Powerlink Queensland

Project Assessment Conclusions Report

19 September 2023

Managing voltages in South East Queensland

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[1] 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 and providing for power system security services such as system strength and inertia. More information on the RIT-T process and how it is applied to ensure that safe, reliable and cost effective solutions are implemented to deliver better outcomes to customers is available on Powerlink's website.
2. Powerlink must identify, evaluate and compare network and non-network options (including, but not limited to, generation and demand side management) to identify the '*preferred option*' which can address future network requirements at the lowest net cost to electricity consumers. This assessment compares the net present value (NPV) of all credible options to identify the option that provides the greatest economic benefits to the market.
3. The document contains the results of this evaluation, and a final recommended solution to address the projected shortfalls in reactive power absorption capability in the South East Queensland (SEQ) area.

[1] Such requirements include, but are not limited to:

- addressing any emerging reliability of supply issues or relevant *ISP actionable projects* identified in the Australian Energy Market Operator's (AEMO) latest Integrated System Plan; and
- providing the services required to meet the system strength and inertia requirements and/or declared shortfalls identified in AEMO's latest System Strength and Inertia Reports for which Powerlink has responsibility as the relevant Transmission Network Service Provider and System Strength and Inertia Service Provider in Queensland.

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Executive Summary

Declining minimum flows and an increasing capacitive contribution from more energy efficient appliances and roof top solar systems in the South East Queensland (SEQ) area are increasing the likelihood of non-compliant over-voltage events. The current strategy of switching out selected feeders to ensure ongoing compliance with the National Electricity Rules (Rules) "voltage of supply at a connection point"[2] requirements is at the limit of its technical effectiveness. Continued reliance on increasingly onerous reconfigurations of the network will result in higher market costs.

Powerlink must therefore take action to avoid the increasing likelihood of unserved energy and the emerging risks arising from the projected shortfalls in reactive power absorption capability in the SEQ area. 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'[3].

On 17 December 2021, AEMO declared an immediate Network Support and Control Ancillary Services (NSCAS) gap in southern Queensland. Powerlink issued an Expression of Interest (EOI) on 19 May 2022 requesting additional system security services to address this gap in the short-term prior to the implementation of any recommendations from the Regulatory Investment Test for Transmission (RIT-T) process.

The Managing voltages in South East Queensland RIT-T addresses the longer-term solutions that can be delivered to ensure compliance with voltage management obligations going forward, while minimising costs incurred from addressing the identified need. This RIT-T has taken into consideration the risks and uncertainties in the external environment in which Powerlink operates through the development of appropriate scenarios.

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 emerging risks arising from the projected shortfalls in reactive power absorption capability in the SEQ area. 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 maximises the present value of net economic benefits is recommended as the preferred option.

Developments since publication of the Project Assessment Draft Report (PADR)

Since publication of the PADR in October 2022, Powerlink completed its assessment in relation to the EOI to address the immediate NSCAS gap in southern Queensland. In December 2022, Powerlink published the findings and outcome of the EOI process in the 'Request for power system security services in central, southern and broader Queensland regions – Final Report Part 1: NSCAS'. As a result, Powerlink entered into in a Network Support Agreement with CleanCo Queensland (CleanCo) to provide the necessary NSCAS through utilising its assets in southern Queensland to operate during times of reactive power shortfall. These services became available from January 2023 to fulfil Powerlink's regulatory obligations under the Rules[4].

In December 2022, AEMO published the 2022 NSCAS Report, confirming the declared gap of 120MVAr reactive power absorption, stating Powerlink was finalising the near-term solution and that newly committed and anticipated generation and storage projects, together with the outcome of this RIT-T, are expected to improve power system voltage control in southern Queensland. Given this, AEMO has not declared a gap at the end of the five-year NSCAS assessment period, noting the NSCAS gap may re-assessed in 2023 as more information becomes available about uncertainties, such as the impact of synchronous generation dispatch and system strength services.

Credible options considered

Powerlink has developed three credible network options under three scenarios for future market-led Battery Energy Storage System (BESS) development, to maintain the existing electricity services, ensuring a reliable, safe and cost effective supply to customers in the area. The major difference between the credible options relates to whether to rely on network support services for reactive power

[2] National Electricity Rules, Version 200, 30 May 2023, Schedule 5.1a.4 Power frequency voltage.
[3] The Rules clause 5.10.2, Definitions, reliability corrective action.
[4] The Rules clauses 3.11.1(c)(2)(i) and (ii).

absorption from either the NSCAS gap network support arrangements and/or BESS units, investment in additional 120MVAr bus reactors in Powerlink's transmission network, or installing 30MVAr bus reactors in Energex's distribution network.

By addressing the reactive power absorption capability in the SEQ area, all 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 PADR in October 2022 to address the reactive power absorption capability in the SEQ area. In addition to CleanCo's submission to the Project Specification Consultation Report (PSCR), two submissions were received in response to the PADR that closed on 9 December 2022. The submissions proposed network support through BESS arrangements that have been captured in the envelope of BESS network support services identified in the PADR. As result, no additional credible options have been identified as a part of this RIT-T consultation.

Taking into consideration the outcome of the EOI process and submissions received, three credible network options, along with their net present values (NPVs) relative to the Base Case are summarised in Table 1. All options have been further refined from those proposed in the PADR, to reflect the network support services available from CleanCo and as a result of the NSCAS gap network support agreement. The absolute NPVs of the Base Case and the Options are shown graphically in Figure 1. Of the three credible network options, Option 1 has the highest NPV relative to the base case.

