not need to be estimated[21]. Other than market benefits associated with involuntary load shedding, Powerlink does not consider any other category of market benefits to be material, and had not estimated them as part of this RIT-T.

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

7. Base Case

7.1 Modelling a Base Case under the RIT-T

Consistent with the RIT-T Application Guidelines the assessment undertaken in this PACR[22] compares the costs and benefits of credible options to address the risks arising from an identified need, with a Base Case[23].

As characterised in the RIT-T Application Guidelines, the Base Case itself is not a credible option to meet the identified need. Specifically, the Base Case reflects a state of the world in which the condition and obsolescence issues arising from the ageing assets are only addressed through standard operational activities, with escalating safety, financial, environmental and network risks.

To develop the Base Case, the existing condition and obsolescence issues are managed by undertaking operational maintenance only, which results in an increase in risk levels as the condition and availability of the asset deteriorates over time. These increasing risk levels are assigned a monetary value that is used to evaluate the credible options designed to offset or mitigate these risk costs.

The Base Case for Kemmis secondary systems therefore includes the costs of work associated with operational maintenance and the risk costs associated with the failure of the assets. The costs associated with equipment failures are modelled in the risk cost analysis and are not included in the operational maintenance costs. The Base Case provides a clear reference point in the cost-benefit analysis to compare and rank the credible options against, other over the same timeframe.

[21] AER, Application guidelines, Regulatory investment test for transmission, December 2018.
[22] The economic assessment as also presented in the PSCR.
[23] AER, Application Guidelines, Regulatory Investment Test for Transmission, December 2018.

7.2 Kemmis Base Case risk costs

Powerlink has developed a risk modelling methodology consistent with the RIT-T Application Guidelines and the AER Industry practice application note for asset replacement planning[24]. A document giving an overview of the methodology is available on Powerlink's website[25] and the principles of the methodology have been used to calculate the risk costs of the Kemmis Base Case. The document includes the modelling methodology and general assumptions underpinning the analysis.

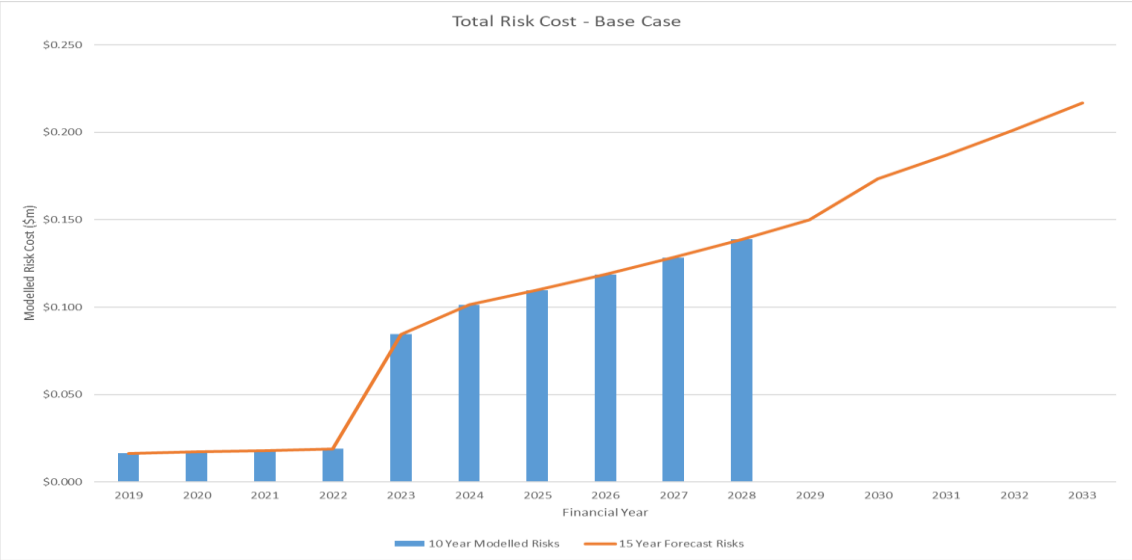
7.3 Base Case assumptions

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

- spares for secondary system items have been assumed to be available prior to the point of expected spares depletion, as after this point, the cost and time to return the secondary system back to service increases significantly
- historical load profiles have been used when assessing the likelihood of unserved energy under concurrent failure events
- peak demand for the greater Kemmis load area consistent with medium demand forecasts published within Powerlink's 2018 Transmission Annual Planning Report have been used[26]
- unserved energy generally accrues under concurrent failure events, and consideration has been given to potential feeder trip events within the wider area
- the network risk cost models have used the Queensland regional VCR published within AEMO 2014 Value of Customer Reliability Review Final Report ($39,710/MWh).

