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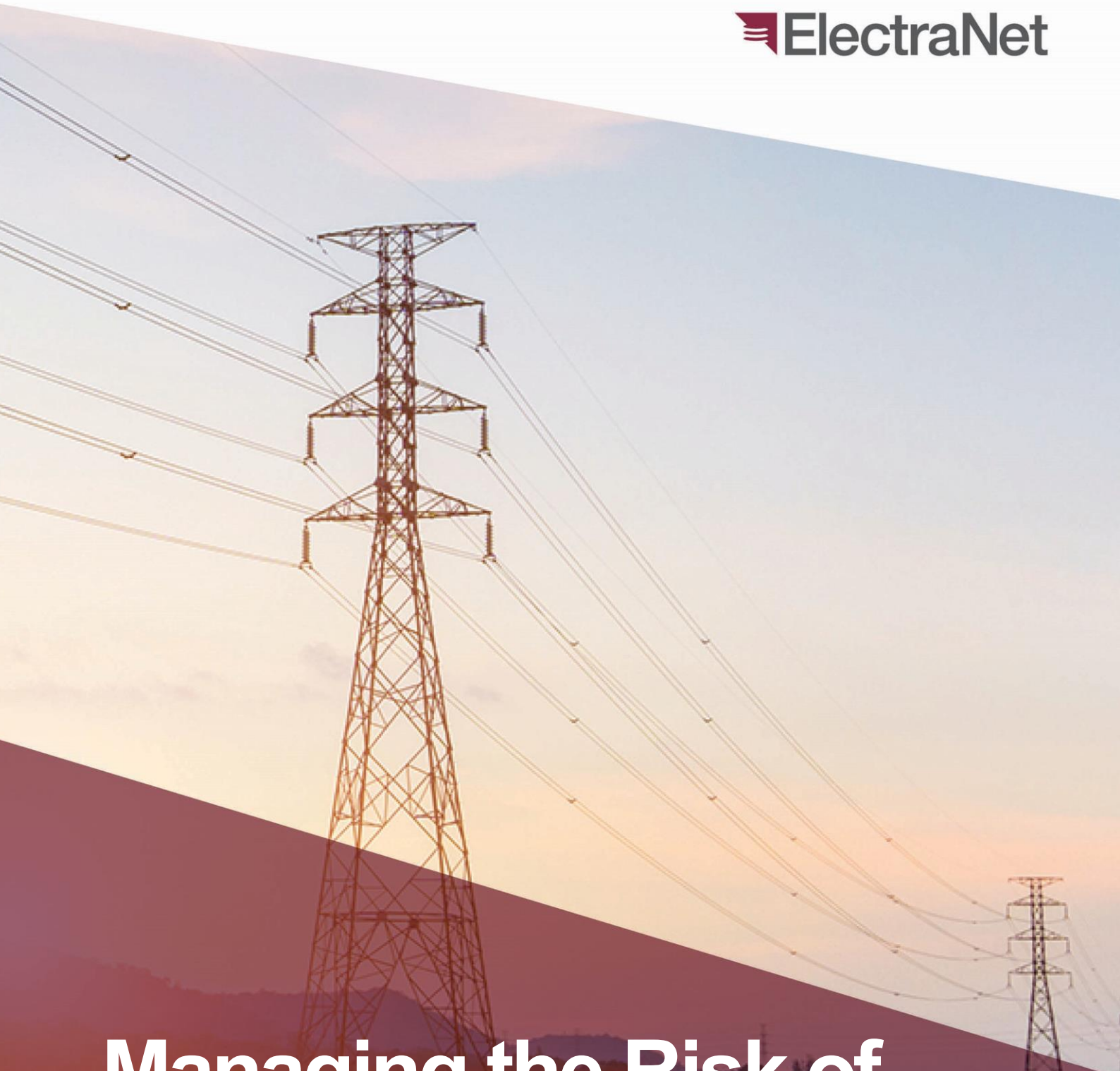

Managing the Risk of South East SVC Control System Failure

Project Assessment Conclusions Report

4 APRIL 2024

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EXECUTIVE SUMMARY

This Project Assessment Conclusions Report is the final stage of identifying the preferred option to address an identified need relating to the two Static VAR Compensator Computer control systems at South East substation.

