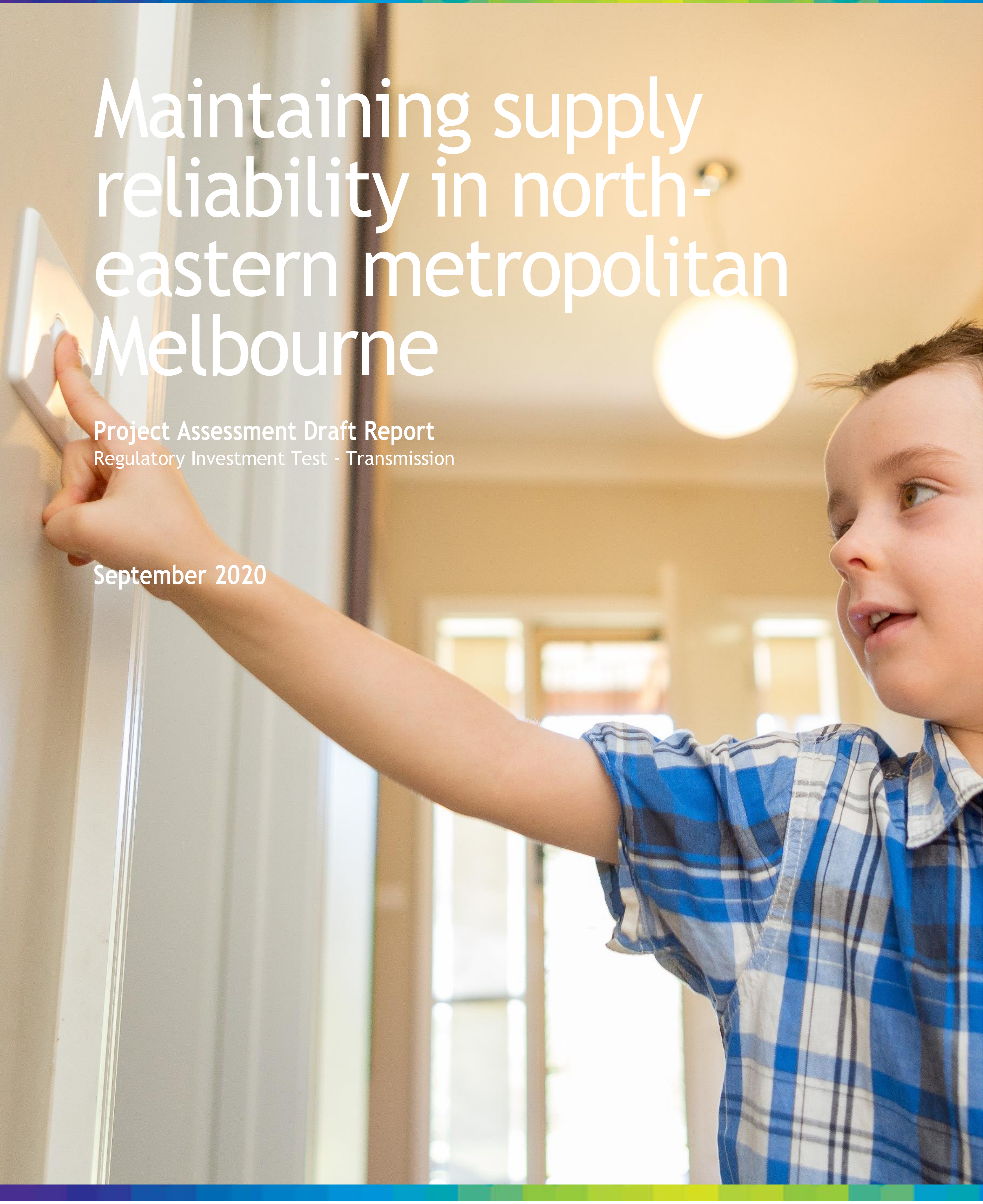

Maintaining supply reliability in north-eastern metropolitan Melbourne

Project Assessment Draft Report
Regulatory Investment Test - Transmission

September 2020

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.

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Executive summary

AusNet Services is undertaking this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain supply reliability in north-eastern metropolitan Melbourne. The Project Specification Consultation Report (PSCR), which 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] has been published in December 2019. This report, the Project Assessment Draft Report (PADR), is the second stage of the RIT-T and provides information about the draft conclusions of the RIT-T.

Templestowe Terminal Station (TSTS) is owned and operated by AusNet Services and is next to the Manningham City Council Depot in Templestowe, 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.

The draft conclusion of the RIT-T is that it is no longer economical to continue to provide supply with the existing assets at TSTS as the asset failure risk has increased to a level where investment to replace these assets present a more economical option based on the value that customers place on supply reliability.

No non-network proposals have been received during the RIT-T PSCR consultation phase. The preferred option to address the asset failure risk at TSTS is an integrated replacement of two of the three 220/66 kV transformers and selected 220 kV and 66 kV switchgear.

