Maintain reliable transmission network services at Moorabool Terminal Station

Project Assessment Conclusions Report

Regulatory Investment Test - Transmission

October 2022

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.

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Executive summary

AusNet Services undertook this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain reliable transmission network services at Moorabool Terminal Station (MLTS).

The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process was published in March 2022 and the succeeding Project Assessment Draft Report (PADR) was published in August 2022. Publication of this Project Assessment Conclusions Report (PACR) represents the third and final step in the RIT-T process in accordance with clause 5.16 of the National Electricity Rules (NER) and section 4.2 of the RIT-T Application Guidelines.

MLTS is owned and operated by AusNet Services and is located north of Geelong in Victoria. It was commissioned in the early 1980s and forms part of the main Victorian 500 kV transmission system with transformation from 500 kV to 220 kV.

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

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

Identified need

The condition of some 500 kV and 220 kV circuit breakers and instrument transformers at MLTS has deteriorated over time to a level where there is a material risk of asset failure, which could have an impact on electricity supply reliability, generation cost, safety, environment, collateral damage and emergency replacement cost. The 'identified need' this RIT-T intends to address is to maintain reliable transmission network services at MLTS and mitigate risks from asset failures.

The present value of the baseline risk cost to maintain the existing assets in service is more than $132 million. The biggest components of the baseline risk are the wholesale market impact and reactive asset replacement cost of an asset failure.

AusNet Services is therefore proposing investment in asset replacement options that will allow continued delivery of safe and reliable transmission network services.

Credible options

AusNet Services did not receive proposals for non-network solutions or any submissions 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 – Integrated Replacement that replaces selected 500 kV and 220 kV switchgear in an integrated project; or
- Option 2 – Staged replacement with 220 kV switchgear deferred; or
- Option 3 – Staged replacement with 500 kV switchgear deferred.

Assessment approach

AusNet Services followed the Australian Energy Regulator (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 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

The cost-benefit assessment confirms that Option 1 is the most economic option as it provides the highest present value of net economic benefits and is hence the RIT-T preferred option. This option will not only maintain reliable transmission network services, but also mitigates safety, environmental, collateral and emergency replacement risks from potential asset failures at MLTS.

The optimal timing of the preferred option to address the identified need is 2026/27 based on an estimated capital cost of $34.6 million and estimated network support cost of up to $17 million.