The identified need is to efficiently manage the risk of failure of the two South East SVC computer control systems, thereby maintaining transfer capability on the Heywood interconnector.

In particular, the identified need is to ensure that the transfer capability made possible by the SVCs remains available by preventing the unexpected failure of the control systems.

The Static VAR Compensators (SVCs) installed at the South East substation are critical to providing reliable power transfer by generating or absorbing reactive power in response to power system disturbances, thereby controlling voltage levels across the South Australian transmission network to maximise transfer capability between South Australia and Victoria. Without the SVCs, the amount of energy that can be transferred across the Heywood Interconnector would be greatly reduced.

The two computer control systems that control the operation of the SVCs at the South East substation are at end of life and pose a risk to operational capacity of the Heywood Interconnector should they fail.

The Project Specification Consultation Report was released in November 2023 identifying a proposed solution.

The Project Specification Consultation Report (PSCR) for this project was published on 16 November 2023. It described the identified need and suggested that there is only one technically and economically feasible option to meet that need, which is to replace the two SVC computer control systems by the end of 2026. This option allows us to continue to ensure reliable operation of the Heywood Interconnector and to maximise the transfer capability between South Australia and Victoria. It has an estimated capital cost of approximately $7.4 million.

We considered the option of delaying the project by several years. This option was considered non credible as there is limited technical support and there are no available spare parts to repair these control systems should they fail.

The PSCR stated that, to meet the identified need in this case, a non-network solution must be able to provide dynamic voltage control at South East substation to maintain the same transfer level between South Australia and Victoria and be available at all times. The dynamic reactive power range for the non-network solution must be from negative 100MVAr to positive 160MVAr. As noted in the PSCR, ElectraNet did not consider that a non-network option can do this, and no submissions were received to the contrary.

No submissions were received on the PSCR.

This PACR maintains the initial conclusion that replacing the two SVC computer control systems within the 2024-2028 regulatory period is the preferred option[1].

The preferred option that has been identified for addressing the identified need is to replace the two SVC computer control systems.

[1] The preferred option is defined as the option that maximises net benefits under the RIT-T framework.

The expected benefit is derived from the avoided loss of transfer capability of the Heywood Interconnector should one or both the SVC control systems fail, and the time that the interconnector would be constrained, while urgent and unplanned replacement of the systems is undertaken.

The preferred option is expected to deliver approximately $3.5 million in net market benefits.

Next steps

ElectraNet intends to commence work on replacing the two SVC computer control systems in 2024.

Further details in relation to this project can be obtained from consultation@electranet.com.au.

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Glossary

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ETC	Electricity Transmission Code
NPV	Net Present Value
NEM	National Electricity Market
NER	National Electricity Rules
OEM	Original Equipment Manufacturer
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
PV	Present Value
RIT-T	Regulatory Investment Test for Transmission
SVC	Static VAR Compensator
TNSP	Transmission Network Service Provider

1. Introduction

This Project Assessment Conclusions Report (PACR) is the final step in the application of the Regulatory Investment Test for Transmission (RIT-T) to address the risk of Static Var Compensator (SVC) computer control system failure at the South East substation.

The Project Specification Consultation Report (PSCR) was released on 16 November 2023. It

- describes the identified need that we are seeking to address, together with the assumptions used in identifying this need;
- sets out the technical characteristics that a non-network option would be required to deliver to address this identified need;
- outlines the only credible option that we consider addresses the identified need;
- discusses specific categories of market benefit that, in the case of this RIT-T assessment, are unlikely to be material;
- presents the results of our economic assessment of the credible option and identifies the preferred option and the reasons for the preferred option; and
- sets out our basis for exemption from a Project Assessment Draft Report (PADR).