Table 1: Summary of credible network options ($m, real 22/23)

Option	BESS Development Scenario	Description	NSP Cost ($m)	NPV relative to Base Case (weighted $m)	Rank
1	120MVAr Belmont reactor, NSA with CleanCo and subsequent NSA				
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 to 2029/30	13.3*		
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2028/29, then 2029/30	13.3*	-10.5	1
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2029/30	13.3*		
2	120MVAr Belmont reactor, NSA with CleanCo and additional TNSP 120MVAr reactors				
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2024/25 then 2028/29	39.8*		
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2027/28 then 2029/30	39.8*	-30.7	2
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactor 2029/30	26.5*		

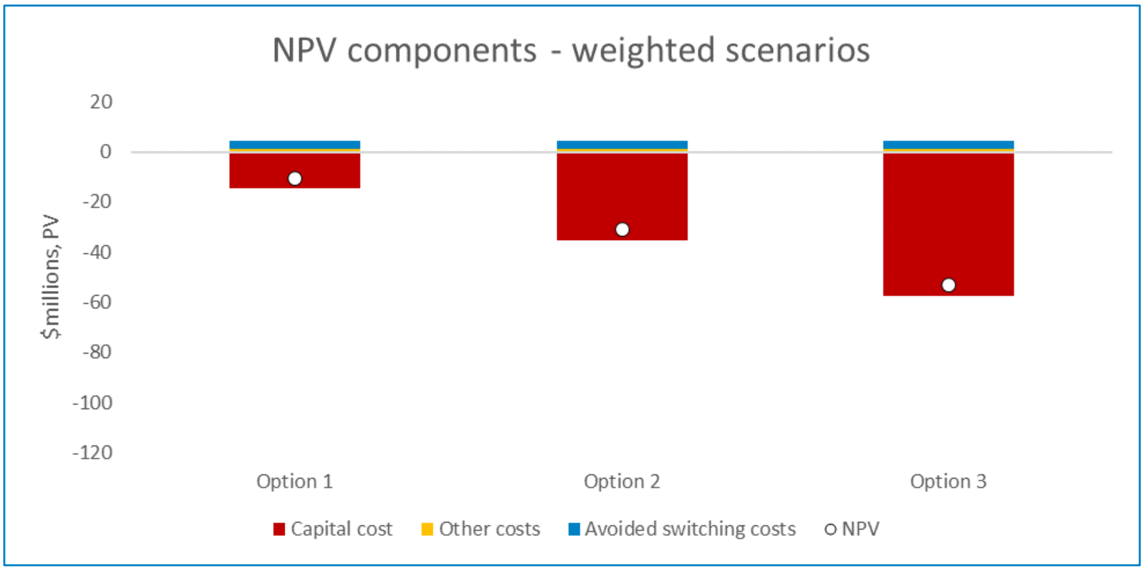
Option	BESS Development Scenario	Description	NSP Cost ($m)	NPV relative to Base Case (weighted $m)	Rank
3	120MVAr Belmont reactor, NSA with CleanCo and additional DNSP 30MVAr reactors				
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2024/25, 2028/29, 2029/30	13.3* 80.0†	-53.0	3
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2027/28, 2028/29, 2029/30	13.3* 50.0†		
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactor 2029/30	13.3* 10.0†		

*TNSP project cost
†DNSP project cost

The absolute NPVs of the credible options are negative, shown graphically in Figure 1, with Option 1 being the least negative of the credible options. Given that the cost of network support services from CleanCo is common across all options, there is no change to the ranking of the refined options in this PACR compared to those in the PADR. CleanCo costs are commercial in confidence and therefore have not been published.

All options significantly reduce the total risks arising from the reactive power absorption capability in the SEQ area, enabling Powerlink to continue to meet reliability and service standards specified within its Transmission Authority. They also ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules and guidelines and standards published by AEMO.

Figure 1: Weighted NPV components of credible network options ($m, real 22/23)



Evaluation and Conclusion

The RIT-T requires that the 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 cost-benefit analysis demonstrates that Option 1 provides the greatest net economic benefit in NPV terms and is therefore the preferred option.

This PACR makes a final recommendation to implement Option 1, which involves the installation of a 120MVAr reactor at Belmont Substation by 2024, and network support services from CleanCo to operate during times of reactive power shortfall, while further reactive support from BESS connections and other non-network developments emerge. The indicative capital cost of this option is $13.3 million in 2022/23 prices. Under Option 1, site works would commence in 2023, with the reactor available for service by late 2024. Powerlink is the proponent of the proposed network project and CleanCo is the proponent of network support services.

Option 1 has been adopted as the final recommendation, and will now be implemented.

Dispute Resolution

In accordance with clause 5.16B(a) of the Rules, Registered Participants, the Australian Energy Market Commission, Connection Applicants, Intending Participants, AEMO and interested parties may, by notice to the Australian Energy Regulator, dispute conclusions in this report in relation to:

- the application of the RIT-T,
- the basis upon which the preferred option was classified as a reliability corrective action or
- the assessment of whether the preferred option has a material inter-regional impact or not

Notice of a dispute must be given to the AER within 30 days of the publication date of this report. Any parties raising a dispute are also required to simultaneously provide a copy of the dispute notice to Powerlink, as the RIT-T proponent.

1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step of the Regulatory Investment Test for Transmission (RIT-T) process[5] prescribed under the National Electricity Rules (Rules) undertaken by Powerlink to address the reactive power absorption capability in the South East Queensland (SEQ) area. It follows the publication of the Project Assessment Draft Report (PADR) in October 2022, which:

- 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 revised 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 not likely 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
- invited submissions and comments, in response to the PADR and the credible options presented, from Registered Participants, The Australian Energy Market Operator (AEMO), potential non-network providers and any other interested parties.

The PADR identified Option 1, the installation and commissioning of a 120MVAr bus reactor at Powerlink's Belmont substation for 2023/24, with a capital cost of $13.3 million in 2022/23 prices, as the preferred option to address the identified need. Subsequent to 2023/24, Powerlink noted it would seek to establish network support agreements with non-network option proponents in the SEQ area to meet projected shortfalls in reactive power absorption capability. Developments which have occurred since publication of the PADR are discussed in Section 2.