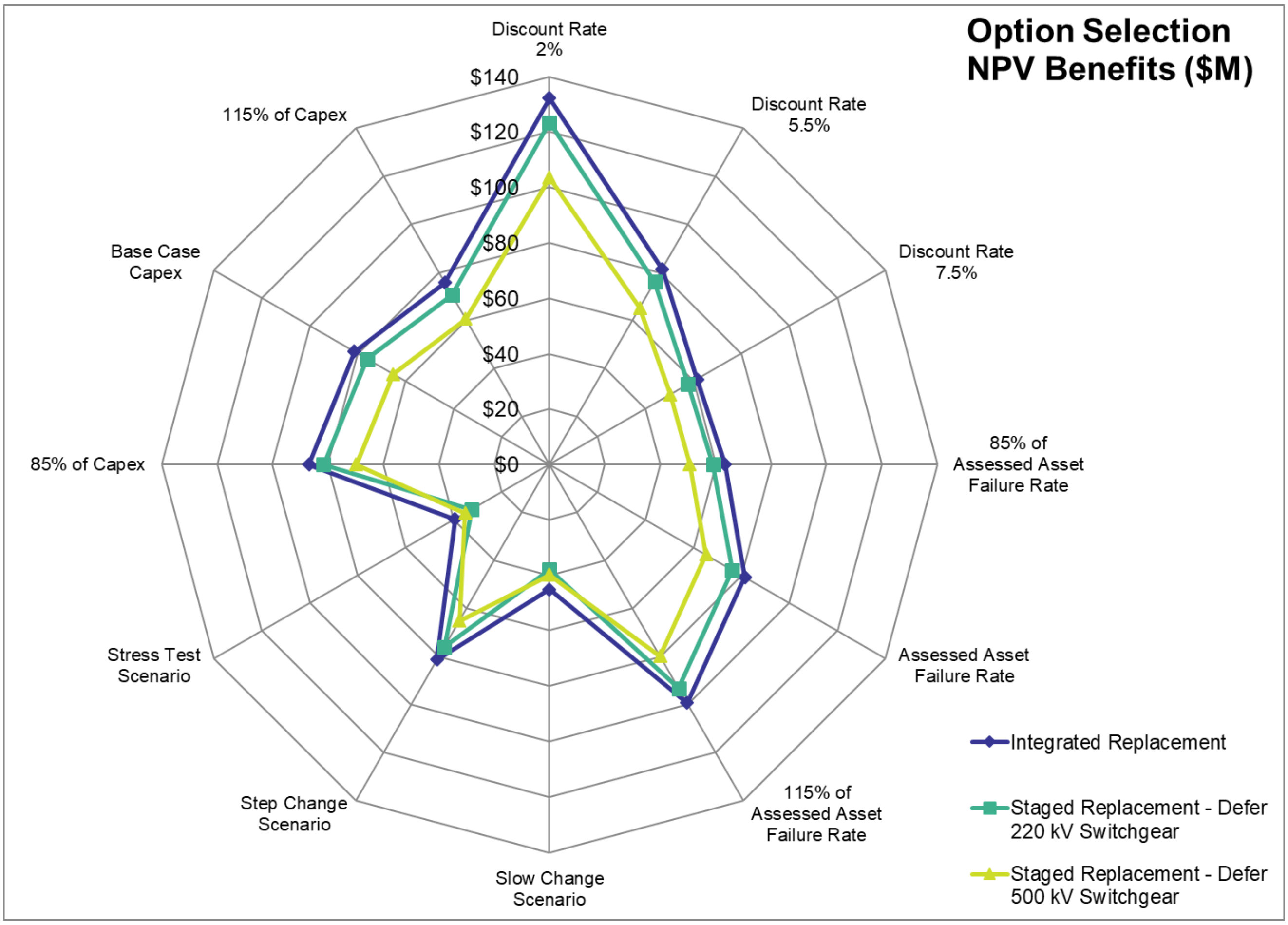

Figure 1 – Preferred option considering different ISP scenarios and sensitivity analysis

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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Tables

1. Introduction

AusNet Services initiated this RIT-T to evaluate options to maintain reliable transmission network services at MLTS and to mitigate the risk of assets failures at MLTS.

The PSCR, which represents the first step in the RIT-T process was published in March 2022 and the succeeding PADR was published in August 2022. Publication of this PACR represents the third and final step in the RIT-T process in accordance with clause 5.16 of the National Electricity Rules (NER) and section 4.2 of the RIT-T Application Guidelines.

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 MLTS has been included in AusNet Services' revenue proposal for the 2022 to 2027 regulatory control period.[1] This investment need is also presented in AusNet Services Asset Renewal Plan that is published as part of AEMO's 2021 Victorian Transmission Annual Planning Report (VAPR).[2]

1 Australian Energy Regulator, *"AusNet Services - Determination 2017–2022"*
2 Australian Energy Market Operator, *"Victorian Annual Planning Report"*

2. Identified need

This section of the PACR describes the condition of key assets at MLTS, quantify the risk costs of an asset failure and establish the need for investment.

2.1. Transmission network services at Moorabool

MLTS is owned and operated by AusNet Services and is located near Geelong. It is part of the main 500 kV transmission network, which provides major transmission network services in Victoria. The 500 kV transmission backbone runs from east to west across the state and connects generation in the Latrobe Valley and western parts of Victoria with the major load centre in Melbourne. It also forms an interconnector with South Australia at Heywood Terminal Station (HYTS) as shown below.

Figure 2 - 500 kV Transmission network backbone

MLTS serves as a 500 kV switching station with 500/220 kV transformation that ties the 500 kV transmission network backbone with the 220 kV transmission network near Geelong as shown in Figure 3. MLTS has two 1000 MVA 500/220 kV transformers. The ongoing need for MLTS is both demonstrated in AEMO's Integrated System Plan (ISP) and Victorian Annual Planning Report (VAPR).