The 15 year forecast of risk costs for the Base Case is shown in Figure 7.1.

Figure 7.1: Modelled Base Case risk costs



Based upon the assessed condition of the ageing secondary systems at Kemmis, the total risk costs are projected to increase from $0.016 million in 2019 to $0.217 million in 2033. The main areas of risk cost are network risks that involve reliability of supply through the failure of deteriorated secondary systems modelled as probability weighted unserved energy[27], and financial risk costs associated mostly with the replacement of failed assets in an emergency.

[24] AER Industry practice application note, Asset Replacement Planning, January 2019.
[25] The risk costs are calculated using the principles set out in the Powerlink document, Overview of Asset Risk Cost Methodology, May 2019.
[26] This forecast remains unchanged in the 2019 TAPR.
[27] Unserved Energy is modelled using a Value of Customer Reliability (VCR) consistent with that published by AEMO in their *Value of Customer Reliability Review, Final Report*, September 2014.

These risks increase over time as the condition of equipment further deteriorates, more equipment becomes obsolete and the likelihood of failure rises.

7.4 Modelling of Risk in Options

Each option is scoped to mitigate the major risks arising in the Base Case and to maintain compliance with all statutory requirements, the Rules and AEMO standards. The residual risk is calculated for each option based upon the individual implementation strategy of the option. This is included with the capital and operational maintenance cost of each option to develop the NPV inputs.

8. General modelling approach adopted to assess net benefits

8.1 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 and complexity of the secondary system replacement options. There will be remaining asset life by 2033, at which point a terminal value is calculated to correctly account for capital costs under each credible option.

8.2 Discount rate

Under the RIT-T, a commercial discount rate is applied to calculate the NPV of the costs and benefits of credible options. Powerlink has adopted a real, pre-tax commercial discount rate of 5.90%[28] 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%[29] and an upper bound discount rate of 8.33% (i.e. a symmetrical upwards adjustment).

8.3 Description of reasonable scenarios

The RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration. The choice of reasonable scenarios must reflect any variables or parameters that are likely to affect the ranking of the credible options, where the identified need is reliability corrective action[30].

Powerlink has considered capital costs and discount rate sensitivities individually and in combination and found that these variables do not affect the relative rankings of the credible options or the identification of the preferred option. As sensitivities (both individually and in combination) do not affect ranking results, Powerlink has elected to present the one central scenario in Table 8.1.

Table 8.1: Reasonable scenario assumed

Key variable/parameter	Central scenario
Capital costs	100% of central capital cost estimate
Discount rate	5.90%

[28] 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.
[29] A discount rate of 3.47% is based on the AER's Final Decision for Powerlink's 2017-2022 transmission determination, which allowed a nominal vanilla WACC of 6.0% and forecast inflation of 2.45% that implies a real discount rate of 3.47%. See AER, Final Decision: Powerlink transmission determination 2017-2022 | Attachment 3 – Rate of return, April 2017, p 9.
[30] AER, Final Regulatory Investment Test for Transmission, June 2010, version 1, paragraph 16, p. 7

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

9.1 NPV Analysis

Table 9.1 outlines the NPV and the corresponding ranking of each credible option relative to the Base Case.

Table 9.1: NPV of credible options relative to base case ($m, 2018/19)

Option	Central Scenario NPV relative to Base Case ($m)	Ranking
Option 1 Replacement of all secondary systems (excluding the capacitor bank secondary systems) into a new building by June 2023 Replacement of the capacitor bank secondary systems by June 2028	-3.710	2
Option 2 Full replacement of all secondary systems into a new building by June 2023	-3.642	1

Both credible options will address the identified need on an enduring basis. Option 2 is ranked first, with Option 1 being $0.068 million more expensive compared to Option 2 in NPV terms. Figure 9.1 sets out the breakdown of capital cost, operational maintenance cost and total risk cost for each option in NPV terms under the central scenario. Note that the non-credible Base Case consists of operational maintenance and total risk costs and does not include any capital expenditure.

