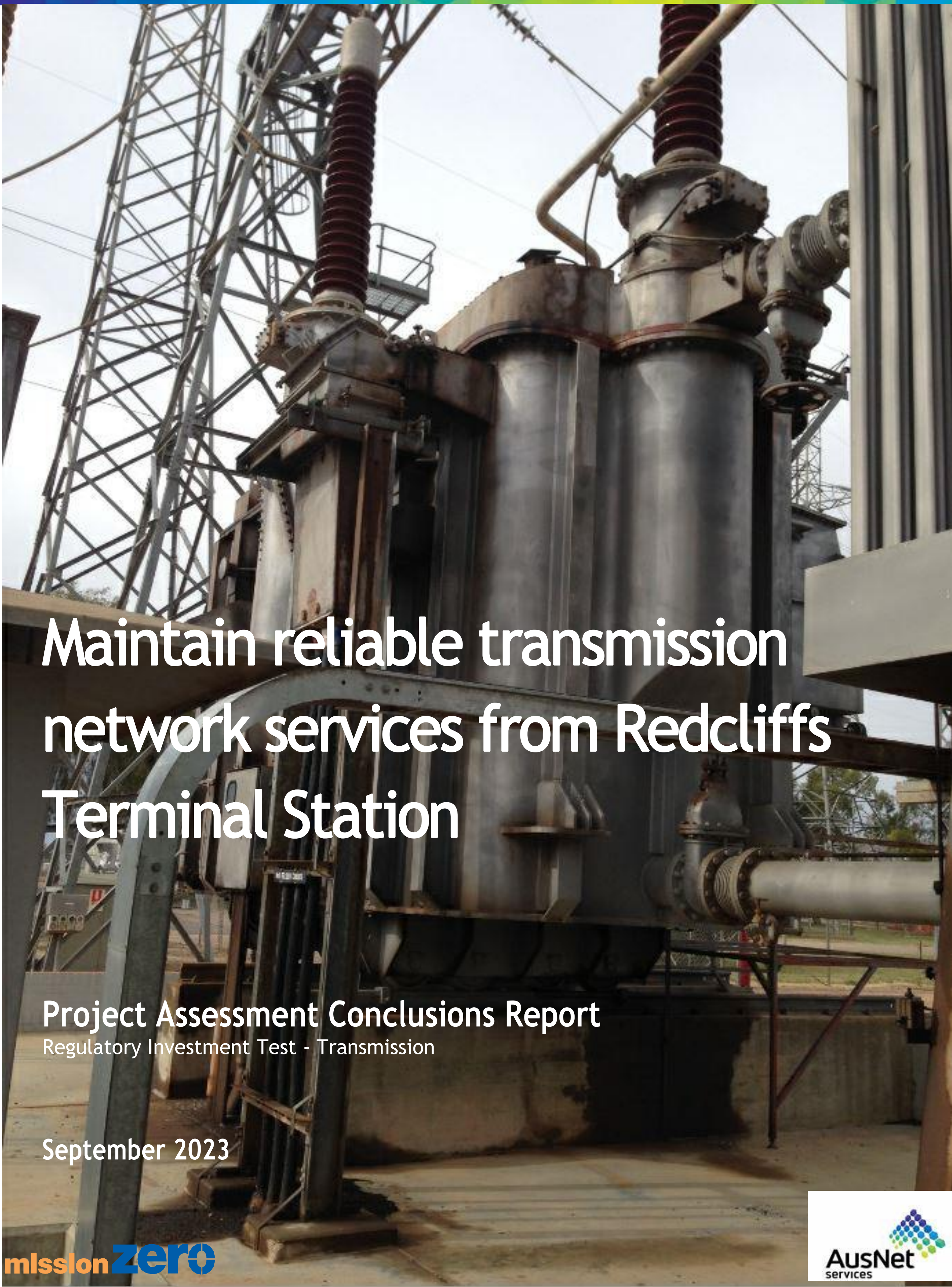

Maintain reliable transmission network services from Redcliffs Terminal Station

Project Assessment Conclusions Report

Regulatory Investment Test - Transmission

September 2023

mission zero

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

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Executive summary

This Regulatory Investment Test for Transmission (RIT-T) evaluated options to maintain reliable transmission network services at Redcliffs Terminal Station (RCTS). Publication of this Project Assessment Conclusions Report (PACR) represents the last 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]. The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process, was published in December 2022 and the succeeding Project Assessment Draft Report (PADR) was published in May 2023

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.

The RIT-T analysis shows that it is no longer economical to continue to provide transmission network services with some of the existing assets at RCTS as the asset failure risk has increased to a level where investment to replace selected assets presents a more economical option.

No non-network proposals were received during the RIT-T consultation.

The preferred option to address the asset failure risk at RCTS is an integrated replacement of the transformers that are in poor or very poor condition by 2028/2029.

Identified need

Some of the assets (power 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 risk, environmental risk, 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 $73 million. One of the components of the baseline risk cost is the supply interruption risk borne by electricity consumers. AusNet Services is therefore proposing investment in asset replacement options that will allow continued delivery of safe and reliable transmission services at RCTS.

Credible options

AusNet Services did not receive proposals for non-network solutions and did not identify a credible, economical non-network solution for the identified need.

The following network investments were evaluated and will deliver more economical and reliable solutions compared with keeping the existing assets in service:

- Option 1 – Replacement of selected assets by 2028/29
- Option 2 – Replacement of selected assets by 2033

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. The assessment approach includes consideration of the costs, economic benefits and

1 Australian Energy Market Commission, *"National Electricity Rule version 200"*
2 Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*

testing the robustness of the investment decision through:

- the use of scenarios that are consistent with the Australian Energy Market Operator's (AEMO) latest Inputs Assumptions and Scenarios Report (IASR); and
- sensitivity analysis that involves variation of assumptions around the values used for the central scenario.