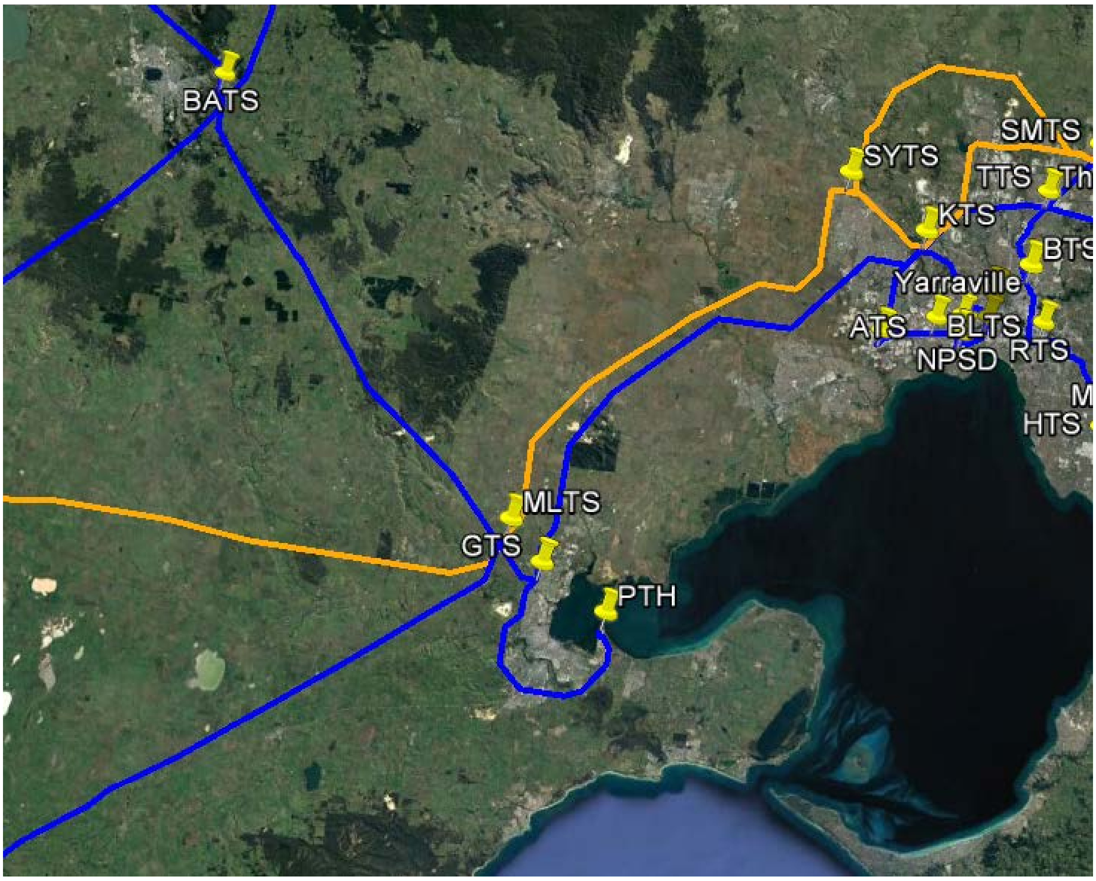

Figure 3 – Transmission network connected at MLTS

2.2. Asset condition

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

AusNet Services classifies asset condition using scores that range from C1 (initial service condition) to C5 (very poor) as set out in Appendix B. The latest asset condition assessment for MLTS 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 1 provides a summary of the condition of relevant major equipment.

Asset class	Condition scores				
	C1	C2	C3	C4	C5
500 kV circuit breakers	1	0	0	0	8
220 kV circuit breakers	3	2	1	3	7
500 kV and 220 kV current transformers	3	31	12	24	5
500 kV and 220 kV voltage transformers	7	0	1	13	14

Table 1 - Summary of major equipment condition scores

500 kV circuit breakers

Eight of the nine 500 kV circuit breakers are in very poor condition and are approaching their end of serviceable life. This is expected of assets that have been in service for a long period of time.

With a condition score of C5, these circuit breakers present challenges due to duty-related deterioration. Common problems are flange corrosion, SF6 leakage and hydraulic mechanism seal deterioration. Spares are limited and large component parts are not replaceable. Manufacturer support for these assets is also limited and refurbishment is thus not a viable economic option.

220 kV circuit breakers

Ten of the sixteen 220 kV circuit breakers are in poor or very poor condition and are approaching their end of serviceable life. This is expected of assets that have been in service for a long period of time.

With condition scores of C4 and C5, these circuit breakers present challenges due to duty-related deterioration. Spares are limited and large component parts are not replaceable. Manufacturer support for these assets is limited and refurbishment is thus not a viable economic option.