Identified need

As expected of assets that have been in service for a long time, the condition of some of the transformers, circuit breakers, and instrument transformers at TSTS 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 more than $84 million. The biggest component of the baseline risk is the risk of supply interruption due to unplanned asset failures, which is borne by electricity consumers. AusNet Services is therefore proposing investment in asset replacement options that would allow continued delivery of safe and reliable supply of electricity.

Credible options

AusNet Services did not receive any proposal for a non-network solution and did not identify a credible, economical non-network solution for the identified need at TSTS.

The following network investments are likely to deliver more economical and reliable solutions to maintain supply reliability in north-eastern metropolitan Melbourne compared with keeping the existing assets in service:

- Option 1 – Replacement of both transformers and switchgear in a single, integrated project;
- Option 2 – Staged replacement with one transformer replacement deferred; and

[1] Australian Energy Market Commission, *“National Electricity Rule version149,”*
[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.

- Option 3 – Staged replacement with the 66 kV switchgear deferred.

Assessment approach

AusNet Services followed the AER's Industry practice application note for asset replacement planning to analyse and rank the economic cost and benefits of the investment options considered in this RIT-T.

None of the options considered will have a material impact on generation market cost and no market simulation studies have hence been conducted for this RIT-T. Scenario analysis as is been used in AEMO's Integrated System Plan (ISP) was hence not required for this RIT-T.

The robustness of the ranking and optimal timing of options have been investigated through sensitivity analysis that involve variations of assumptions around the values used in the base case.

Options assessment and draft conclusion

AusNet Services' cost-benefit assessment confirms that integrated replacement (Option 1) is the most economic option as it provides the highest present value of net economic benefits as illustrated by the results of the sensitivity analysis in Figure 1.

This option will not only maintain supply reliability in north-eastern metropolitan Melbourne, but also mitigates safety, environmental, and emergency replacement risk costs from deteriorating assets at TSTS.

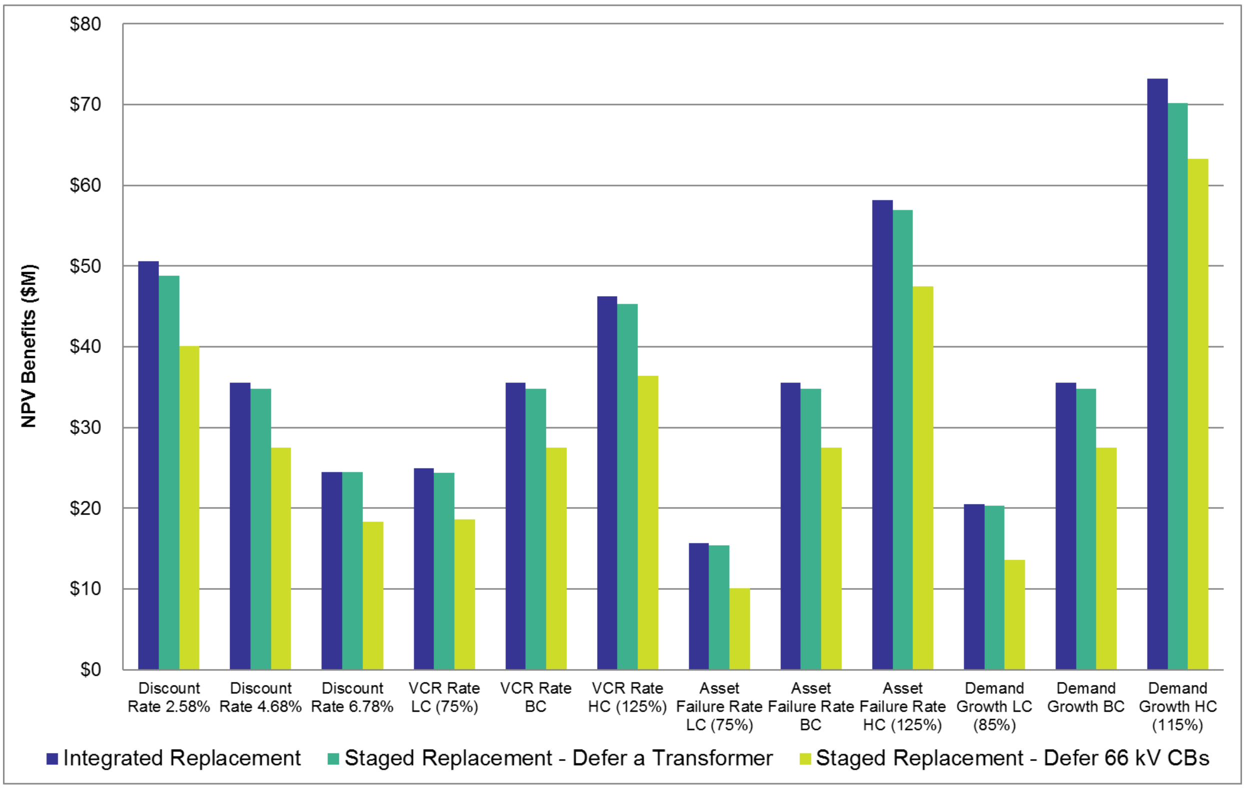

Figure 1 – Option selection sensitivity analysis

The optimal timing of Option 1 is 2022/23 as supported by the sensitivity analysis.