Powerlink is now publishing this PACR, which:

- describes the identified need and the credible option 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 purpose of this RIT-T assessment
- provides the results of the cost-benefit 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

With more than five million Queenslanders and 253,000 Queensland businesses depending on Powerlink's performance, 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. Together with our industry counterparts from across the electricity and gas supply chain, Powerlink has committed to The Energy Charter.

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

[5] This RIT-T consultation has been prepared based on the following documents: National Electricity Rules, Version 200, 30 May 2023 and AER, Application guidelines, Regulatory Investment Test for Transmission, August 2020.

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 Transparency on future network requirements

Powerlink's annual planning review findings are published in the Transmission Annual Planning Report (TAPR) and TAPR templates, providing early information and technical data to customers and stakeholders on potential transmission network needs over a 10-year outlook period. The TAPR plays an important part in planning Queensland's transmission network and helping to ensure it continues to meet the needs of Queensland electricity consumers and participants in the National Electricity Market.

In addition, beyond the defined TAPR process, Powerlink's associated engagement activities provide an opportunity for non-network alternatives to be raised, further discussed or formally submitted for consideration as options to meet transmission network needs, well in advance of the proposed investment timings and commencement of regulatory consultations (where applicable).

2.3.1 Voltage control in South East Queensland

Powerlink identified in its 2020-2022 TAPRs, an expectation that action would be required to address the emerging voltage control issues in the Moreton, Gold Coast and parts of the Wide Bay transmission zones[6].

Powerlink advised members of its Non-network Engagement Stakeholder Register (NNESR) of the publication of 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 the TAPR 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.

2.5 The transmission component of electricity bills

Powerlink's contribution to electricity bills comprises approximately 9% of the total cost of the residential electricity bill (refer to Figure 2-1).

Figure 2-1: Components of end user bills

[6] This relates to the standard geographic definitions (zones) identified within Powerlink's TAPR.

Detailed information on transmission pricing, including discussion on how Powerlink is actively engaging with customers and stakeholders on transmission pricing concerns, is available on Powerlink's website.

3. AEMO declaration of a NSCAS gap and interactions with the current RIT-T

The Australian Energy Market Operator (AEMO) declared a Network Support and Control Ancillary Services (NSCAS) gap in southern Queensland on 17 December 2021, after the commencement of this RIT-T in August 2021. Specifically, AEMO declared an immediate Reliability and Security Ancillary Service (RSAS – a type of NSCAS) gap of approximately 120MVAr reactive power absorption, increasing to 250MVAr reactive power absorption by 2026 in southern Queensland[7].

In the first instance,[8] Powerlink, as the Transmission Network Service Provider (TNSP), is responsible for acquiring NSCAS services to address NSCAS gaps in Queensland as declared by AEMO. Accordingly, Powerlink issued an Expression of Interest (EOI) on 19 May 2022 requesting additional power system security services to address the immediate RSAS gap, until the preferred option identified as a result of this RIT-T consultation can be implemented.

3.1 Developments since publication of the PADR

Since publication of the PADR in October 2022, Powerlink completed its assessment in relation to the EOI to address the immediate NSCAS gap in southern Queensland. In December 2022 Powerlink published the findings and outcome of the EOI process in the 'Request for power system security services in central, southern and broader Queensland regions – Final Report Part 1: NSCAS'. As a result, Powerlink entered into in a Network Support Agreement (NSA) with CleanCo Queensland (CleanCo) to provide the necessary NSCAS through utilising its assets in southern Queensland to operate during times of reactive power shortfall. These services became available from January 2023 to fulfil Powerlink's regulatory obligations under the Rules[9].

The immediate term solution delivered through the EOI process has been treated as common across all options and reflected in the base case in the cost-benefit analysis. In response to CleanCo's submission to the PSCR, Powerlink has now finalised its assessment, and included the network support services offered as a component of the longer-term options assessed in this PACR.

In December 2022, AEMO published the 2022 NSCAS Report, confirming the declared gap of 120MVAr reactive power absorption, stating Powerlink was finalising the near-term solution and that newly committed and anticipated generation and storage projects, together with the outcome of this RIT-T, are expected to improve power system voltage control in southern Queensland. Given this, AEMO has not declared a gap at the end of the five-year NSCAS assessment period, noting the NSCAS gap may re-assessed in 2023 as more information becomes available about uncertainties, such as the impact of synchronous generation dispatch and system strength services[10].

4. Identified need

This section provides an overview of the network in the SEQ area, and the context in which the identified need arises, including assumptions and requirements underpinning the identified need. It 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.

4.1 Geographical and network need

The ongoing impact of over-voltage events in SEQ extends from Woolooga in the north, to Mudgeeraba in the south and west to Blackstone, with the majority of affected substations located within the Moreton and Gold Coast transmission zones. The impacted grid sections service a population of approximately 4 million people and over 190,000 businesses.

