Maintain relaible transmission network services from Redcliffs Terminal Station

Project Specification Consultation Report

Regulatory Investment Test - Transmission

December 2022

missionzero

AusNet services

Important notice

Purpose

AusNet Services has prepared this document to provide information about potential limitations in the 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 initiating this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain reliable transmission services at Redcliffs Terminal Station (RCTS). 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].

RCTS is owned and operated by AusNet Services and is in Red Cliffs, northern Victoria. It was commissioned in the early 1960's and serves as the main transmission connection point for embedded generation connected to the Powercor network and distribution of electricity to approximately 27,000 Powercor customers. Peak demand during summer 2021/22 reached 120 MW at RCTS 66 kV and 37 MW at RCTS 22 kV.

Identified need

Some of the assets (transformers and instrument transformers) at RCTS have been in service for an extended time and their condition 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 cost of emergency replacements. The 'identified need' this RIT-T intends to address is to maintain reliable transmission network services at RCTS.

AusNet Services determined that the present value of the baseline risk cost to maintain the existing assets in service is more than $62 million. One of the component of the baseline risk cost is the supply interruption risk borne by electricity consumers. AusNet Services is therefore investigating options that could allow continued delivery of safe and reliable transmission services at RCTS.

Credible options

AusNet Services estimates that network or non-network investments are likely to deliver a more economical solution to maintain reliable transmission network services at RCTS than keeping the existing assets in service. The following network solutions meet the identified need:

- Option 1 – Replacement of selected assets by 2027
- Option 2 – Replacement of selected assets by 2032

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

- options that defer or avoid the need to replace the power transformers and instrument transformers that are in poor condition

Assessment approach

AusNet Services will investigate the cost and economic benefits of the proposed options and test the robustness of the investment decision with sensitivity analysis that involves variation of assumptions around the central values.

Submissions

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

[1] Australian Energy Market Commission, *"National Electricity Rules"*
[2] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*

Submissions should be emailed to rittconsultations@ausnetservices.com.au on or before 7 March 2023. In the subject field, please reference 'RIT-T PSCR Redcliffs 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.

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 the end of April 2023.

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1. Introduction

AusNet Services is initiating this RIT-T to evaluate options to maintain reliable transmission services at RCTS.

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)[3] and section 4.2 of the RIT-T Application Guidelines[4].

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 presented in AusNet Services Asset Renewal Plan, published as part of AEMO's 2022 Victorian Transmission Annual Planning Report (VAPR)[5].

1.1. Making submissions

AusNet Services welcomes written submissions on 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 7 March 2023. In the subject field, please reference 'RIT-T PSCR Redcliffs 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] Australian Energy Market Commission, *"National Electricity Rules"*
[4] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*
[5] Australian Energy Market Operator, *"Victorian Annual Planning Report"*

2. Identified need

The role of RCTS in providing transmission network services and the condition of key assets are discussed below. Quantification of the asset failure risk and the need for the investments are also presented.

2.1. Transmission network services

RCTS is owned and operated by AusNet Services and is in Red Cliffs, northern Victoria. Since it was commissioned in the early 1960's, RCTS has served as the main 220/66 kV and 220/22 kV transmission connection point for distribution of electricity, via the Powercor distribution network, to communities in the towns of Red Cliffs, Colignan, Werrimull, Merbein, Mildura and Robinvale.[6]

A total of 202 MW capacity of large-scale embedded generation is installed on the Powercor sub-transmission and distribution systems connected to RCTS 66 kV[7].