AusNet Services concluded that Option 1 is the most economical option and hence the preferred option to address the identified need and that the project should now proceed to meet the economical timing of 2022/23.

Submissions

AusNet Services welcomes written submissions on the issues and the credible options presented in this PADR. Submissions should be emailed to rittconsultations@ausnetservices.com.au on or before 26 October 2020. In the subject field, please reference 'RIT-T PADR Templestowe Terminal Station.'

Next steps

Assessments of the options and responses to this PADR will be presented in the Project Assessment Conclusions Report (PACR) that is intended to be published before 4 December 2020.

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Figures

Tables

1. Introduction

AusNet Services initiated this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain supply reliability in north-eastern metropolitan Melbourne due to the poor condition of some of the assets at TSTS. The Project Specification Consultation Report (PSCR) has been published in December 2019 in accordance with clause 5.16 of the National Electricity Rules (NER)[3] and section 4.2 of the RIT-T Application Guidelines.[4] Publication of this Project Assessment Draft Report (PADR) represents the second step in the RIT-T process[5] and describes the following:

- credible network options that may address the identified need;
- a summary of the submissions to the PSCR;
- the assessment approach and assumptions that AusNet Services has employed for this RIT-T assessment as well as the specific categories of market benefits that are unlikely to be material; and
- the identification of the proposed preferred option

The need for investment to address risks from the deteriorating assets at TSTS has been 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].

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[3] Australian Energy Market Commission, *"National Electricity Rule version149"*.
[4] 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.
[5] A RIT-T process will assess the economic efficiency and technical feasibility of proposed network and non-network options.
[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.
[7] Australian Energy Market Operator, *"Victorian Annual Planning Report"*.

2. Identified need

The role of TSTS in providing electricity supply services and the condition of key assets is discussed in this section. 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 TSTS is owned and operated by AusNet Services and is in Templestowe, Victoria. Since it was commissioned in 1966, TSTS 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 2 – North-eastern metropolitan Melbourne transmission network and service area

Electricity demand

Around 116,000 customers depend on TSTS for their electricity supply. While 93% of these customers are residential, approximately 40% of energy supplied by TSTS 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 the metered quantity and does not include the appropriate allocation of distribution losses.

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**

Table 1 - Customer number and demand composition

Peak demand at TSTS is normally experienced during summer periods. The highest peak demand of 357.6 MW 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 and during the summer of 2018/19 peak demand was 337.2 MW.

The Australian Energy Market Operator (AEMO) forecasts[10] that the peak demand at TSTS will grow at an average annual rate of 0.5% over the next ten years. Figure 3 shows the 10% probability of exceedance (POE10)[11] and the 50% probability of exceedance (POE50)[12] forecasts for peak demand during summer and winter periods.[13]

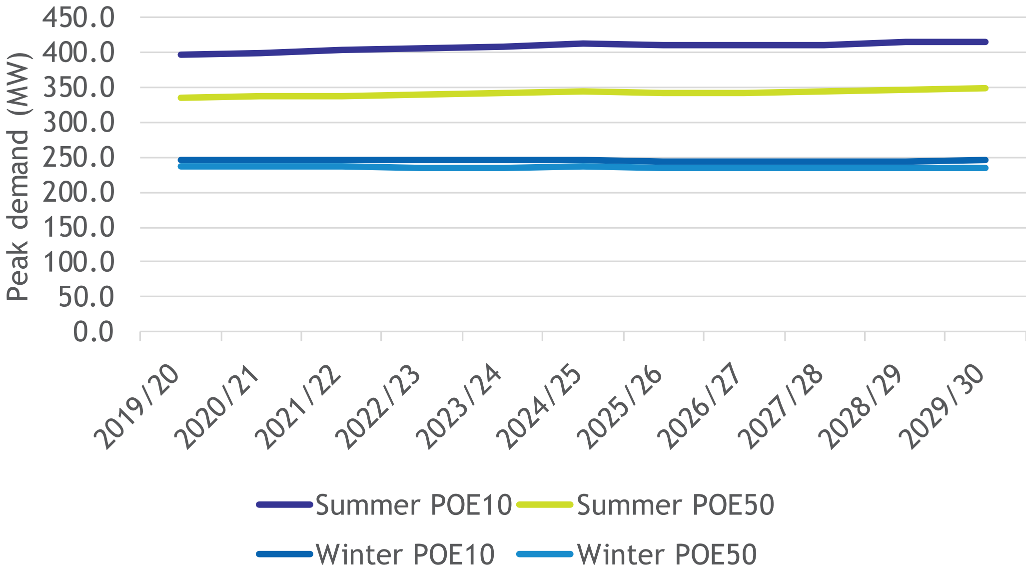

Figure 3 - Demand forecasts for TSTS

Due to the existing and growing demand, both AEMO and the relevant Distribution Network Service Providers (DNSPs) recognise that there is ongoing need for electricity supply services to communities in north-eastern Melbourne as reflected in the various jurisdictional planning reports.