No submissions were received on the PSCR.

1.1. Why we consider this RIT-T is necessary

The National Electricity Rules (NER) require the application of the RIT-T to replacement capital expenditure where there is at least one credible option costing more than $7 million.[2]

Accordingly, we have initiated this RIT-T to consult on proposed expenditure related to replacing the South East SVC computer control systems, noting that none of the exemptions listed in NER clause 5.16.3(a) apply.

The credible option discussed in this PACR has not been foreshadowed in AEMO's Integrated System Plan (ISP) as the works involved do not impact on the main transmission flow paths between the NEM regions, unless the works are not undertaken. The ISP assumes full operation of the South East SVC going forward.

1.2. Next steps

ElectraNet intends to commence work on replacing the two SVC computer control systems in 2024.

Further details in relation to this project can be obtained from consultation@electranet.com.au

[2] NER clause 5.15A.1(c) states that the purpose of the RIT–T is to: identify the credible option that maximises the present value of net economic benefit to all those who produce, consume and transport electricity in the market (the preferred option). For the avoidance of doubt, a preferred option may, in the relevant circumstances, have a negative net economic benefit (that is a net economic cost) to the extent the identified need is for reliability corrective action, or the provision of inertia network services required under clause 5.20B.4 or the provision of system strength services required under clause 5.20C.3.

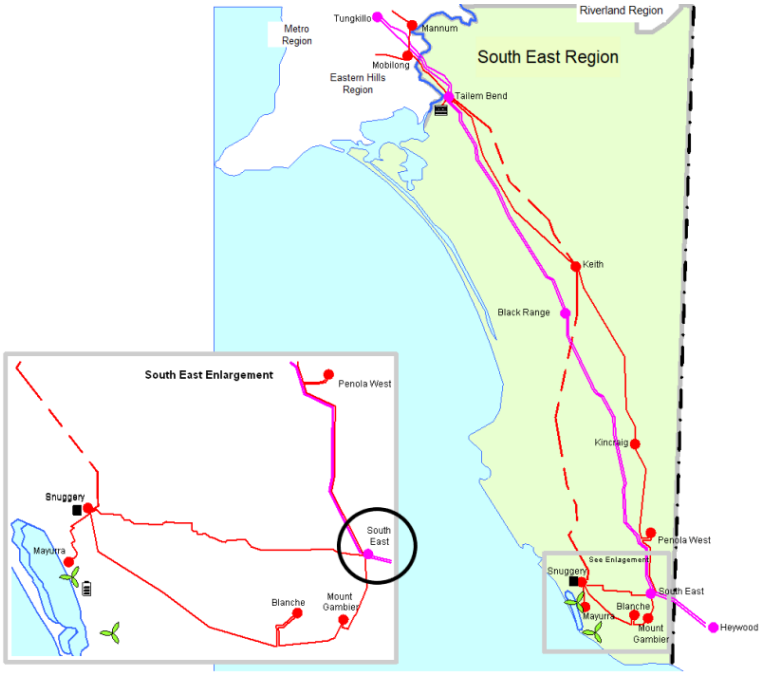
2. The identified need

This section outlines the identified need and the assumptions underpinning it. It first provides some background on the SVCs and their role in the wider transmission of electricity in South Australia.

2.1. Background to the identified need

The two computer control systems identified for replacement are an integral part of the two SVC installed at the South East substation, located in the lower south east region of South Australia (refer Figure 1).

Figure 1 Location of the South East substation



The two SVCs are critical in providing reliable power transfer by generating or absorbing reactive power in response to power system disturbances, thereby controlling voltage levels across the South Australian transmission network to maximise the transfer capability between South Australia and Victoria along the Heywood Interconnector.

Should either of the SVCs be unavailable the result would be a loss of reliable power transfer capability of approximately 50 MW per unit. This would persist until the SVC was returned to service, impacting network reliability, voltage control capability and security, and may result in increased electricity market prices.

