Maintain reliable transmission network services at Sydenham Terminal Station

Project Assessment Conclusions Report
Regulatory Investment Test - Transmission

October 2021

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 Sydenham Terminal Station (SYTS).

The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process was published in December 2020; and the succeeding Project Assessment Draft Report (PADR) was published in August 2021. 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)[1] and section 4.2 of the RIT-T Application Guidelines[2].

SYTS is owned and operated by AusNet Services and is in Sydenham, which is north west of Melbourne's CBD. It was commissioned in the early 1980s and is part of the main Victorian 500 kV transmission system.

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

The preferred option to address the asset failure risk at SYTS is an integrated replacement of the 500 kV gas insulted switchgear (GIS) with 500 kV air insulted switchgear (AIS) by 2025/26.

Network support payments might be required for some of the 500 kV circuit outages that will be required for the asset replacements and the estimated economic cost has been included in the economic cost benefit analysis.

Identified need

As expected of assets that have been in service for a long time, the condition of the 500 kV GIS has deteriorated 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. Therefore, the 'identified need' this RIT-T intends to address is to maintain reliable transmission network services at SYTS and mitigate risks from asset failures.

The present value of the baseline risk cost to maintain the existing assets in service is more than $155 million, and the biggest components of the baseline risk are the market impact (generation and electricity consumers) and reactive asset replacement cost of an asset failure at SYTS. 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 during the RIT-T consultation and did not identify a credible, economical non-network solution for the identified need at SYTS.

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

- Option 1 – Replace the GIS with air insulated switchgear (AIS)
- Option 2 – Replace the GIS with indoor GIS

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

[1] Australian Energy Market Commission, *"National Electricity Rules"*

[2] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*

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 three 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.

Options assessment and 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 risks.

The optimal timing of the preferred option to address the identified need at SYTS is 2025/26 based on an estimated capital cost of $82.6 million. The proponent of this project is AusNet Services.