Embedded generation

There is one embedded generator greater than 1 MW within the network served by TSTS.

[10] Australian Energy Market Operator (AEMO), *"2019 Transmission Connection Point Forecast for Victoria,"*
[11] A POE10 forecast indicates a level where there is 10 % likelihood that actual peak demand will be greater.
[12] A POE50 forecast indicates a level where there is 50 % likelihood that actual peak demand will be greater.
[13] Victorian electricity demand is sensitive to ambient temperature and 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).

Electricity network

TSTS 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 4. These rings are designed to provide redundancies and increase supply reliability for electricity consumers.

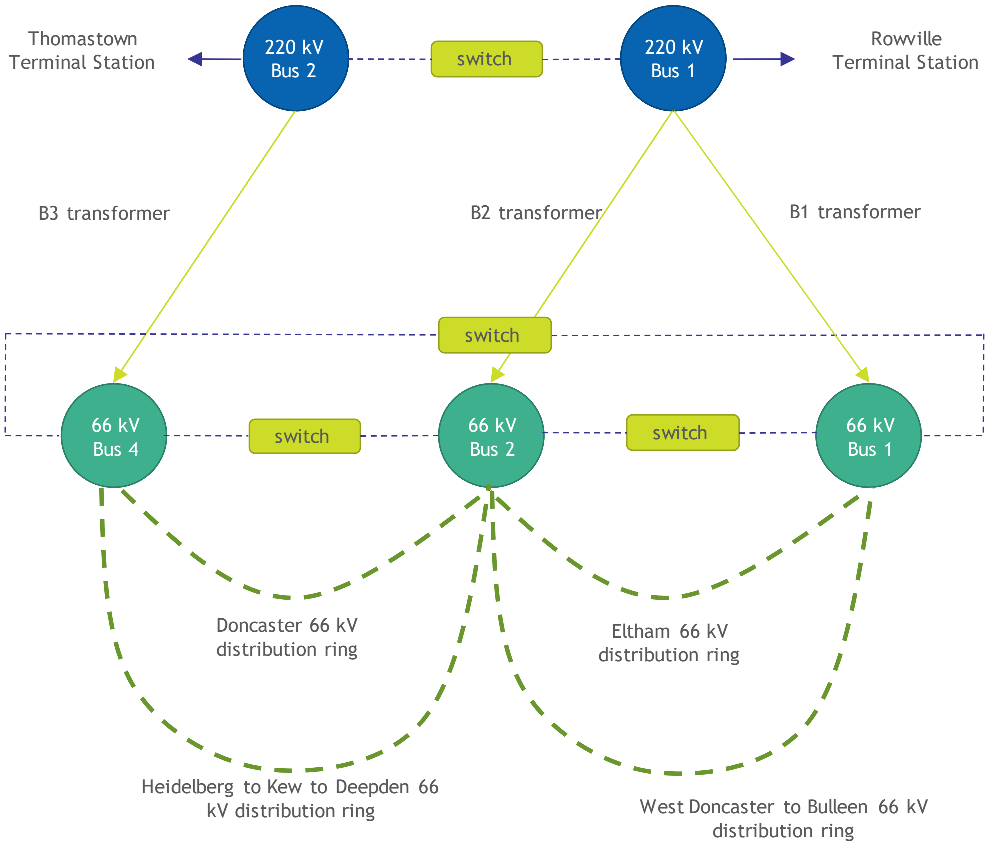

Figure 4 - Representative diagram for TSTS

2.2. Asset condition

Several primary (power transformers and switchgear) and secondary (protection and control) assets at TSTS 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 selected 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.

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

Table 2 - Summary of major equipment condition scores

Power transformers

There are three 150 MVA 220/66 kV transformers at TSTS. 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. Assets in this condition (C4) requires remedial action within the next ten years.

AusNet Services considers that there is a high probability that a winding failure, major tap changer failure or bushing failure of either the 'B2' or 'B3' transformer will result in extended service interruptions. 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 TSTS 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[14]. This is expected of assets that have been in service for a long time. The two minimum oil circuit breakers are also in poor condition.

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 TSTS are assessed to be in poor or very poor condition (C4 and C5). Fourteen other voltage transformers at the terminal station are in the same condition. Management of safety risks from potential explosive failures[15] of instrument transformers of this type is costly due to the need for regular oil sampling and partial discharge condition monitoring.

[14] 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.

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

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 have been necessary, but there is still some very old technologies such as electromechanical type relays from 1966 and first generation digital relays that have mal-operated in the past in-service at TSTS.

Replacement of the secondary systems is being proposed to manage interface issues between the different protection technologies and rising operation and maintenance cost.

2.3. Description of the identified need

TSTS 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, environmental 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 asset failures.

