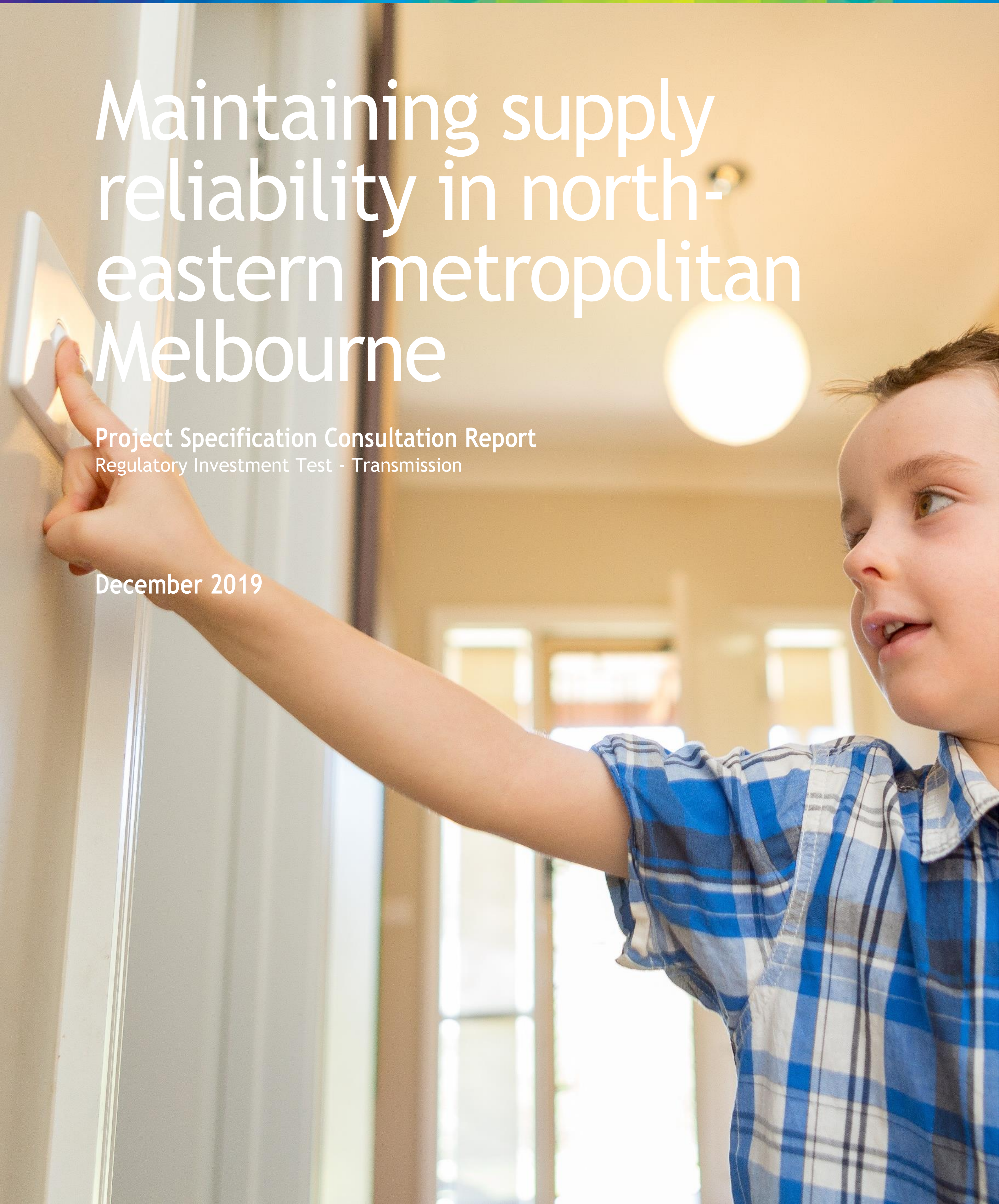
Maintaining supply reliability in north-eastern metropolitan Melbourne

Project Specification Consultation Report

Regulatory Investment Test - Transmission

December 2019



Important notice

Purpose

AusNet Services has prepared this document to provide information about potential limitations in Victoria transmission network and options that could address these limitations.

Disclaimer

This document may or may not contain all available information on the subject matter this document purports to address. The information contained in this document is subject to review and may be amended any time.

To the maximum extent permitted by law, AusNet Services makes no representation or warranty (express or implied) as to the accuracy, reliability, or completeness of the information contained in this document, or its suitability for any intended purpose. AusNet Services (which, for the purposes of this disclaimer, includes all of its related bodies corporate, its officers, employees, contractors, agents and consultants, and those of its related bodies corporate) shall have no liability for any loss or damage (be it direct or indirect, including liability by reason of negligence or negligent misstatement) for any statements, opinions, information or matter (expressed or implied) arising out of, contained in, or derived from, or for any omissions from, the information in this document.

Executive summary

AusNet Services is initiating this Regulatory Investment Test for Transmission (RIT-T) to evaluate options for maintaining supply reliability in north-eastern metropolitan Melbourne. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process in accordance with clause 5.16 of the National Electricity Rules (NER)[1] and section 4.2 of the RIT-T Application Guidelines[2].

Templestowe Terminal Station is owned and operated by AusNet Services and is located in Templestowe, next to the Manningham City Council Depot in Victoria. It was commissioned in 1966 and serves as the main transmission connection point for distribution of electricity to approximately 116,000 customers. It supplies 1,100 GWh of electric energy per year.

Identified need

As expected of assets that have been in service for a long time, the condition of the transformers, circuit breakers, and instrument transformers at Templestowe Terminal Station has deteriorated to a level where there is a material risk of asset failure, which could have an impact on electricity supply reliability, safety, environment, and potential costs of emergency replacements. Therefore, the 'identified need' this RIT-T intends to address is to maintain supply reliability in north-eastern metropolitan Melbourne and mitigate risks from asset failures.

AusNet Services estimates that the present value of the baseline risk costs associated with maintaining the existing assets in service is $77 million – the biggest component of which comes from the supply interruption risks borne by electricity consumers. AusNet Services is therefore investigating options that could allow continued delivery of safe and reliable supply of electricity to consumers.

Credible options

AusNet Services estimates that network or non-network investments are likely to deliver more economical and reliable solutions to maintaining supply reliability in north-eastern metropolitan Melbourne, compared with keeping the existing assets in service. AusNet Services has identified the following credible network solutions that could meet the identified need:

- Option 1 – Replacement of both the transformers and the circuit breakers in a single, integrated project;
- Option 2 – Staged replacement, with one transformer replacement deferred by seven years; and
- Option 3 – Staged replacement, with the 66 kV circuit breakers deferred by seven years.

AusNet Services also welcomes proposals from proponents of non-network options (stand-alone or in conjunction with a network solution), that may meet the identified need, such as:

- options that avoid the need for a 220/66 kV Templestowe Terminal Station and which are of sufficient scale and flexibility to supply 350 MW or more;
- options that defer the need to replace at least one 220/66 kV transformer, by addressing short-term supply shortfalls in an event of simultaneous outage of two transformers at the

[1] Australian Energy Market Commission, *"National Electricity Rule version126,"* available at https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current, viewed on 7 November 2019.
[2] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission,"* available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%2014%20December%202018_0.pdf, viewed on 7 November 2019.

terminal station; and

- options that allow for one or more of the 66 kV distribution rings to become self-sufficient in islanded operation by providing local supply or demand curtailment in conjunction with local supply options.

Assessment approach

AusNet Services will investigate the costs, the economic benefits, and the ranking of options in this RIT-T assessment.

The robustness of the ranking and optimal timing of options will be investigated through:

- the use of three scenarios that are selected to explore a wide range of potential benefits: a high-benefit scenario, a central scenario, and a low-benefit scenario; and
- sensitivity analysis which involves variations of assumptions around the relevant variables from those employed under the central scenario.