Without a control system an SVC cannot operate. Therefore, failure of either control system would result in a reduction of up to50 MW in transfer capacity between South Australia and Victoria until the control system was restored.

The control system hardware for the South East SVCs, shown in Figure 2, was designed, and installed by ABB in 2007 based on the MACH 2.0 control system. This is now out of production and support from Hitachi Energy (ex ABB) has significantly reduced. Further, ElectraNet no longer has spare parts available to undertake repairs when required.

Figure 2 SVC 2 secondary system cabinet including computer control system.

In these circumstances, the failure of any part of the control system and associated input/ output cards would likely trigger a need to replace the entire control systems with the modern equivalent.

ElectraNet estimates that it would take approximately 18 months to design, manufacture and install such a system. It is prudent, therefore, to replace the control systems before they fail unexpectedly to avoid prolonged reductions in interconnector capacity.

It is noteworthy that the primary equipment in the SVCs themselves, such as the thyristor valves and primary plant components, have an estimated useful life of 30 years in total. Having been installed in 2007, these are currently at mid-life and are not planned to be replaced in the foreseeable future.

2.2. Description of the identified need for this RIT-T

As set out in the PSCR, the identified need is to efficiently manage the risk of failure of the two South East SVC computer control systems, thereby maintaining transfer capability on the Heywood interconnector.

In particular, the identified need is to ensure that the transfer capability made possible by the SVCs remains available by preventing the unexpected failure of the control systems.

3. Credible options to address the identified need

There is only one credible option, which is to replace the two South East SVC computer control systems. This option is technically and economically feasible and able to be implemented in sufficient time to meet the identified need.[3] We have not identified other credible options.

The option of delaying the investment by several years was considered and determined to be non-credible as it would not meet the identified need. The recent extended outage of one of the Para SVCs has demonstrated the market impact of these systems failing and being out of service.

3.1. Option 1 – Planned replacement of SVC Computer Control

Option 1 involves replacing the two South East SVC computer control systems identified in section 2.1.

Replacement of the two SVC computer control systems is planned to occur between 2024 and 2026.

ElectraNet has prepared an estimate of the cost of implementing this option which is $7.4 million. This is a Class 4 estimate prepared in accordance with the Australian Association of Cost Engineer's 'class 4' estimate categorisation. As such it was produced through a desktop review based on a scope prepared by ElectraNet's asset engineering team. It has an estimating range of -30% to +50%.

There is no change in routine maintenance when the assets are replaced under Option 1 compared to the base case.

The estimated construction time is approximately 2 years. We estimate that both SVC computer control systems could be replaced and commissioned by end of 2026 under this option.

3.2. There is expected to be a material inter-network impact

The South East SVCs has a direct impact on the inter-network capacity of the Heywood Interconnector. As such, failure to replace the SVC computer control systems prior to failure will have a material inter-regional impact[4].

By reference to AEMO's screening test for an inter-network impact[5], a material inter-regional impact arises if the option:

- involves a series capacitor or modification near an existing series capacitor, or
- is expected to result in a change in power transfer capability between South Australia and neighbouring transmission networks, or
- is expected to increase fault levels at any substation in another TNSP's network.

If either or both SVC computer control systems fail, there will be a reduction in the power transfer capability between South Australia and Victoria of up to 50 MW for failure of one or 100 MW for failure of both.

[3] In accordance with those identified in section 3.2.

[4] In accordance with NER clause 5.16.4(b)(6)(ii).

[5] AEMO's suggested screening test for a material inter-network impact is set out in Appendix 3 of the Inter-Regional Planning Committee's Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations, Version 1.3, October 2004.

4. Assessment of credible options

Given the assumptions outlined in Appendix C, the risk cost of an unplanned outage of the South East SVCs in a 'do nothing' base case is approximately $5.5 million per SVC computer control system or $10.9 million for both systems.