The present value of the baseline risk costs over the forty-five year period from 2020 is more than $84 million. The key elements of the risk costs are shown in Figure 5. The biggest component of the baseline risk is the risk of supply interruption due to asset failures, which is borne by electricity consumers.

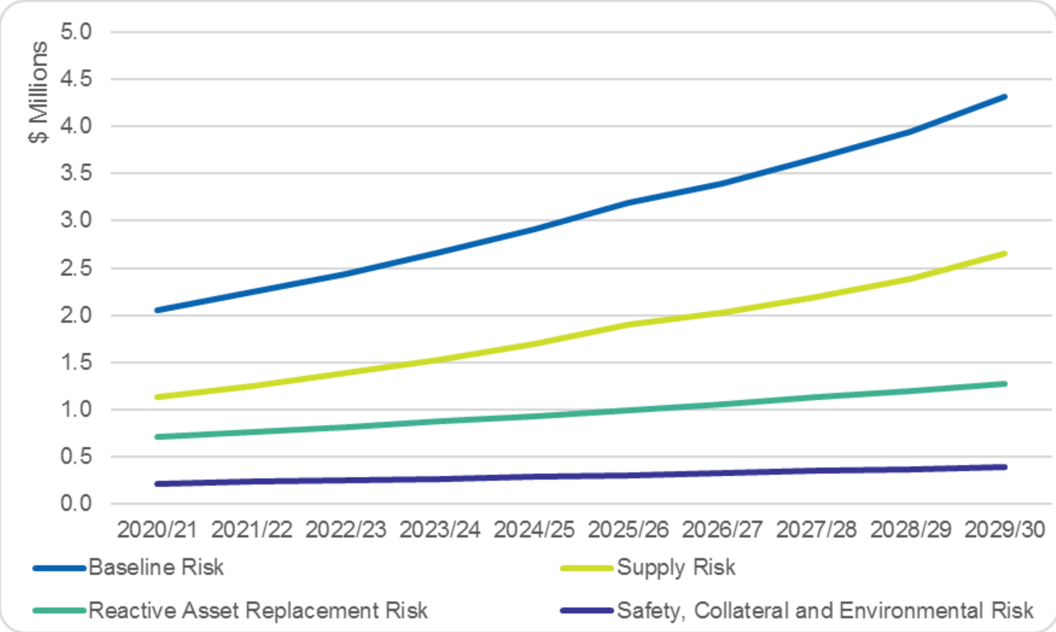

Figure 5 - Baseline risk costs

By undertaking one of 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 adopted the assumptions detailed in the following subsection to quantify the risks associated with asset failure.

Supply risk costs

Supply risk cost has been calculated from the expected unserved energy at TSTS and AEMO's most recent demand forecast for ERTS[16] and has been monetised at a Value of Customer Reliability (VCR)[17] of $28,456/MWh. The VCR rate is based on the AER survey and the load composition at ERTS.

The total supply risk cost is calculated by estimating the community impact of different combinations of forced outages and weighting them by their probabilities of occurrence.

Safety risk costs

The *Electricity Safety Act 1998*[18] 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:

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[16] Australian Energy Market Operator (AEMO), *"2019 Transmission Connection Point Forecast for Victoria"*.

[17] 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).

[18] 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.

- a value of statistical life[19] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[20]; and
- a disproportionality factor[21].

AusNet Services notes that this approach, including the use of a disproportionality factor, is consistent with practice notes[22] provided by the AER.

Financial risk costs

As there is a lasting need for the services that TSTS provides, the failure rate-weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[23]

Environmental risk costs

Environmental risks from assets 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 TSTS, are valued at $100,000 per event.

[19] 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.

[20] 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.

[21] 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 a public inquiry conducted between January 1983 and March 1985 into a proposal to construct a nuclear power station in the UK.

[22] 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.

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

3. Credible network options

AusNet Services considered both network and non-network options to address the identified need caused by the deteriorating assets at TSTS, but did not find any suitable non-network solution. The three network options that AusNet Services has identified are presented below.

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

Option 1 involves replacement of two 220/66 kV transformers, switchgear, and secondary assets in a single integrated project. The estimated capital cost of this option is $42.6 million with no material change in operating cost and an estimated delivery lead time of three to four years. Allowing for construction lead time, the earliest commissioning date is in 2023/24.

3.2. Option 2 – Staged replacement with one transformer replacement 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 completion of the first stage.

The estimated capital cost of the first and second stage of this option is $34.4 million and $9 million respectively with no material change in operating cost. Allowing for construction lead time, the earliest commissioning date of Stage 1 is in 2023/24 as the delivery lead time is around three to four years. The second stage is seven years after the first stage.

3.3. Option 3 – Staged replacement with the 66 kV switchgear deferred

Option 3 is another staged replacement option. All deteriorated assets except for the 66 kV switchgear are replaced in the first stage and the 66 kV switchgear are than replaced in Stage 2.

