Powerlink Queensland

Project Specification Consultation Report

30 July 2021

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. 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 customers.
3. The main purpose of this document is to provide details of the identified need, credible options, technical characteristics of non-network options, and categories of market benefits likely to impact selection of the preferred option. In particular, it encourages submissions from potential proponents of feasible non-network options to address the identified need.

[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 (ISP), for which Powerlink has responsibility as the relevant Transmission Network Service Provider (TNSP)

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Executive Summary

An increase in the uptake of roof top solar systems and more efficient energy devices within South East Queensland requires Powerlink to take action

The uptake of rooftop solar systems within Queensland has been one of the highest per capita rates in the world, with over 700,000 installed rooftop PV systems totalling an aggregate statewide capacity of more than 3,300MW.

While the cumulative effect of small-scale renewable energy has reduced average demand and energy consumption, power produced by embedded solar installations has also significantly reduced the minimum demand profile during daylight hours[2].

In addition to the falling minimum daytime demand, the installation of more energy efficient devices has also resulted in the load becoming more capacitive, particularly during the traditional early morning low load period between midnight and dawn, causing an increase in the reactive charging of overhead lines.

A decline in the amount of traditional synchronous generation being dispatched during the low demand periods has also meant the system has less capacity to absorb reactive power and hence help maintain safe voltage levels.

The combination of a declining minimum demand during the day, increasing capacitive nature of the load and the loss of system capacity to absorb reactive power, has created a growing reactive power surplus in both the distribution and transmission networks, particularly during low demand periods. This has resulted in an increased voltage profile and a growing potential for sustained over-voltage events.

Over-voltage events can result in equipment damage, loss of supply and safety issues. The Rules specify allowable over-voltage limits and require Powerlink to take action to ensure these limits are not exceeded in order to maintain the power system in a secure state. Surplus reactive power, measured in MVArs, is increasingly having to be absorbed by transmission connected plant such as shunt reactors, dynamic Static Var Compensators (SVCs) and generators.

However, with present reactive plant at capacity, Powerlink is having to manage these limits by switching out of feeders. This operational solution is now at its technical limit and is not considered a sustainable strategy. Switching out feeders on an on-going regular basis impacts system strength and reliability of supply, impacts the market by increasing transmission losses and accelerates the ageing of primary plant.

Insufficient reactive capacity in the South East Queensland section of the grid is also making it increasingly difficult to obtain outages of reactive plant for maintenance and project work, increasing the likelihood of Powerlink breaching its responsibilities as a Transmission Network Service Provider (TNSP) under the Rules, as well as its Transmission Authority reliability and service standards.

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

The identified need to manage voltages within allowable limits requires Powerlink to apply the RIT-T.

The proposed investment is to meet reliability and service standards specified within Powerlink's Transmission Authority and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules, and is classified as a 'reliability corrective action'[3].

As the identified need is not discussed in the most recent Integrated System Plan (ISP), it is subject to the application and consultation process for RIT-T projects not defined as *actionable ISP projects*[4].

Powerlink has presented three credible network options in this Project Specification Consultation Report (PSCR) to maintain the existing electricity services, ensuring an ongoing reliable, safe and cost effective supply to customers in the area.

[2] AEMO 2020 Electricity Statement of Opportunities, page 4
[3] The Rules clause 5.10.2, Definitions, reliability corrective action
[4] Refer to Clause 5.16.2 of the NER

As the preferred option is below $43 million, and the modelled changes in ancillary service costs and potential network losses do not change the ranking of the options, Powerlink has adopted the expedited process for non-ISP projects for this RIT-T[5]. Changes in ancillary service costs and potential network losses have been modelled in the Base Case risk costs and included in the NPV analysis of the options.

A non-credible Base Case has been developed against which to compare the credible options

Consistent with the Australian Energy Regulator's (AER's) RIT-T Application Guidelines for non-ISP projects, the assessment undertaken in this PSCR compares the net present value (NPV) of the credible network options identified to address the emerging risk-costs of a "do-nothing" Base Case.

The Base Case is modelled as a **non-credible** option where the emerging issue of non-compliant over-voltage events is managed via the ongoing switching out of feeders and the dispatch of generation units in the greater South East Queensland network to absorb reactive power under light load conditions. The standby and usage charges associated with dispatching this generation capacity forms the market costs of the "do nothing" Base Case.

Proposed network options to address the identified need

As the need arises from a combination of factors across two networks, Powerlink as the TNSP and Energex as the DNSP, have conducted a joint assessment of the emerging over-voltage issues in SEQ to develop potential network options.

The proposed network options, along with their NPVs relative to the Base Case are summarised in Table 1. The absolute NPVs of the Base Case and the credible network options are shown in Figure 1.

Table 1 illustrates that the two transmission options have a net economic benefit relative to the non-credible Base Case.

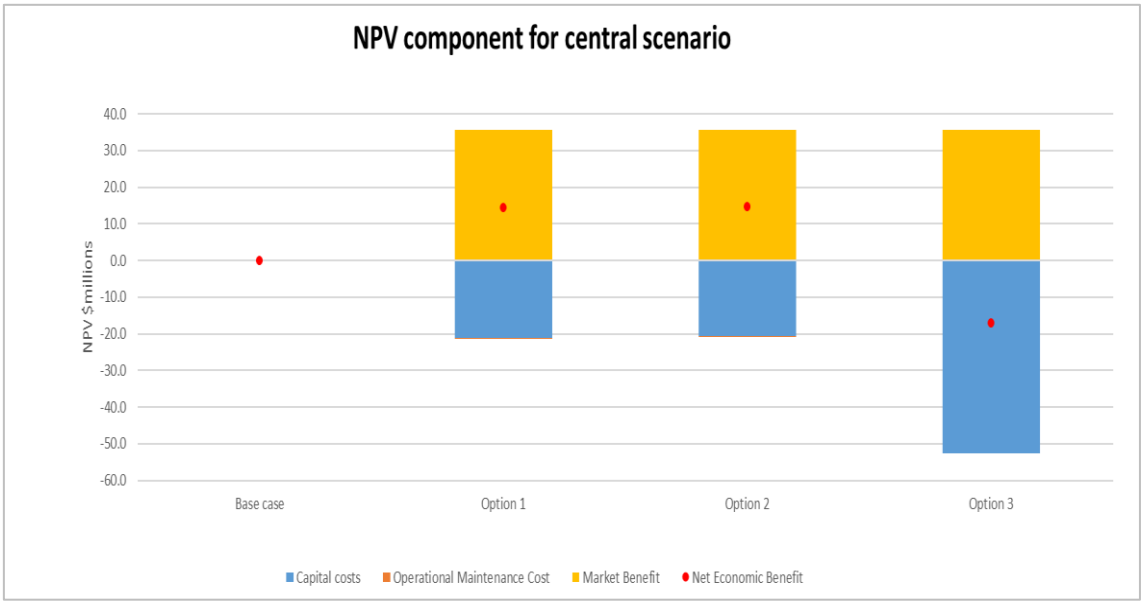
Table 1: Summary of the credible network options

Option	Description	Total costs ($m) 2020/21	Net Economic Benefit ($m)
1	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Greenbank Substations in Powerlink's South East Queensland Transmission Network from 2022	30.29	14.27
2	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Belmont Substations in Powerlink's South East Queensland Transmission Network from 2022	29.61	14.69
3	Install 11 x reactors with a total 335MVAr capacity on the Energex Network in the Sunshine Coast, Gold Coast and Brisbane areas from 2022	80.50	-17.12

Note: Powerlink is the proponent of options 1 and 2, while Energex is the proponent of option 3.