500 kV and 220 kV instrument transformers

Several instrument transformers at MLTS are in poor or very poor condition (C4 and C5). Management of safety risks from potential explosive failures of instrument transformers is costly due to the need for regular oil sampling and partial discharge condition monitoring. Refurbishment is not a viable economic option for these assets.

2.3. Description of the identified need

MLTS is part of the main 500 kV transmission network, which provides major transmission services in Victoria. AusNet Services expects that the services that the terminal station provides will continue to be required given the transmission network developments that are foreshadowed in AEMO's Integrated System Plan[3].

The poor condition of some of the components at the terminal station has increased the likelihood of asset failures. Such failures would result in prolonged 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 asset failure will result in a higher likelihood of an impact on transmission network users, heightened safety risks due to potential explosive failure, environmental risks, collateral damage risks, and the risk of increased costs resulting from emergency asset replacements and reactive repairs. Therefore, the 'identified need' this RIT-T intends to address is to maintain reliable transmission network services at MLTS and to mitigate risks from asset failures.

AusNet Services calculated the present value of the baseline risk costs to be more than $132 million over the forty-five year period from 2022/2023. The key risks are shown in Figure 4 with the largest component of the baseline risk costs being the market impact from an asset failure, which will impact customers through higher electricity cost as generators will have to be operated out of merit and involutory load shedding may be required due to network constraints.

3 AEMO, 2022 Integrated System Plan for the National Electricity Market

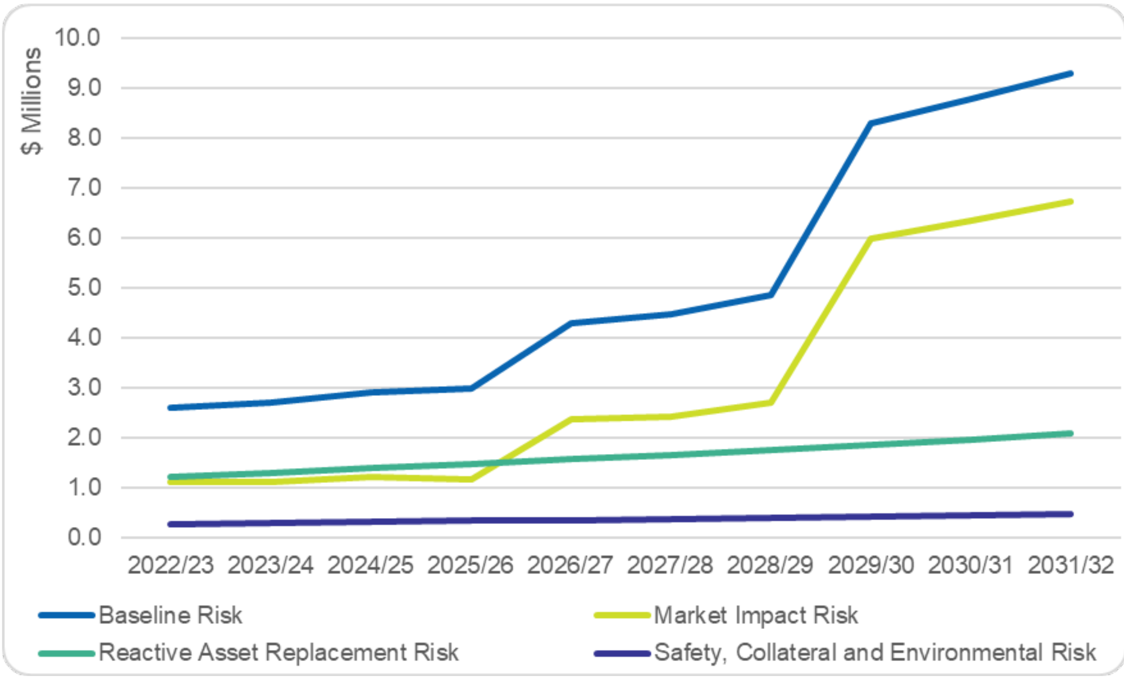

Figure 4 - Baseline risk costs

By undertaking the options identified in this RIT-T, AusNet Services will be able to maintain reliable transmission network services at MLTS and mitigate safety and environmental risks as required by the NER and Electricity Safety Act 1998[4].