The estimated capital cost of the first and second stage of this option is $33.8 million and $9.2 million respectively with no material change in operating cost. Allowing for construction lead time, the earliest commissioning date of Stage 1 is in 2023/24 as the delivery lead time is around three to four years. The second stage is seven years after the first stage.

3.4. Material inter-regional network impact

As the TSTS 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."*

4. Assessment approach

Consistent with the RIT-T requirements and practice notes on risk-cost assessment methodology[24], AusNet Services undertook a cost-benefit analysis to evaluate and rank the net economic benefits of the credible options over a 45-year period.

All options considered has been 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 is the year when the annual benefits from implementing the option become greater than the annualised investment costs.

4.1. Input assumptions and sensitivity studies

The robustness of the investment decision is tested using the range of input assumptions described in Table 3. This analysis involves variations of assumptions from those used for the base case.

Parameter	Lower Bound	Base Case	Higher Bound
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 AER VCR figures - 25%	Latest AER VCR figures	Latest AER VCR figures + 25%
Discount rate	2.58% - the WACC rate of a network business	4.68% - the latest commercial discount rate	6.78% - a symmetrical adjustment upwards

Table 3 - Input assumptions used for the sensitivity studies

4.2. 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 involuntary load shedding is set out in section 2.3.

4.3. 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, environmental 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.

[24] 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.

4.4. 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 - the wholesale market impact is expected to be the same for all options as the network is radial and involuntary load shedding as a result of an asset failures cannot be remediated by re-dispatch of generation.
- 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 –competing generation is not affected by the options considered for this RIT-T.
- Option value – as the need for and timing of the proposed investment options are driven by asset deterioration, there is no need to incorporate flexibility in response to uncertainty around any other factor.

5. Options assessment

This section presents the results of the economic costs benefits analysis and the economical timing of the preferred option.

All the options assessed will deliver a reduction in the following risks: involuntary load shedding, safety, environmental, collateral and emergency asset replacement.

Presented in Figure 6, the total risk cost reduction outweighs the investment cost for all options and all sensitivities where input variables are varied one at a time.