[5] In accordance with clause 5.16.4(z1) of the Rules and S4.1 AER Regulatory investment test for transmission application guidelines, August 2020

Figure 1: NPV of Base Case and Credible Network Options



The Base Case is not a credible option, in that it does not allow Powerlink to continue to maintain compliance with the requirements of relevant regulatory instruments and the Rules.

Taking into account capital, operational maintenance and market benefits, Option 2 delivers the greatest net economic benefit, providing a $14.69 million net economic benefit in NPV terms when compared to the Base Case over the 20-year analysis period.

Option 2 has been identified as the preferred network option

The preferred network option involves installing three 120MVar reactors at the Blackstone, Woolooga and Belmont Substations by 2025. Powerlink is the proponent of this network option.

Under this option, installation and commissioning of the reactors will be completed by 2025.

Powerlink welcomes the potential for non-network options to form part or all of the solution

Powerlink welcomes submissions from proponents who consider they could offer a potential non-network solution by 2025.

A non-network option that avoids the proposed installation of the new reactors would need to replicate, in part or full, the support that the reactors deliver to the network in South East Queensland, on a cost effective and ongoing basis.

Lodging a submission with Powerlink

Powerlink is seeking written submissions on this Project Specification Consultation Report on or before Friday, 29 October 2021, particularly on the credible option presented[6].

Please address submissions to:

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Powerlink Queensland
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VIRGINIA QLD 4014
Tel: (07) 3860 2328

Submissions can be emailed to: networkassessments@powerlink.com.au

[6] Powerlink's website has detailed information on the types of engagement activities, which may be undertaken during the consultation process. These activities focus on enhancing the value and outcomes of the RIT-T engagement process for customers and non-network providers

1 Introduction

1.1 Powerlink Asset Management and Obligations

Powerlink Queensland is a Transmission Network Service Provider (TNSP) in the National Electricity Market (NEM) that owns, develops, operates and maintains Queensland's high-voltage electricity transmission network. This network transfers bulk power from Queensland generators to electricity distributors Energex and Ergon Energy (part of the Energy Queensland Group), and to a range of large industrial customers.

Powerlink's approach to asset management includes a commitment to sustainable asset management practices that ensure Powerlink provides valued transmission services to its customers by managing risk[7], optimising performance and efficiently managing assets through the whole of asset life cycle[8].

Planning studies have confirmed there is a long-term requirement to continue to supply electricity services to customers in South East Queensland.

Declining minimum flows and an increasing capacitive contribution from more energy efficient appliances and roof top solar systems in South East Queensland are increasing the likelihood of non-compliant over-voltage events. The current strategy of switching out selected feeders to ensure ongoing compliance with the Rules' "*voltage* of *supply* at a *connection point*"[9], is at the limit of its technical effectiveness. Continued reliance on increasingly onerous reconfigurations of the network will result in higher market costs, reduced system resilience, and compromised system security, and is not an effective sustainable strategy.

Powerlink must therefore take action to ensure compliance with management of voltages in its transmission network.

As the proposed credible options to address the identified need include a potential investment in excess of $6 million, Powerlink must assess these options under the RIT-T.

When developing the credible options, Powerlink has focussed on implementing cost effective solutions that ensure a reliable supply, delivering positive outcomes for customers.

1.2 RIT-T Overview

The identified need referred to in this RIT-T, managing the over-voltage risks in South East Queensland, is not discussed in the most recent Integrated System Plan (ISP). As such, it is subject to the application and consultation process for RIT-T projects not defined as *actionable ISP projects*[10].

This Project Specification Consultation Report (PSCR) is the first step in the RIT-T process[11]. It:

- describes the reasons why Powerlink has determined that investment is necessary (the 'identified need'), together with the assumptions used in identifying this need
- provides potential proponents of non-network options with information on the technical characteristics that a non-network solution would need to deliver, in order to assist proponents in considering whether they could offer an alternative solution
- describes the credible options that Powerlink currently considers may address the identified need
- discusses why Powerlink does not expect specific categories of market benefit to be material for this RIT-T[12]

[7] Risk assessments are underpinned by Powerlink's corporate risk management framework and the application of a range of risk assessment methodologies set out in AS/NZS ISO31000:2018 Risk Management Guidelines
[8] Powerlink aligns asset management processes and practices with AS ISO55000:2014 Asset Management – Overview, principles and terminology to ensure a consistent approach is applied throughout the life cycle of assets
[9] National Electricity Rules, Version 166, 3 June 2021, Schedule 5.1a.4 Power frequency voltage
[10] Refer to Clause 5.16.2 of the NER
[11] This RIT-T consultation has been prepared based on the following documents: National Electricity Rules, Version 166, 3 June 2021 and AER, Regulatory investment test for transmission application guidelines, August 2020
[12] As required by clause 5.16.1(c)(iv) of the Rules

- presents the NPV assessment of the credible option compared to a Base Case (as well as the methodologies and assumptions underlying these results)
- identifies and provides a detailed description of the credible option that satisfies the RIT-T, and is therefore the preferred option
- describes how customers and stakeholders have been engaged with regarding the identified need
- provides stakeholders with the opportunity to comment on this assessment so that Powerlink can refine the analysis (if required)

Powerlink has adopted the expedited process for this RIT-T, as allowed for under the Rules for investments of this nature[13]. Specifically, Powerlink will publish a PACR following public consultation on this PSCR and apply the exemption from publishing a Project Assessment Draft Report (PADR) as:

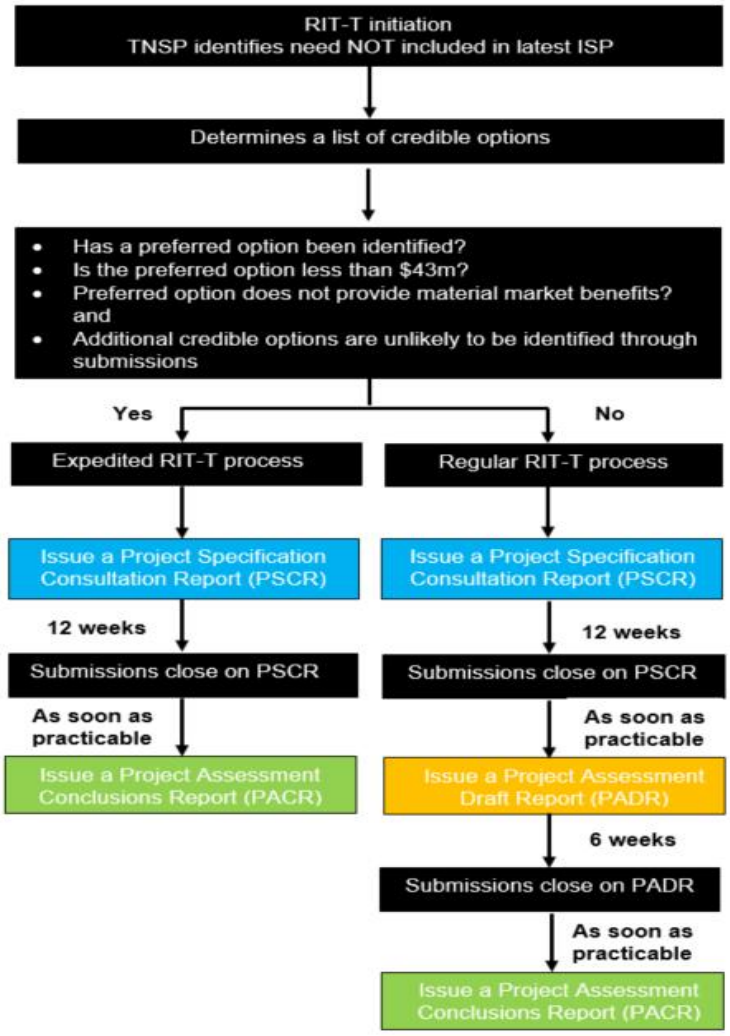
- the preferred option has an estimated capital cost of less than $43 million
- market benefits arising from the credible options do not impact the ranking of options or the selection of the preferred option[14]
- Powerlink has identified its preferred option in this PSCR (together with the supporting quantitative cost benefit analysis)
- Powerlink is currently not aware of any non-network options that could be adopted. This PSCR provides a further opportunity for providers of feasible non-network options to submit details of their proposals for consideration.