2.3.1. Assumptions

Aside from the failure rates (determined by the condition of the assets) and the likelihood of relevant consequences, AusNet Services also adopted the following assumptions to quantify the risks associated with asset failure.

Market impact and supply risk costs

AusNet Services calculated the market impact cost, which consist of increased generation cost and expected unserved energy resulting from an asset failure at MLTS based on the Victoria state wide Value of Customer Reliability (VCR)[5].

Safety risk costs

The Electricity Safety Act 1998[6] 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. By implementing this principle for assessing safety risks from explosive asset failures, AusNet Services uses:

- a value of statistical life[7] to estimate the benefits of reducing the risk of death;

4 Victorian State Government, Victorian Legislation and Parliamentary Documents, "Electricity Safe Act 1998"
5 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).
6 Victorian State Government, Victorian Legislation and Parliamentary Documents, "Electricity Safe Act 1998"
7 Department of the Prime Minister and Cabinet, Australian Government, "Best Practice Regulation Guidance Note: Value of statistical life"

- a value of lost time injury[8]; and
- a disproportionality factor[9].

AusNet Services notes this approach, including the use of a disproportionality factor, is consistent with the practice notes[10] provided by the AER.

Financial risk costs

As there is a lasting need for the services that MLTS provides, the failure rate-weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[11]

Environmental risk costs

Environmental risks from plant that could impact the environment when it fails and where cleanup cost could be in the order of $30,000 per event.

8 Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13"
9 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.
10 Australian Energy Regulator, "Industry practice application note for asset replacement planning"
11 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 three network options are presented below.

3.1. Option 1 –Integrated Replacement

Option 1 involves replacement of all poor or very poor condition 500 kV and 220 kV assets in a single integrated project. It includes:

- Replacement of eight 500 kV circuit breakers and associated primary and secondary equipment; and
- Replacement of ten 220 kV circuit breakers and associated primary and secondary equipment.

The estimated capital cost of this option is $34.6 million and the change in operating and maintenance cost is negligible.

3.2. Option 2 – Staged replacement with 220 kV switchgear deferred

Option 2 is a staged replacement option to assess whether it would be more economic to stage the asset replacement investment over two stages that are six years apart.

The first stage replaces all 500 kV assets that are in poor or very poor condition and all 220 kV assets that are targeted for replacement are deferred six years after completion of the first stage.

The estimated capital cost of the first and second stage of this option is $24.7 million and $12.2 million respectively. The change in operating and maintenance cost is negligible.

3.3. Option 3 – Staged replacement with 500 kV switchgear deferred

Option 3 is another staged replacement option to assess whether it would be more economic to stage the asset replacement investment over two stages that are six years apart.

The first stage replaces all 220 kV assets that are in poor or very poor condition and all 500 kV assets that are targeted for replacement are deferred six years after completion of the first stage.

The estimated capital cost of the first and second stage of this option is $12.2 million and $24.7 million respectively. The change in operating and maintenance cost is negligible.

3.4. Material inter-regional network impact

The proposed asset replacements at MLTS 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, 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 have 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 cost.

4.1. Proposed scenarios and input assumptions

The robustness of the investment decision is tested using the range of input assumptions and scenarios described in the table below. This analysis involves variation of assumptions around the most likely values as per the IASR and AusNet Service's best estimate of project cost and assessment of asset failure rates.

Parameter	Lower Bound	Most likely assumption or scenario	Upper Bound
Market Scenario	Slow Change Scenario	Step Change Scenario	Stress Test (Slow Change Scenario and high capital cost)
Asset failure rate	85% of assessed failure rate	Assessed failure rate	115% of assessed failure rate
Project Capital Cost	85% of estimated cost	Estimated cost	115% of estimated cost
Discount rate[12]	2.0% - the WACC rate of a network business	5.5% - the latest commercial discount rate	7.5% - Upper Bound

Table 2 - Summary of input assumptions for the proposed scenarios

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 classes of market benefits that are likely to be material include changes in involuntary load shedding, and changes in fuel consumption arising through different patterns of generation dispatch.

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, 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.

12 Discount rates as recommended in the AEMO Inputs, Assumptions and Scenarios Report (IASR)

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 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.

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 market impact risk, safety risk, environmental risk, collateral risk and risk cost of emergency replacement in the event of asset failure.