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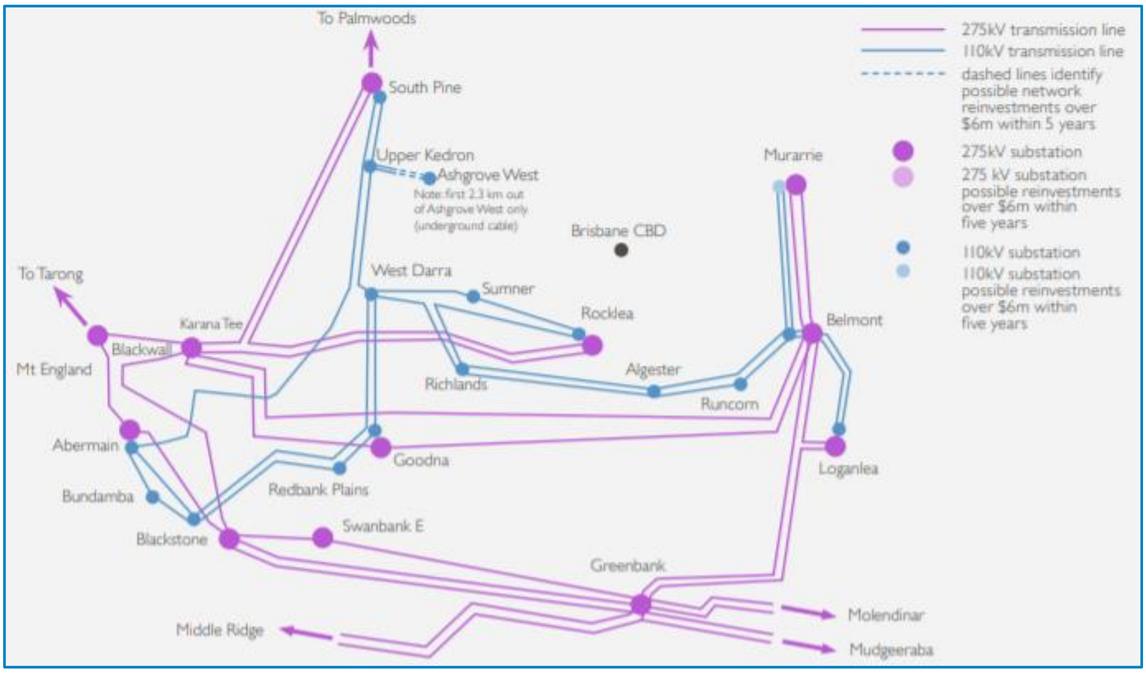
[7] AEMO, *2021 system security reports,* 17 December 2021, p 49. RSAS is a form of NSCAS.
[8] The Rules clauses 3.11.1(c)(2)(i) and (ii).
[9] The Rules clauses 3.11.1(c)(2)(i) and (ii).
[10] In March 2023 Powerlink published a PSCR to address system strength requirements in Queensland from December 2025.

Planning studies have confirmed there is a long-term requirement to continue to supply the existing electricity services in SEQ. The Greater Brisbane transmission network is shown in Figure 4-1.

Figure 4-1: Greater Brisbane transmission network



4.2 Description of identified need

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". 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[11].

In particular, Schedule 5.1a.4 of the Rules states that under system normal conditions, the voltage at a connection point must not exceed 1.1 per unit. Following a credible contingency, the voltage at a connection point must be able to be restored to less than 1.1 per unit in less than 1 second.

Schedule 5.1.2.1 of the Rules also states "*Network Service Providers must plan, design, maintain and operate their transmission networks … to allow the transfer of power from generating units to Customers …*". With reactive plant at capacity, obtaining outages for maintenance work is becoming increasingly difficult. Switching out lines during low load and/or low power transfer periods, to help gain access for reactive plant maintenance, reduces system strength.

Planning studies have confirmed that in order to continue to meet the reliability standard within Powerlink's Transmission Authority, reactive power absorption capability in the SEQ area is required into the foreseeable future to meet ongoing customer requirements.

Under current system normal conditions, peak operating voltages are at or near Powerlink's operational limits, while dynamic reactive plant is at its limit. Studies indicate that the current reactive capacity of the grid in this area would be unable to provide the necessary management of voltages under the forecast declines in electricity demand and increasing net capacitive load. Consequently, there is a need for Powerlink to address these emerging issues to ensure ongoing compliance with Schedule 5.1 of the Rules and applicable regulatory instruments, which are designed to ensure Powerlink's customers continue to receive safe, reliable and cost effective electricity services.

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 because it is required to meet an externally imposed obligation on the network business. The identified need is described in greater detail in the PADR published in October 2022.

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

5. Submissions received

Two submissions were received in response to the PADR, which was open for consultation until 9 December 2022, in addition to CleanCo's submission in response to the PSCR[12]. The submissions to the PADR were received from CS Energy and a confidential proponent. Powerlink also met with the proponent of the confidential submission in December 2022 to discuss their proposal. As noted in the PADR, Powerlink was also engaging with CleanCo at the time of publication with regards to the confidential details of their submission to the PSCR.

The submissions from CS Energy and the confidential proponent both offered BESS services that have been captured in the envelope of BESS network support services identified in the PADR. As a result, no additional credible options that could deliver a material market benefit have been identified as part of this RIT-T consultation.

6. Credible options assessed in this RIT-T

The identified need arises from a combination of factors across two networks and Powerlink as the TNSP, and Energex as the Distribution Network Service Provider (DNSP), have conducted a joint assessment of the emerging over-voltage issues in SEQ to determine the cause and have developed three credible network options.[13]

The capital cost for TNSP elements of network options has been developed using Powerlink's cost estimating methodology[14], and are considered class 3[15] estimates. The capital cost for DNSP elements of network options has been based upon estimates provided by Energy Queensland. Non-network option costs are based upon confidential pricing information from potential proponents. Where technically and economically feasible, the immediate term submissions received in the EOI process have also informed Powerlink's consideration of the longer-term options as well as the scenarios developed for this RIT-T.

All three options share the 120MVAr reactor at Belmont with commissioning in 2023/24 as a common component, which will address the immediate identified need from 2023/24 onwards. All options incorporate varying degrees of flexibility to meet the identified need, depending on the extent of market-led BESS investment in the Base Case under each scenario.

Option 1: utilises network support agreements (NSA) to address shortfall capacity for reactive power absorption from either the NSCAS gap network support arrangements and/or BESS units as required

Option 2: reflects investment in additional 120MVAr bus reactors in Powerlink's transmission network as required

Option 3: involves installing 30MVAr bus reactors in Energex's distribution network as required.

A summary of these options is given in Table 6-1.

[12] One confidential submission received to the PSCR was later withdrawn by the proponent.
[13] The Rules, clause 5.14.1, Joint planning obligations of Transmission Network Service Providers and Distribution Network Service Providers.
[14] An overview of Powerlink's cost estimating methodology was published with our 2023-27 Revenue Proposal and is available on the AER website.
[15] AACE International, Recommended Practice No. 17R-97 Cost Estimate Classification System, August 2020.