RIT-T Conclusion

AusNet Services' cost-benefit assessment confirms that Option 1 is the most economic option as it provides the highest present value of net economic benefits. This option will not only maintain reliable transmission network services, but also mitigates safety, environmental, collateral and emergency replacement risk costs from potential asset failures at RCTS.

The optimal timing of the preferred option to address the identified need is by 2028/29 based on an estimated capital cost of $57.2 million.

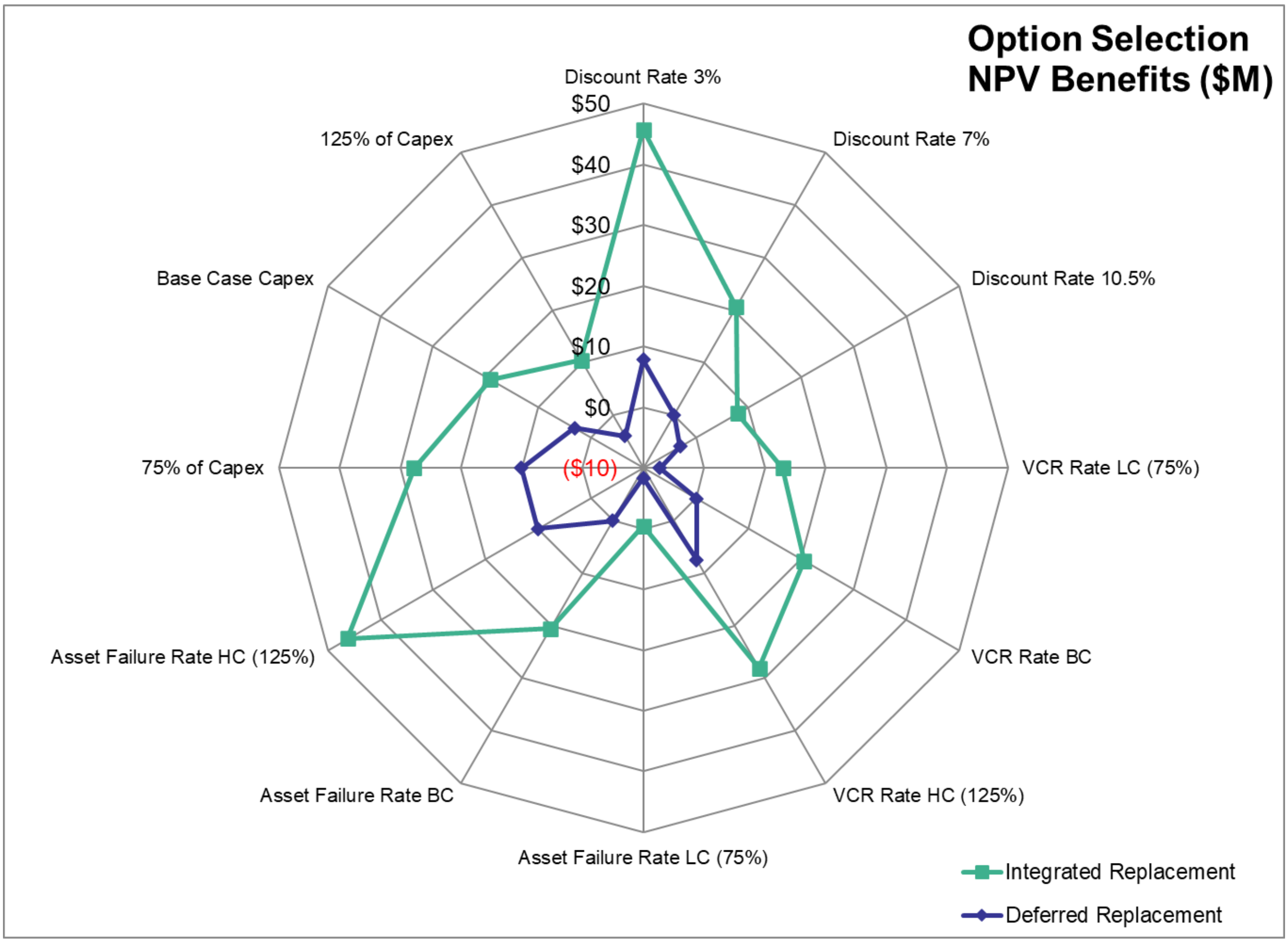

Figure 1 - Option selection and sensitivity analysis

Next steps

In accordance with clause 5.16B of the NER, within 30 days of the date of publication of this PACR, any party disputing the conclusion made in this PACR should give notice of the dispute in writing setting out the grounds for the dispute (the dispute notice) to the AER. If there are no dispute notices within 30 days of the date of publication of this PACR, AusNet Services expects to implement the preferred option.

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Figures

Tables

1. Introduction

AusNet Services initiated this RIT-T to evaluate options to maintain reliable transmission network services at RCTS. Publication of this Project Assessment Conclusions Report (PACR) represents the last 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]. The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process, was published in December 2022 and the succeeding Project Assessment Draft Report (PADR) was published in May 2023.

This document describes:

- the identified need that AusNet Services is seeking to address;
- credible network options that may address the identified need;
- a summary of, and the RIT-T proponent's response to, the submissions received to the PADR, if any;
- the assessment approach and assumptions that AusNet Services employed for this RIT-T assessment as well as the specific categories of market benefits that are unlikely to be material;
- the option evaluation; and
- the identification of the proposed preferred option.