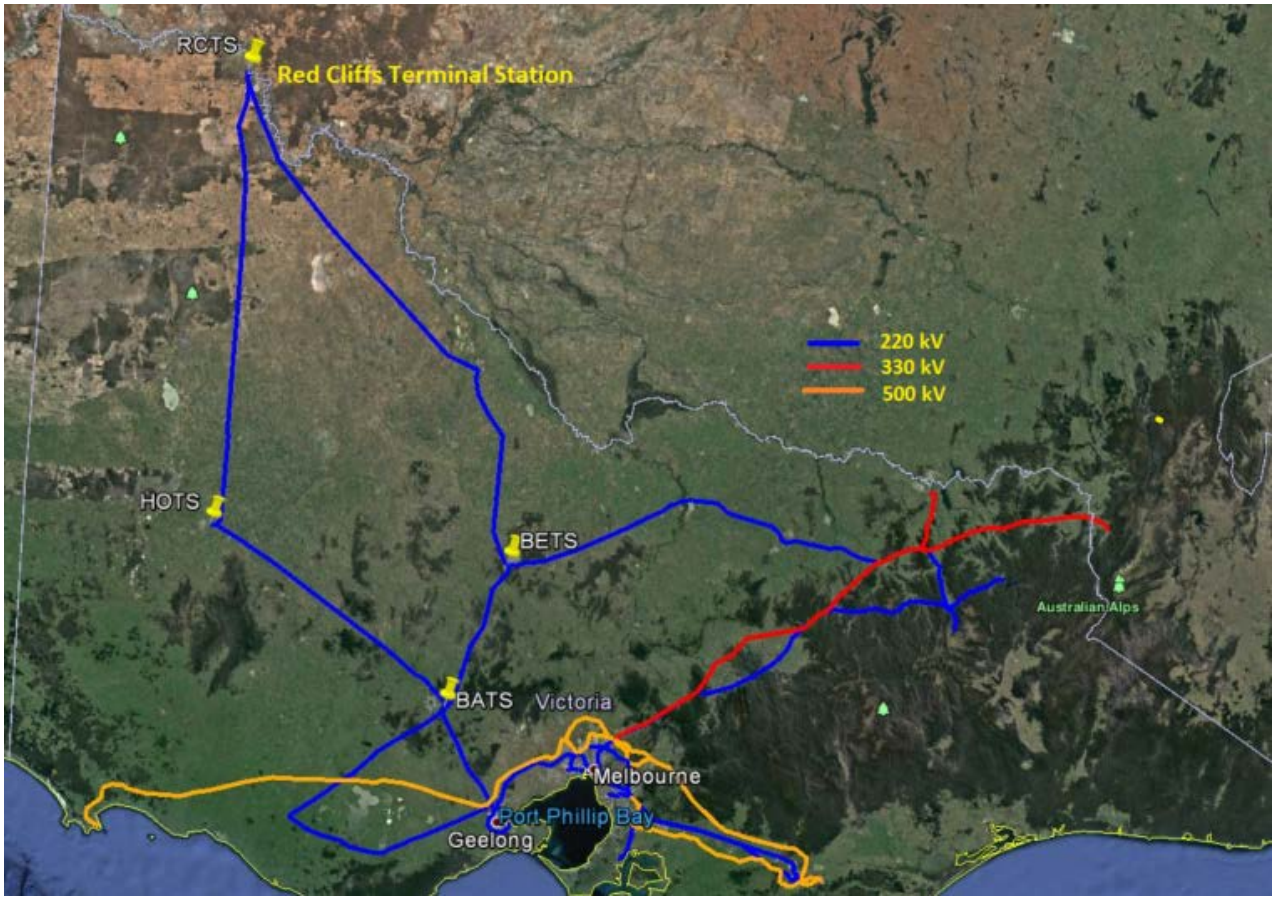

Figure 1 – Transmission network supplying RCTS

Electricity demand

Approximately 27,000 customers depend on Red Cliffs Terminal Station for their electricity supply. The majority of the total annual energy at RCTS 66 kV is consumed by commercial customers (45.6%) and residential customers (30.3%) with the remainder consumed by industrial and agricultural customers as illustrated in Table 1.

[6] Distribution of electricity to relevant communities is supported by Powercor.
[7] 2021 Transmission Connection Planning Report

Customer type	Share of 66 kV load consumption (%)	Share of 22 kV load consumption (%)
Commercial	45.6%	44.1%
Residential	30.3%	22.6%
Industrial	21.2%	14.9%
Agricultural	2.9%	18.4%

Table 1 – RCTS 66 kV and 22 kV load composition

Peak demand during summer 2021/22 reached 120 MW at RCTS 66 kV and 37 MW at RCTS 22 kV. Powercor forecasts[8] that peak demand at RCTS 66 kV and RCTS 22 kV will grow slightly over the next ten years. Figure 2 and Figure 3 show the 10% probability of exceedance (POE10)[9] and the 50% probability of exceedance (POE50)[10] forecasts for peak demand during summer and winter periods[11] for the RCTS 66 kV and 22 kV networks respectively.

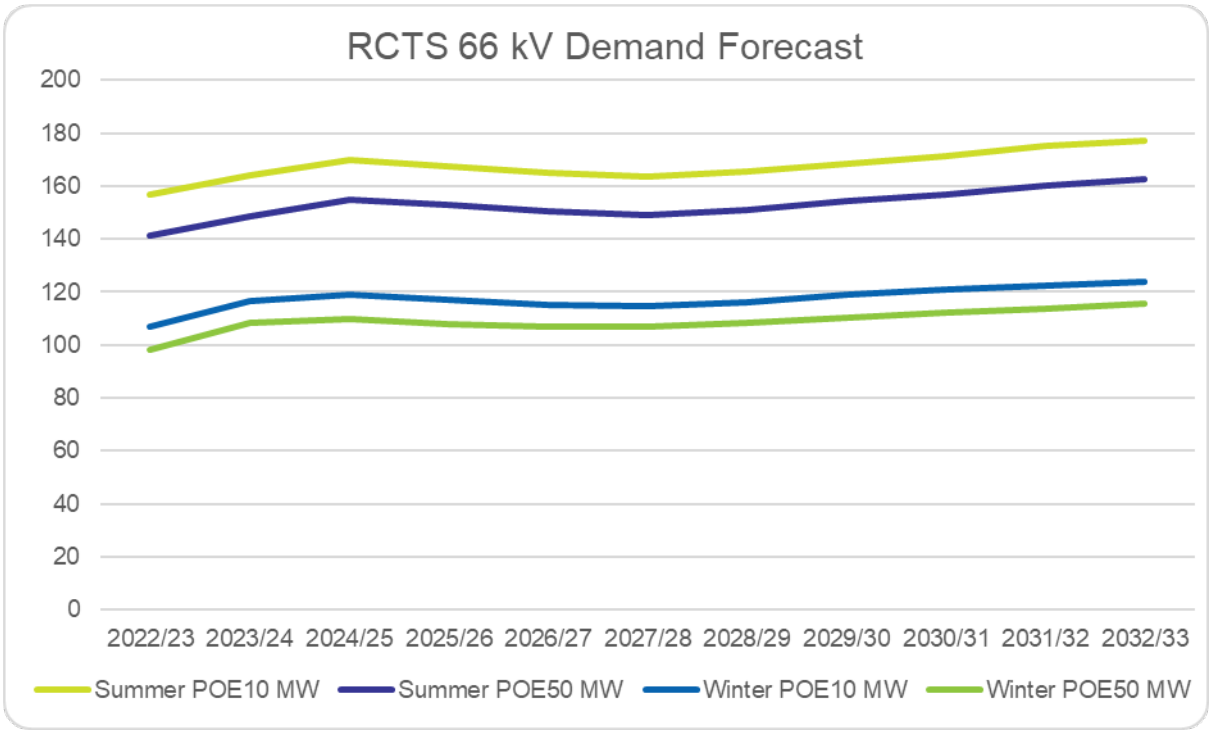

Figure 2 - Demand forecasts for RCTS 66 kV network

[8] Transmission Connection Planning Report

[9] A POE10 forecast indicates a level where there is 10 % likelihood that actual peak demand will be greater.