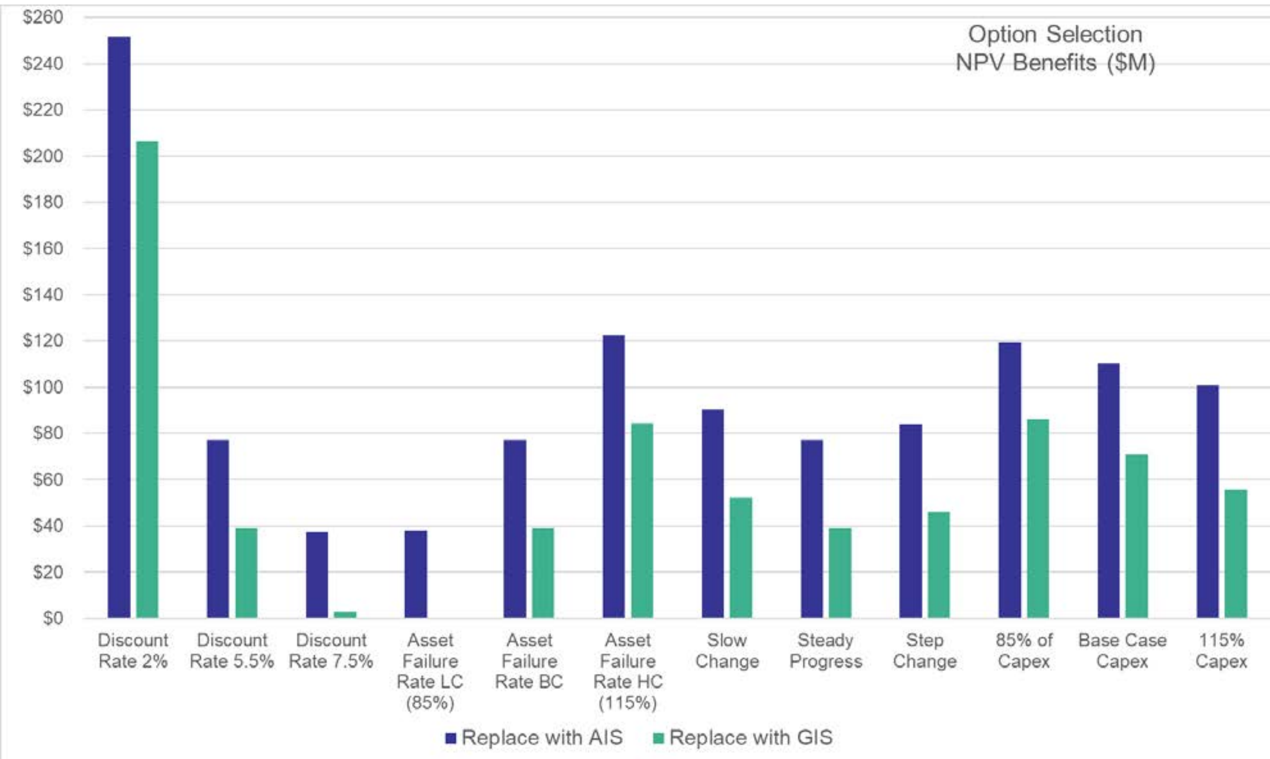

Figure 1 – Option selection and sensitivity analysis (NPV Benefits $M)

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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1. Introduction

AusNet Services initiated this Regulatory Investment Test for Transmission (RIT-T) to evaluate options to maintain reliable transmission network services at Sydenham Terminal Station (SYTS) in response to the poor condition of assets at SYTS.

The Project Specification Consultation Report (PSCR), which represents the first step in the RIT-T process was published in December 2020; and the succeeding Project Assessment Draft Report (PADR) was published in August 2021. 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)[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;
- 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 SYTS 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 2020 Victorian Transmission Annual Planning Report (VAPR).[6]

[3] Australian Energy Market Commission, *"National Electricity Rules"*
[4] Australian Energy Regulator, *"Application guidelines Regulatory investment test for transmission"*
[5] Australian Energy Regulator, *"AusNet Services - Determination 2017–2022,"* p. 42
[6] Australian Energy Market Operator, *"Victorian Annual Planning Report"*

2. Identified need

The role of SYTS in providing transmission network services and the condition of key assets is discussed below. Quantification of the risk costs associated with the deterioration of these assets and the need for the investments is also presented.

2.1. Transmission network services at SYTS

SYTS is owned and operated by AusNet Services and is located north west of Melbourne's CBD. 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 center in Melbourne. It also forms an interconnector with South Australia at Heywood Terminal Station (HYTS) as shown blow.

Figure 2 – 500 kV Transmission Backbone

SYTS serves as a 500 kV switching station located inside the Melbourne metropolitan area as shown in Figure 3.