Powerlink will however publish a PADR if submissions to this PSCR identify other credible options that have not yet been considered and which could provide a material market benefit.

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

[14] Section 4.3 Project assessment draft report, Exemption from preparing a draft report, AER, Regulatory investment test for transmission application guidelines, August 2020

Figure 1.1: RIT-T Process Overview for projects that are not *actionable ISP Projects*



2 Customer and non-network engagement

With almost five million Queenslanders and 236,000 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 effective, timely and transparent information with customers and stakeholders within the broader community.

Powerlink's annual Transmission Network Forum (TNF) is a primary vehicle used to engage with the community, understand broader customer and industry views and obtain feedback on key topics.

It also provides Powerlink with an opportunity to further inform its business network and non-network planning objectives. TNF participants include customers, landholders, environmental groups, Traditional Owners, government agencies, and industry bodies.

Engagement activities such as the TNF 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, providing an ongoing opportunity for:

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

Powerlink will continue providing updates to and request input from the Customer Panel throughout 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 NEM. Powerlink undertakes engagement activities, such as a webinar and/or forum, to share with customers and stakeholders the most recent TAPR findings and respond to any questions that may arise.

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 TAPR, 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. [15].

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 help 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).

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

Figure 2.1: Components of end user bills

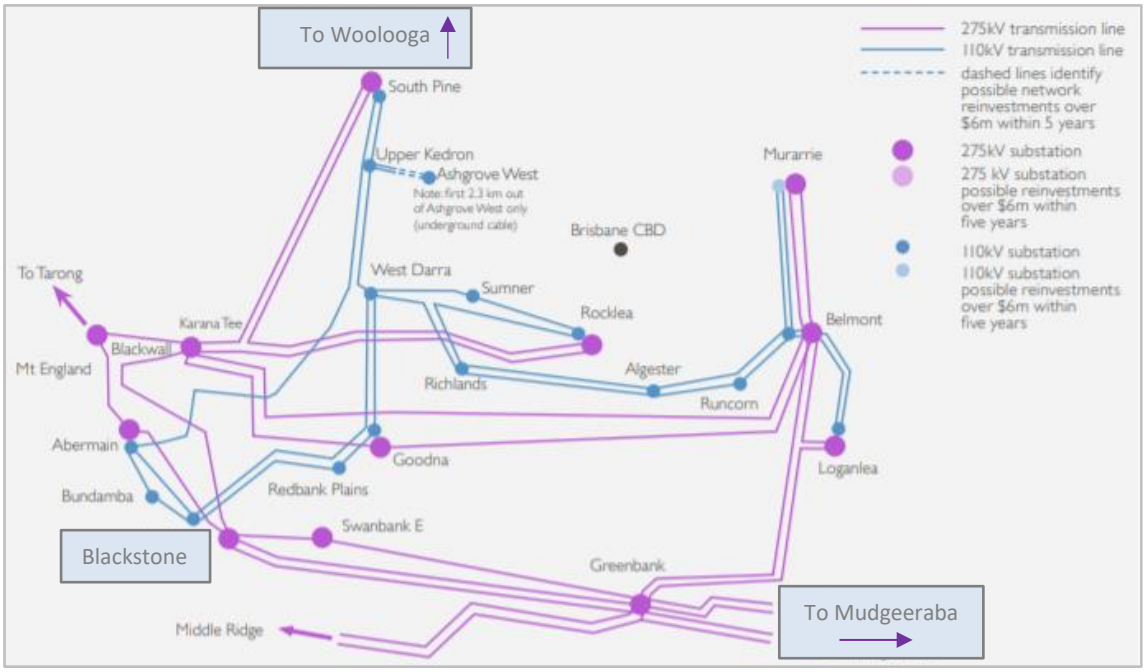
Detailed information on transmission pricing, including discussion on how Powerlink is actively engaging with customers and stakeholders on transmission pricing concerns, is available on Powerlink's website.

3 Identified need

3.1 Geographical and network need

The ongoing impact of over-voltage events 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[16]. The impacted grid sections service a population of approximately 4 million people and over 190,000 businesses.

Figure 3.1: Greater Brisbane transmission network



3.2 Increasing voltage risks associated with a rapidly transitioning energy system

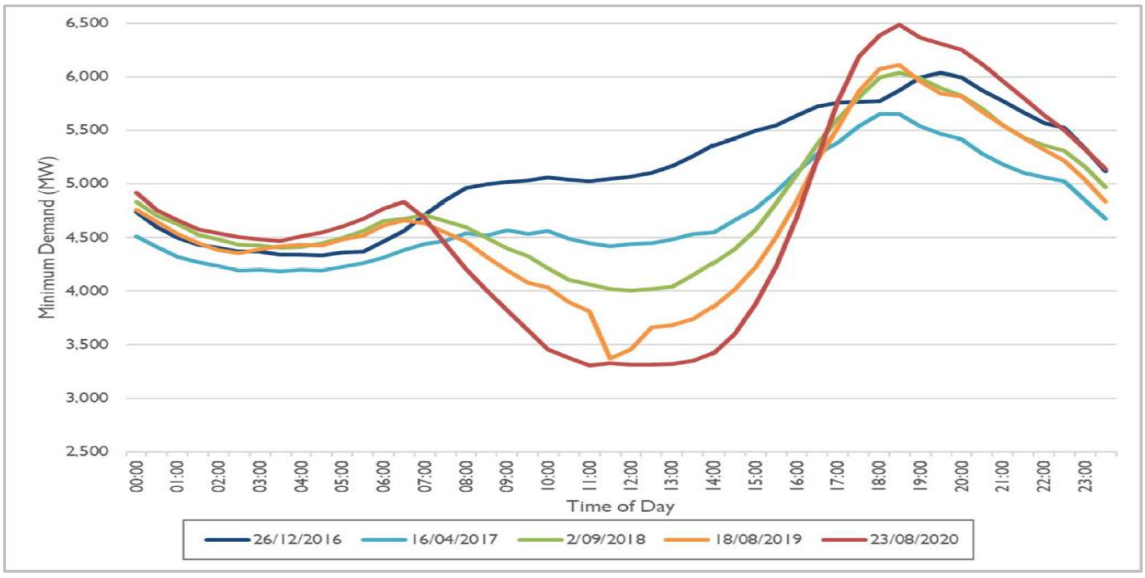
The large scale uptake of roof top solar systems and the use of more efficient energy devices have resulted in a substantial decline in the amount of reactive power being absorbed within the distribution network.

The uptake of rooftop solar systems within Queensland has been one of the highest per capita rates in the world, with over 700,000 installed rooftop PV systems totalling an aggregate state-wide capacity of more than 3,300MW.

This rapid increase in small scale rooftop PV systems has substantially reduced the overall minimum demand in the system and increased the likelihood of over-voltage events in the network during the middle of the day (Figure 3.2).