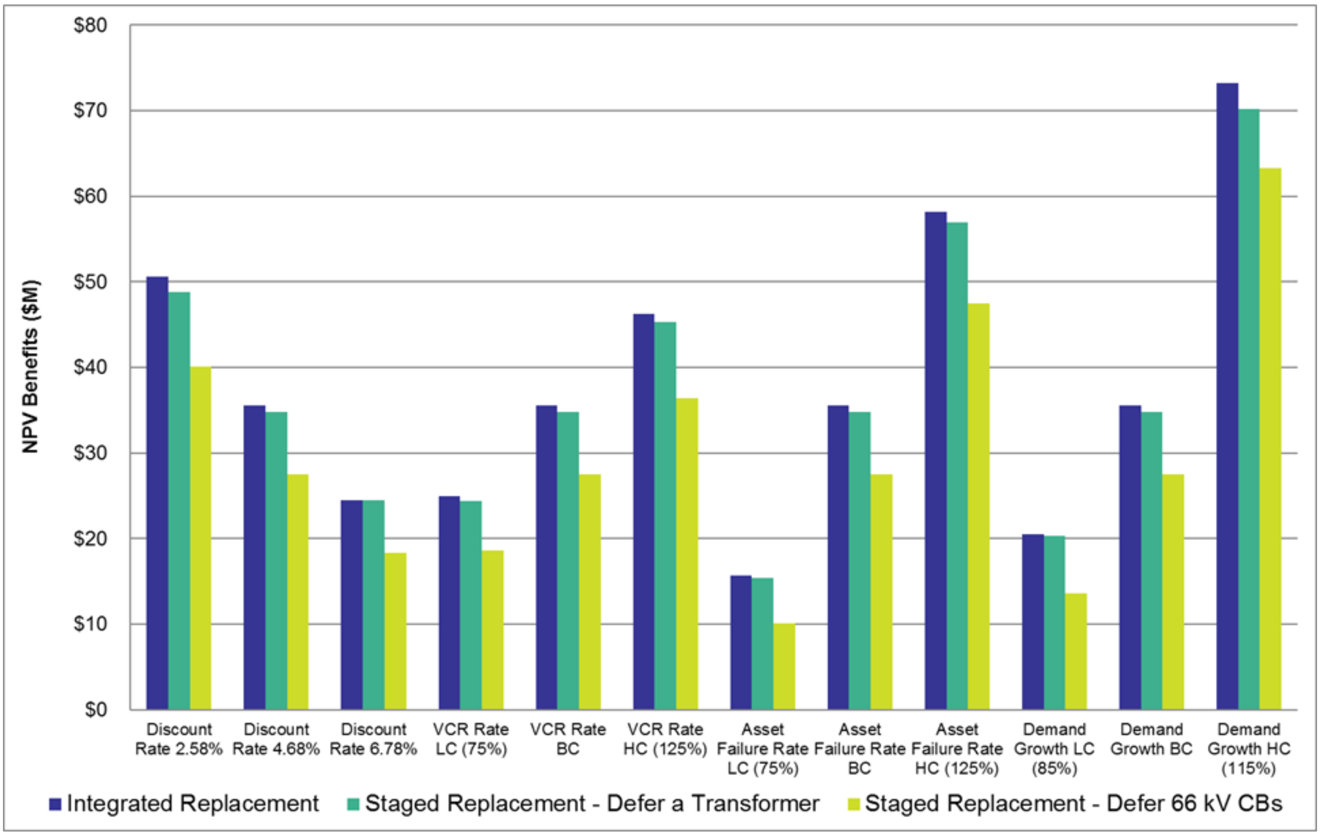

Figure 6 - Option selection and sensitivity analysis (NPV Benefits $M)

5.1. Preferred option

Option 1 (Integrated Replacement) has the greatest net economic benefit for most of the sensitivities considered and is therefore the preferred option.

5.2. Optimal timing of preferred option

This section describes the optimal timing of the preferred option for different assumptions of key variables. Figure 7 shows that the economical time for Option 1 is 2022/23 for the base case assumptions.

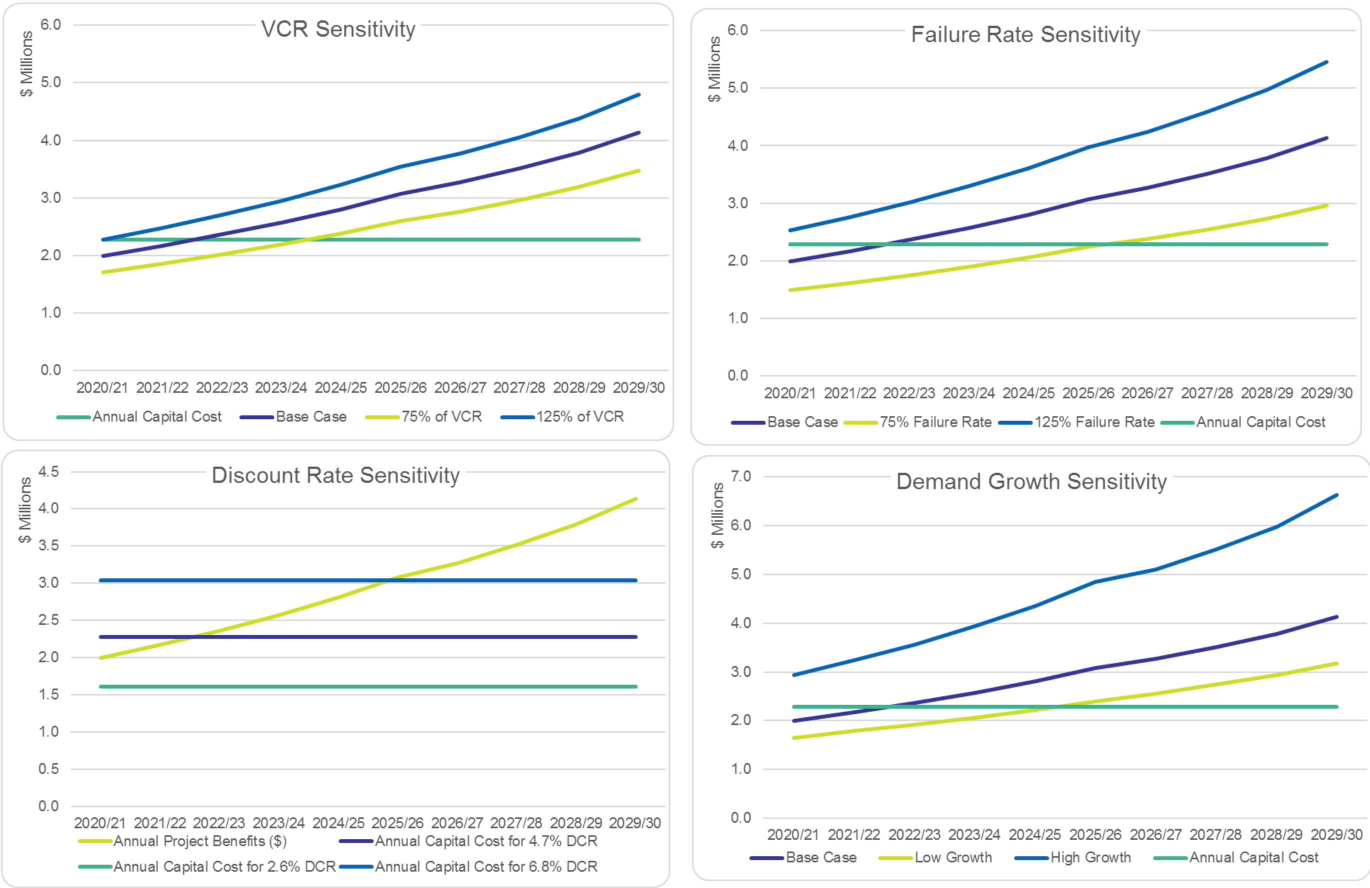

Figure 7 - Investment optimal timing sensitivity analysis

6. Draft conclusion and next steps

Amongst the options considered in this RIT-T, Option 1 is the most economical option to maintain supply reliability in north-eastern metropolitan Melbourne and manage safety, environmental and emergency replacement risks at TSTS.