As discussed in section 3.1, the estimated capital cost to replace the two SVC computer control systems is $7.4 million. We consider that there is only one credible option, which is to undertake planned replacement of the two South East SVC computer control systems between 2024 and 2026.

Table 1 shows the NPV of Option 1 is approximately $3.5 million.

Table 1 NPV analysis

Key items	Value (PV, $million)
Risk cost of unplanned outage	10.9
Capital cost	- 7.4
NPV (preferred option)	3.5

In normal circumstances we would consider a delayed replacement option, however, as discussed in section 3, we don't consider this to be a feasible option in this case.

For details about the economic modelling and process we followed, please refer to the following appendices:

- Appendix A defines the terms used in the economic assessment,
- Appendix B provides the process that we followed,
- Appendix C the assumptions underpinning the identified need,
- Appendix D the materiality of market benefits, and
- Appendix E the modelling methodologies used for the assessment of the options.

This information was included in the PSCR.

5. Conclusion on the preferred option

The preferred option that has been identified in this assessment for addressing the identified need is Option 1, i.e., replacing two SVC computer control system by end of 2026. This is estimated to have a capital cost of $7.4 million.

Option 1 is the preferred option in accordance with NER clause 5.16.1(b) because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. In addition, Option 1 ensures ongoing compliance with a range of obligations under the NER.

We consider that the analysis undertaken and the identification of Option 1 as the preferred option satisfies the RIT-T.

The Compliance Checklist in Appendix F demonstrates that the PACR complies with section 5.16.4(v) of the NER.

We intend to commence work on replacing the two SVC computer control systems at the South East substation in 2024 and to have both assets replaced by the end of 2026.

City West Substation

Appendices

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Appendix A Definitions

This appendix defines the terms used in the economic assessment.