Submissions

AusNet Services welcomes written submissions on the issues and the credible options presented in this PSCR, and invites proposals from proponents of potential non-network options.

Submissions should be emailed to rittconsultations@ausnetservices.com.au on or before 24 March 2020. In the subject field, please reference 'RIT-T PSCR Templestowe Terminal Station.'

Next steps

Assessments of the options and responses to this PSCR will be presented in the Project Assessment Draft Report (PADR) that is intended to be published before 24 June 2020.

Table of Contents

Figures

Tables

1. Introduction

AusNet Services is initiating this Regulatory Investment Test for Transmission (RIT-T) to evaluate options for maintaining supply reliability in north-eastern metropolitan Melbourne, in the light of deteriorating assets at Templestowe Terminal Station. Publication of this Project Specification Consultation Report (PSCR) represents the first step in the RIT-T process[3] in accordance with clause 5.16 of the National Electricity Rules (NER)[4] and section 4.2 of the RIT-T Application Guidelines.[5]

This document describes:

- the identified need that AusNet Services is seeking to address, together with the assumptions used in identifying this need;
- credible network options that may address the identified need;
- the technical characteristics that would be required of a non-network option to address the identified need;
- the assessment approach and scenarios AusNet Services is intending to employ for this RIT-T assessment; and
- the specific categories of market benefits that are unlikely to be material in this RIT-T.

The need for investment to address risks from the deteriorating assets is included in AusNet Services' revenue proposal for the current regulatory control period (2017 to 2022)[6]. This investment need is also presented in AusNet Services Asset Renewal Plan that is published as part of AEMO's 2019 Victorian Transmission Annual Planning Report (VAPR)[7].

1.1. Making submissions

AusNet Services welcomes written submissions on the issues and the credible options presented in this PSCR and invites proposals from proponents of potential non-network options. Submissions should be emailed to rittconsultations@ausnetservices.com.au on or before 24 March 2020. In the subject field, please reference 'RIT-T PSCR Templestowe Terminal Station.'

Submissions will be published on AusNet Services' and AEMO's websites. If you do not wish for your submission to be made public, please clearly stipulate this at the time of lodgment.

[3] A RIT-T process will assess the economic efficiency and technical feasibility of proposed network and non-network options.
[4] Australian Energy Market Commission, *"National Electricity Rule version126,"* available at https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current, viewed on 7 November 2019.
[5] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission,"* available at https://www.aer.gov.au/system/files/AER%20-%20Final%20RIT-T%20application%20guidelines%20-%2014%20December%202018_0.pdf, viewed on 7 November 2019.
[6] Australian Energy Regulator, *"AusNet Services - Determination 2017-2022,"* p. 42, available at https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/ausnet-services-determination-2017%E2%80%932022/revised-proposal, viewed on 7 November 2019.
[7] Australian Energy Market Operator, *"Victorian Annual Planning Report,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Victorian-transmission-network-service-provider-role/Victorian-Annual-Planning-Report, viewed on 7 November 2019.

2. Identified need

The role of Templestowe Terminal Station in providing supply services to meet a growing electricity demand and the condition of key assets is discussed below. Quantification of the risk costs associated with the deterioration of these assets, and the need for the investments is also presented.

2.1. Supply to north-eastern metropolitan Melbourne

The 220/66 kV Templestowe Terminal Station is owned and operated by AusNet Services and is located in Templestowe, Victoria. Since it was commissioned in 1966, Templestowe Terminal Station has served as the main transmission service connection point for distribution of electricity to communities in north-eastern Melbourne – from Eltham in the north to Canterbury in the south, and from Donvale in the east to Kew in the west.[8]

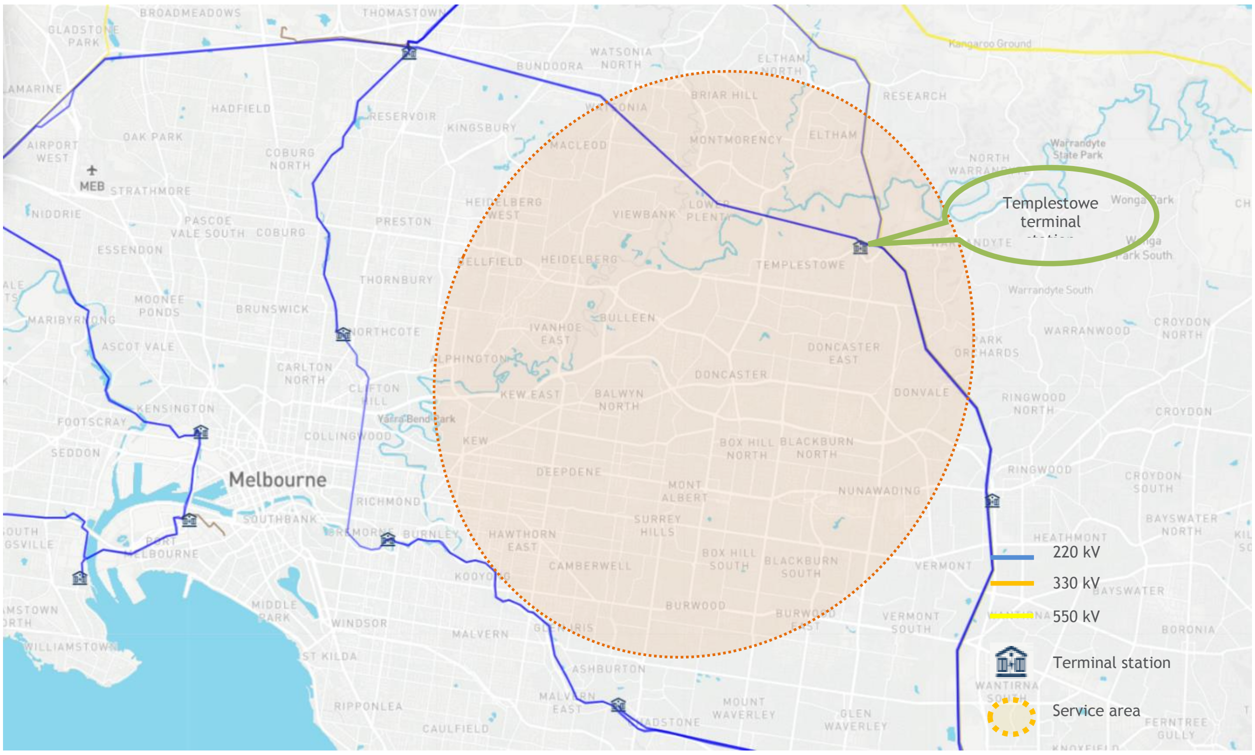


Figure 1 – North-eastern metropolitan Melbourne transmission network and relevant service area

Electricity demand

Around 116,000 customers depend on Templestowe Terminal Station for their electricity supply. While 93% of these customers are residential, approximately 40% of energy supplied by Templestowe Terminal Station is consumed by commercial customers– equivalent to 360 GWh[9] per year, see Table 1.

---

[8] Distribution of electricity to relevant communities is supported by four businesses: United Energy, CitiPower, AusNet Services, and Jemena Electricity Networks.

[9] This figure is metered quantity and does not include the appropriate allocation of distribution losses.

Table 1 - Customer number and demand composition

Customer type	Number of customers	Share of consumption (%)
Residential	108,491	57.07
Commercial	6,768	40.04
Industrial	528	2.81
Agricultural	86	0.08
Total	115,877	100

Peak demand at Templestowe Terminal Station is normally experienced during summer periods. The highest peak demand of 357.6 MW[10] was recorded in the summer of 2008/09 during an extreme weather event. The annual peak demand has not reached that level since 2008/09, in the summer of 2018/19 peak demand was 337.2 MW[11].