[10] A POE50 forecast indicates a level where there is 50 % likelihood that actual peak demand will be greater.

[11] Victorian electricity demand is sensitive to ambient temperature. Peak demand forecasts are therefore 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).

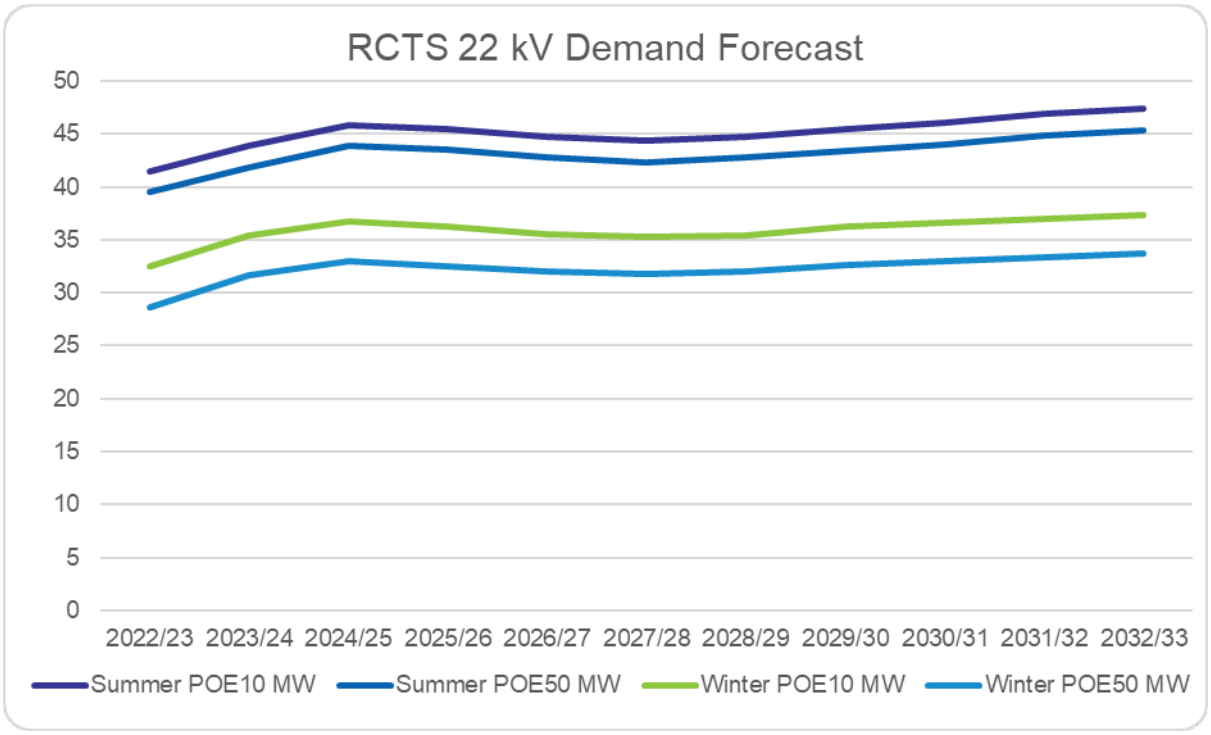

Figure 3 - Demand forecasts for RCTS 22 kV network

The Powercor forecasts confirm there is an ongoing need for electricity supply services to communities in Red Cliffs and the surrounding area as reflected in the official demand forecast for RCTS.

Embedded generation

There are two major embedded generators – the Karadoc Solar Farm (90 MW) and the Yatpool Solar Farm (81 MW) - connected at RCTS 66 kV.

Electricity network

RCTS sources its electricity supply from the 220 kV transmission network in the northern part of Victoria, as shown in Figure 1. It is also connected to the New South Wales (NSW) electricity network via Buronga. RCTS supplies five 66 kV feeders (Powercor) that distribute electricity to customers as shown in Figure 4. The zone substations supplied from RCTS include Merbein (MBN), Karadoc Solar Farm (KSF), Mildura (MDA), Robinvale (RVL) and Yatpool Solar Farm (YSF).