Presented in Figure 5, the total risk cost reduction outweighs the investment cost for all options for all sensitivities where input variables are varied one at a time.

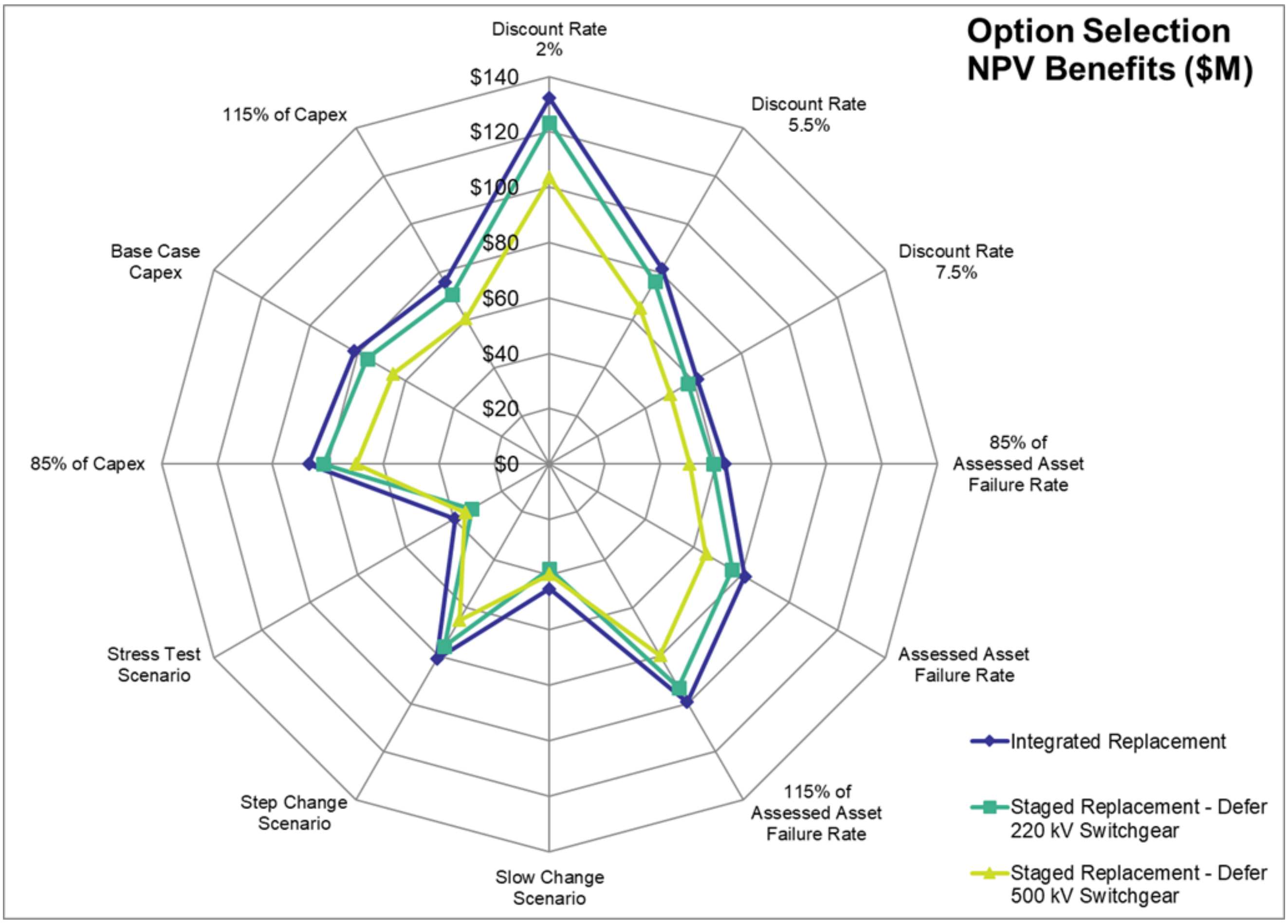

Figure 5 – Option Selection, scenario and sensitivity study

5.1. Preferred Option

Option 1 (Integrated replacement) 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 three scenarios (Slow Growth, Step Change and the Stress Test Scenario).

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 6 shows that the optimal timing of the preferred option (Option 1) is before 2026/27 and that the investment is needed within the 2022 to 2027 regulatory control period.