The Australian Energy Market Operator (AEMO) forecasts[12] that the peak demand at Templestowe Terminal Station will grow at an average annual rate of 0.5% over the next ten years. Figure 2 shows the 10% probability of exceedance (POE10)[13] and the 50% probability of exceedance (POE50)[14] forecasts for peak demand during summer and winter periods.[15]

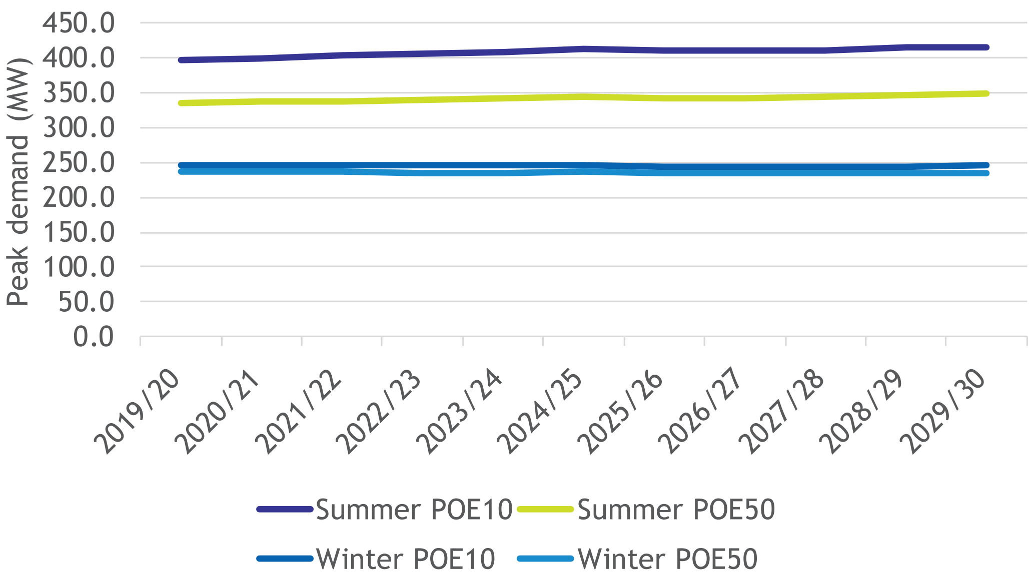


Figure 2 - Demand forecasts for Templestowe Terminal Station

Due to the existing and growing demand, both AEMO and the relevant Distribution Network Service Providers (DNSPs) recognise that there is ongoing and additional need for electricity supply services to communities in north-eastern Melbourne. The augmentation plans detailed in the 2018 Distribution Annual Planning Report (DAPR) that have been developed to increase the capacity of this terminal

[10] Equivalent to 377.1 MVA of apparent electrical demand.
[11] Equivalent to 348.1 MVA of apparent electrical demand.
[12] Australian Energy Market Operator (AEMO), *"2018 Transmission Connection Point Forecast for Victoria,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting/Victoria, viewed on 7 November 2019.
[13] A POE10 forecast indicates a level where there is 10 % likelihood that actual peak demand will be greater.
[14] A POE50 forecast indicates a level where there is 50 % likelihood that actual peak demand will be greater.
[15] Victorian electricity demand is sensitive to ambient temperature, hence, peak demand forecasts are based on expected demand during extreme temperature that could occur once every ten years (POE10) and during average summer condition that could occur every second year (POE50).

station,[16,17,18,19,20] align with the asset maintenance and replacement strategies for this part of the network.

Embedded generation

There is one embedded generator greater than 1 MW within the network served by Templestowe Terminal Station.

Electricity network

Templestowe Terminal Station sources its electricity supply from Thomastown and Rowville Terminal Stations. It is part of the eastern metropolitan 220 kV network which supplies most of the inner north-eastern suburbs of Melbourne, as shown in Figure 1.

The terminal station supplies four 66 kV ring networks that distribute electricity to customers, namely: Doncaster zone substation (DC), Heidelberg to Kew to Deepdene zone substations (HB-Q-L), West Doncaster to Bulleen zone substations (WD-BU), and Eltham zone substation (ELM), as shown in Figure 3. These rings are designed to provide redundancies and increase supply reliability for electricity consumers.

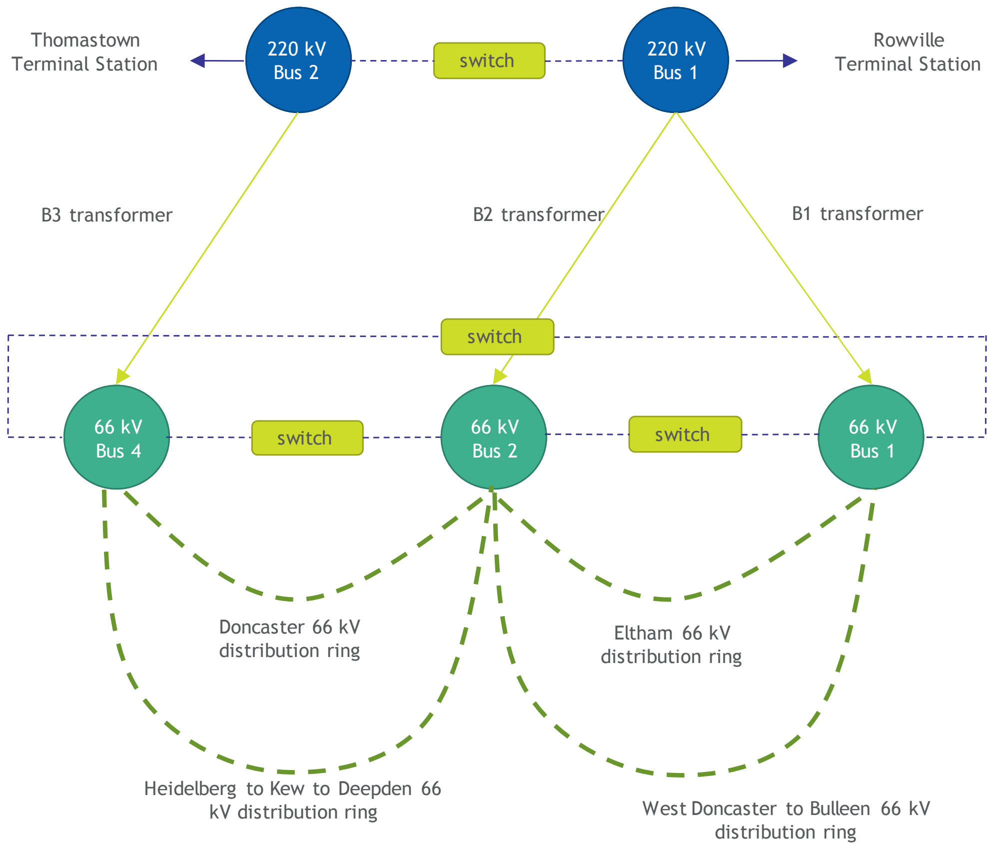


Figure 3 - Representative diagram for Templestowe Terminal Station

---

[16] Australian Energy Market Operator, *"2019 Victorian Annual Planning Report (VAPR),"* available at https://www.aemo.com.au/Media-Centre/2019-Victorian-Annual-Planning-Report---VAPR, viewed on 7 November 2019.
[17] CitiPower, *"Distribution Annual Planning Report,"* available at https://media.powercor.com.au/wp-content/uploads/2019/02/05081603/CitiPower-Distribution-Annual-Planning-Report-2018-final.pdf, viewed on 7 November 2019.
[18] United Energy, *"Distribution Annual Planning Report,"* available at https://www.unitedenergy.com.au/wp-content/uploads/2018/12/UE-Distribution-Annual-Planning-Report-DAPR-2018.pdf, viewed on 7 November 2019.
[19] Jemena Electricity Networks (Vic) Limited, *"Distribution Annual Planning Report,"* available at https://jemena.com.au/documents/electricity/jen-2018-dapr-v1-1.aspx, viewed on 7 November 2019.
[20] AusNet Services, *"Regulatory Publications,"* available at https://www.ausnetservices.com.au/Misc-Pages/Links/About-Us/Publications, viewed on 7 November 2019.