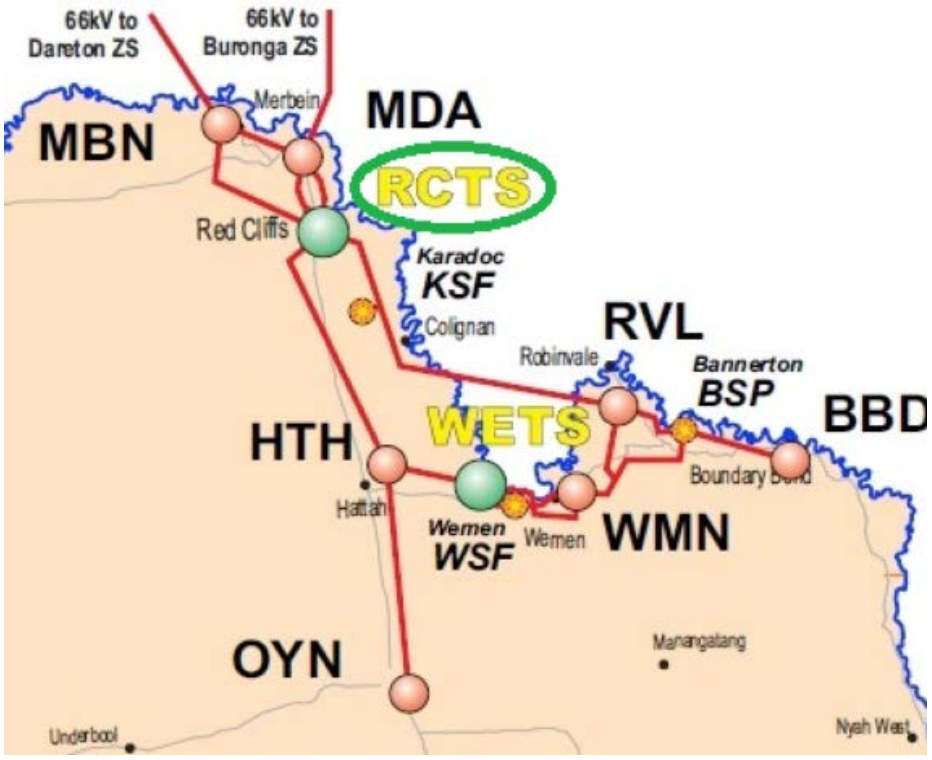

Figure 4 – Distribution network supplied from RCTS

2.2. Asset condition

Several primary (power transformers and instrument transformers) and secondary (protection and control) assets at RCTS are in poor condition as expected of assets that have been in service for a long time.

AusNet Services classifies asset condition using scores that range from C1 (initial service condition) to C5 (extreme deterioration) – as set out in Appendix B. The latest asset condition assessment for RCTS reveals some assets at the terminal station are in poor condition (C4) or very poor condition (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 major equipment.

Asset class	Condition scores				
	C1	C2	C3	C4	C5
Power transformers			2	3	
220 kV current transformers	5	3	6	7	
66 kV current transformers	2	11	4	7	10
66 kV voltage transformers				2	
22 kV current transformers	3	1	8	5	1
22 kV voltage transformers	6			2	

Table 2 - Summary of major equipment condition scores (quantity of assets)

Power transformers

There are five 220/66/22 kV transformers (named B1, B2, B3, L1 and L2) at RCTS. The B1 and B2 transformers are rated 70 MVA each, and with the B3 (140 MVA) transformer supply the 66 kV load at RCTS. According to a recent asset condition assessment, both B1 and B2 transformers are in overall poor condition. The B2 transformer was commissioned in 1974 and approaching end of economic life with no suitable spare transformer for replacement when an unplanned outage occurs. The B1 transformer is relatively younger and has been commissioned in 1987 but has no suitable spare transformer. The B3 transformer was commissioned in 2006 and its condition would be managed by asset works.

The smaller L1 and L2 transformers providing 22 kV supply, are in poor condition (C4) and require remedial action within the next five years. Both L transformers have been in service since 1962 and are approaching the end of their economic life. The probability of a B or L transformer failure is forecast to increase over time as the condition of these transformers deteriorates further.

Instrument transformers

Several instrument transformers (220 kV, 66 kV and 22 kV current transformers and voltage transformers) at RCTS are assessed to be in poor condition and are in an advanced deterioration phase (C4 and C5). Management of safety risks from potential explosive failures[12] of instrument transformers is costly due to the need for regular oil sampling and partial discharge condition monitoring. These instrument transformers need to be replaced for correct functioning of the protection systems and to maintain reliable transmission network services.

2.3. Description of the identified need

RCTS provides electricity supply to Red Cliffs and surrounding area. The services that the terminal station provides will continue to be required as the demand for electricity is forecast to remain at present levels over the next ten-year period. The poor condition of some of the assets at the terminal station has increased the likelihood of asset failures. Such failures would result in prolonged supply outages.

Without remedial action, other than ongoing maintenance practice (business-as-usual), affected assets are expected to deteriorate further and more rapidly. Further increase in the probability of failure will result 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 reliable transmission services at RCTS and to mitigate asset failure risks.

AusNet Services calculated the present value of the baseline risk costs to be more than $62 million over the forty-five year period from 2022/2023. The key elements of these risk costs are shown in Figure 5. The largest component of the baseline risk costs is the supply interruption risk, which is borne by electricity consumers and the cost of emergency replacements and repairs.

[12] Since 2002, two current transformers have failed explosively in the Victorian network.