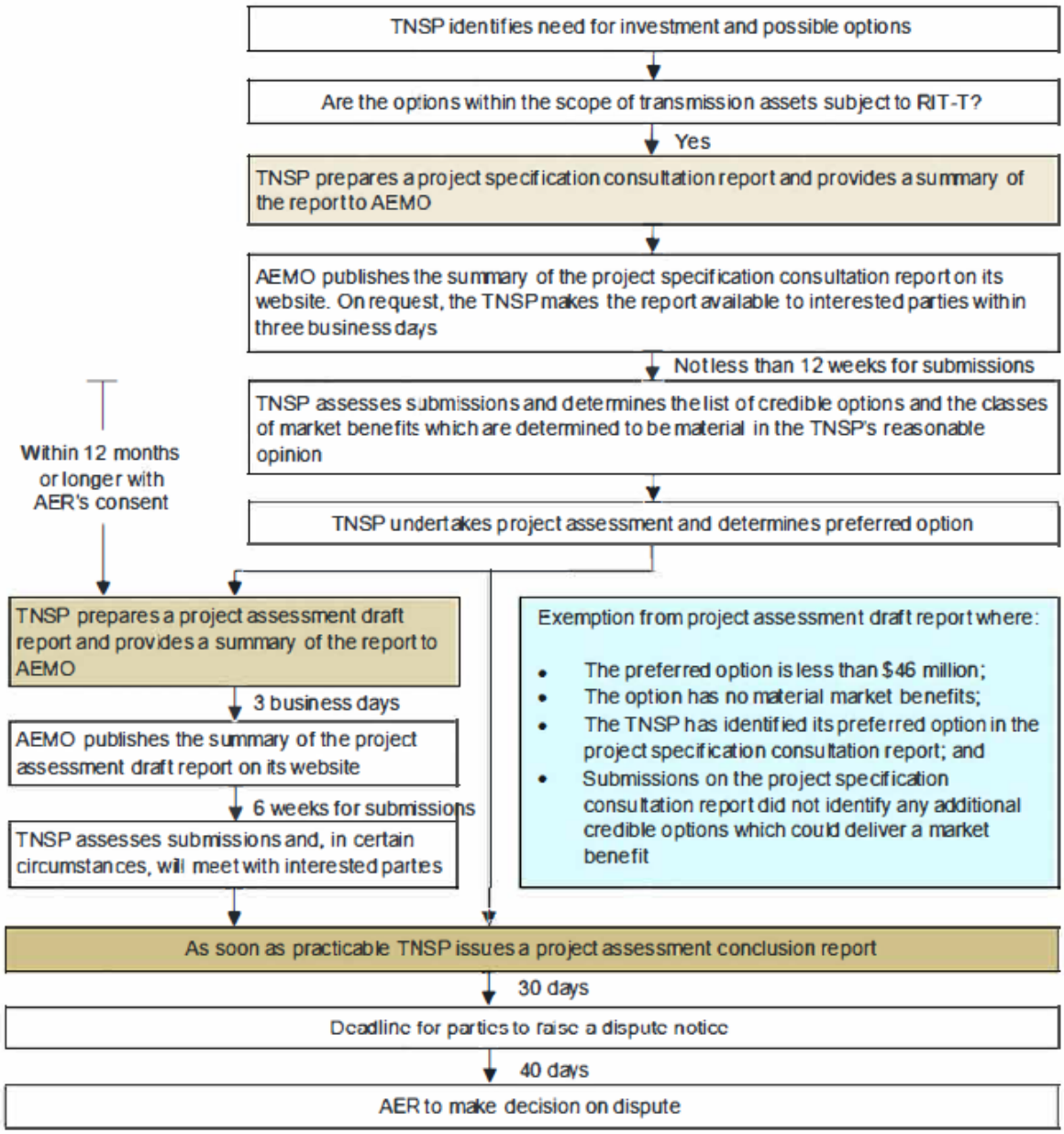
Definitions	
AEMO	Australian Energy Market Operator
Base case	A situation in which no option is implemented by, or on behalf of the transmission network service provider.
Commercially feasible	An option is commercially feasible if a reasonable and objective operator, acting rationally in accordance with the requirements of the RIT-T, would be prepared to develop or provide the option in isolation of any substitute options. This is taken to be synonymous with 'economically feasible'.
Costs	Costs are the present value of the direct costs of a credible option.
Credible option	A credible option is an option (or group of options) that: a) address the identified need; b) is (or are) commercially and technically feasible; and c) can be implemented in sufficient time to meet the identified need.
Economically feasible	An option is likely to be economically feasible where its estimated costs are comparable to other credible options which address the identified need. One important exception to this Rules guidance applies where it is expected that a credible option or options are likely to deliver materially higher market benefits. In these circumstances the option may be "economically feasible" despite the higher expected cost. This is taken to be synonymous with 'commercially feasible'.
Identified need	The reason why the Transmission Network Service Provider proposes that a particular investment be undertaken in respect of its transmission network.
Market benefit	Market benefit must be: a) the present value of the benefits of a credible option calculated by: i) comparing, for each relevant reasonable scenario: a) the state of the world with the credible option in place to b) the state of the world in the base case, And ii) weighting the benefits derived in sub-paragraph (i) by the probability of each relevant reasonable scenario occurring. b) a benefit to those who consume, produce and transport electricity in the market, that is, the change in producer plus consumer surplus.

Definitions	
Net market benefit	Net market benefit equals the market benefit less costs.
Preferred option	The preferred option is the credible option that maximises the net economic benefit to all those who produce, consume and transport electricity in the market compared to all other credible options. Where the identified need is for reliability corrective action, a preferred option may have a negative net economic benefit (that is, a net economic cost).
Reasonable Scenario	Reasonable scenario means a set of variables or parameters that are not expected to change across each of the credible options or the base case.
Technically feasible	An option is technically feasible if there is a high likelihood that it will, if developed, provide the services that the RIT-T proponent has claimed it could provide for the purposes of the RIT-T assessment.