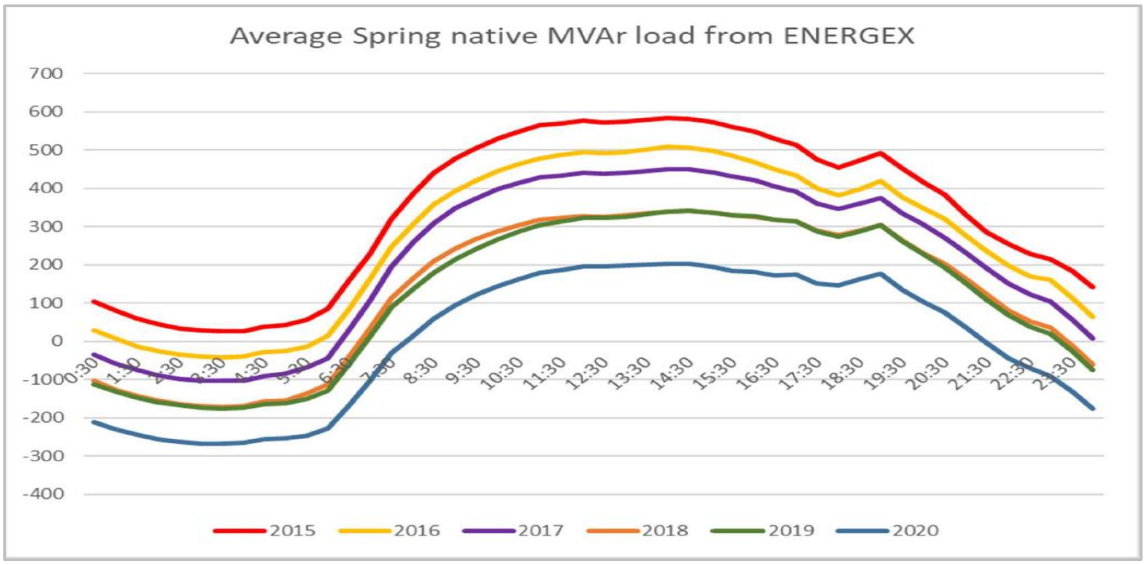
Figure 3.2: Transmission delivered Queensland minimum demand: 2016 – 2020

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



Since 2016, this decline in minimum daytime demand has been coupled with an increasing net injection of reactive power to the transmission network during the early hours of the day. (Figure 3.3)

Figure 3.3: Average spring MVAr load on the Energex distribution network



Changes in the load's leading power factor during these early hours of the morning has seen system voltages increasingly approach allowable limits during normal operating conditions, leaving the network susceptible to over-voltage events following a reactive power contingency.

The recent reduction of the nominal low voltage level within the distribution network from 240V to a 'preferred operating range' of 230 volts +6/-2 % further exacerbates this need.

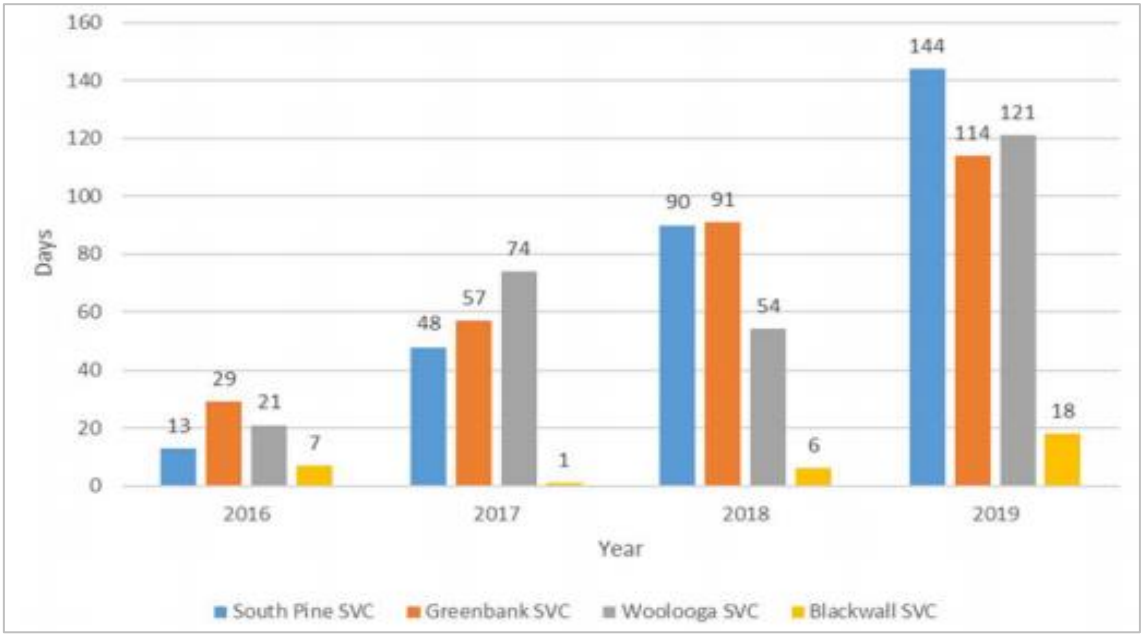
This combination of declining minimum daytime demand and a worsening leading power factor has resulted in a deficit of reactive power absorption capability in South East Queensland's transmission network. Without additional reactive absorption capacity there is a growing potential for sustained over-voltage events, substantially reducing the network's current ability to operate within the voltage limits prescribed in the Rules[17].

Good electricity industry practice is to maintain sufficient headroom in the system to be able to manage disturbances so that voltages do not exceed allowable safe limits. Under system normal conditions, the dynamic reactive plant (Static Var Compensators or SVCs) at South Pine, Greenbank, Woolooga and Blackwall Substations are increasingly operating at their limits, where they would become ineffective in responding to network disturbances. The instances when these SVCs were at their inductive limits during normal operating conditions are

[17] The Rules, Schedule 5.1a.4 Power frequency voltage

increasing rapidly. (Figure 3.4) With the SVCs functioning near capacity, the allowable 275kV operational voltage limits will be exceeded under key reactive plant outages.

Fig 3.4: Number of days where SVCs were at their inductive limit.



3.3 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". 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[18].

Planning studies have confirmed that in order to continue to meet the reliability standard within Powerlink's Transmission Authority, the services currently supplied by the Moreton, Gold Coast and Wide Bay networks are needed into the foreseeable future to meet ongoing customer requirements.

Schedule 5.1a of the Rules sets minimum standards for network service providers that:

(a) are necessary or desirable for the safe and reliable operation of the *facilities* of *Registered Participants*

(b) are necessary or desirable for the safe and reliable operation of equipment

(c) could reasonably be considered *good electricity industry practice*

S5.1a.4 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. With the SVCs at South Pine, Greenbank, Woolooga and Blackwall Substations are being utilised to the point where they would be unable to respond to credible network disturbances following a credible contingency, resulting in non-compliant over-voltages at the associated 275kV Bus.

S5.1.2.1 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. Gaining access for maintenance during peak load conditions is also problematic, as these same

[18] Transmission Authority No. T01/98, section 6.2(c)

dynamic reactive power devices are required to maintain voltage stability under high power transfer conditions.

There is a need for Powerlink to address this 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.

The network options were identified through the joint planning project process between Energex and Powerlink. Powerlink is acting as lead party undertaking the regulatory investment test in accordance with Clause 5.14.1(e) of the Rules.

The proposed investment addresses the need to meet operational safety, reliability and service standards arising from Powerlink's Transmission Authority and to ensure Powerlink's ongoing compliance with Schedule 5.1 of the Rules and is categorised as 'reliability corrective action' under the Rules[19].

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.

3.4 Assumptions and requirements underpinning the identified need

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.

The rate at which the reactive power component of the load is changing means that there is a need to install an additional 120MVAr of reactive capacity as soon as practicable, to mitigate the impacts of switching out feeders in the short term, and a further 240MVAr by 2024 to ensure ongoing compliance with S5.1a.4 of the Rules.