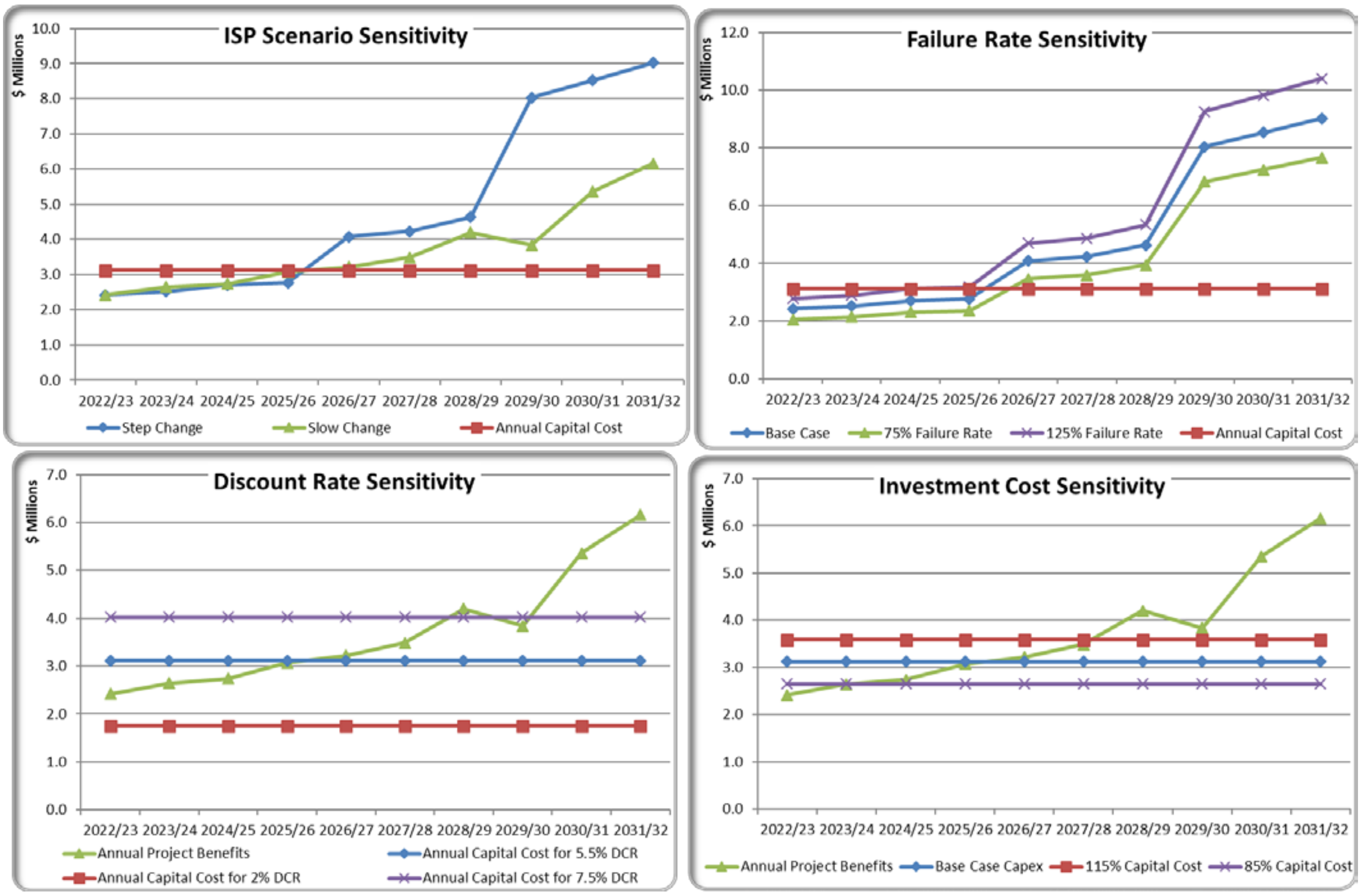

Figure 6 - Optimal investment timing sensitivity study

6. Conclusion

Amongst the options considered in this RIT-T, Option 1 is the most economical option to maintain reliable transmission network services at MLTS and manage safety, environmental, collateral and emergency replacement risks. The preferred option involves the selective replacement of 500 kV and 220 kV circuit breakers and instrument transformers as well as protection relays and secondary assets that are in poor or very poor condition in an integrated project.