The need for investment to address risks from the deteriorating assets at RCTS has been included in AusNet Services' revenue proposal for the 2022 to 2027 regulatory control period.[5] This investment need is also presented in AusNet Services Asset Renewal Plan that is published as part of AEMO's 2022 Victorian Transmission Annual Planning Report (VAPR).[6]

3 Australian Energy Market Commission, *"National Electricity Rule version 200"*
4 Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*
5 Australian Energy Regulator, *"AusNet Services - Determination 2017-2022"*
6 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 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 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.[7]

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[8].

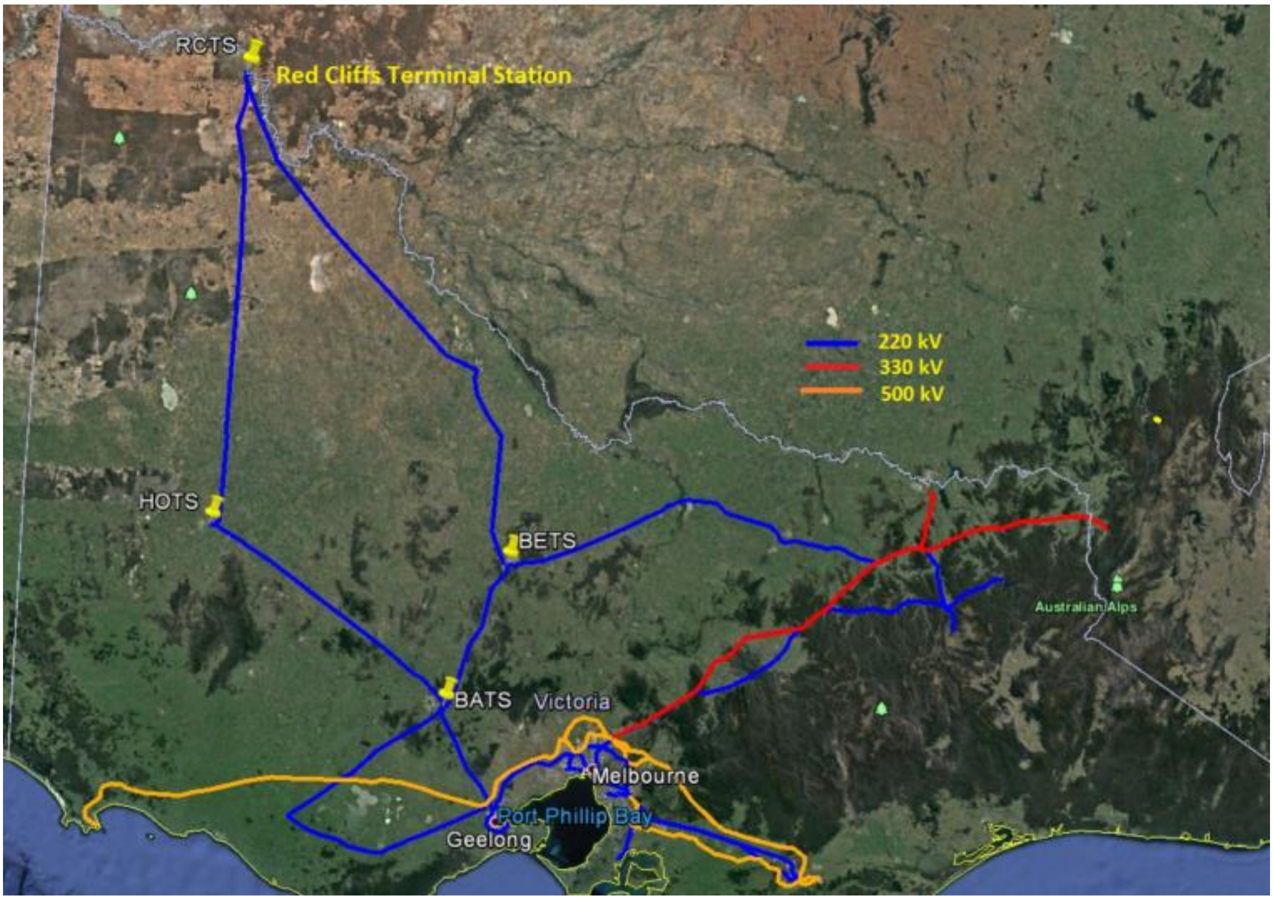

Figure 2 – Transmission network supplying RCTS

Electricity demand

Approximately 27,000 customers depend on RCTS 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.

7 Distribution of electricity to relevant communities is supported by Powercor
8 2022 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[9] that peak demand at RCTS 66 kV and RCTS 22 kV will grow slightly over the next ten years. Figure 3 and Figure 4 show the 10% probability of exceedance (POE10)[10] and the 50% probability of exceedance (POE50)[11] forecasts for peak demand during summer and winter periods[12] for the RCTS 66 kV and 22 kV networks respectively.