4 Required technical characteristics for non-network options

The information provided in this section is intended to enable interested parties to formulate and propose genuine and practicable non-network solutions such as, but not limited to, local generation and storage, demand response initiatives and the provision of ancillary services.

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

4.1 Criteria for proposed network support services

Under system normal conditions, a complete network support solution would need to provide voltage control equivalent to the proposed three reactors across South East Queensland, at a nominal 360MVars. Reactive support would be required to be available on a continuous basis, and not coupled to generation output.

Partial network support solutions designed to address either the declining minimum daytime demand or the increasing early morning leading power factor are also encouraged. Where technically and economically feasible, the relevant detailed requirements will be refined with proponents through the submission process and assessed on a case-by-case basis given the nature of the identified need.

The network support must continue to operate as per system normal for planned and unplanned outages. Outages of the network support must be coordinated to ensure that Powerlink is able to maintain system security at all times.

The location(s) of any proposed non-network solution will determine the exact levels of support required and will be considered on a case-by-case basis. Powerlink has identified the following

[19] The Rules clause 5.10.2 ,Definitions, reliability corrective action

common criteria that must be satisfied if proposed network support services are to meet supply requirements[20].

Size and location

- Proposed solutions must be large enough, individually or collectively, to provide the size of injection or demand response set out above. However, the level of support is dependent on the location, type of network support (including consideration of the connection point i.e. to either the distribution or the transmission network) and load forecasts.
- Due to the bulk nature of the transmission network, aggregation of sub 10MW non-network solutions will be the sole responsibility of the non-network provider.
- Notwithstanding the location of any solution, each proposal would require assessment in relation to technical constraints pertinent to the network connection, such as impacts on intra-regional transfer limits, fault level, system strength, maintaining network operability and quality of supply.

Operation

- A non-network option would need to be capable of operating continuously 24 hours per day over a period of years.
- If a generation service is proposed (either standalone or in conjunction with other services), such operation will be required regardless of the market price[21].
- Proponents of generation services are advised that network support payments are intended for output that can be demonstrated to be additional to the plant's normal operation in the NEM.
- Where there are network costs associated with a proposed non-network option, including asset decommissioning, these costs will form part of the option economic assessment.

Reliability

- Proposed services must be capable of reliably meeting electricity demand under a range of conditions and, if a generator must meet all relevant National Electricity Rules requirements related to grid connection.
- Proponents of non-network options must be willing to accept any liability in accordance with the Rules that may arise from its contribution to a reliability of supply failure.

Timeframe and certainty

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

Duration

- The agreement duration for any proposed service will provide sufficient flexibility to ensure the most economic long run investment is undertaken to address the voltage control issues in South East Queensland.

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

[20] Powerlink's Network Support Contracting Framework has been developed as a general guide to assist potential non-network solution providers. This framework outlines the key contracting principles that are likely to appear in any non-network support agreement

[21] The National Electricity Rules prevent a generator that is providing network support from setting the market price

5 Potential credible network options to address the identified need

As the need arises from a combination of factors across two networks, Powerlink as the TNSP and Energex as the DNSP, have conducted a joint assessment of the emerging over-voltage issues in SEQ to determine the cause and develop credible network options[22].

This PSCR therefore includes network options from both Powerlink and Energex to address the identified need for additional voltage control capacity in SEQ. All are technically feasible and address the identified need in a timely manner.

Table 5.1 Summary of the credible network option

Option	Description	Total costs ($m) 2020/21	Annual O&M Costs ($m) 2020/21
1	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Greenbank Substations in Powerlink's South East Queensland Transmission Network from 2022	30.29	0.03
2	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Belmont Substations in Powerlink's South East Queensland Transmission Network from 2022	29.61	0.03
3	Install 11 x reactors with a total 335MVAr capacity on the Energex Network in the Sunshine Coast, Gold Coast and Brisbane areas from 2022	80.50	0.1*

Note: Powerlink is the proponent of options 1 and 2, while Energex is the proponent of option 3.

* Powerlink estimate based on number of devices installed.

All options are designed to:

- Maintain voltages within operational and design limits and keep the power system in a secure operating state,
- Reduce the impact on network reliability resulting from de-energising the 275kV transmission lines

5.1 Option 1 - Install a total of 3x 120MVAr bus reactors at Powerlink's Woolooga, Blackstone and Greenbank from 2022

Under this option, a 120MVAr bus reactor would be established at each of Powerlink's Woolooga, Blackstone and Greenbank Substations. The reactors would be connected via a combination of existing and new bays. Powerlink is the proponent of this network option.

5.2 Option 2 - Install a total of 3x 120MVAr bus reactors at Powerlink's Woolooga, Blackstone and Belmont Substations from 2022

Under this option, a 120MVAr bus reactor would be established at each of Powerlink's Woolooga, Blackstone and Belmont Substations. The reactors would be connected via a combination of existing and new bays. Powerlink is the proponent of this network option.

[22] The Rules S5.14.1, Joint planning obligations of Transmission Network Service Providers and Distribution Network Service Providers

5.3 Option 3 - Install a total of 11 bus reactors across the Energex network in the Sunshine Coast, Gold Coast and Brisbane areas from 2022.

Under this Option, Energex would install a combination of 140MVAr, 115 MVAr and 90MVAr reactors across its distribution networks on the Gold and Sunshine Coasts, as well as the Greater Brisbane area. These would be connected at 110 or 132kV, 33kV and 11kV, based upon available substation space across the network. Energex is the proponent of this network option.

5.4 Material inter-network impact

Powerlink does not consider that the credible option under consideration will have a material inter-network impact, based on AEMO's screening criteria[23].

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 to the option rankings.[24]

6.1 Market benefits modelled in this RIT-T assessment

Powerlink considers that changes in ancillary costs, arising from the need to provide additional synchronous capacity in the market, will impact the NPV values of the options relative to the Base Case. These benefits do not however change the identification of the preferred option under this RIT-T as the ranking of options remains unchanged. These benefits have been quantified and included within the cost benefit analysis.

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.

A discussion of each market benefit under the RIT-T that is considered not material is presented below:

- **changes in fuel consumption arising through different patterns of generation dispatch:** the options do not result in changing patterns of generation dispatch as they do not impact patterns of consumption or levels of demand.
- **changes in voluntary and involuntary load curtailment:** while the installation of additional reactive power plant will mitigate against the need to de-energise lines, due to the meshed nature of the network in the area, the impact on load shedding is not considered material.
- **changes in costs for parties, other than the RIT-T proponent:** the proposed installation of reactors on the network by the proponent to meet the requirements of S5.1 of the Rules, does not affect the timing of new plant, capital costs or operational and maintenance costs for other parties.
- **differences in the timing of expenditure:** as all three options are designed to be delivered within 3 years, provide the same operational outcome and address the potential breach of a mandatory service standard, it is unlikely any potential transmission investment at a future date will be impacted.
- **competition benefits: d**ue to the localised nature of the voltage issues**,** Powerlink does not consider that any of the credible options will materially affect competition between generators, and generators' bidding behaviour and, consequently, considers that the

[23] In accordance with Rules clause 5.16.4(b)(6)(ii). AEMO has published guidelines for assessing whether a credible option is likely to have a material inter-network impact
[24] S3.6.1 Material classes of market benefits, AER, Regulatory investment test for transmission application guidelines, August 2020

techniques required to capture any changes in such behaviour would involve a disproportionate level of effort compared to the additional insight it would provide

- **option value**: the estimation of any option value benefit over and above that already captured via the scenario analysis in the RIT-T would require significant modelling, which would be disproportionate to any additional option value benefit that may be identified. No additional option value has therefore been estimated for this RIT-T
- **the negative of any penalty paid or payable:** Powerlink does not consider the reactive plant proposed will in any material way impact its obligation to meet any relevant government-imposed instruments

6.3 Consideration of market benefits for non-network options

Powerlink notes that non-network options may impact the wholesale electricity market (for example by displacing generation output). Accordingly, it is possible that several of the above classes of market benefits will be material where there are credible non-network options, depending on the specific form of the option.