Figure 9.1: NPV of the Base Case and each credible option (NPV $m, 2018/19)

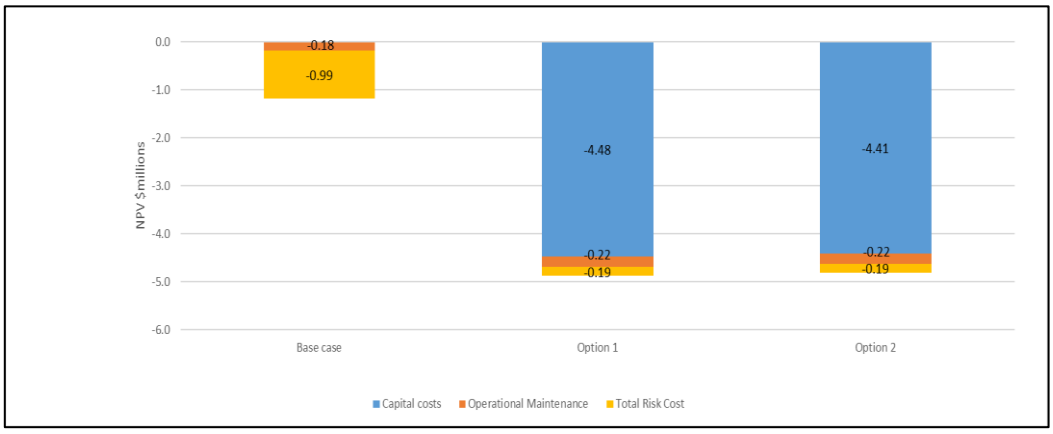


Figure 9.1 illustrates that both credible options will reduce the total risk cost compared to the Base Case. Due to the lower capital cost component, Option 2 results in a marginally less negative NPV than Option 1. The credible options show a slight increase in operational maintenance costs when compared to the Base Case due to the maintenance requirements of the additional building required in both options to house the new secondary systems equipment.

9.2 Sensitivity analysis

Powerlink has investigated the following sensitivities on key assumptions:

- a range from 3.47% to 8.33% discount rate
- a range from 75% to 125% of base capital expenditure estimates.
- a range from 75% to 125% of base maintenance expenditure estimates.

- a range from 75% to 125% of base total risk cost estimates.

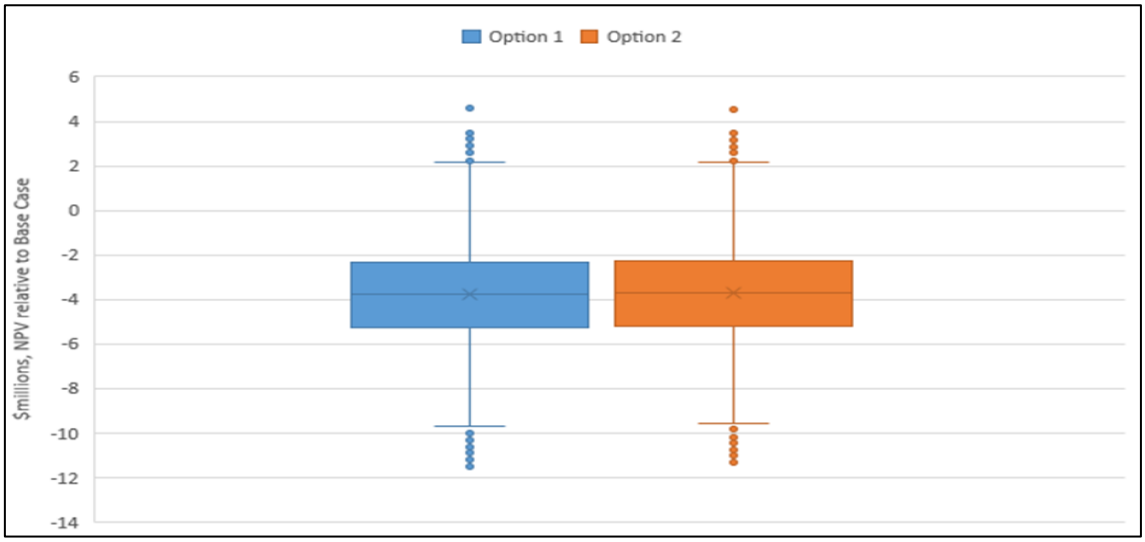
Sensitivity analysis for the NPV relative to the Base Case shows that varying the discount rate, capital expenditure, operational maintenance expenditure and total risk costs has no impact on the preferred option.