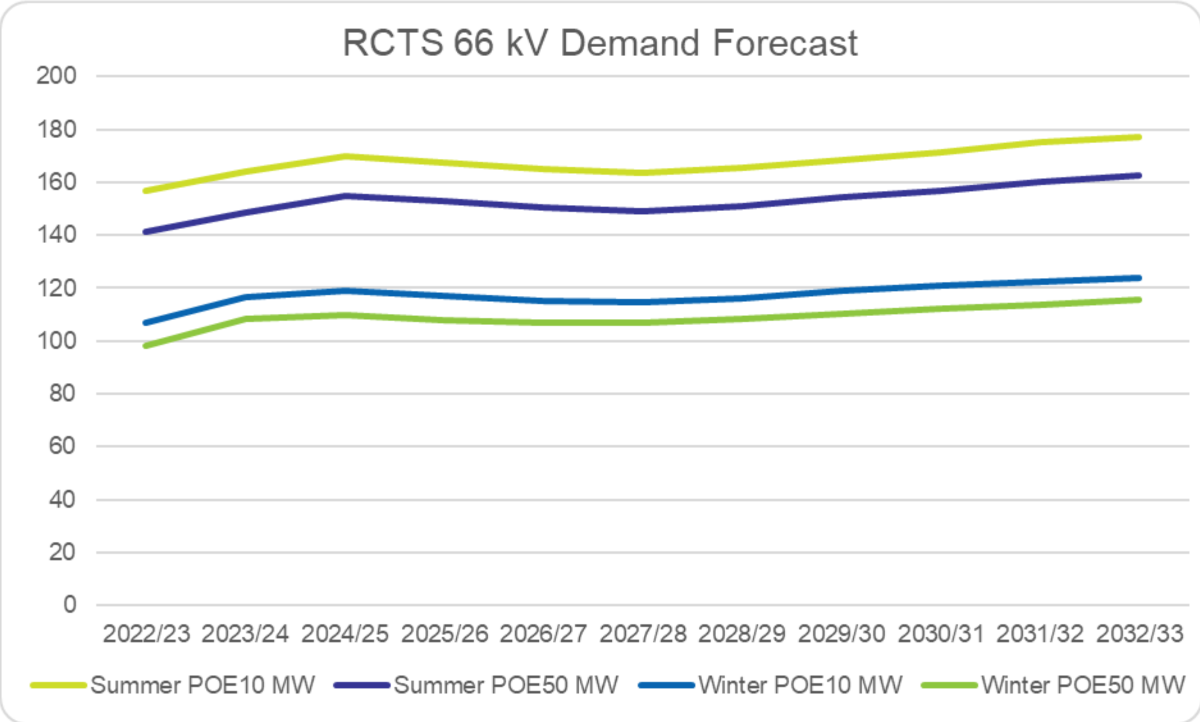

Figure 3 - Demand forecasts for RCTS 66 kV network

9 Transmission Connection Planning Report
10 A POE10 forecast indicates a level where there is 10 % likelihood that actual peak demand will be greater
11 A POE50 forecast indicates a level where there is 50 % likelihood that actual peak demand will be greater
12 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)

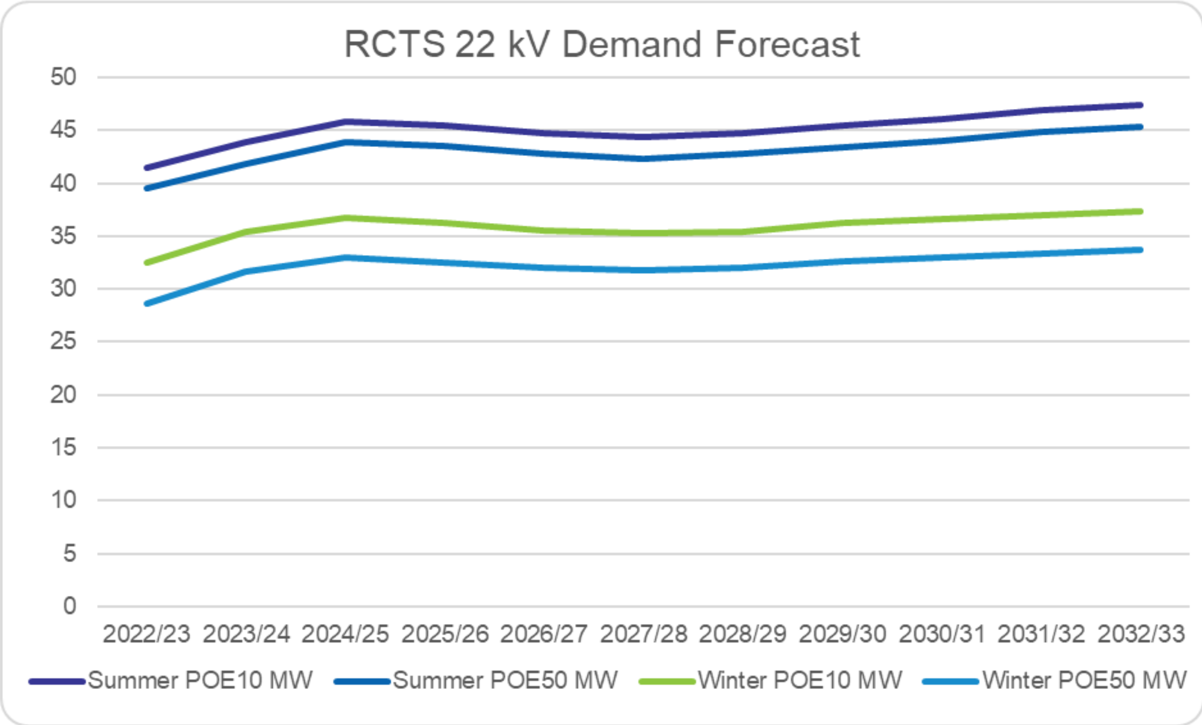

Figure 4 - Demand forecasts for RCTS 22 kV network

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 5. The zone substations supplied from RCTS include Merbein (MBN), Karadoc Solar Farm (KSF), Mildura (MDA), Robinvale (RVL) and Yatpool Solar Farm (YSF).