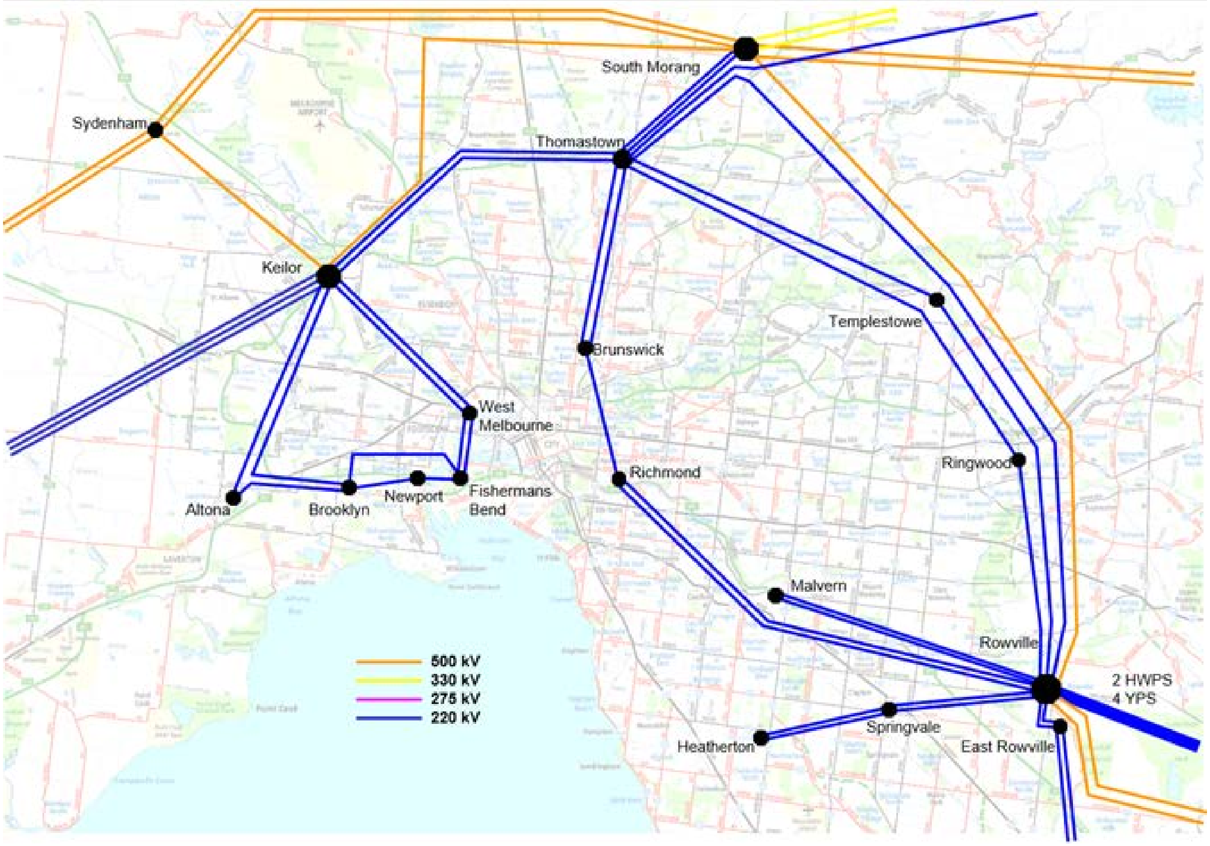

Figure 3 – Transmission network connected at SYTS

2.2. Asset condition

The GIS is in a poor condition despite a major refurbishment that has been undertaken around six years ago. The GIS is no longer supported by the original equipment manufacturer (OEM) and AusNet Services has only a limited number of spares to repair asset failures. The mean time to restore supply following an asset failure is expected to be very long, especially when faced with multiple failures.

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 probability of GIS failure is high and is likely to increase further if no remedial action is taken. Table 1 provides a summary of the condition of the GIS.

Asset class	Condition scores				
	C1	C2	C3	C4	C5
500 kV GIS	O	0	1	4	1

Table 1 - Summary of major equipment condition scores

2.3. Description of the identified need

SYTS is part of the main Victorian 500 kV transmission network, which provides major transmission network 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[7], which also includes connecting two more 500 kV lines from North Ballarat Terminal Station at SYTS by end 2024.

[7] AEMO, Integrated System Plan for the National Electricity Market

Without remedial action, other than ongoing maintenance practice (business-as-usual), the GIS is expected to deteriorate further and more rapidly. This will increase the probability of asset failure, resulting in a higher likelihood of an impact on users of the transmission network, heightened safety risks due to potential explosive failure of the assets, environmental risks, collateral damage risks, 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 network services at SYTS and to mitigate risks from asset failures.

AusNet Services calculated the present value of the baseline risk cost to be more than $155 million over the forty-five year period from 2021/2022. The key risk costs are shown in Figure 4 with the largest component of the baseline risk being reactive asset replacement and the market impact from a potential asset failure.