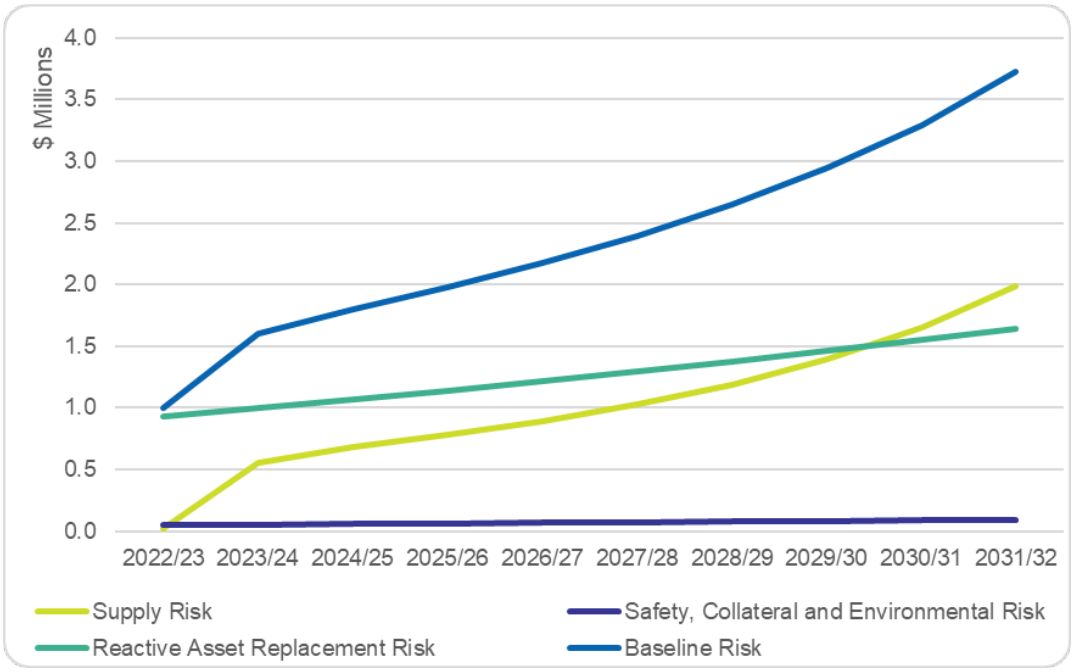

Figure 5 - Baseline risk costs

By undertaking the options identified in this RIT-T, AusNet Services will be able to maintain supply reliability at RCTS and mitigate safety and environmental risks, as required by the NER and Electricity Safety Act 1998[13].

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 further 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 expected unserved energy based on the most recent Distribution Business (DB) demand forecasts for RCTS,[14] and has valued this expected unserved energy with the latest AER Value of Customer Reliability (VCR)[15]. The choice of VCR value is based on those published by the AER and the composition of customers supplied from RCTS. The resulting estimate of the weighted VCR for affected customers is $42,966/MWh for RCTS 66 kV and $42,469/MWh for RCTS 22 kV.

The total supply risk cost is calculated by estimating the impacts of different combinations of relevant forced outages to reliability of supply and weighting them by their probabilities of occurrence.

Safety risk costs

The Electricity Safety Act 1998[16] requires AusNet Services to design, construct, operate, maintain,

[13] Victorian State Government, Victorian Legislation and Parliamentary Documents, *"Electricity Safety Act 1998,"* available at Electricity Safety Act 1998 (legislation.vic.gov.au).
[14] *2021 Transmission Connection Planning Report"*
[15] 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).
[16] Victorian State Government, Victorian Legislation and Parliamentary Documents, *"Electricity Safety Act 1998,"* available at Electricity Safety Act 1998 (legislation.vic.gov.au)

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

- a value of statistical life[17] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[18]; and
- a disproportionality factor[19].

AusNet Services notes this approach, including the use of a disproportionality factor, is consistent with the practice notes[20] provided by the AER.

Financial risk costs

As there is a lasting need for the services that the RCTS provides, the failure rate-weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[21]

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) are valued at $100,000 per event.

[17] 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

[18] 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

[19] 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.

[20] Australian Energy Regulator, *"Industry practice application note for asset replacement planning"*

[21] 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.

The technical requirements that a non-network option would have to provide are detailed in the next section.

3.1. Option 1 – Replace transformers and switchgear in an integrated project

Option 1 includes the following scope of work:

- Installation of two standard 150 MVA 220/66 kV transformers;
- Installation of two standard 20/33/49.5 MVA 66/22 kV transformers;
- Retiring the old transformers
- Selective replacement of 66 kV and 22 kV instrument transformers and associated primary and secondary equipment.

The estimated capital cost of this option is $45 million with no material change in operating cost and an estimated delivery lead time of three to four years.

3.2. Option 2 – Defer Integrated replacement by 5 years

The scope of work for Option 2 is similar to Option 1 with the only difference being deferring the asset replacement by 5 years.

3.3. Options considered and not progressed

Retirement of aging plant such as the 220/66 kV or 220/22 kV transformers may avoid emergency reactive replacement, environment and safety risk costs, but will also reduce the terminal station capacity and increase supply risk costs.

Refurbishment options do not significantly reduce the asset failure rates and the risk from asset failure and are therefore not progressed further for this RIT-T.

3.4. Material inter-regional network impact

The proposed asset replacements at RCTS will not change the transmission network configuration and none of the network options 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. 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 identified non-network options based on their economic and technical feasibility.

A non-network option will have to provide transmission network services that facilitate the following

- a reliable supply to RCTS 66 kV and 22 kV customers
- least cost dispatch of NEM generation by avoiding network constraints impacting efficient generation dispatch or the reliability of the transmission network
- Is of sufficient size and function to avoid the need for connection transformers that transforms the voltage from 220 kV to 66 kV and 22 kV at RCTS

Figure 6, Figure 7 and Figure 8 shows a recent annual load profile, annual load duration curve and weekly load profile for RCTS 22 kV.