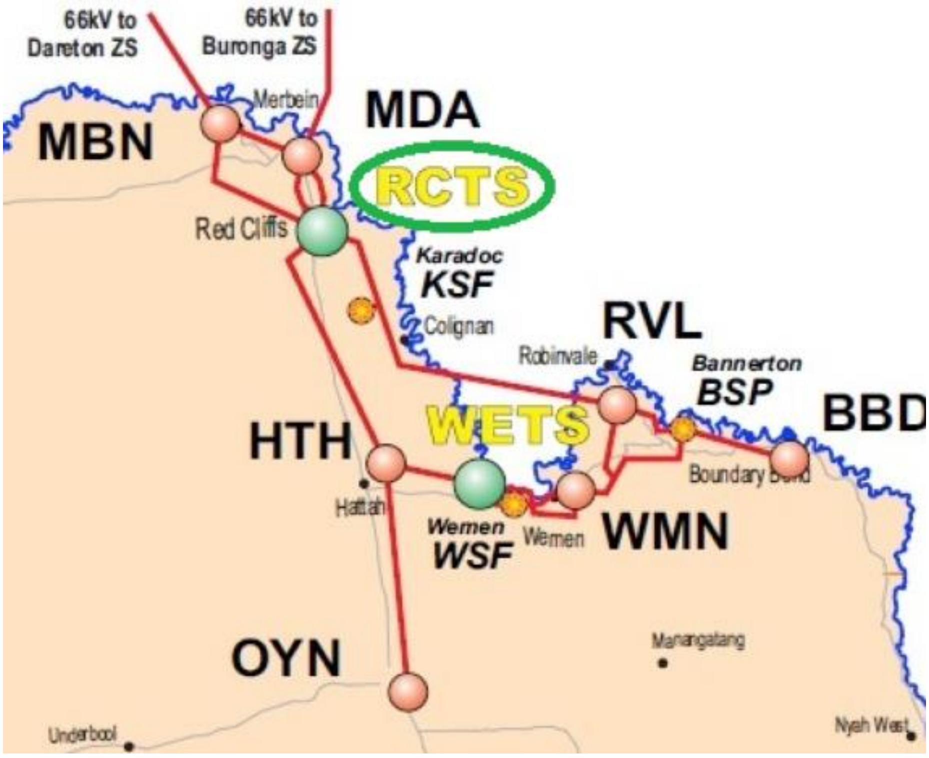

Figure 5 - Distribution network supplied from RCTS

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 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 - 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. The B1 and B2 transformers are in poor condition. The B2 transformer was commissioned in 1974 and is approaching the end of its economic life with no suitable spare transformer of similar size to replace it following an unplanned outage. The B1 transformer has been commissioned in 1987 and does not have a suitable spare transformer. The B3 transformer was commissioned in 2006 and its condition is managed by asset works.

The smaller L1 and L2 transformers are providing a 22 kV supply. They are in poor condition (C4) and require remedial action within the next five years. Both 220/22 kV transformers have been in service since 1962 and are approaching the end of their economic life. The probability of a 220/66 kV or 220/22 kV 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 or very condition (C4 and C5). Management of safety risks from potential explosive failures[13] 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 to maintain correct functioning of the protection systems and to maintain reliable transmission network services.

2.3. Description of the identified need

RCTS provides an electricity supply to Red Cliffs and the 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 some 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 $73 million over the forty-five-year period from 2023. The key elements of these risk costs are shown in Figure 6. 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.

13 Since 2002, two current transformers have failed explosively in the Victorian network

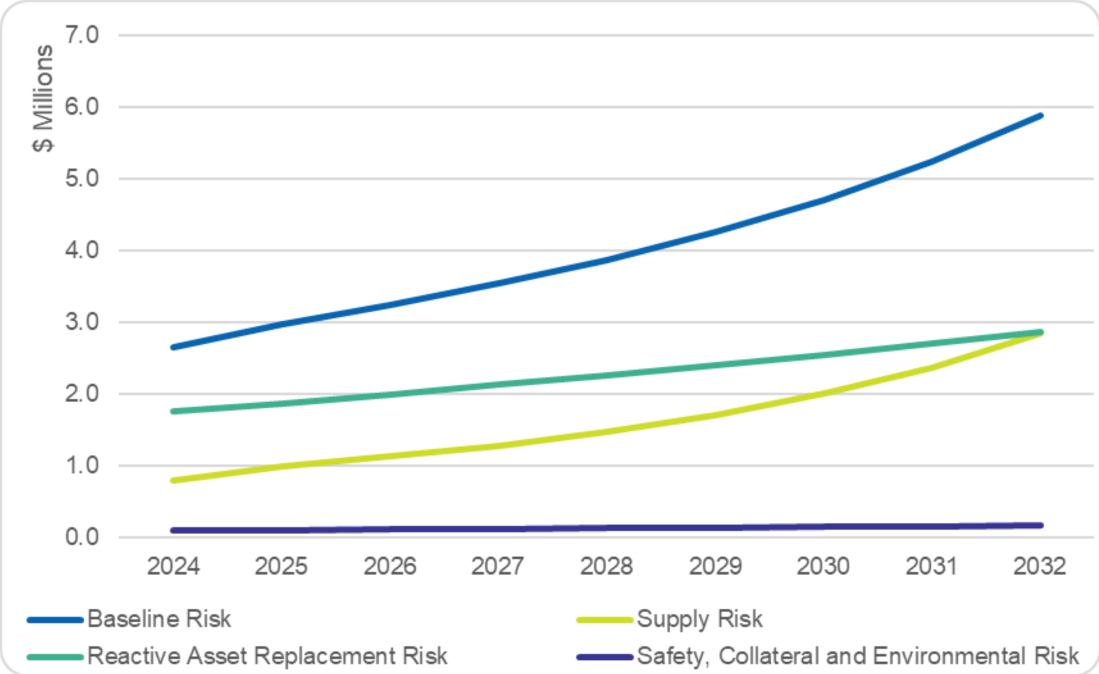

Figure 6 - Baseline risk costs

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[14].