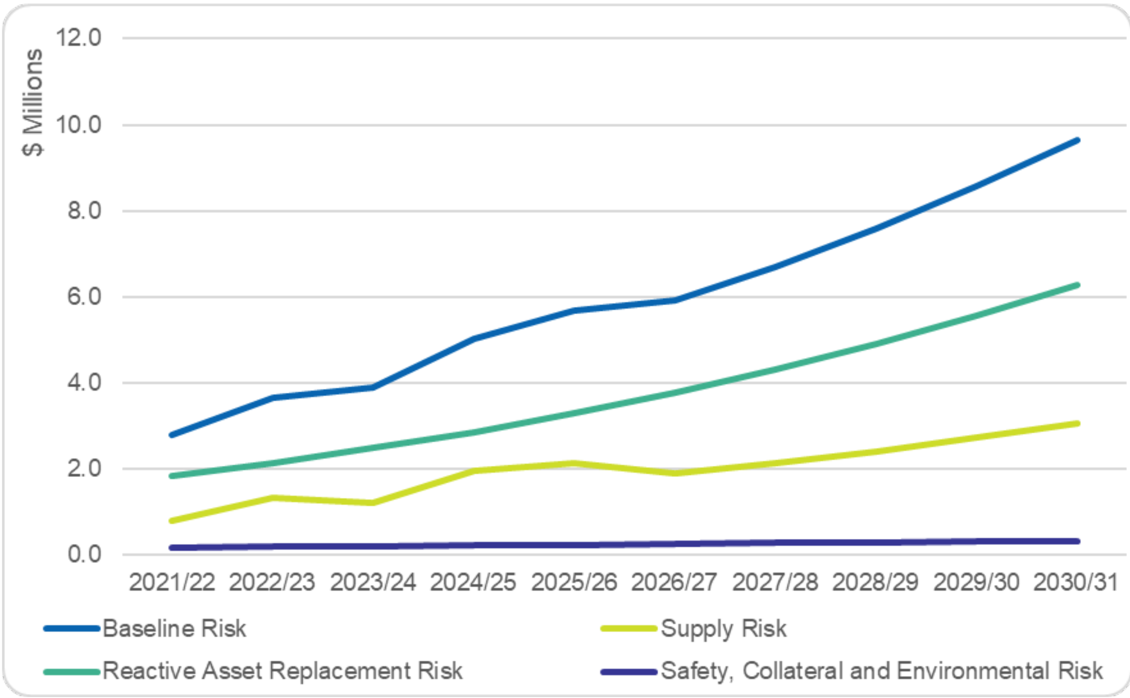

Figure 4 - Baseline risk costs

By delivering the options identified in this RIT-T, AusNet Services will be able to maintain reliable transmission network services at SYTS and mitigate safety and environmental risks, as required by the NER and Electricity Safety Act 1998[8].

2.3.1. Assumptions

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

Market impact costs

AusNet Services calculated the market impact cost, which consist of increased generation cost and expected unserved energy of an asset failure at SYTS based on the latest Value of Customer Reliability (VCR).

[8] 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.

Safety risk costs

The Electricity Safety Act 1998[9] 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[10] to estimate the benefits of reducing the risk of death;
- a value of lost time injury[11]; and
- a disproportionality factor[12].

AusNet Services notes this approach, including the use of a disproportionality factor, is consistent with the practice notes[13] provided by the AER.

Financial risk costs

As there is a lasting need for the services that SYTS provides, the failure rate weighted cost of replacing failed assets (or undertaking reactive maintenance) is included in the assessment.[14]

Environmental risk costs

Environmental risks from plant that contains large volumes of oil or SF6, which may be released in an event of asset failure, is valued at $100,000 per event.

[9] 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

[10] 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

[11] 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

[12] 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.

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

[14] 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 the GIS with AIS

Option 1 involves replacement of the 500 kV GIS with air insulated switchgear (AIS) just to the north of the existing GIS. The estimated capital cost of this option is $82.6 million with no material change in operating and maintenance cost.

3.2. Option 2 – Replace the GIS with indoor GIS

Option 2 replaces the outdoor GIS with indoor GIS at an estimated cost of $132 million and no material change in operating and maintenance cost.

3.3. Material inter-regional network impact

The proposed asset replacement at SYTS 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[15], 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 costs.

4.1. Input assumptions and sensitivity studies

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 from those used for the base case.

Parameter	Lower Bound	Base Case	Upper Bound
Market Scenario	Slow Change Scenario	Steady Progress Scenario	Step Change Scenario
Asset failure rate	AusNet Services assessment – 15%	AusNet Services assessment	AusNet Services assessment + 15%
Project Capital Cost	Base Case - 15%	Base Case Estimate	Base Case + 15%
Discount rate[16]	2.0% - the WACC rate of a network business	5.5% - the latest commercial discount rate	7.5% - Upper Bound

Table 2 - 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 classes of market benefits that are likely to be material include changes in involuntary load shedding, and changes in fuel cost arising through different patterns of generation dispatch. AusNet Services' proposed approach to assess these classes of market benefits 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 or release of greenhouse gasses, 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.