Where credible non-network options are identified as part of the consultation process on this PSCR, Powerlink will assess the materiality of market benefits associated with these options. Where the market benefits are considered material, these will be quantified as part of the RIT-T assessment of these options.

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 PSCR compares the costs and benefits of the credible options developed to address the risks arising from an identified need, with a Base Case[25].

As characterised in the RIT-T Application Guidelines, the Base Case itself is not a credible option to meet the identified need. In developing the Base Case, the emerging over-voltage issues in SEQ are managed by the ongoing switching out of 275kV feeders and the dispatching of off-line synchronous generators to provide the necessary reactive support in the system.

Accordingly, the Base Case provides a clear reference point in the cost benefit analysis to compare any credible options (network or non-network).

7.2 Base Case assumptions

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

- Switching of the Middle Ridge to Greenbank 275kV circuits. The costs associated with switching of feeders as a strategy to manage over-voltages (advanced equipment replacement and an estimate for increased project costs) has been estimated within the base case.

- Dispatch of synchronous generating units within the greater Queensland network to absorb excess reactive power

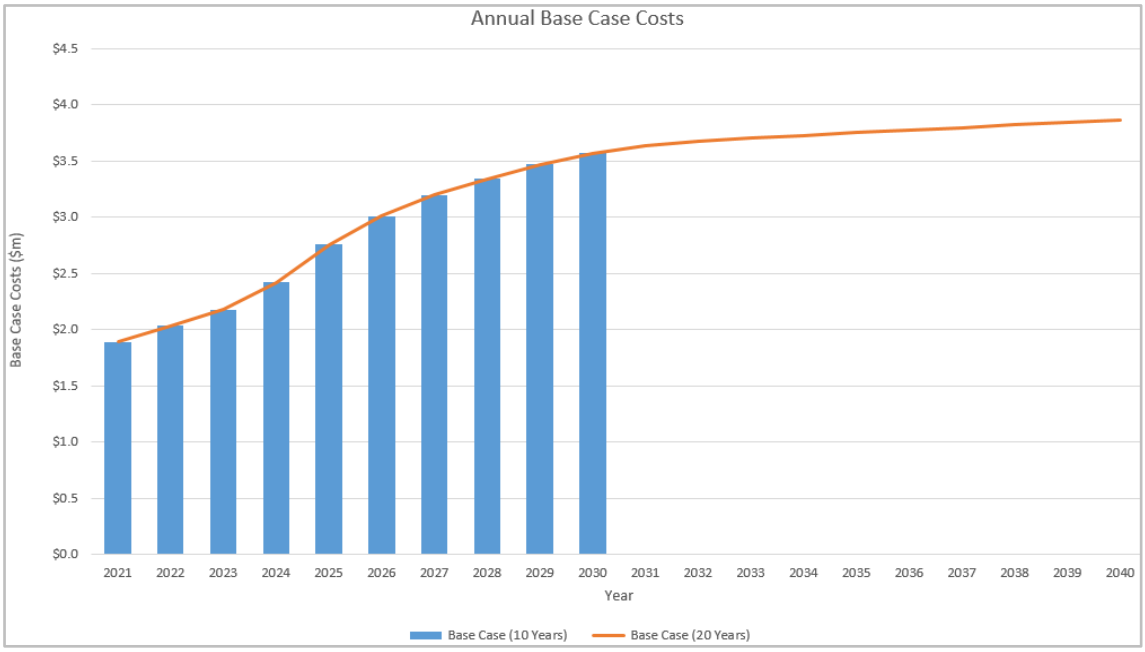
These measures have been modelled to increase over time with the continued uptake of roof-top PV systems, embedded renewable energy systems, and progressive installation of energy efficient devices within residential and commercial premises.

7.2.1 Base Case costs

The main cost categories are changes in the cost of ancillary generator services, as well as increases in equipment maintenance and replacement, project delays and network losses due to increased feeder switching.

[25] AER, Regulatory investment test for transmission application guidelines, August 2020

Figure 7.3: 20 year Base Case Cost Projections



7.3 Modelling of cost in Options

Each option is scoped to manage the major risks arising in the Base Case in order to maintain compliance with all statutory requirements. The residual risk and/or market benefits are calculated for each option based upon the individual implementation strategy of the option. These are included with the capital and operational costs of each option to develop the NPV inputs.

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

8 General modelling approach adopted for net benefit analysis

8.1 Analysis period

The RIT-T analysis has been undertaken over a 20-year period, from 2021 to 2040. A 20-year period takes into account the size and complexity of the additional reactive plant.

There will be remaining asset life by 2040, at which point a terminal value[26] is calculated to account for any future benefits that would accrue over the balance of the asset's life.

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%[27] 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%[28] and an upper bound discount rate of 8.33% (i.e. a symmetrical upwards adjustment).

[26] Terminal value was calculated based on remaining asset value using straight-line depreciation over the capital asset life

[27] This commercial discount rate on is based on AEMO's 2019 forecasting and planning scenarios, inputs, and assumptions report in accordance with AER, RIT-T, August 2020 paragraphs 18-19

[28] 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

8.3 Description of reasonable scenarios and sensitivities

The RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate market benefits and rank options. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration and reflect any variables or parameters that are likely to affect the ranking of the credible options, where the identified need is reliability corrective action[29].

8.3.1 Reasonable Scenarios

Given the specific and localised nature of the over-voltage limitations, the detailed market modelling using ISP scenarios from the most recent Input Assumptions and Scenario Report represents a disproportionate cost in relation to the scale of the proposed network investment, and will not materially impact the ranking of options[30].

Powerlink has chosen to present a single central scenario consistent with the requirements for reasonable scenarios in the RIT-T instrument [31] and in accordance with the provisions of the RIT-T Application Guidelines[32].

Table 8.1: Reasonable scenario assumed

Key variable/parameter	Central Scenario
Capital costs	100% of baseline capital cost estimate
Discount rate	5.90%
Maintenance costs	100% of baseline maintenance cost estimate
Market benefits	100% of baseline market benefit projection

9 Cost benefit analysis and identification of the preferred option

9.1 NPV Analysis

Table 9.1 outlines the NPV of the credible network options relative to the Base Case.

Table 9.1: NPV of the credible network options relative to the Base Case ($m, 2020/21)