Table 6-1: Summary of credible options

Option	BESS Development Scenario	Description	NSP Cost ($m)	Indicative annual average O&M costs ($m)
1	120MVAr Belmont reactor, NSA with CleanCo and subsequent NSA			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 to 2029/30	13.3*	0.009 to 0.016
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2028/29, then 2029/30	13.3*	
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2029/30	13.3*	
2	120MVAr Belmont reactor, NSA with CleanCo and additional TNSP 120MVAr reactors			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2024/25 then 2028/29	39.8*	0.009 to 0.045
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2027/28 then 2029/30	39.8*	0.009 to 0.046
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactor 2029/30	26.5*	0.009 to 0.030
3	120MVAr Belmont reactor, NSA with CleanCo and additional DNSP 30MVAr reactors			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2024/25, 2028/29, 2029/30	13.3* 80.0†	0.009 to 0.016
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2027/28, 2028/29, 2029/30	13.3* 50.0†	
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactor 2029/30	13.3* 10.0†	

*TNSP project cost
†DNSP project cost

All credible options address the major risks resulting from the reactive power absorption capability in the SEQ area, allowing Powerlink to meet its reliability of supply and safety obligations under its Transmission Authority, the Electricity Act 1994 (Qld) and Schedule 5.1 of the Rules.

None of these options has been discussed by AEMO in its most recent Integrated System Plan (ISP)[16].

[16]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 ISP. The most recent ISP was published in June 2022.

6.1 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[17].

7. 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 to the option rankings.[18]

7.1 Market benefits that are material in this RIT-T assessment

Powerlink considers that there are no material market benefits that are incremental to the Base Case from the credible options considered.

Benefits modelled in this RIT-T assessment arise from avoided costs compared to those incurred in the Base Case, which informs the identification of the preferred option that minimises net costs.

7.2 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[19].

In particular, the non-network option (Option 1) considered (and the non-network component of other options) will not have an impact on the wholesale electricity market, as the non-network option only relies on generator and BESS assets that are already in the Base Case for network support and only to the extent that it does not affect generator and BESS operations. Consequently, generation and BESS assets operate no differently under the non-network option compared to the Base Case, and therefore the non-network option does not affect the wholesale market so as to give rise to wholesale market benefits.

More information on consideration of individual classes of market benefits can be found in the PADR. In addition to the classes of market benefit identified in the PADR, Powerlink also considers that no material benefits will arise from changes in network losses as none of the credible options are expected to provide any material changes in network losses.

8. Base Case

8.1 Modelling a Base Case under the RIT-T

Consistent with the RIT-T Application Guidelines the assessment undertaken in this RIT-T compares the costs and benefits of the credible options developed to address the risks arising from an identified need with a Base Case[20].

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 network in which the over-voltage issue is only addressed through standard operational activities, with escalating safety, financial, environmental and network risks.

In developing the Base Case, the emerging over-voltage issues in SEQ are managed by the switching out of 275kV feeders and the dispatching of off-line synchronous generators to provide reactive support in the system (assumed as part of a continuation of the NSCAS Network Support Agreement with CleanCo). The reactive capability availed by these actions do not meet the full need as the N-1 secure gap continues to grow.

The Base Case for reactive power absorption capability in the SEQ area therefore includes the costs associated with network losses due to increased feeder switching and the operating costs incurred in providing network support services under the NSA. Accordingly, the Base Case provides a clear

[17] 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.
[18] AER, *Application guidelines, Regulatory investment test for transmission,* August 2020, Section 3.6.1 Material classes of market benefits.
[19] AER, *Application guidelines, Regulatory investment test for transmission,* August 2020, page 29.
[20] AER, *Application guidelines, Regulatory investment test for transmission*, August 2020.

reference point in the cost-benefit analysis to compare and rank the credible options (network or non-network) against each other over the same timeframe.

8.2 Scenarios adopted for the RIT-T

The detailed market modelling using ISP scenarios from the most recent Inputs, Assumptions and Scenarios Report represents a disproportionate cost in relation to the scale of the proposed network investment given the specific and localised nature of the over-voltage limitations. As such, it will not materially impact the ranking of options.[21] Furthermore, the size of over-voltage limitations in the SEQ network area will be most affected by the development of renewable generation and BESS facilities over the next decade.

Consequently, Powerlink has chosen to present three BESS scenarios in southern Queensland, Low, Central and High. The Low and High BESS scenarios represent low and high levels of market-led BESS developments respectively, while the Central BESS scenario represents the most likely scenario in terms of future BESS developments.

In particular, these scenarios reflect a range of possible renewable generation and BESS developments between 2024/25 and 2027/28, which in turn determines the scope of network solutions and non-network solutions for each credible option considered. This approach is consistent with the requirements for reasonable scenarios in the RIT-T Instrument[22] and in accordance with the provisions of the RIT-T Application Guidelines.[23]

8.3 Base Case assumptions

In calculating the costs required to address emerging over-voltage events during light load conditions, the following measures have been modelled:

- switching of up to two 275kV circuits between south west and south east Queensland; and
- dispatch of synchronous generating units within the greater Queensland network to absorb excess reactive power as part of the NSCAS gap agreement.

Alleviating over-voltages in the Base Case are connecting wind generators and BESS projects that will provide reactive power absorption capacity, both in the near term, and in the future, as part of the automatic access standards for connections under the Rules.

Under the Base Case, generation and BESS units have the potential to contribute between 120MVAr and 180MVAr and are assumed to be installed and commissioned between 2024/25 and 2027/28. However, there is uncertainty as to the timing and scale of future BESS connections. Therefore, three Base Case scenarios have been developed that incorporate committed and advanced projects, and uncertainty relating to future BESS development into the NPV analysis:

- the Low BESS scenario includes only committed and advanced new generation and BESS projects assumed to be commissioned in 2024/25 and 2025/26;
- the central BESS scenario includes, in addition to the developments included in the Low BESS scenario, an additional BESS assumed to be commissioned in 2024/25, with a further BESS assumed to be commissioned for 2025/26; and
- the high BESS scenario includes, in addition to the committed and projected BESS in the central scenario, two further projected BESS units are included: an additional BESS in 2025/26 and a further BESS commissioned in 2027/28.