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

[16] Discount rates as recommended in the AEMO Inputs Assumptions and Scenarios Report (IASR) 2021

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. Result of 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 also considering possible network support payments to allow planned 500 kV circuit outages during the asset replacement project.

Presented in Figure 5, the total risk cost reduction outweighs the investment cost for both options for all sensitivities where input variables are varied one at a time. Both options deliver net market benefits for all three ISP scenarios, i.e. Slow Change, Steady Progress and Step Change.

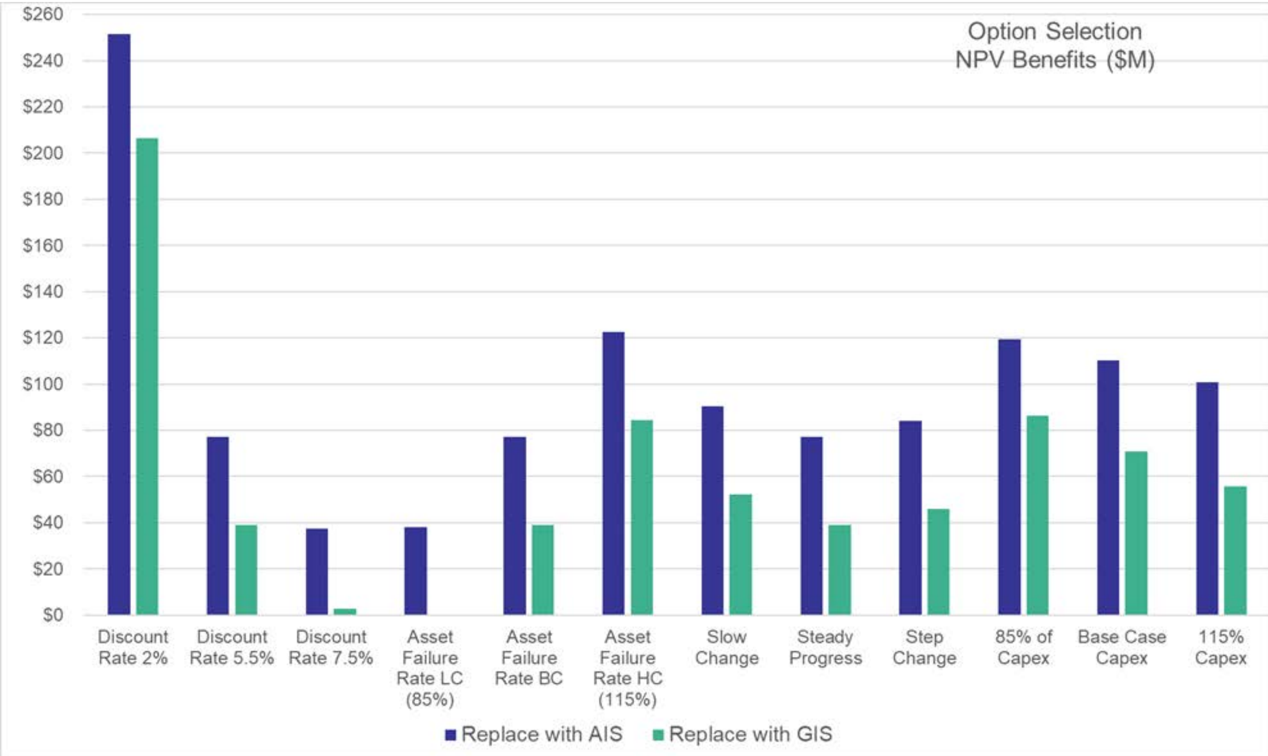

Figure 5 – Option selection and sensitivity analysis (NPV Benefits $M)

5.1. Preferred Option

Option 1 (Replace with AIS) 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 Change, Steady Progress and Step Change).

5.1. Optimal timing of the preferred option

This section describes the optimal 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 2025/26 and that the investment is needed within the 2022 to 2027 regulatory control period.