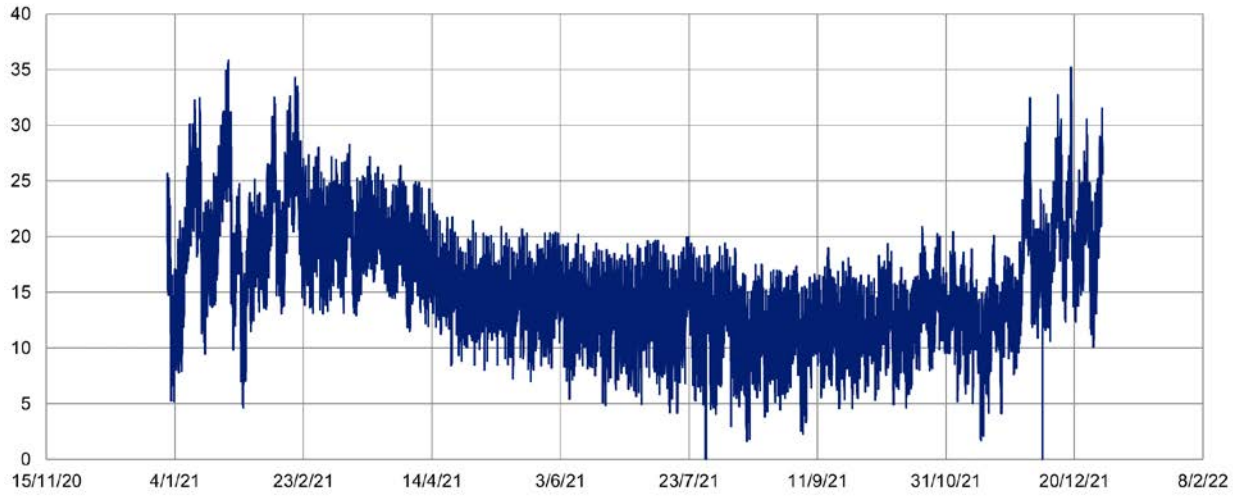

Figure 6 - Recent annual load profile for RCTS 22 kV (MVA)

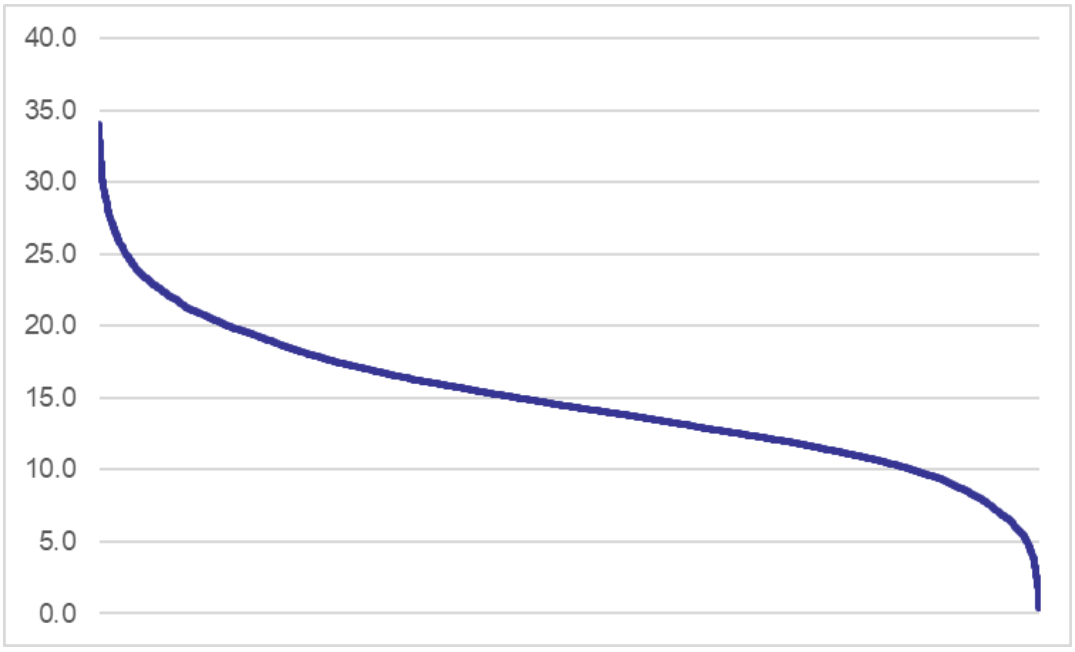

Figure 7 - Annual load duration curve for RCTS 22 kV (MW)

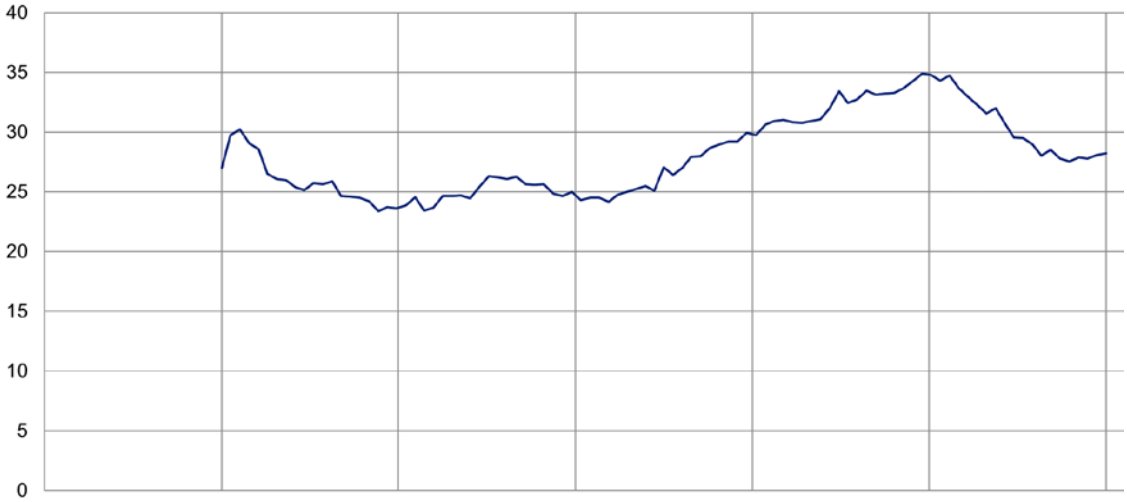

Figure 8 - Recent summer day load profile for RCTS 22 kV (MVA)

Figure 9, Figure 10 and Figure 11 shows a recent annual load profile, annual load duration curve and weekly load profile for RCTS 66 kV.