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,[15] and has valued this expected unserved energy with the latest AER Value of Customer Reliability (VCR)[16]. 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[17] 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

14 Victorian State Government, Victorian Legislation and Parliamentary Documents, "Electricity Safety Act 1998"
15 2022 Transmission Connection Planning Report"
16 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)
17 Victorian State Government, Victorian Legislation and Parliamentary Documents, "Electricity Safety Act 1998"

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

- a value of statistical life[18] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[19]; and
- a disproportionality factor[20].

AusNet Services notes this approach, including the use of a disproportionality factor, is consistent with the practice notes[21] 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.[22]

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.

18 Department of the Prime Minister and Cabinet, Australian Government, "Best Practice Regulation Guidance Note: Value of statistical life"
19 Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13"
20 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
21 Australian Energy Regulator, "Industry practice application note for asset replacement planning"
22 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 but did not find any suitable non-network solution or received a proposal for a non-network solution. The two network options are presented below.

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 $57.2 million with no material change in operating cost and an estimated delivery lead time of four to five 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 and requiring refurbishment of the transformers to address urgent condition related issues.

3.3. Options considered and not progressed

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

Refurbishment options do not reduce the risk from asset failure as the deteriorated components cannot be refurbished 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. Assessment approach

Consistent with the RIT-T requirements and practice notes on risk-cost assessment methodology[23], AusNet Services undertook a cost-benefit analysis to evaluate and rank the net economic benefits of all credible options over a 45-year period.

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

The 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. Sensitivity analysis and input assumptions

The robustness of the investment decision and the optimal timing of the preferred option have been 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
Value of customer reliability	Latest AER VCR figures - 25%	Latest AER VCR figures	Latest AER VCR figures + 25%
Asset failure rate	AusNet Services assessment – 25%	AusNet Services assessment	AusNet Services assessment + 25%
Discount rate	3.0% - WACC rate of a network business	7% - latest commercial discount rate	10.5% - Upper Bound
Capital cost	Estimated capital cost - 25%	Estimated capital cost	Estimated capital cost + 25%

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 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 deteriorated 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 one of the options considered in this RIT-T.

4.4. Classes of market benefits that are not material

The following classes of market benefits are unlikely to be material for the options considered in this RIT-T:

23 Australian Energy Regulator, "Industry practice application note for asset replacement planning"

- Changes in costs for parties, other than the RIT-T proponent – there is no other known investment, either generation or transmission, which 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 to be 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.

5. Options assessment

This section presents the results of the economic cost benefit analysis and the economic timing of the preferred option. All the options considered in this RIT-T will deliver a reduction in supply risk, safety risk, environmental risk, collateral risk and risk cost of emergency replacement in the event of asset failure. Presented in Figure 7, the total risk cost reduction outweighs the investment cost for most of the sensitivities for both options where input variables are varied one at a time.