2.2. Asset condition

Several primary (power transformers and circuit breakers) and secondary (protection and control) assets at Templestowe Terminal Station are in poor and deteriorating condition as expected of assets that have been in service for a long time.

AusNet Services classifies asset conditions using scores that range from C1 (initial service condition) to C5 (extreme deterioration) – as set out in Appendix C. The latest asset condition monitoring for Templestowe Terminal Station was conducted in 2019 and reveals that most assets at the terminal station are in poor condition (C4), or are rapidly deteriorating (C5). For the affected assets, the probability of failure is high, and is likely to increase further if no remedial action is taken. Table 2 provides a summary of the condition of relevant primary and secondary assets.

Table 2 - Summary of major equipment condition scores

Asset class	Condition scores				
	C1	C2	C3	C4	C5
Power transformers		1		2	
66 kV circuit breakers		1	2	1	12
220 kV instrument transformers				5	
66 kV instrument transformers				1	5
Station service transformers and switchboard					2

Power transformers

There are three 150 MVA 220/66 kV transformers at Templestowe Terminal Station. The 'B2' and 'B3' transformers were commissioned in late 1960's. The transformers have deteriorated significantly and according to the recent asset condition assessment report, the transformers are in poor condition and in advanced deterioration. Assets in this condition (C4) requires remedial action within the next five years.

AusNet Services estimates that there is a high probability that a winding failure, major tap changer failure or bushing failure of either 'B2' or 'B3' transformer will result in extended service interruption from the subsequent need for outages for repairs or replacement. The probability of a transformer failure is forecast to increase over time as the condition of these two transformers deteriorates further.

66 kV circuit breakers

Eleven of the sixteen 66 kV circuit breakers at Templestowe Terminal Station are bulk-oil circuit breakers, three are sulfur-hexafluoride (SF6) gas insulated circuit breakers, and two are minimum oil circuit breakers. The bulk-oil circuit breakers are among the oldest circuit breakers installed in AusNet Services' network. They have been in service for more than 50 years. The vast majority of these circuit breakers have suffered extreme deterioration and are approaching their end of economic and technical life[21]. This is expected of assets that have been in service for a long time. The two minimum oil circuit breakers are also in poor and deteriorating condition.

[21] Australian Energy Regulator, *"Industry practice application note for asset replacement planning,"* available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning, viewed on 7 November 2019.

With condition scores of C4 and C5, these circuit breakers present challenges due to: duty-related deterioration including erosion of arc control devices, bushing oil leakages, and wear of operating mechanisms and drive systems; intensive maintenance; lack of spares and manufacturer support; lack of oil containment bunding; and limited fault level capability requiring restrictive switching configurations.

Instrument transformers

All six 66 kV oil-insulated post-type current transformers and five other 220 kV current transformers installed at Templestowe Terminal Station are assessed to be in poor condition and in an advanced deterioration phase (C4 and C5). Fourteen other voltage transformers at the terminal station are in the same condition. Management of safety risks from potential explosive failures[22] of instrument transformers of this type is costly due to the need for regular oil sampling and partial discharge condition monitoring.

Station service transformers and switchboard

Templestowe Terminal Station's alternating current supply comes from two station service transformers that are at the end-of-serviceable-life. The station service transformers and the associated switchboard were installed in 1966.

Secondary systems

Over the years, incremental upgrades of protection systems for specific primary assets within Templestowe Terminal Station have been necessary. Some of the very old technologies such as electromechanical type relays from 1966 and first generation digital relays have mal-operated in the past and have been incrementally replaced with newer protection equipment. However, not all relays have been replaced, leaving various technologies designed in different time periods interacting with each other.

Further interfaces between existing equipment and the new protection systems required for new replacement primary plant will complicate the non-standard protection system configuration even more, and will increase the corresponding operation and maintenance costs. Therefore replacement of the secondary systems is considered in the credible options reviewed in this RIT-T

2.3. Description of the identified need

Templestowe Terminal Station provides electricity supply to north-eastern metropolitan Melbourne. AusNet Services expects that the services that the terminal station provides will continue to be required as the demand for electricity is forecast to increase in the future. However, the poor and deteriorating condition of some of the components at the terminal station has increased the likelihood of asset failures. Such failures would result in prolonged substation outages.

Without remedial action, other than ongoing maintenance practice (business-as-usual), affected assets are expected to deteriorate further and more rapidly. This will increase the probability of failure, resulting in a higher likelihood of electricity supply interruptions, heightened safety risks due to potential explosive failure of the assets, environment risks from possible oil spillage, collateral damage risks to adjacent plant, and the risk of increased costs resulting from the need for emergency asset replacements and reactive repairs.

Therefore, the 'identified need' this RIT-T intends to address is to maintain supply reliability in north-eastern metropolitan Melbourne and mitigate risks from relevant asset failures.

AusNet Services has estimated the present value of the baseline risk costs is $77 million over the forty-

[22] Since 2002, two current transformers of this type have failed explosively in the Victorian network.

five year period from 2019/20. The key elements of these risk costs are shown in Figure 4. The largest component of the baseline risk costs comes from the supply interruption risks, borne by electricity consumers, from potential failure of components.

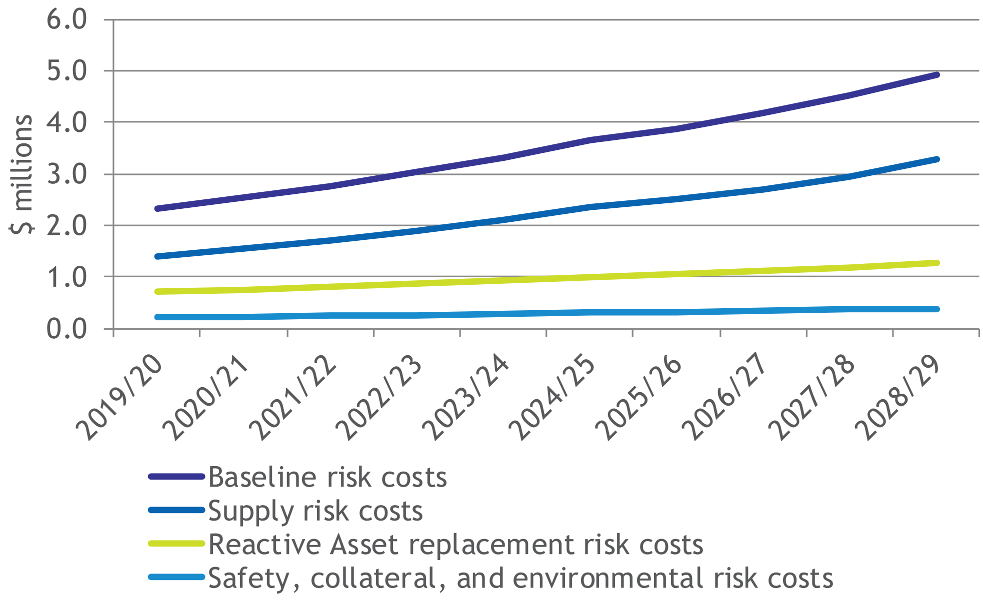


Figure 4 - Baseline risk costs

By undertaking the options identified in the RIT-T, AusNet Services will be able to maintain supply reliability in north-eastern metropolitan Melbourne and mitigate safety and environmental risks, as required by the NER and Electricity Safety Act.

2.3.1. Assumptions

Aside from the failure rates (determined by the condition of the assets) and the likelihood of relevant consequences, AusNet Services has adopted a number of other assumptions to quantify the risks associated with asset failure. These assumptions are detailed in the following subsections.

Supply risk costs

In calculating the supply risk costs, AusNet Services has estimated the unserved energy based on the most recent AEMO demand forecasts for Templestowe Terminal Station,[23] and has valued this expected unserved energy at an appropriate Value of Customer Reliability (VCR)[24]. The choice of VCR value is based on those published by AEMO, escalated to 2019/20 values, and the composition of customers supplied by the terminal station. The resulting estimate of the weighted VCR applicable for affected customers is $35,172/MWh.