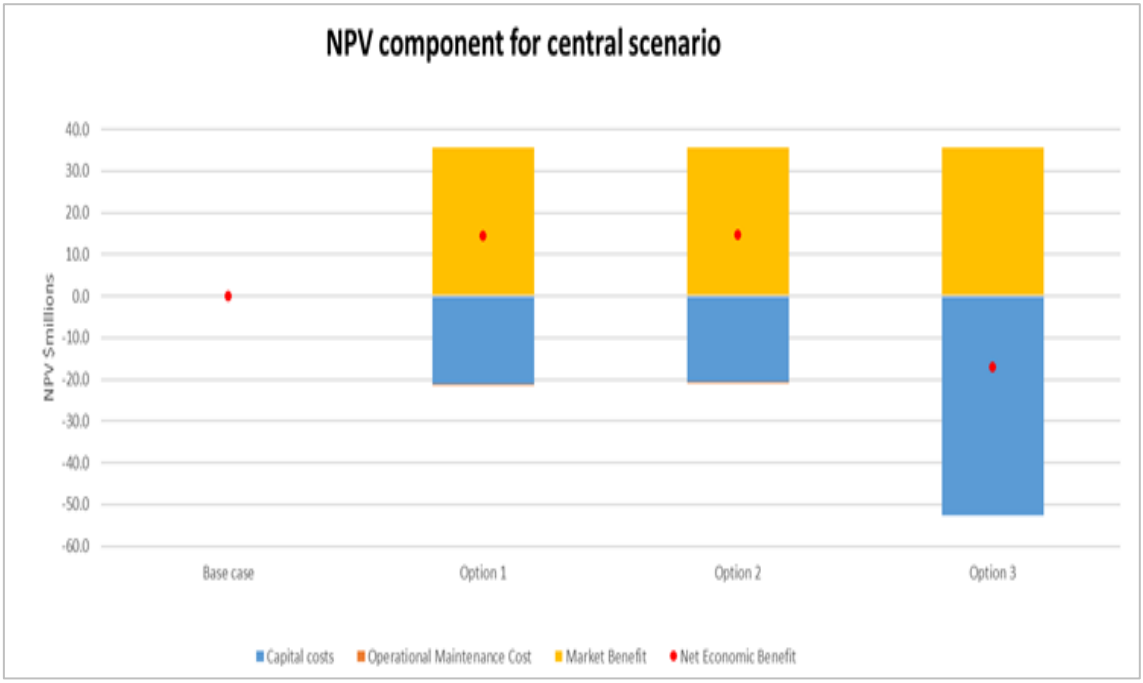
Option	Description	Net Economic Benefit ($m)	Ranking
1	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Greenbank Substations in Powerlink's South East Queensland Transmission Network from 2022	14.27	2
2	Install a total of 3x 120MVAr bus reactors at Woolooga, Blackstone and Belmont Substations in Powerlink's South East Queensland Transmission Network from 2022	14.69	1
3	Install 11 x reactors on the Energex Network in the Sunshine Coast, Gold Coast and Brisbane areas from 2022	-17.12	3

[29] AER, Regulatory investment test for transmission, August 2020, Section 23
[30] AER, Final: RIT–T, August 2020, sub-paragraph 20(b)
[31] AER, Final: RIT–T, August 2020, sub-paragraph 22
[32] S3.8.1 Selecting reasonable scenarios, RIT-T Application Guidelines, August 2020

The credible network options address the identified need on an enduring basis by installing additional reactive capacity.

Figure 9.1 sets out the breakdown of capital cost, operational maintenance cost and market benefit of the credible options, as well as the net economic benefit in weighted NPV terms. All credible options have positive net economic benefits compared to the Base Case.

Figure 9.1: NPV of the Base Case and credible option (NPV $m)



9.2 Sensitivity analysis

Sensitivity analysis was carried out to test the robustness of the analysis resulting in the preferred option and to determine if any factors would change the order of the credible options assessed:

The following sensitivities on key assumptions were investigated:

- 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.

Figures 9.2 to 9.4 show the impacts of varying the discount rate, capital expenditure and operational maintenance expenditure on the NPV relative to the Base Case. Option 2 is the preferred option under all scenario tested.

Figure 9.2: Discount Rate Sensitivity

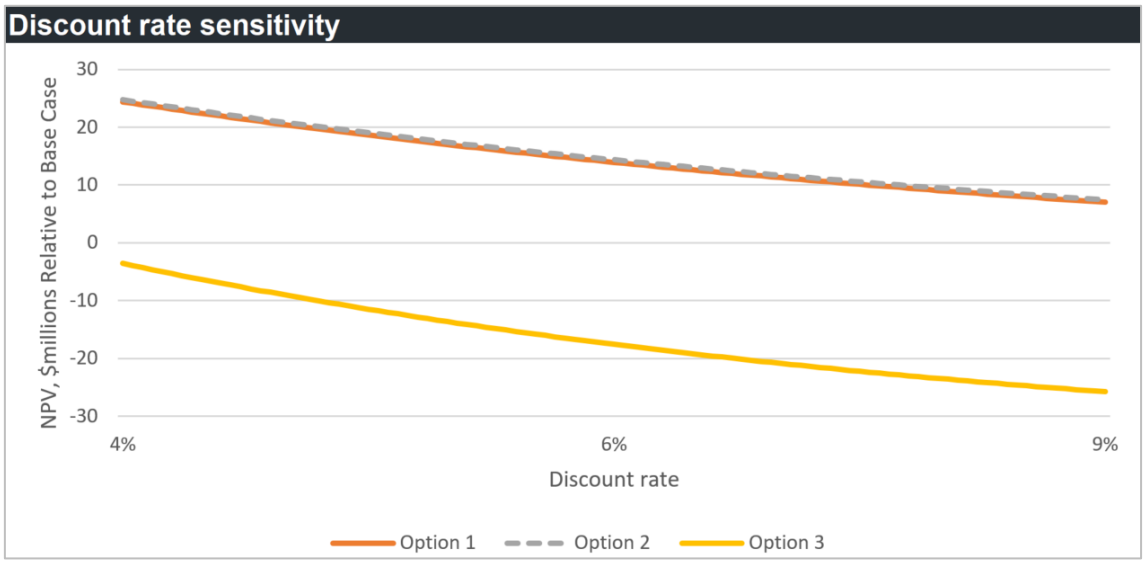


Figure 9.3: Capital Cost Sensitivity

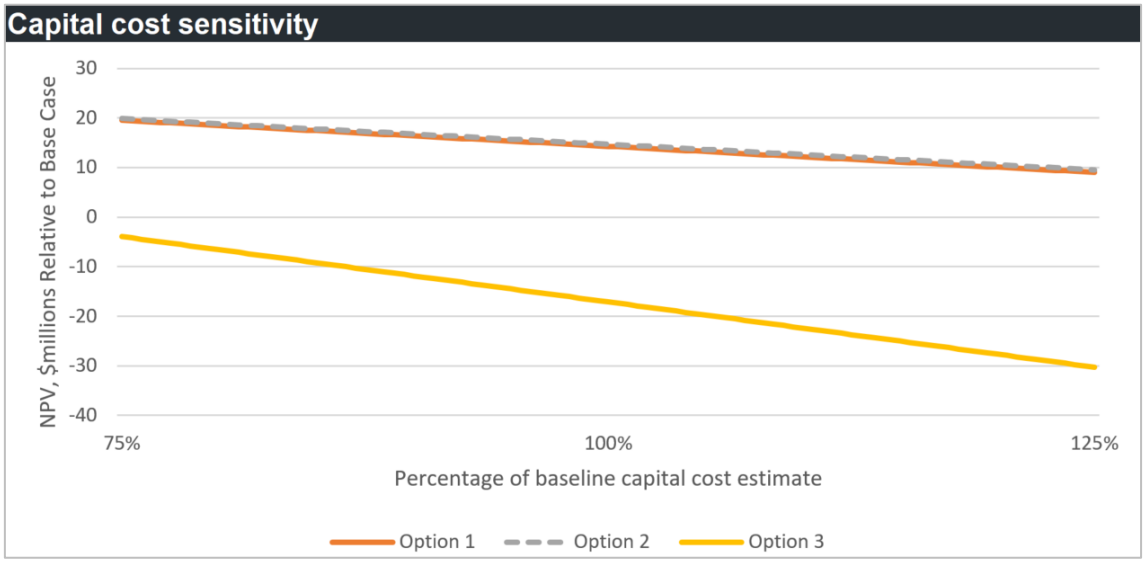
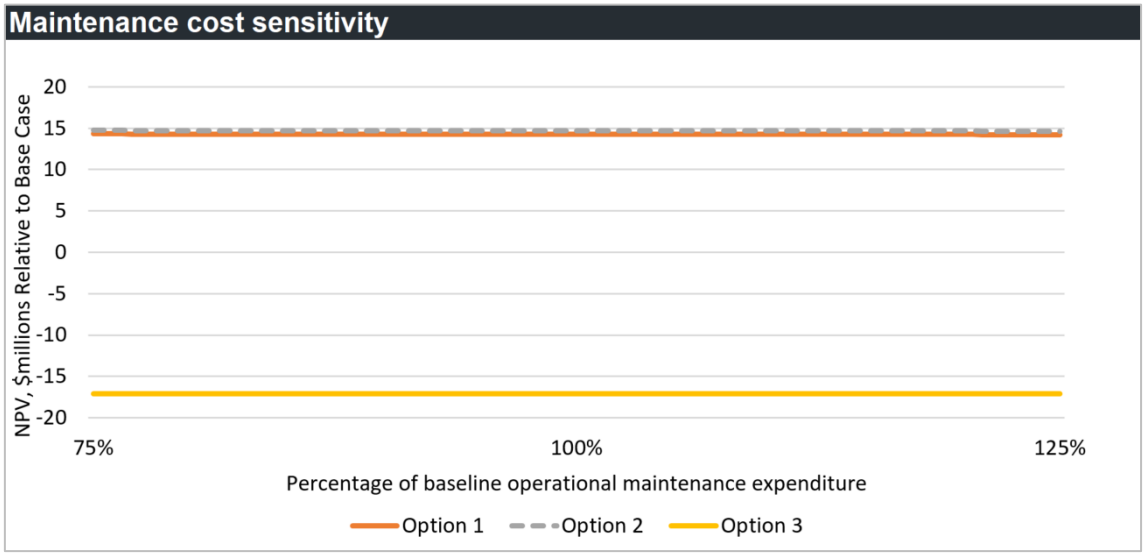