The estimated capital cost of this option is $34.6 million with no material change in operating and maintenance cost. The project is economic before 2026/27 based on a total investment cost (including network support cost) of $51.6 million and AusNet Services is targeting a commissioning date of December 2027. Network support may be required to allow planned outages, which is estimated to cost less than $17 million.

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

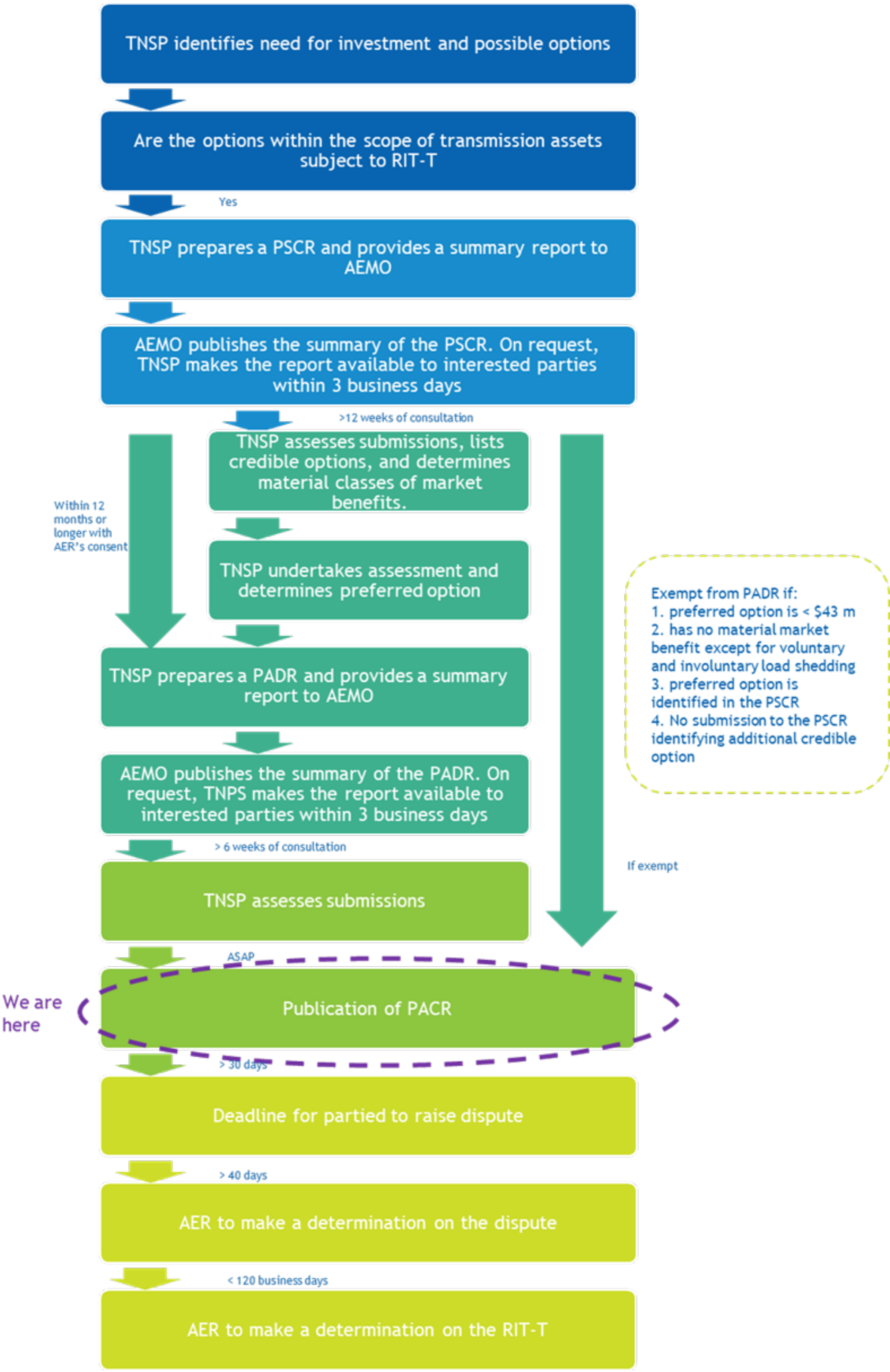

Figure 7 - RIT-T Process

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 3 - 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).