AusNet Services is aware that the Australian Energy Regulator (AER) is reviewing the Value of Customer Reliability and will update this assumption once the findings are published.

The total supply risk cost is calculated by estimating the impacts of different combinations of relevant

[23] Australian Energy Market Operator (AEMO), *"2018 Transmission Connection Point Forecast for Victoria,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Transmission-Connection-Point-Forecasting/Victoria, viewed on 7 November 2019.

[24] In dollar terms, the Value of Customer Reliability (VCR) represents a customer's willingness to pay for the reliable supply of electricity. The values produced are used as a proxy, and can be applied for use in revenue regulation, planning, and operational purposes in the National Electricity Market (NEM). Australian Energy Market Operator, *"Value of Customer Reliability,"* available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Value-of-Customer-Reliability-review, viewed on 7 November 2019.

outages to reliability of supply in the north-eastern metropolitan area and weighting them by their probabilities of occurrence.

Safety risk costs

The *Electricity Safety Act 1998*[25] requires AusNet Services to design, construct, operate, maintain, and decommission its network to minimize hazards and risks to the safety of any person as far as reasonably practicable or until the costs become disproportionate to the benefits from managing those risks.

In implementing this principle for assessing safety risks from explosive asset failures, AusNet Services uses:

- a value of statistical life[26] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[27]; and
- a disproportionality factor[28].

AusNet Services notes that this approach, including the use of a disproportionality factor, is consistent with practice notes[29] provided by the AER.

Financial risk costs

As there is a lasting need for the services that Templestowe Terminal Station provides, the failure rate-weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[30]

Environmental risk costs

Environmental risks from plant that contains large volumes of oil, which may be released in an event of asset failure, is valued at $30,000 per event while risks from transformers with oil containing poly-chlorinated biphenyls (PCB), such as those at Templestowe Terminal Station, are valued at $100,000 per event.

---

[25] Victorian State Government, Victorian Legislation and Parliamentary Documents, *"Energy Safe Act 1998,"* available at http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/LTObject_Store/ltobjst9.nsf/DDE300B846EED9C7CA257616000A3571/1D9C11F63DEBA5E2CA257E70001687F4/%24FILE/98-25aa071%20authorised.pdf, viewed on 7 November 2019.

[26] Department of the Prime Minister and Cabinet, Australian Government, *"Best Practice Regulation Guidance Note: Value of statistical life,"* available at https://www.pmc.gov.au/resource-centre/regulation/best-practice-regulation-guidance-note-value-statistical-life, viewed on 7 November 2019.

[27] Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13," available at https://www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf, viewed on 7 November 2019.

[28] Health and Safety Executive's submission to the1987 Sizewell B Inquiry suggesting that a factor of up to 3 (i.e. costs three times larger than benefits) would apply for risks to workers; for low risks to members of the public a factor of 2, for high risks a factor of 10. The Sizewell B Inquiry was public inquiry conducted between January 1983 and March 1985 into a proposal to construct a nuclear power station in the UK.

[29] Australian Energy Regulator, *"Industry practice application note for asset replacement planning,"* available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning, viewed on 7 November 2019.

[30] The assets are assumed to have survived and their condition-based age increases throughout the analysis period.

3. Credible network options

AusNet Services will consider both network and non-network options to address the identified need caused by the deteriorating assets at Templestowe Terminal Station.

The three network options that AusNet Services has identified are presented below while the technical requirements that a non-network option would have to provide are detailed in the next chapter.

3.1. Option 1 – Replacement of both the transformers and the circuit breakers in a single, integrated project

Option 1 involves replacement of the relevant 220/66 kV transformers, 66 kV circuit breakers, and the secondary assets, in a single integrated project.

The estimated capital cost of this option is $48.2 million. The estimated operating cost is $7,000 per year.

AusNet Services' preliminary analysis shows that the optimal timing is to deliver a solution as soon as possible. Allowing for construction lead time, the earliest commissioning date is in 2023/24.

3.2. Option 2 – Staged replacement, with one transformer replacement being deferred

Option 2 is a staged replacement option to reduce the failure rates of the assets in phases. In the first stage, the secondary assets and all deteriorated primary assets except one of the 220/66 kV transformers will be replaced. The remaining 220/66 kV transformer will then be replaced after the completion of the first stage.

The estimated capital cost of the first and second stage of this option is $42.9 million and $14.2 million respectively. The estimated operating cost is $8,000 per year.

AusNet Services' preliminary analysis shows that the optimal timing to deliver a solution is as soon as possible. Allowing for construction lead time, the earliest commissioning date for the first stage is in 2023/24. The second stage is seven years after.

3.3. Option 3 – Staged replacement, with the 66 kV circuit breakers being deferred

Option 3 is another staged replacement option. In the first stage, the secondary assets and all deteriorated assets except for the 66 kV circuit breakers will be replaced. The 66 kV circuit breakers will be replaced after the completion of the first stage.

The estimated capital cost of the first and second stage of this option is $33.4 million and $18.9 million respectively. The estimated operating cost is $13,000 per year.

AusNet Services' preliminary analysis shows that the optimal timing to deliver a solution is as soon as possible. Allowing for construction lead time, the earliest commissioning date for the first stage is in 2023/24. The second stage is seven years after.

3.4. Options considered but not progressed

Retirement of aging plant: Though it may avoid emergency reactive replacement, environment, and safety risk costs, retiring at least one transformer will reduce the terminal station's capacity and will inadvertently increase the supply risk costs. The overload control scheme installed at the terminal station allows for the remaining in-service transformers to be operated at higher ratings, however it is not sufficient to mitigate electricity supply risks caused by asset failure if one transformer was already retired. The expected high annual supply risk cost if a transformer was retired, shown in Figure 5, demonstrates that the service provided by the asset will continue to be required in the future. Consequentially, there would be a requirement to urgently replace the asset should they fail.

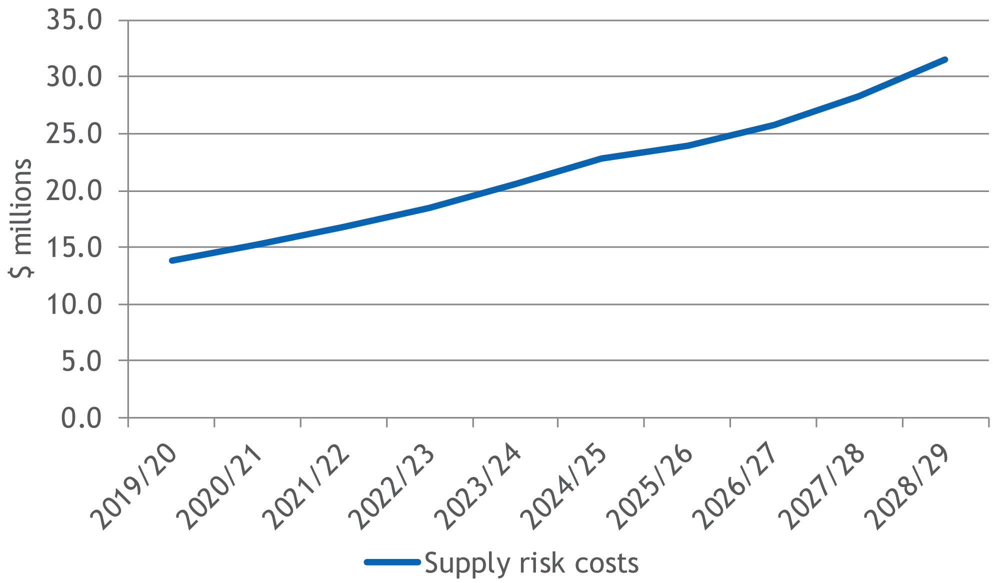


Figure 5 - Supply risk costs if one transformer was retired

Therefore, any option that reduces the terminal stations' capability is not progressed further.