Figure 9.4: Maintenance Cost Sensitivity

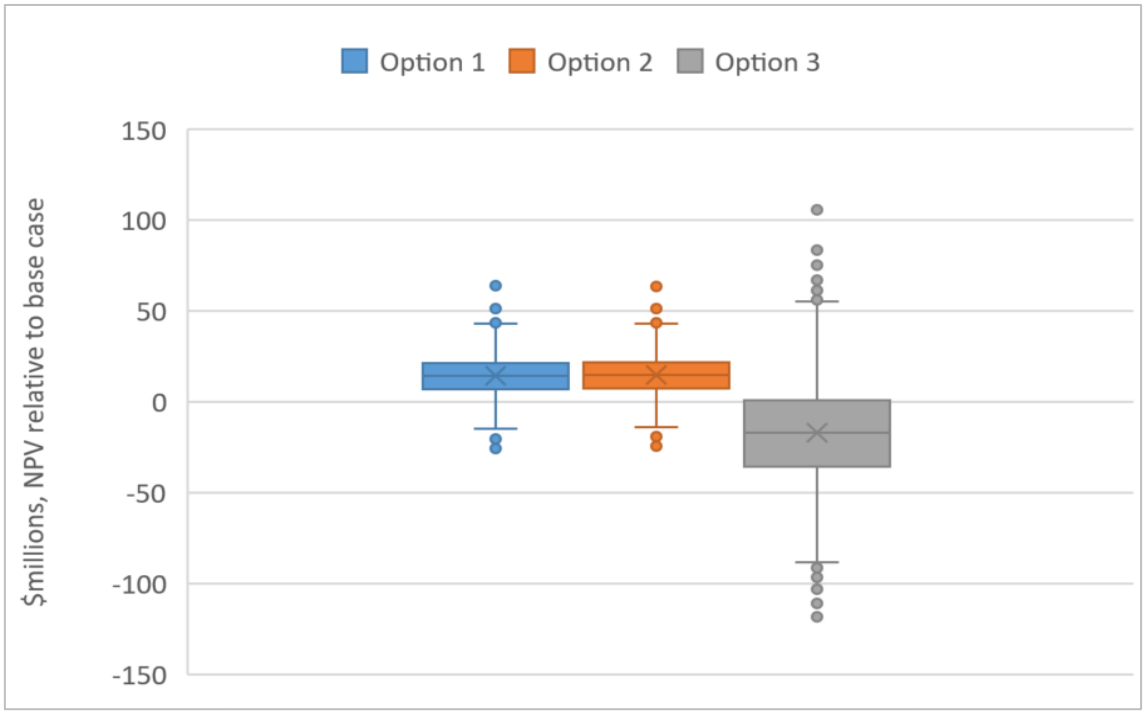


9.3 Sensitivity to multiple parameters

A Monte Carlo simulation was performed with multiple input parameters (including capital cost, discount rate, operational maintenance cost) generated for the calculation of the NPV for the credible network 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 the credible option, as illustrated in Figure 9.5.

The Monte Carlo simulation results identify that Option 2 has less statistical dispersion in comparison to Options 3 and has a highest mean of the three Options. This confirms that the preferred option, Option 2, is robust over a range of input parameters in combination.

Figure 9.5: NPV sensitivity analysis of multiple key assumptions relative to the Base Case



9.4 Conclusion

The Base Case is not a credible option, in that it does not allow Powerlink to continue to maintain compliance with relevant standards, applicable regulatory instruments and the Rules. As the investment is classified as a 'reliability corrective action' under the Rules, the purpose of the RIT-T is to identify the credible option that minimises the total cost to customers.

Installing reactors at Woolooga, Blackstone and Belmont Substation presents the highest net economic benefit to customers and is considered to satisfy the RIT-T.

10 Draft recommendation

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 proposed network Option 2 be implemented to address over-voltage issues in SEQ. Implementing this option will also ensure ongoing compliance with relevant standards, applicable regulatory instruments and the Rules.

Option 2 involves the installation of reactors at Woolooga, Blackstone and Belmont Substations at an indicative capital cost of $29.61 million in 2020/21 prices.

Under this option, installation and commissioning of the reactors will commence in mid-2022 and will be completed by 2025 .

11 Submissions requirements

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

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

11.1 Submissions from non-network providers

This is not a tender process – submissions are requested so that Powerlink can fulfil its regulatory obligations to analyse non-network options. In the event that a non-network option appears to be a genuine and practicable alternative that could satisfy the RIT-T, Powerlink will engage with that proponent or proponents to clarify cost inputs and commercial terms.

Submissions from potential non-network providers should contain the following information:

- details of the party making the submission (or proposing the service)
- technical details of the project (capacity, proposed connection point if relevant, etc.) to allow an assessment of the likely impacts on future supply capability
- sufficient information to allow the costs and benefits of the proposed service to be incorporated in a comparison in accordance with AER RIT-T guidelines
- an assessment of the ability of the proposed service to meet the technical requirements of the Rules
- timing of the availability of the proposed service
- other material that would be relevant in the assessment of the proposed service.

As the submissions will be made public, any commercially sensitive material, or material that the party making the submission does not want to be made public, should be clearly identified.

It should be noted that Powerlink is required to publish the outcomes of the RIT-T analysis. If parties making submissions elect not to provide specific project cost data for commercial-in-confidence reasons, Powerlink may rely on cost estimates from independent specialist sources.

11.2 Assessment and decision process

Powerlink intends to carry out the following process to assess what action, if any, should be taken to address future supply requirements:

Part 1	PSCR Publication	30 July 2021
	Submissions due on the PSCR Have your say on the credible options and propose potential non-network options.	29 October 2021
Part 3	Publication of the PACR Powerlink's response to any further submissions received and final recommendation on the preferred option for implementation.	December 2021

Powerlink reserves the right to amend the timetable at any time. Amendments to the timetable will be made available on the Powerlink website (www.powerlink.com.au).

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