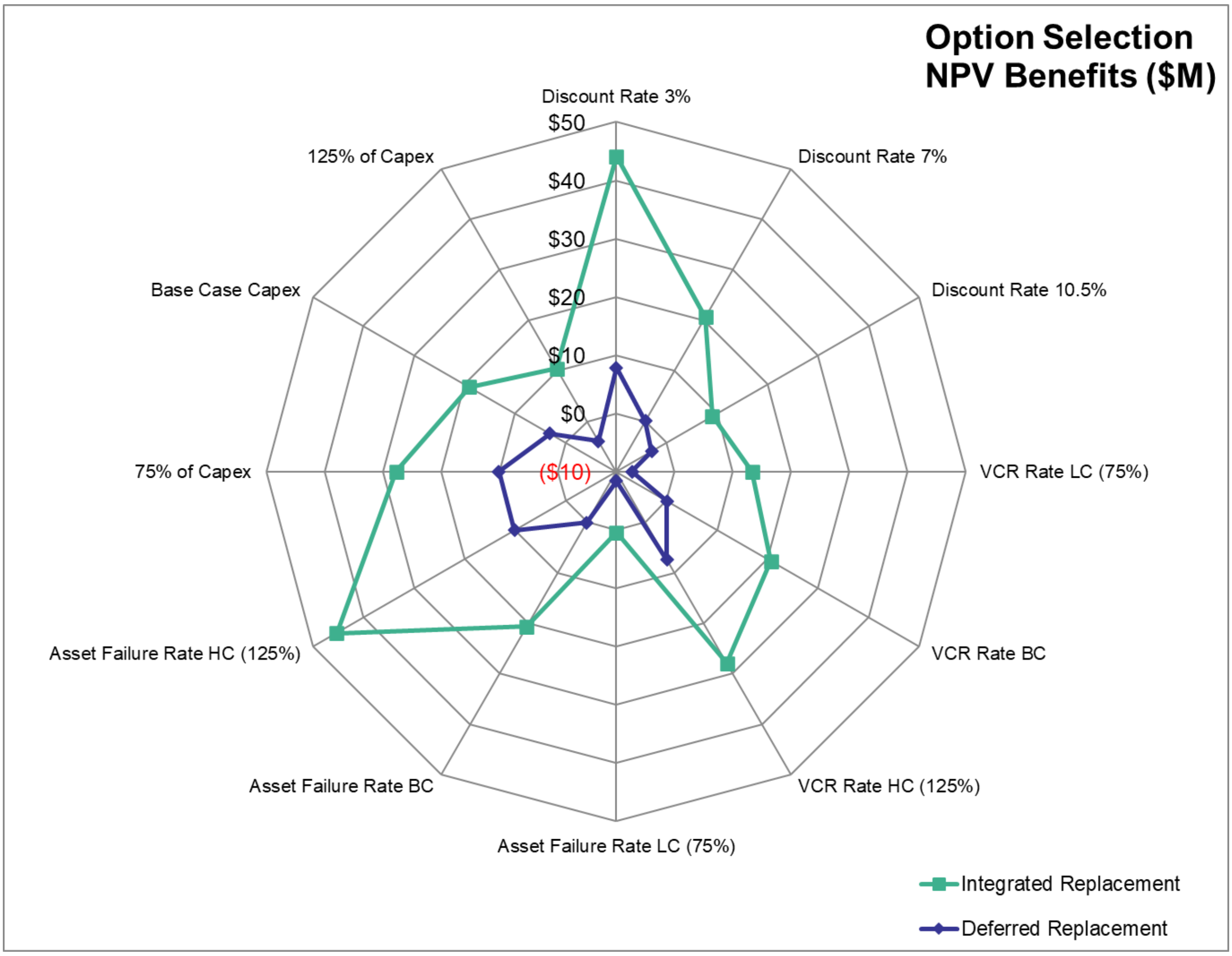

Figure 7 - Option selection, scenario and sensitivity study

5.1. Preferred Option

Option 1 (Integrated replacement by 2028) has the highest net economic benefit for all the scenarios and sensitivities considered and is therefore the preferred option. Scenario weighting will not make a difference to the preferred option as Option 1 has the highest net benefits for all the scenarios.

5.2. Optimal timing of the preferred option

This section describes the optimal investment timing of the preferred option for different assumptions of key variables. Figure 8 shows that the optimal timing of the preferred option (Option 1) is 2028.