Refurbishment options do not significantly reduce the failure rates and the risks from asset failure and are therefore not progressed further. Hence, refurbishment options are not proposed for this RIT-

3.5. Material inter-regional network impact

As the Templestowe Terminal Station network is electrically radial, and the network impact is confined within the inner suburbs of Melbourne, none of the network options being considered are likely to have a material inter-regional network impact. A 'material inter-regional network impact' is defined in the NER as:

> *"A material impact on another Transmission Network Service Provider's network, which may include (without limitation): (a) the imposition of power transfer constraints within another Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."*

AEMO's suggested screening test to indicate that a transmission augmentation has no material inter-network impact is that it satisfies the following[31]

[31] Inter-Regional Planning Committee, *"Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations,"* available at https://www.aemo.com.au/-/media/Files/PDF/170-0035-pdf.pdf, viewed on 7 November 2019.

- a decrease in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW
- an increase in fault level by less than 10 MVA at any substation in another TNSP's network
- the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

By reference to AEMO's screening criteria, there is no material inter-regional network impact associated with any options considered.

4. Non-network options

AusNet Services welcomes proposals from proponents of non-network options that could be implemented on a stand-alone basis or in conjunction with a network option to meet or contribute to meeting the identified need for this RIT-T. AusNet Services will evaluate non-network options identified as part of the Project Assessment Draft Report, based on their economic and technical feasibility.

Table 3 lists some of the potential non-network services that AusNet Services considers may assist in meeting the identified need:

Table 3 - Potential services that could be provided by non-network options

Non-network option	High-level requirements	Supplementary network requirements
Supply to north-eastern metropolitan Melbourne	Permanent supply that meets a peak demand of about 350 MW and a total annual energy of more than 1,100 GWh. This service must also be expandable to meet forecast growth in the service area.	As this service would avoid the need for the 220/66 kV connection station, transmission lines could bypass Templestowe Terminal Station and the terminal station could be retired.
Back-up supply (combined network and non-network solution)	At least 150 MW of back-up supply for major transformer failure(s).	This service could defer the need for replacement of the 150 MVA 220/66 kV transformers
Supply to at least one 66 kV ring that is connected to Templestowe Terminal Station	Supply for the entire service requirement of any of the 66 kV rings to make it self-sufficient.	This service allows selective-replacement of assets, disconnection of the relevant 66 kV ring, and retirement of relevant feeder circuit breakers but will require reconfiguration of distribution networks. Depending on the size and which ring the non-network option is offered at, this service could reduce the scope of replacement needs and allow deferral of investment while mitigating the failure risks from deteriorating assets.

4.1. Required technical characteristics of a non-network option

Up to 200 MW of demand is at risk of being shed during a simultaneous outages of two 220/66 kV transformers to avoid overloading of the remaining transformer. Non-network options could potentially address this risk of supply shortfall, reducing the risk costs associated with such an event.

Figure 6 shows a typical annual demand profile serviced by Templestowe Terminal Station and the supportable demand levels for different network outage configurations. Using this reference demand profile, any non-network option would need to be able to reliably and immediately reduce the loading on the terminal station by at least 150 MW for up to 12 hours per day within 6 hours following failure of one or more transformers.

Whilst this section provides basic information that proponents of non-network solutions could use to evaluate their proposals, AusNet Services invites a collaborative approach and is open for discussions to maximize the potential benefits from non-network options.

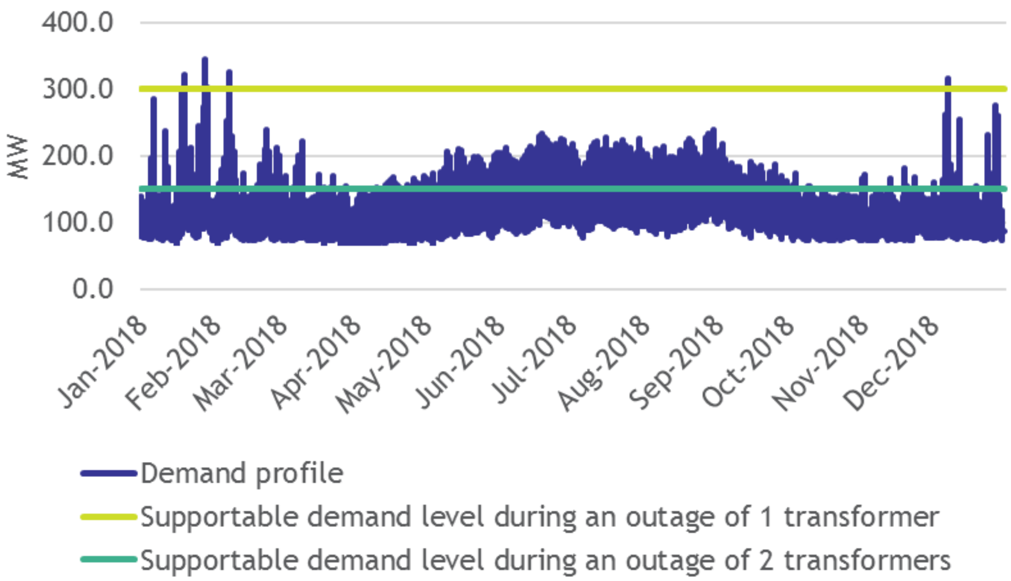


Figure 6 - Typical annual demand profile and supportable demand levels at different network configurations at Templestowe Terminal Station