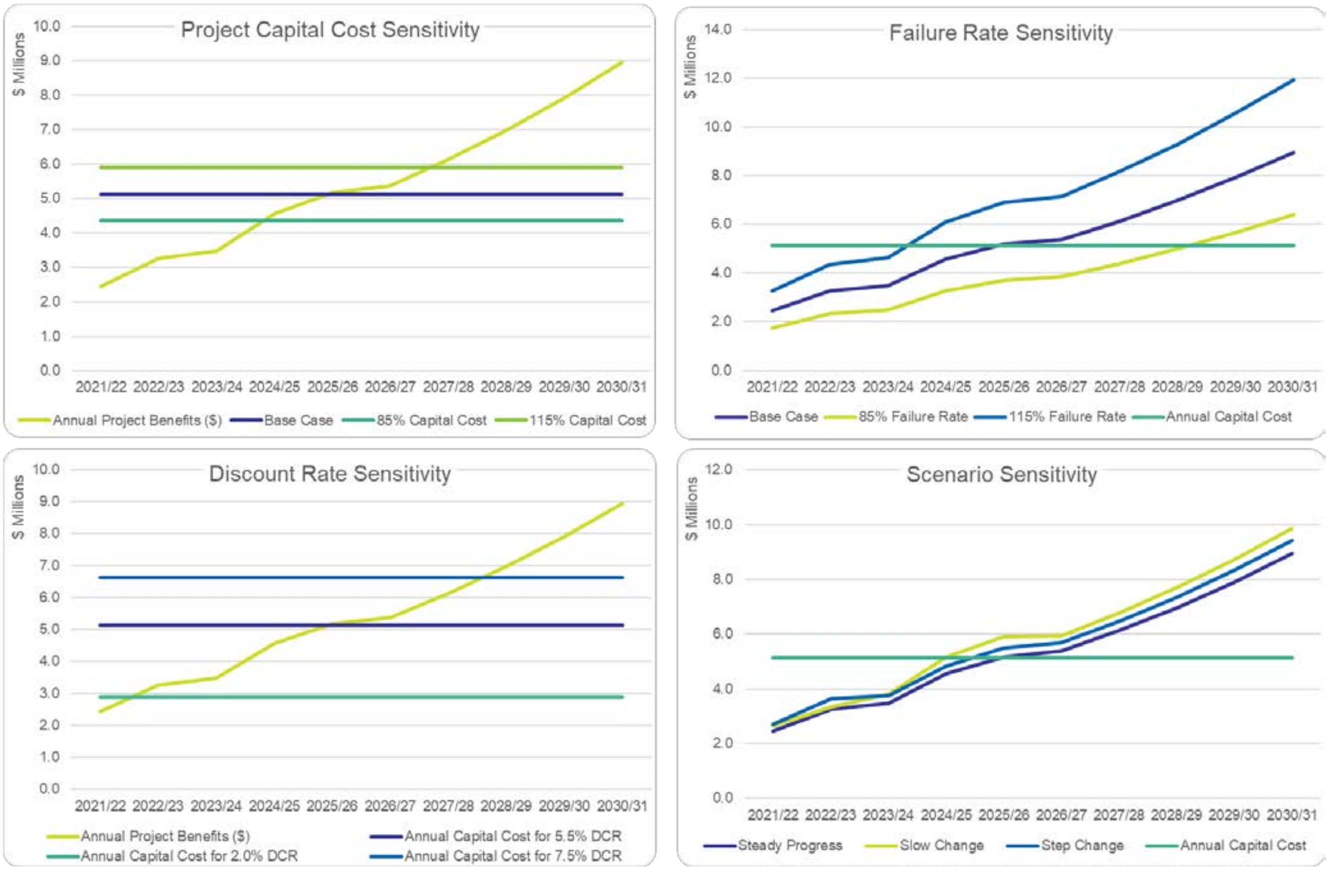

Figure 6 - Investment optimal timing with respect to variation of key parameters

6. Conclusion of the RIT-T

Amongst the options considered in this RIT-T, Option 1 is the most economical option to maintain reliable transmission network services at SYTS and manage safety, environmental, collateral and emergency replacement risks. This preferred option involves the following scope of work in a single integrated project:

- Construction of a new 500 kV switchyard using conventional AIS.
- Transferring the 500 kV circuits from the GIS to the AIS

The estimated capital cost of this option is $82.6 million with no material change in operating cost. The project is economic by 2025/26 and will take about four years to deliver.