Appendix B Process for implementing the RIT-T

For the purposes of applying the RIT-T, the NER establishes a typically three stage process, i.e.: (1) the PSCR; (2) the PADR; and (3) the PACR. This process is summarised in the figure below (in gold), as well as the criteria for PADR exemption that this RIT-T is seeking to apply (in blue).

Figure 3 The RIT-T assessment and consultation process



Appendix C Assumptions underpinning the identified need

This appendix summarises the key assumptions that underpin the identified need for this RIT T. Appendix E provides further details on the general modelling approaches applied, including the risk cost modelling framework.

The sections below detail the adverse effects, likelihood, and cost of the SVC computer control system failure.

C.1. Adverse effects of the SVC computer control system failure

The two South East SVC systems enable the Heywood Interconnector to transfer 100 MW more than it could without either SVC, or 50 MW per SVC. Without control systems the SVCs themselves cannot function, so the consequences of losing either control system would be the loss of 50 MW in transfer capacity per control system (100 MW if both are lost).

We estimate that, following the unplanned replacement of either control system, it would take 18 months to return the SVC(s) to service. This means that the Heywood Interconnector would be constrained for 18 months following a failure.

In addition to the reduction in transfer capability, the lack of availability of the SVCs will make voltage control more challenging in the South East region of South Australia.

At times of high demand, the reduction in transfer capability may result in the need to shed load in South Australia.

C.2. The likelihood and cost of SVC control system failure

We have assessed the condition of the two computer control systems as part of our ongoing asset management processes. There is an increased likelihood that one or both systems will fail in coming years given their current condition.

In other circumstances it may be acceptable to leave the control systems in place until they fail. However, as noted above, ElectraNet does not currently have spare equipment, meaning that a failure could not be addressed quickly. This is further exacerbated by the lack of vendor support for this equipment.

We have constructed a risk cost model of failure of the control systems. In doing this, we note that the probability of failure is not well understood, which is typical for digital assets.

The risk cost model assigns:

- probability of failure of 10% / SVC unit in any given year,
- value of $78,450/MW/year of the reduction of Heywood Interconnector capacity[6],
- loss of transfer capacity of 50 MW / control system,
- return to service duration of 18 months in the event a control system fails,
- the same cost of replacement for both planned and unplanned replacement, and
- discount rate of 7%.

Any risk cost model is limited by the assumptions upon which it is based. In this case, the probability of failure is not well understood.

[6] This is the same value applied to the value of incremental interconnection capacity in the previous Project Energy Connect RIT-T.

Neither ElectraNet nor the OEM has a robust understanding of the relationship between asset age and failure for the control systems in question.

For this reason, we have made the plausible assumption that the assets in question will fail with 10 per cent probability in any given year.

Appendix D Materiality of market benefits for this RIT-T assessment

This appendix outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T.

The bulk of the benefits associated with the preferred option are from the avoidance of reduction of inter-regional transfer capability by replacing the end-of-life SVC computer control system in a planned manner as opposed to the base case to replace on failure.

The replacement of the SVC computer control system in a planned manner will avoid potential and prolonged constraints on the Heywood Interconnector.

D.1. Market benefits relating to the wholesale market are material

The AER has recognised several classes of market benefits to be material in RIT-T assessment if the credible options are considered to have an impact on the wholesale market.

Should the preferred option not be implemented prior to the failure of either SVC computer control systems, it is expected that there would be network constraints between competing generating centres, that could change dispatch outcomes and wholesale market prices.

In this case the impact has been estimated to be $78,450/MW/year as discussed above.

D.2. Other classes of market benefits are not expected to be material

In addition to the classes of market benefits listed above, NER clause 5.16.1(c)(4) requires us to consider the following classes of market benefits in relation to each credible option:

- differences in the timing of transmission investment;
- option value; and
- changes in network losses.

We consider that none of these are material for this RIT-T assessment for the reasons set out in Table 2.

Table 2 Reasons why non-wholesale market benefit categories are considered immaterial.