This preferred option involves the following scope of work in a single integrated project:

- Replacement of the B2 and B3 transformers; and
- Replacement of selected switch gear and secondary systems

The estimated capital cost of this option is $42.6 million with no material change to the operating and maintenance cost.

The preferred option will take three to four years to deliver.

Submissions

AusNet Services welcomes written submissions on the topics and the credible options presented in this PADR. Submissions should be emailed to rittconsultations@ausnetservices.com.au on or before 26 October 2020. In the subject field, please reference 'RIT-T PADR 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.

Appendix A - RIT-T assessment and consultation process

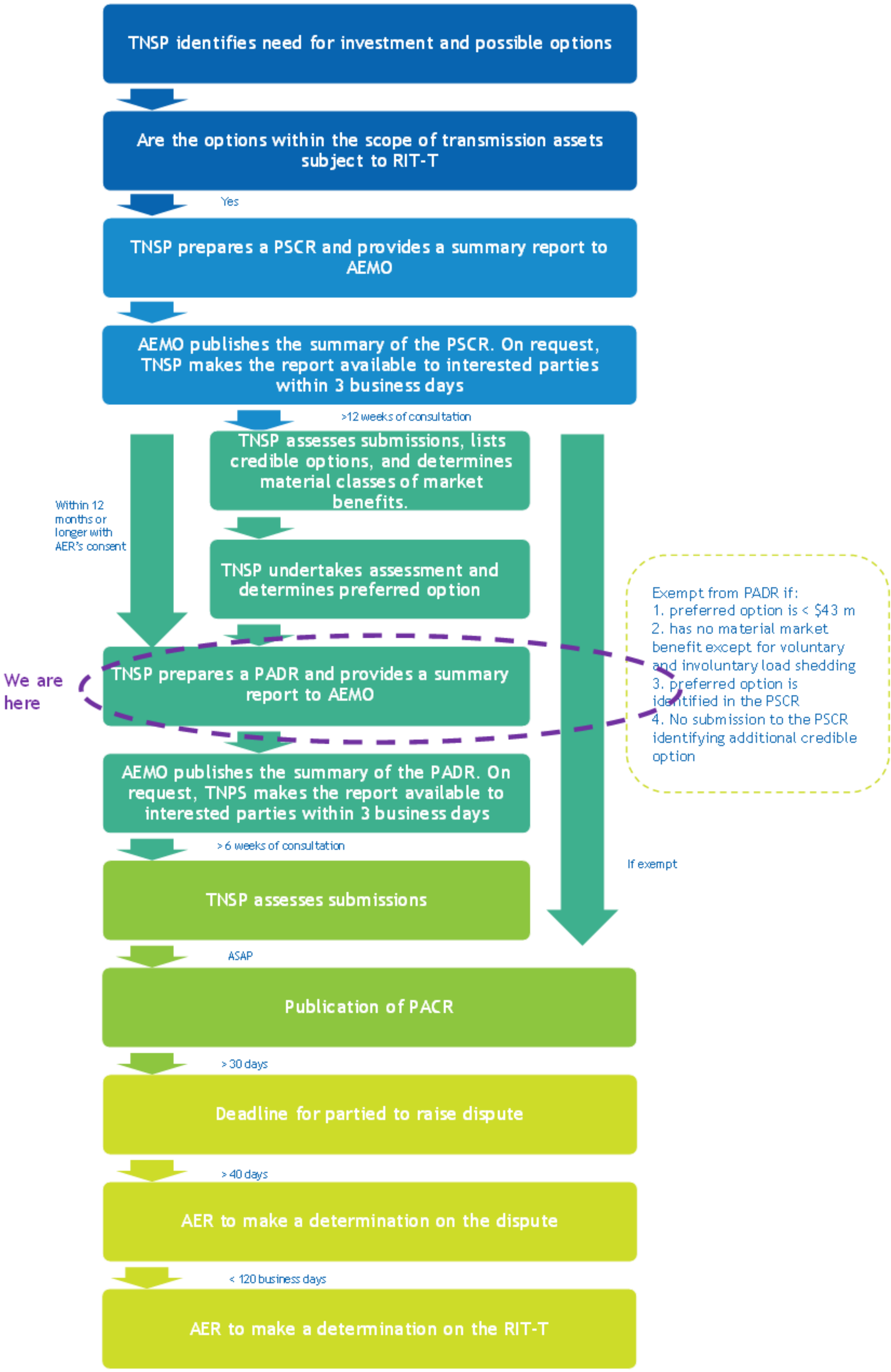

Figure 8 - RIT-T Process

Appendix B - 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.

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

Table 4 - Condition scores framework

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).