Table 8-1 sets out the assumed connections in the Base Case under three BESS scenarios.

[21] AER, Final: RIT–T, August 2020, sub-paragraph 20(b)
[22] AER, Final: RIT–T, August 2020, sub-paragraph 22
[23] AER, *Application guidelines, Regulatory investment test for transmission,* August 2020, S3.8.1 Selecting reasonable scenarios

Table 8-1: Connection assumptions in the Base Case under each scenario

Connections	Status	MW	MVAr capacity	Low BESS	Central BESS	High BESS
Greenbank BESS	Committed[24]	200	120	24/25	24/25	24/25
MacIntyre Wind Precinct	Early works	1,100	150	25/26	24/25	24/25
BESS A	Projected	200	120		24/25	24/25
BESS B	Projected	200	120		25/26	25/26
BESS C	Projected	300	180			25/26
BESS D	Projected	300	180			27/28
Scenario weighting				25%	50%	25%

The Central BESS scenario is given a weight of 50%, reflecting a view that the Central BESS scenario is most likely to occur. The Low and High BESS scenarios each have a weight of 25%, on the basis that these scenarios are less likely to occur than the Central BESS scenario. It should be noted that the NPV assessment for this RIT-T shows that the option ranking is the same under each of the three scenarios. The weightings applied to the scenarios therefore do not affect the RIT-T outcome. For other variables and parameters, Powerlink has elected to adopt the same parameter values across all three scenarios, set out in Table 8-2 as they are unlikely to change the outcome of the analysis.

Table 8-2: Other parameters for reasonable scenarios assumed

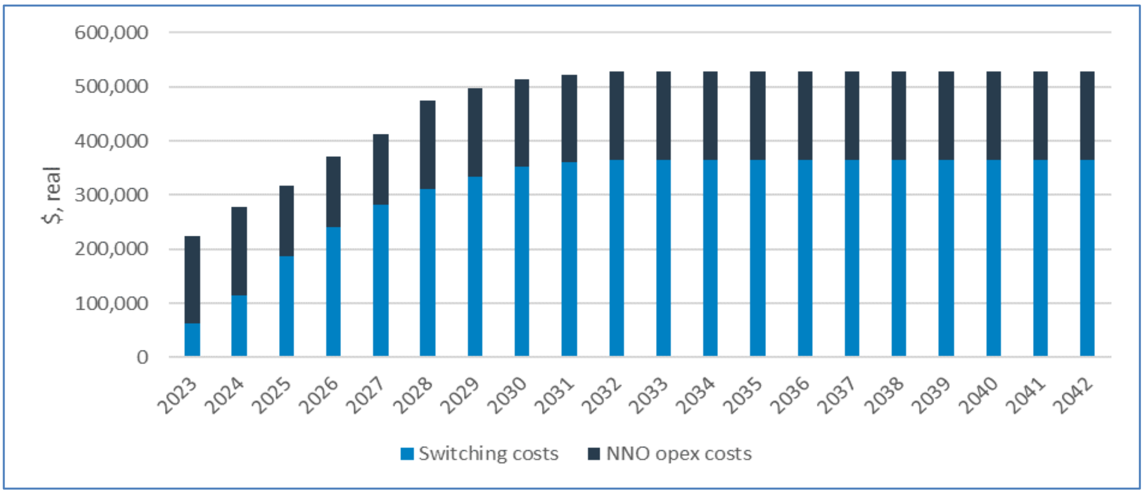
Variables and parameters	Description
Capital costs	100% of baseline capital cost estimate
Discount rate	7.0%
Maintenance costs	100% of baseline maintenance cost estimate
Market benefits	100% of baseline market benefit projection

8.3.1 Base Case costs

The main cost categories in the Base Case are changes in the cost of network losses due to increased feeder switching and the operating costs incurred in providing network support services under the network support contract Powerlink in entering into in response to the NSCAS gap. Under the Base Case, this network support arrangement is assumed to continue to be needed and these costs increase over the first 10 years, and are then assumed to level off from 2032/33 at $524,000 per year in real terms.

[24] Commercially committed

Figure 8-1: Annual Base Case cost projections



8.4 Modelling of option costs

All three options have been modelled to deliver the minimum required reactive capacity to meet the identified need.

The costs that are incurred in the Base Case are able to be avoided under the options assessed in this RIT-T, and so are shown in the analysis as 'avoided costs' for each option. These avoided costs are included with the capital and operational costs of each option to develop the NPV inputs.

9. General modelling approach adopted for net benefits analysis

9.1 Analysis period

The RIT-T analysis has been undertaken over a 20-year period, from 2022/23 to 2041/42. A 20-year period takes into account the size and complexity of the additional reactive plant.

As there will be remaining asset life in 2041/42, a residual value[25] is calculated to account for future benefits that would accrue over the balance of the asset's life.

9.2 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 7% as the central assumption for the NPV analysis presented in this report.[26]

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%[27] and an upper bound discount rate of 11% (i.e. a symmetrical upwards adjustment).

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

10.1 NPV Analysis

Table 10-1 outlines the net present value for each credible option and the corresponding ranking of each credible option, relative to the Base Case.

[25] Residual value was calculated based on remaining asset value using straight-line depreciation over the capital asset life.
[26] This indicative commercial discount rate of 7% is based on the AEMO 2023 Inputs, Assumptions and Scenarios Report, p123.
[27] A discount rate of 3.04% pre-tax real Weighted Average Cost of Capital is based on the most recent AER determination, Final decision: Transgrid transmission determination 1 July 2023 to 30 June 2028.