Based on the consultation and assessment implemented, the preferred option satisfies the regulatory investment test for transmission.

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

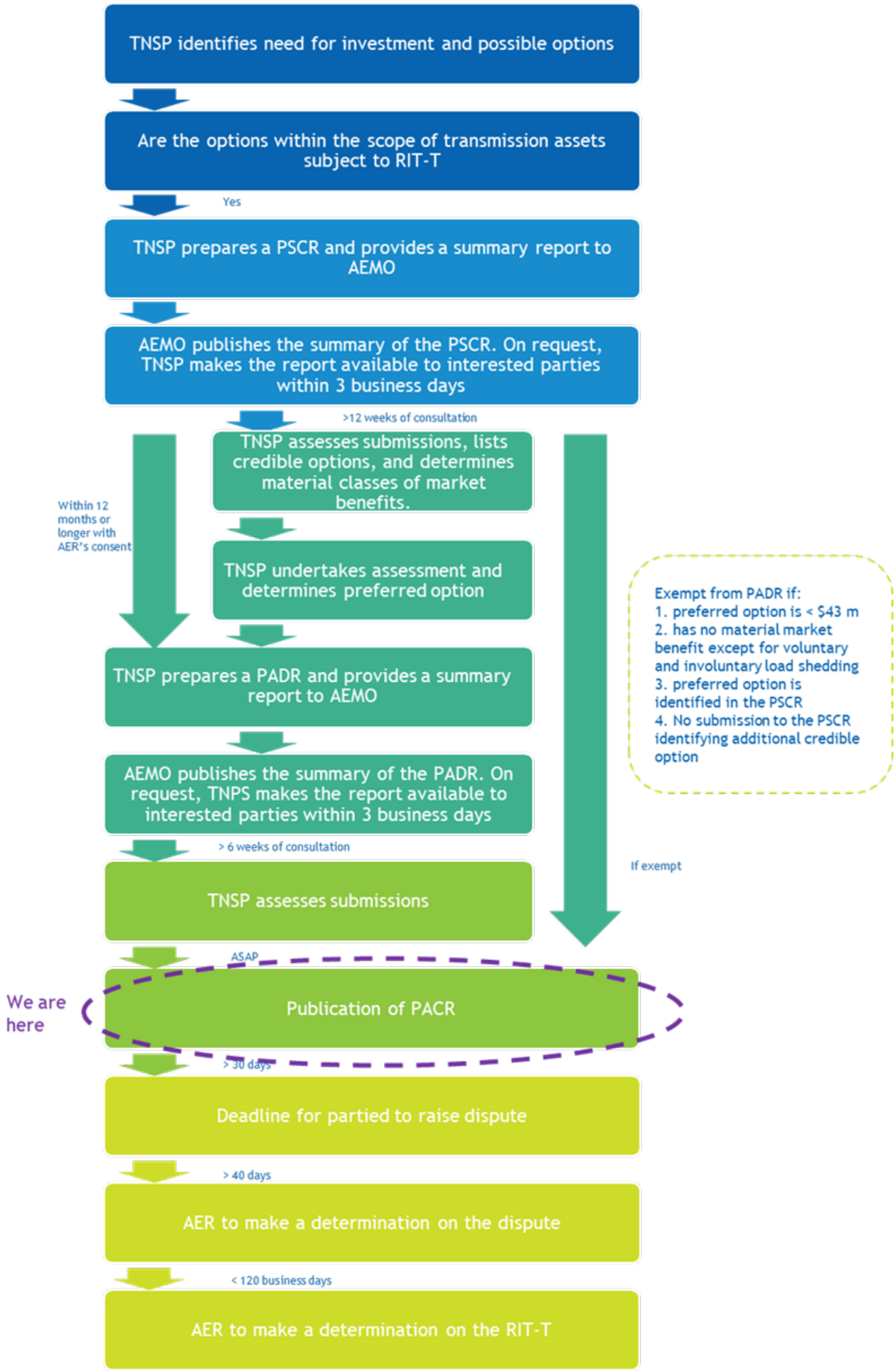

Figure 7 - RIT-T Process

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)

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).