9.3 Sensitivity to multiple parameters

A Monte Carlo simulation was performed with multiple input parameters (including capital cost, discount rate, operational maintenance cost and total risk cost) generated for the calculation of the NPV for each option. This process is repeated over 5000 iterations, each time using a different set of random variables from the probability function. The sensitivity analysis output is presented as a distribution of possible NPVs for each option, as illustrated in Figure 9.2.

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

Figure 9.2 NPV sensitivity analysis of multiple key assumptions relative to the Base Case



10. Preferred option

Based on the conclusions drawn from the economic analysis and the Rules requirements relating to the proposed replacement of transmission network assets, it is recommended that Option 2 be implemented to address the risks arising from the deteriorated condition of the aged and obsolete secondary systems infrastructure at Kemmis Substation. Implementing this option will also ensure ongoing compliance with relevant standards, applicable regulatory instruments and the Rules.

The result of the cost benefit analysis indicates that Option 2 is the credible option with the lowest cost to customers, in NPV terms, over the 15 year analysis period. Sensitivity testing shows the analysis is robust to variations in the capital cost, operational maintenance cost, risk cost and discount rate assumptions.

Option 2 is therefore considered to satisfy the requirement of the RIT-T and is the preferred option.

11. Conclusions

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

- Powerlink has identified condition risks arising from the ageing and obsolete secondary systems equipment at Kemmis Substation as requiring action.
- S5.1.9(c) of the Rules requires a TNSP to provide sufficient primary protection systems and back-up protection systems (including breaker fail protection systems) to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.
- TNSPs must also ensure that all protection systems for lines at a voltage above 66kV are well maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of a protection system is being carried out.
- The increasing likelihood of faults arising from the condition of the ageing secondary systems and their obsolescence compels Powerlink to undertake reliability corrective action at Kemmis Substation if it is to continue meeting the reliability standards set out in its Transmission Authority and to ensure ongoing compliance with the Rules' standards for protection system availability and avoid the impacts of taking primary systems out of service.
- Studies were undertaken to evaluate two credible options. Both credible options were evaluated in accordance with the AER's RIT-T.
- Powerlink published a PSCR in June 2019 requesting submissions from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options, which could address the secondary systems condition risks at Kemmis Substation.
- The PSCR also identified the preferred option and that Powerlink was adopting the expedited process for this RIT-T, claiming exemption from producing a PADR as allowed for under the Rules Clause 5.16.4(z1) for investments of this nature.
- There were no submissions received in response to the PSCR, which was open for consultation until 27 September 2019. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation. The conditions specified under the Rules for exemption have now been fulfilled.
- The result of the cost-benefit analysis under the RIT-T identified that Option 2 is the least cost solution over the 15 year analysis period. Sensitivity testing showed the analysis is robust to variations in discount rate, capital expenditure, operational maintenance expenditure and risk costs assumptions. As a result, Option 2 is considered to satisfy the RIT-T.
- The outcomes of the economic analysis contained in this PACR remain unchanged from those published in the PSCR. Consequently, the draft recommendation has been adopted without change as the final recommendation and will now be implemented.

12. Final Recommendation

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

Option 2 involves the full replacement of the Kemmis secondary systems, including the capacitor bank secondary systems, in a new demountable building at an indicative capital cost of $6.8 million in 2018/2019 prices. Design and procurement activities will commence in 2020, followed by construction commencing in 2021, and works to be completed by June 2023.

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

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