Table 10-1: NPV of credible options relative to the Base Case ($m, 2022/23)

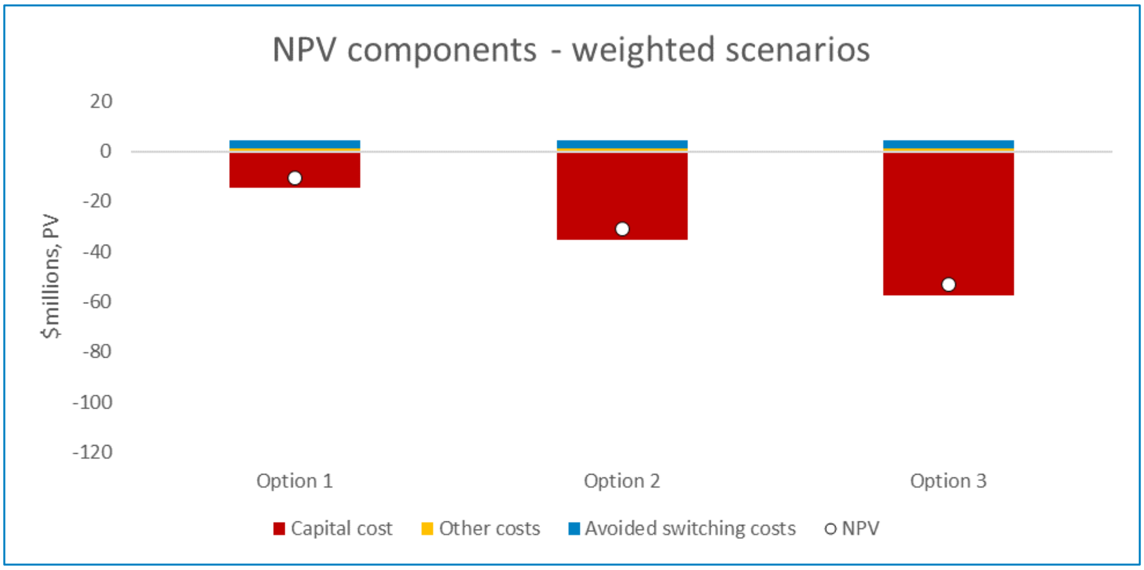
Option	BESS Development Scenario	Description	NPV relative to Base Case (weighted $m)	Rank
1	120MVAr Belmont reactor, NSA with CleanCo and subsequent NSA			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 to 2029/30	-10.5	1
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2028/29, then 2029/30		
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 Incremental BESS support 2029/30		
2	120MVAr Belmont reactor, NSA with CleanCo and additional TNSP 120MVAr reactors			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2024/25 then 2028/29	-30.7	2
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactors 2027/28 then 2029/30		
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 120MVAr TNSP reactor 2029/30		
3	120MVAr Belmont reactor, NSA with CleanCo and additional DNSP 30MVAr reactors			
	Low	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2024/25, 2028/29, 2029/30	-53.0	3
	Medium	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactors 2027/28, 2028/29, 2029/30		
	High	120MVAr Belmont reactor 2023/24 NSA 2023/24 30MVAr DNSP reactor 2029/30		

All credible options will address the identified need on an enduring basis. Option 1 is ranked first, with Option 2 being $22.7 million more expensive compared to Option 1 in NPV terms. The limited net cost under Option 1 is due to this option only requiring incremental resource costs incurred for the Belmont reactor. In contrast, both Options 2 and 3 have additional network expenditure on the addition reactor elements. Option 3 incurs the most net cost, as the cost of each 30MVAr reactor is higher for each MVAr of capacity when compared to 120MVAr reactors under Option 2.

The majority of the cost of each option relates to capital cost, with only relatively marginal operating costs incurred. Benefits under each option relate to avoided switching costs, which are the same across all options.

Figure 10-1 sets out the breakdown of capital cost, avoided switching costs, and other maintenance and operating costs for each option in NPV terms under the weighted scenario.

Figure 10-1: Weighted scenario NPV components of credible network options ($m, real 22/23)



10.2 Sensitivity analysis

Sensitivity analysis was performed to test the robustness of the analysis resulting in the preferred option and to determine whether any factors would change the relative ranking of the credible options assessed:

The following sensitivities on key assumptions were investigated:

- a range from 75% to 125% of base capital expenditure estimates;
- a range from 3.04% to 10.96% for the discount rate[28]; and
- a range from 75% to 125% of maintenance expenditure estimates.[29]

Table 10-2 shows the effects of varying the discount rate, capital expenditure and operating & maintenance expenditure on the NPV relative to the Base Case. Option 1 remains the preferred option under all sensitivities tested.

Table 10-2: Sensitivity analysis

Sensitivity	Option 1	Option 2	Option 3
75% of capex estimate	-$7 million	-$22 million	-$39 million
125% of capex estimate	-$14 million	-$40 million	-$67 million
3.04% discount rate	-$11 million	-$39 million	-$69 million
10.96% discount rate	-$10 million	-$26 million	-$44 million
75% of maintenance expenditure estimate	-$10 million	-$31 million	-$53 million
125% of maintenance expenditure estimate	-$11 million	-$31 million	-$53 million