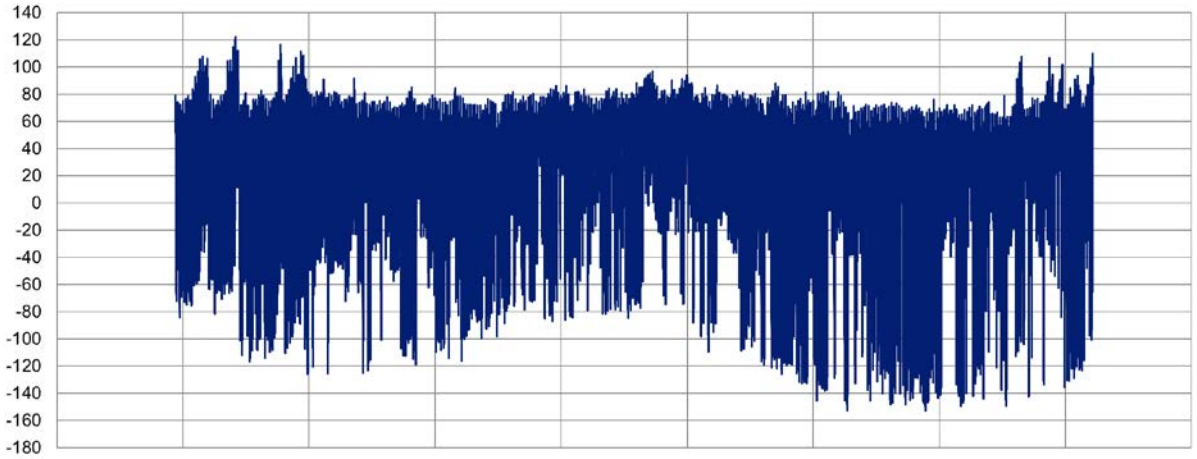

Figure 9: Recent annual load profile for RCTS 66 kV (MW)

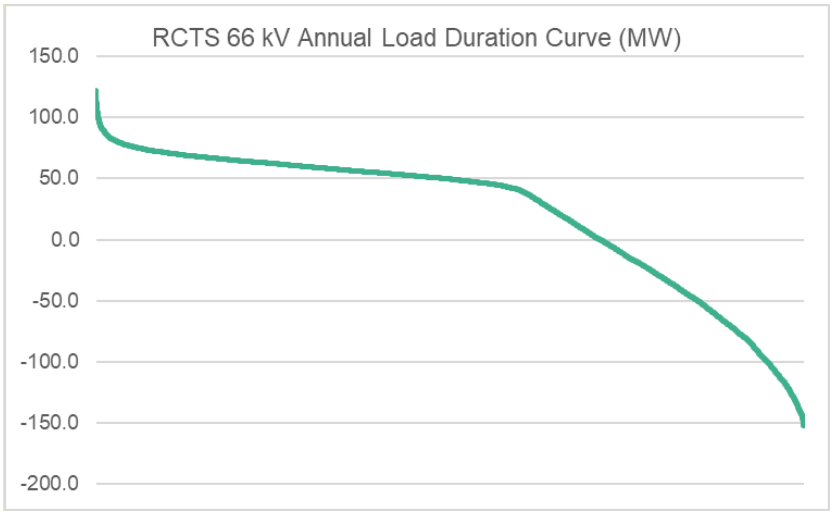

Figure 10: Annual load duration curve for RCTS 66 kV (MW)

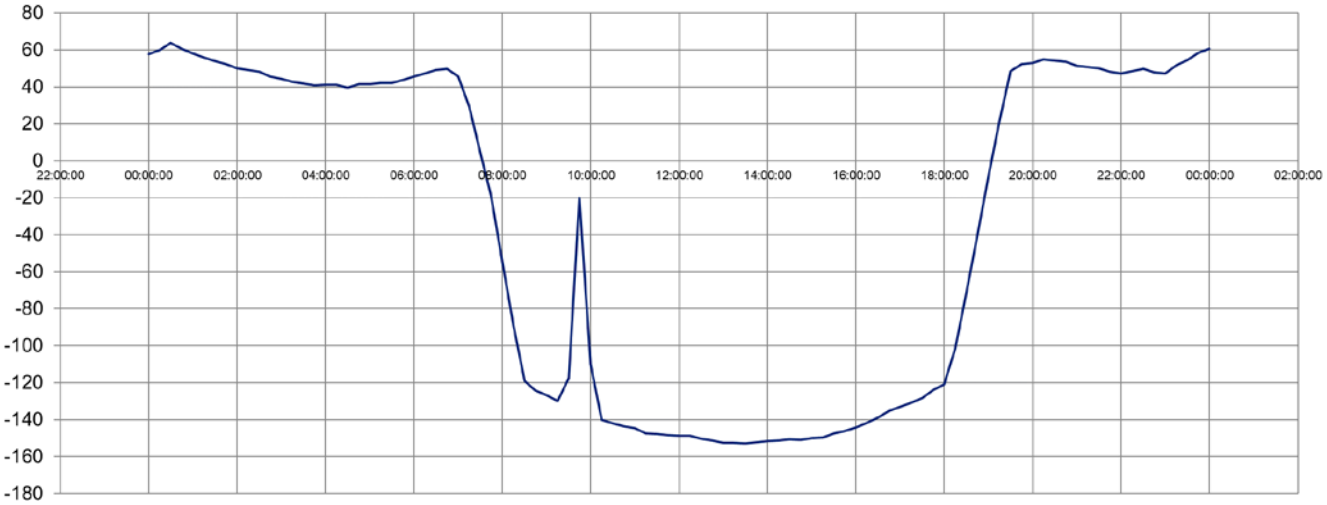

Figure 11: Recent summer day load profile for RCTS 66 kV (MW)

Proposals for non-network solutions should be emailed to rittconsultations@ausnetservices.com.au by 7 March 2023.