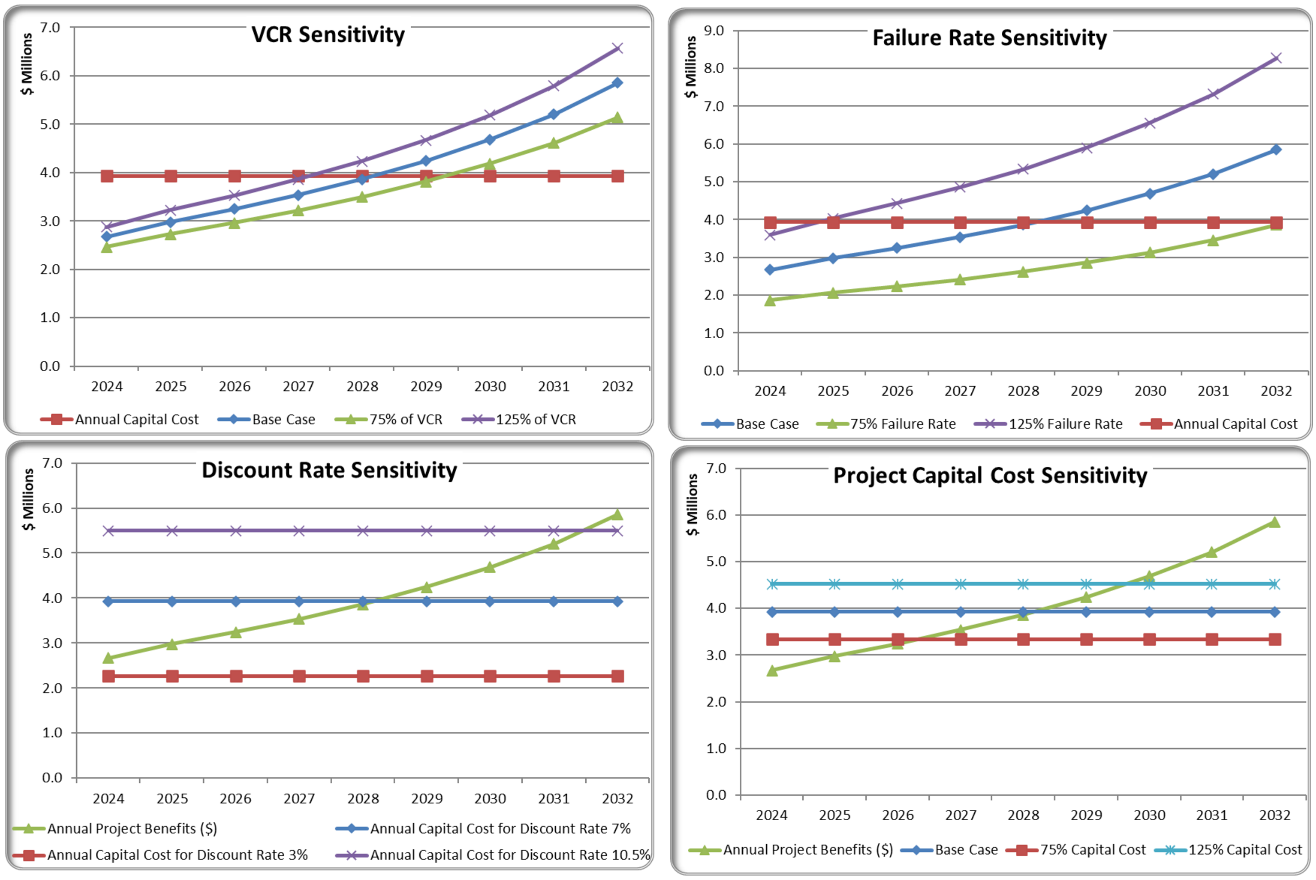

Figure 8 - Optimal investment timing sensitivity study

6. Conclusion and next steps

Amongst the options considered in this RIT-T, Option 1 is the most economical option to maintain reliable transmission network services at RCTS and manage safety, environmental, collateral and emergency replacement risks. The preferred option involves selective replacement of assets that are in poor condition, including two 220/66 kV transformers, two 220/22 kV transformers, instrument transformers, protection relays and secondary assets that are in poor or very poor condition.

The estimated capital cost of this option is $57.2 million with no material change in operating and maintenance cost. The project is economic by 2028 based on a total investment cost of $57.2 million and AusNet Services is targeting a commissioning date of November 2028.

Next steps

In accordance with clause 5.16B of the NER, within 30 days of the date of publication of this PACR, any party disputing the conclusion made in this PACR should give notice of the dispute in writing setting out the grounds for the dispute (the dispute notice) to the AER. If there are no dispute notices within 30 days of the date of publication of this PACR, AusNet Services expect to implement the preferred option.

Appendix A - RIT-T assessment and consultation process

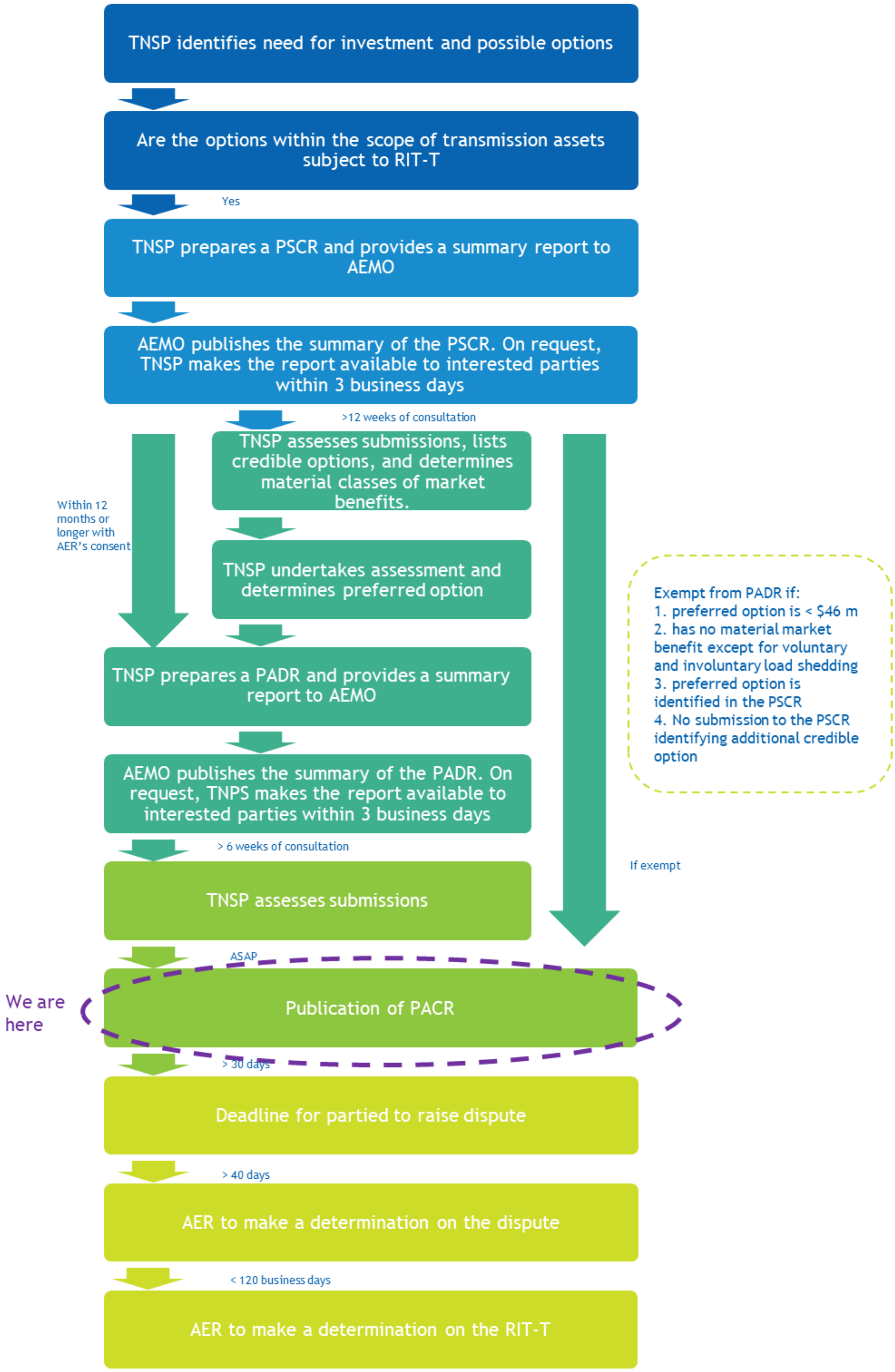

Figure 9 - RIT-T Process

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).