10.3 Sensitivity to multiple parameters

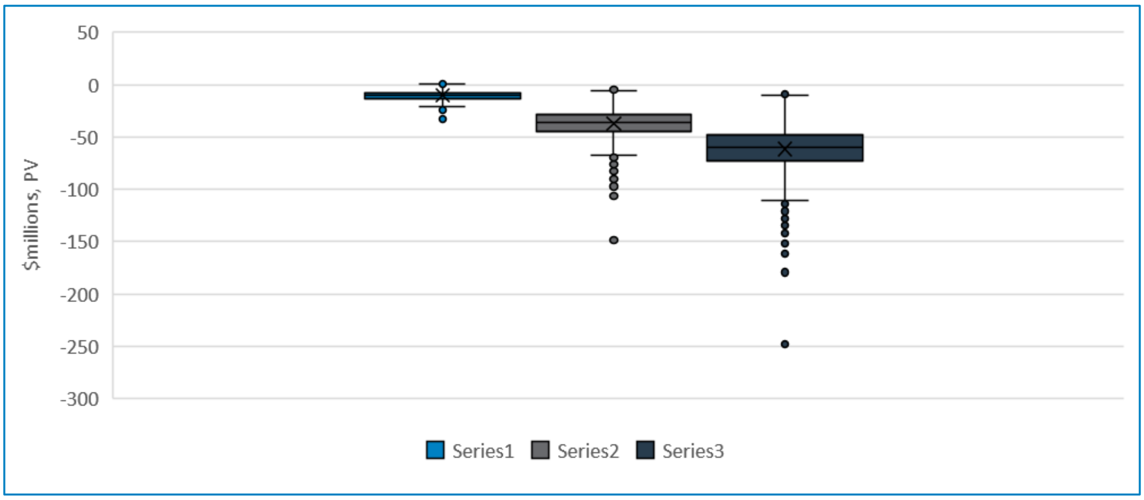
A Monte Carlo simulation was performed with multiple input parameters (including capital cost, discount rate, operational & maintenance cost, NNO operating costs) generated for the calculation of the NPV for the credible options. This process is repeated over 5,000 iterations, each time using a different set of random variables from a normal distribution probability function.

[28] Discount rates have been updated from when the PADR was published in line with the most recent publications referenced. This has had no impact on the relative ranking of options.
[29] Sensitivity only relates to maintenance expenditures (i.e. routine and reactive maintenance), and does not include operating costs related to switching.

The sensitivity analysis output is presented as a distribution of possible NPVs for the credible option, as illustrated in Figure 10-2.

The Monte Carlo simulation results identify that Option 1 has less statistical dispersion in comparison to the other credible options and has a highest mean (i.e. smallest net cost) of the three options. This is a function of Option 1 having the smallest amount of capital and operating costs out of the options considered. The Monte Carlo simulation results confirm that the preferred option, Option 1, is robust over a range of input parameters in combination.

Figure 10-2: NPV sensitivity analysis of multiple key assumptions relative to the Base Case



11. Preferred option

Based on the conclusions drawn from the cost-benefit analysis and the Rules requirements relating to the reactive power absorption capability in the SEQ area, it is recommended that Option 1 be implemented to manage voltages in SEQ. 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 1 is the credible option with the highest net economic benefit, over the 20-year analysis period. Sensitivity testing shows that the analysis is robust to variations in discount rates, capital costs and operating costs. Option 1 is therefore considered to satisfy the requirement of the RIT-T and is the preferred option.

12. Conclusions

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

- Powerlink has identified a shortfall in reactive power absorption capability arising from declining minimum flows and an increasing capacitive contribution from more energy efficient appliances and roof top solar systems in the SEQ area as requiring action.
- The increasing voltage issues compels Powerlink to undertake reliability corrective action in the SEQ area to continue to meet the reliability standards set out in its Transmission Authority. Such action will also ensure Powerlink's ongoing obligations under the Electrical Safety Act 2002 (Qld) and its service standards under the Electricity Act 1994 (Qld) and Regulations and its Queensland Transmission Authority,
- Studies were undertaken to evaluate three credible options. All options were evaluated in accordance with the AER's RIT-T.
- Powerlink published a PSCR on 31 July 2021 requesting submission from Registered Participants, AEMO and interested parties on the credible options presented, including alternative credible non-network options, which could address the voltage issues in SEQ.
- 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 two submissions received in response to the PSCR, which was open for consultation until 29 October 2022. One confidential submission was later withdrawn by the proponent. The remaining submission was received from CleanCo Queensland. Nonetheless, no additional credible options that could deliver material market benefits were identified.
- Powerlink issued an EOI on 19 May 2022 requesting additional power system security services to address the immediate RSAS gap, until the preferred option identified as a result of this RIT-T consultation can be implemented.
- A number of developments emerged while the PSCR was open for consultation, which impact both the extent and timing of the voltage management issues which form the identified need for this RIT-T, as well as the potential solutions to addressing the identified need.
- Powerlink published a PADR on 24 October 2022 requesting submission from Registered Participants, AEMO and interested parties on the revised credible options presented, including alternative credible non-network options, which could address the voltage issues in SEQ.
- Two submissions were received in response to the PADR, one from a confidential proponent and another from CS Energy. The submissions proposed network support through BESS arrangements that have been captured in the envelope of BESS network support services identified in the PADR, anticipated from 2024/25.
- In December 2022, Powerlink completed its assessment in relation to the EOI to address the immediate NSCAS gap in southern Queensland. As a result, Powerlink entered into in a Network Support Agreement with CleanCo to provide the necessary NSCAS through utilising its assets in southern Queensland to operate during times of reactive power shortfall. These services became available from January 2023.
- Taking into consideration the outcome of the EOI process and submissions received to this RIT-T, the three credible network options, have been further refined from those proposed in the PADR, to reflect the network support services available from CleanCo and as a result of the NSCAS gap network support agreement.
- The result of the cost-benefit analysis under the RIT-T identified that Option 1 provides the greatest net economic benefit over the 20-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 1 is considered to satisfy the RIT-T.
- Option 1 has been adopted as the final recommendation, and will now be implemented.

13. Final recommendation

Based on the conclusions drawn from the cost-benefit analysis and the Rules requirement relating to the reactive power absorption capability in the SEQ area, it is recommended that Option 1 be implemented to address over-voltage issues in SEQ. Option 1 allows Powerlink to continue to maintain compliance with relevant AEMO standards, Powerlink’s Transmission Authority and Schedule 5.1 of the Rules.

Option 1 involves the installation and commissioning of a 120MVAr bus reactor at Powerlink’s Belmont substation for 2023/24, with a capital cost of $13.3 million in 2022/23 prices. Site works would commence in 2023, with the reactor available for service by late 2024. Powerlink is the proponent of the proposed network project and CleanCo is the proponent of network support services.

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

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