5. Assessment approach

Consistent with the RIT-T requirements and practice notes on risk-cost assessment methodology[22], AusNet Services will undertake a cost-benefit analysis to evaluate and rank the net economic benefits of all 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 sensitivity analysis and input assumptions

The robustness of the investment decision and the optimal timing of the preferred option will be tested by a sensitivity analysis. This analysis involves variation of assumptions from those employed under the base case.

Parameter	Lower Bound	Central Scenario	Higher Bound
Asset failure rate	AusNet Services assessment – 15%	AusNet Services assessment	AusNet Services assessment + 15%
Demand forecast	2021 Transmission Connection Point Forecasts - 15%	2021 Transmission Connection Point Forecasts	2021 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	2.0% - the WACC rate of a network business	5.5% - the latest commercial discount rate	7.5% - Upper Bound

Table 3 - Input assumptions used for the sensitivity studies

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 deteriorated 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.

[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

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 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.
- 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 the investment options are driven by asset deterioration, there is no need to incorporate flexibility in response to uncertainty around any other factor.
- 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.

Appendix A - RIT-T assessment and consultation process

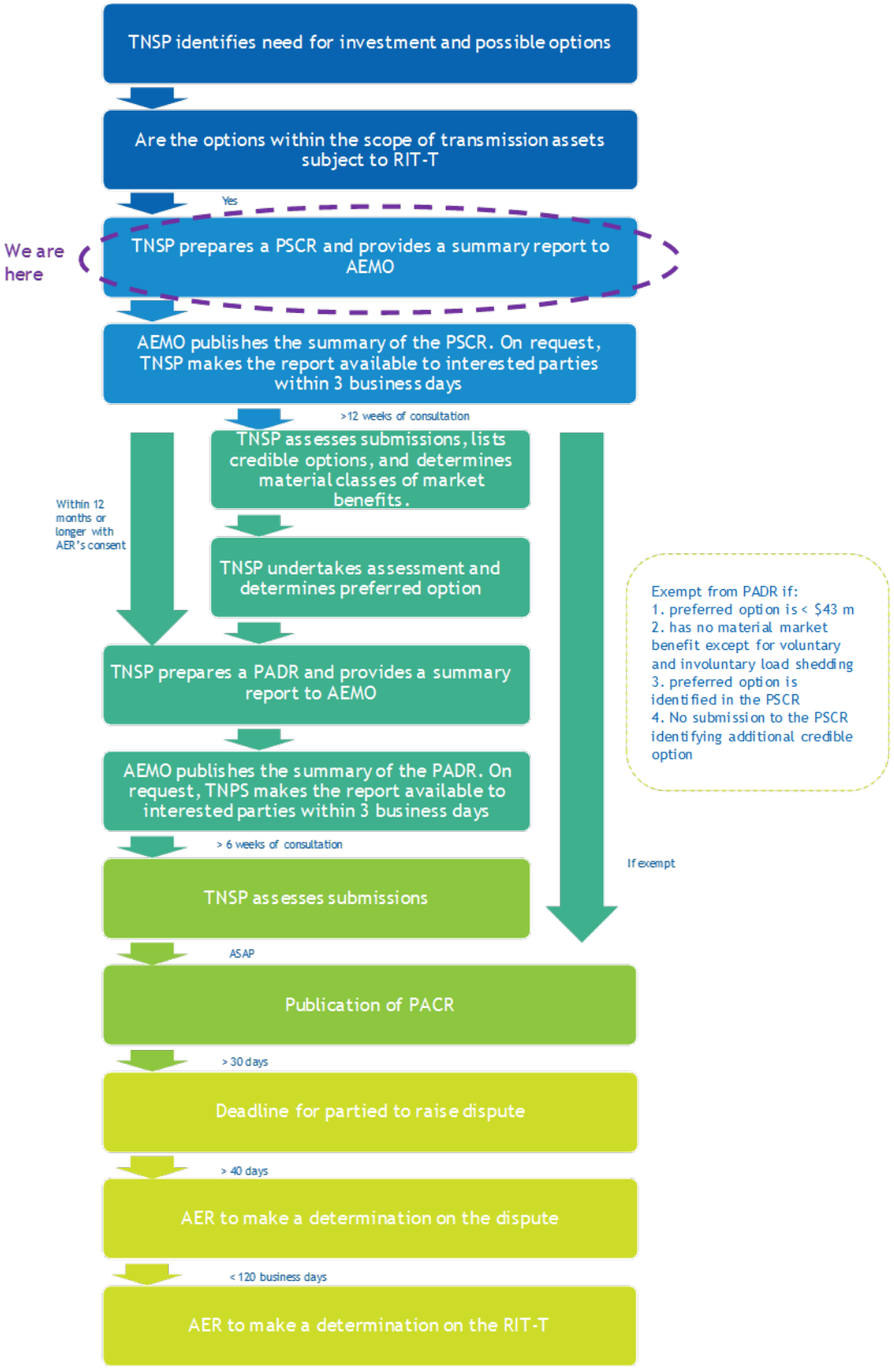

Figure 12 - RIT-T Process

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)

ß = 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 (ß) 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).