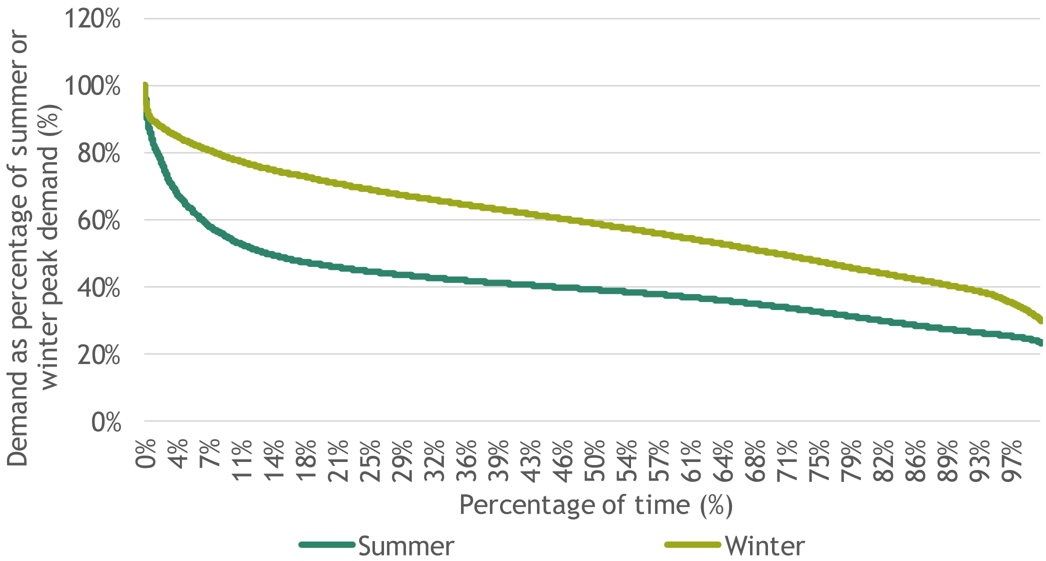


Figure 7 - Templestowe Terminal Station summer and winter demand duration curves

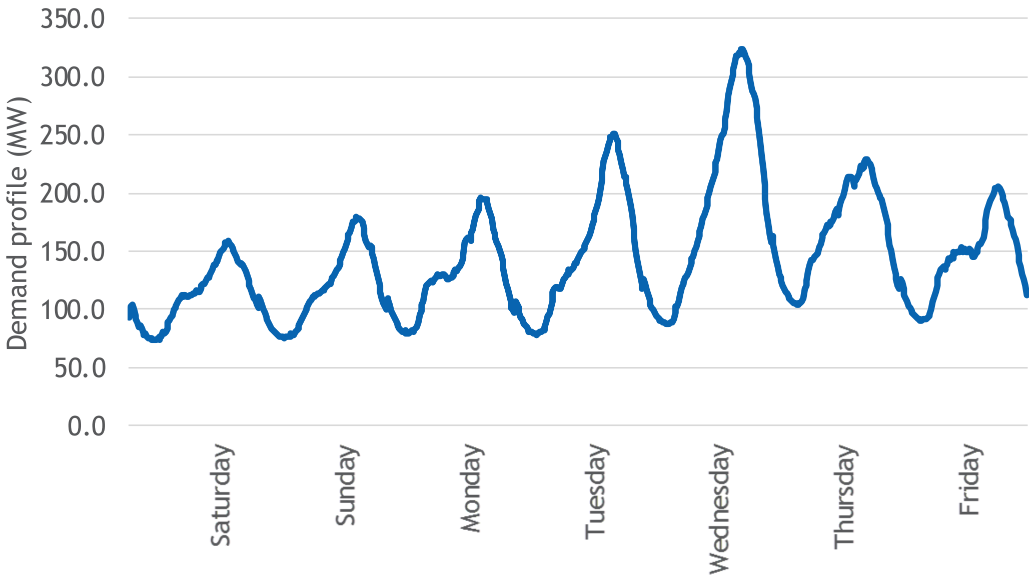


Figure 8 - Templestowe Terminal Station typical summer weekly demand profile

4.2. Location of non-network option

Non-network options connected to any of the four 66 kV rings[32] supplied from Templestowe Terminal Station could be most effective in addressing this risk of supply shortfall.

4.3. Information to be included in non-network solution proposals

To manage a complex portfolio of demand management of sufficient scale, proposals for non-network solutions must be at least 5 MW in size and of proven technology which may include embedded generation, energy storage (including battery system) that injects power into the grid as required, voluntary curtailment of customer demand, and permanent reduction of customer demand (including energy efficiency).

Table 4 shows the relevant parameters that must be included in any proposal for non-network solution.

Table 4 - Required information that a proponent of non-network option must submit

Parameter	Description
Block ID	Block Identifier (e.g. Block 1) of non-network solution
Block capacity	Discrete amount of the non-network option (reduced demand or additional supply) capacity in MW. Sum of block capacities must meet a minimum requirement of 5 MW. AusNet Services may choose to select a subset of blocks it determines that is most economical and reliable to dispatch.
Location	For new generation solutions, details of the proposed sites for the new generators
Availability period	Time periods the blocks are available (months/days/hours)

[32] Doncaster zone substation (DC), Heidelberg to Kew to Deepdene zone substations (HB-Q-L), West Doncaster to Bulleen zone substations (WD-BU), and Eltham zone substation (ELM), as per Chapter 2

Parameter	Description
Call notice period	Minimum period of time before the block can be dispatched
Establishment fee	Setup payment that applies to a block
Availability fee	A fee per month for a block to be made available to be dispatched
Indicative dispatch fee	Fee for a block to be dispatched per MWh
Dispatch lead time	Time required (in hours) to activate the non-network service
Timeframe for project delivery	When the block of DR will be available for dispatch
Communications	Proposed dispatch communications protocol with AusNet Services' control room
Metering	Metering equipment installed or to be installed to measure and record the data to be verified
Any other special technical requirements	e.g. terms of commitment and length of service.

Proposals for non-network solutions should be emailed to rittconsultations@ausnetservices.com.au by 24 March 2020.

5. Assessment approach

Consistent with the RIT-T requirements and practice notes on risk-cost assessment methodology[33], AusNet Services will undertake a cost-benefit analysis to evaluate and rank the net economic benefits of various credible options.

AusNet Services proposes to undertake this assessment over a 45-year period.

All options considered will be assessed against a business-as-usual case where no proactive capital investment to reduce the increasing baseline risks is made.

Optimal timing of an investment option will be the year when the annual benefits from implementing the option become greater than the annualised investment costs.

5.1. Proposed scenarios and input assumptions

The robustness of the investment decision is tested using scenarios described in Table 5.

Table 5 - Summary of input assumptions for the proposed scenarios

Parameter	Low-benefit scenario	Central	High-benefit scenario
Description	explore the lower bound of potential benefits	most likely scenario	gives high estimates for the benefits
Weighting	10%	80%	10%
Asset failure rate	AusNet Services assessment – 25%	AusNet Services assessment	AusNet Services assessment + 25%
Demand forecast	AEMO 2019 Transmission Connection Point Forecasts - 15%	AEMO 2019 Transmission Connection Point Forecasts	AEMO 2019 Transmission Connection Point Forecasts + 15%
Value of customer reliability	Latest AEMO VCR figures - 25%	Latest AEMO VCR figures	Latest AEMO VCR figures + 25%
Capital cost	AusNet Services assessment + 15%	AusNet Services assessment	AusNet Services assessment – 15%
Discount rate	8.49%, a symmetrical adjustment upwards	5.9% - the latest commercial discount rate[34]	3.31% - the latest regulated cost of capital[35,36,37]

AusNet Services proposes a weighting of 80% for the Central scenario as it expects it to be most likely. For the other two scenarios, a 10% weighting will be applied for each – as the simultaneous occurrence

[33] Australian Energy Regulator, *"Industry practice application note for asset replacement planning,"* available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning, viewed on 7 November 2019.

[34] Energy Networks Australia, *"RIT-T Economic Assessment Handbook,"* available at https://www.energynetworks.com.au/resources/fact-sheets/rit-t-economic-assessment-handbook/, viewed on 7 November 2019.

[35] Using the regulated nominal, pre-tax rate of return of 5.36% based on AER's final decision and the consumer price index of 1.7% as at September 2019 from the Reserve Bank of Australia.

[36] Reserve Bank of Australia, "Measures of Consumer Price Inflation," available at https://www.rba.gov.au/inflation/measures-cpi.html, viewed on 15 November 2019.

[37] Australian Energy Regulator, "AER releases final decision on rate of return for regulated energy networks," available at https://www.aer.gov.au/news-release/aer-releases-final-decision-on-rate-of-return-for-regulated-energy-networks, viewed on 7 November 2019.

of extreme parameters, which the scenarios represent, is less likely.

5.1.1. Sensitivity analysis

The robustness of the net economic benefits and the optimal timings of the options considered will be tested by using sensitivity analysis. This analysis involves variations of assumptions from those employed under the Central scenario.

5.2. Material classes of market benefits

NER clause 5.16.1(c)(4) formally sets out the classes of market benefits that must be considered in a RIT-T. AusNet Services estimates that the only class of market benefits that is likely to be material is the change in involuntary load shedding. AusNet Services' proposed approach to calculate the benefits of reducing the risk of load shedding is set out in section 2.3.

5.3. Other classes of benefits

Although not formally classified as classes of market benefits under the NER, AusNet Services expects material reduction in: safety risks from potential explosive failure of the assets, environment risks from possible oil spillage, collateral damage risks to adjacent plant, and the risk of increased costs resulting from the need for emergency asset replacements and reactive repairs by implementing any of the options considered in this RIT-T.

5.4. Classes of market benefits that are not material

AusNet Services estimates that the following classes of market benefits are unlikely to be material for any of the options considered in this RIT-T:

- Changes in fuel consumption arising through different patterns of generation dispatch - as the network is sufficiently radial to the extent that asset failures cannot be remediated by re-dispatch of generation, the wholesale market impact is expected to be the same for all options.
- Changes in costs for parties, other than the RIT-T proponent – there is no other known investment, either generation or transmission, that will be affected by any option considered.
- Changes in ancillary services costs – the options are not expected to impact on the demand for and supply of ancillary services.
- Change in network losses – while changes in network losses are considered in the assessment, they are estimated to be small and unlikely to be a material class of market benefits for any of the credible options.
- Competition benefits – there is no competing generation affected by the limitations and risks being addressed by the options considered for this RIT-T.
- Option value – as the need for and timing of any investment option is driven by asset deterioration, there is no need to incorporate flexibility in response to uncertainty around any other factor.

AusNet Services notes that non-network options of significant size and duration may impact the wholesale electricity market and the materiality of several of the classes of market benefits mentioned above. Where appropriate, AusNet Services will assess the materiality of these market benefits as part of the next step in the evaluation process.

Appendix A - RIT-T assessment and consultation process

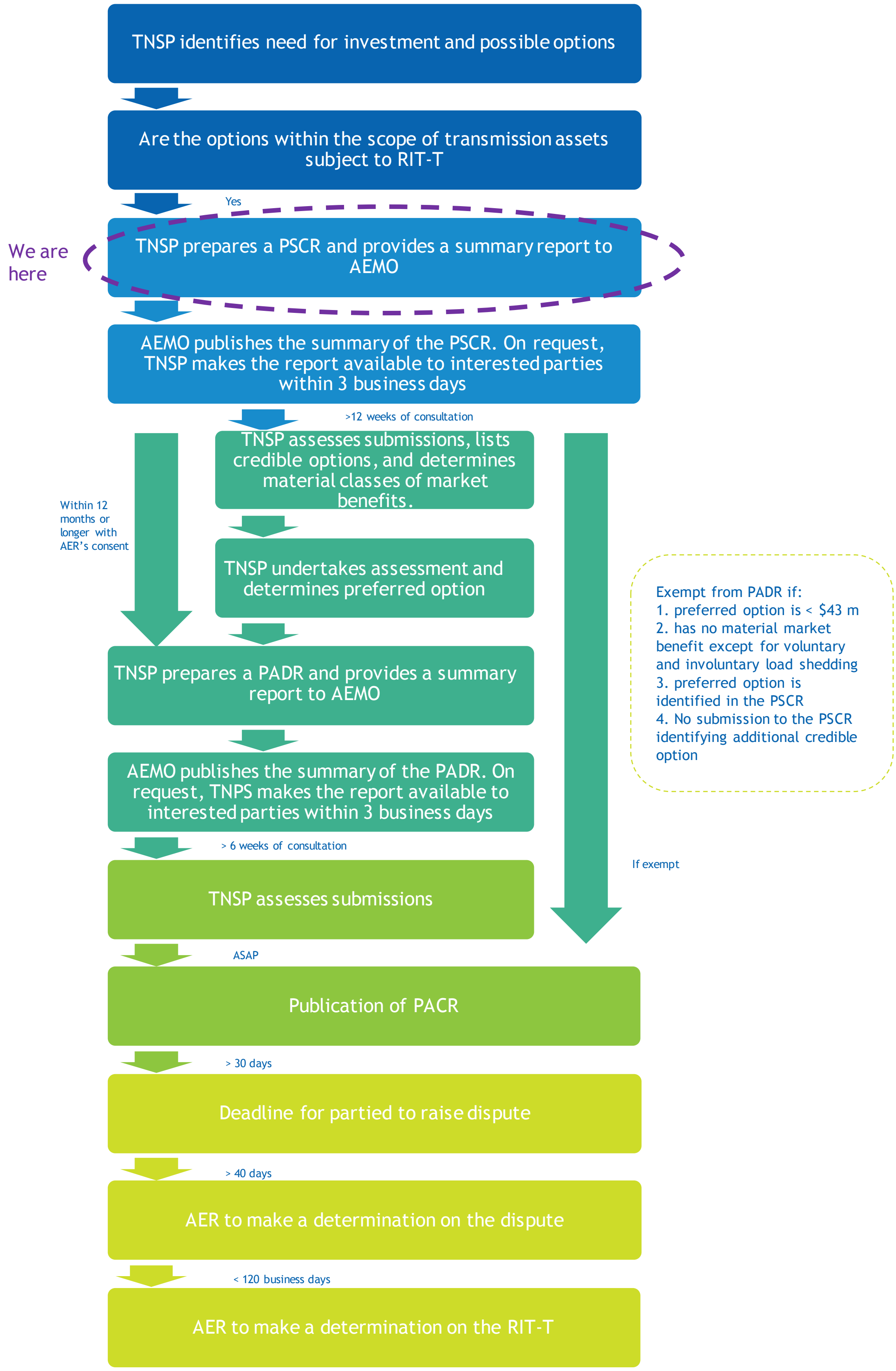


Figure 9 - RIT-T Process

Appendix B - Checklist of compliance clauses

The table below demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the National Electricity Rules version 126[38], which states that a RIT-T proponent must prepare a PSCR which must include:

Table 6 - Summary of requirements

Requirement	Relevant section
(1) a description of the identified need;	2
(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	2
(3) the technical characteristics of the identified need that a non-network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	4
(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent National Transmission Network Development Plan;	Not applicable
(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alterative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3
(6) for each credible option identified in accordance with subparagraph (5), information about: (i) the technical characteristics of the credible option; (ii) whether the credible option is reasonably likely to have a material inter-network impact; (iii) the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.1(c)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefit are not likely to be material; (iv) the estimated construction timetable and commissioning date; and (v) to the extent practicable, the total indicative capital and operating and maintenance costs.	3 and 5
A RIT-T proponent is exempt from paragraphs (j) to (s) if: 1. the estimated capital cost of the proposed preferred option is less than $35 million (as varied in accordance with a cost threshold determination); 2. the relevant Network Service Provider has identified in its project specification consultation report: (i) its proposed preferred option; (ii) its reasons for the proposed preferred option; and (iii) that its RIT-T project has the benefit of this exemption;	Not applicable

[38] Australian Energy Market Commission, *"National Electricity Rule version126,"* available at https://www.aemc.gov.au/regulation/energy-rules/national-electricity-rules/current, viewed on 7 November 2019.

Requirement	Relevant section
3. the RIT-T proponent considers, in accordance with clause 5.16.1(c)(6), that the proposed preferred option and any other credible option in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4) except those classes specified in clauses 5.16.1(c)(4)(ii) and (iii), and has stated this in its project specification consultation report; and 4. the RIT-T proponent forms the view that no submissions were received on the project specification consultation report which identified additional credible options that could deliver a material market benefit.	

Appendix C - Asset condition framework

AusNet Services uses an asset health index, on a scale of C1 to C5, to describe asset condition. The condition range is consistent across asset types and relates to the remaining service potential. The table below provides an explanation of the asset condition scores used.

Table 7 - Condition scores framework

Condition score	Likert scale	Condition description	Recommended action	Remaining service potential (%)
C1	Very Good	Initial service condition	No additional specific actions required, continue routine maintenance and condition monitoring	95
C2	Good	Better than normal for age		70
C3	Average	Normal condition for age		45
C4	Poor	Advanced deterioration	Remedial action or replacement within 2-10 years	25
C5	Very Poor	Extreme deterioration and approaching end of life	Remedial action or replacement within 1-5 years	15

Asset failure rates

AusNet Services uses the hazard function of a Weibull two-parameter distribution to estimate the probability of failure of an asset in a given year. The asset condition scores are used to establish a condition-based age which is used to calculate the asset failure rates using a two-parameter Weibull Hazard function (h(t)), as presented below.

$$h(t) = \beta.\frac{t^{\beta-1}}{\eta^{\beta}}$$

Equation 1: Weibull Hazard Function

where:

t = Condition-based age (in years)

η = Characteristic life (Eta)

β = Shape Parameter (Beta)

Hazard functions are defined for the major asset classes including power transformers, circuit breakers, and instrument transformers. All assets in the substation risk-cost model use a Beta (β) value of 3.5 to calculate the failure rates. The characteristic life represents that average asset age at which 63% of the asset class population is expected to have failed.

The condition-based age (t) depends on the specific asset's condition and characteristic life (η).