Market benefit category	Reason(s) why it is considered immaterial
Differences in the timing of transmission investment	The preferred option does not affect the timing of other unrelated transmission investments (i.e., transmission investments based on a need that falls outside the scope of that described in section 2). Consequently, the market benefits associated with differences in the timing of unrelated transmission investment are not material to the RIT-T assessment.

Market benefit category	Reason(s) why it is considered immaterial
Option value	The AER has stated that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[7] None of these conditions apply to the present assessment. The AER has also stated the view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. Changes in future demand levels are not relevant for this RIT-T since the need for and timing of the required investment is being driven by asset condition rather than future demand growth. As a result, it is not relevant to consider different future demand scenarios in undertaking the RIT-T analysis.
Changes in network losses	Given the preferred option maintains the current network capacity at the same location, there are not expected to be any differences in network losses.

[7] AER, *Regulatory Investment Test for Transmission Application Guidelines*, August 2020, p. 52.

Appendix E Description of the modelling methodologies applied

This appendix outlines the methodologies and assumptions we have applied to undertake this RIT-T assessment.

E.1. Overview of the risk cost modelling analysis

We have applied risk cost modelling analyses to quantify the risk cost reduction associated with replacing the identified SVC computer control systems.

The 'risk cost reduction' has been calculated as the product of:

- Probability of Failure, which is the probability of a failure occurring based on asset failure history information and industry data;
- Likelihood of Consequence, which is the likelihood of an adverse consequence of the failure event based on historical information and statistical factors (in this case 100%); and
- Cost of Consequence, which is the estimated cost of the adverse consequence.

These three variables allow the expected risk cost reduction benefit to be quantified and an assessment against the cost of the project to be undertaken. The risk cost reduction benefit is the difference between risk costs incurred under the base case and the preferred option.

E.2. The discount rate and assessment period

The RIT-T analysis has been undertaken over a 20-year period from 2024 to 2043. This considers the size, complexity and expected life of each option to provide a reasonable indication of its cost.

We have adopted a real, pre-tax discount rate of 7.0 percent for the analysis presented in this report, consistent with AEMO's most recent Inputs, Assumptions and Scenarios Report – July 2021.[8] We consider that this is a reasonable contemporary approximation of a 'commercial' discount rate (a different concept to a regulatory WACC), consistent with the RIT-T.

The RIT-T requires that sensitivity testing be conducted on the discount rate and that the discount rate scenarios from AEMO's ISP Inputs Assumptions and Scenarios Report should be applied.[9]

[8] AER, *Regulatory Investment Test for Transmission*, August 2020 p. 6 and AEMO, *Inputs, Assumptions and Scenarios Report*, July 2021, p. 104.

[9] AER, *Regulatory Investment Test for Transmission*, August 2020 p. 6.

Appendix F Compliance Checklist

This appendix sets out a compliance checklist which demonstrates the compliance of this PACR with the requirements of clause 5.16.4(v) of the NER version 204.

Rules clause	Summary of requirements	Relevant section(s) in PACR
5.16.4(v)	The project assessment conclusions report must set out:	-
	(1) the matters detailed in the project assessment draft report as required under paragraph (k): and	See below
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought under paragraph (q)	No responses received
5.16.4(k)	The project assessment draft report must include:	-
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	NA
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	3, 4, Appendix D & Appendix E
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	Appendix D
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	Appendix D
	(6) the identification of any class of market benefit estimated to arise outside the *region* of the *Transmission Network Service Provider* affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	4
	(8) the identification of the proposed preferred option;	5

Rules clause	Summary of requirements	Relevant section(s) in PACR
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a *material inter-network impact* and if the *Transmission Network Service Provider* affected by the RIT-T project has received an *augmentation technical report*, that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the *regulatory investment test for transmission*.	3 & 5
	(10) if each of the following apply to the RIT-T project: (i) the estimated capital cost of the proposed preferred option is greater than $100 million (as varied in accordance with a cost threshold determination); and (ii) AEMO is not the sole RIT-T proponent, the RIT reopening triggers applying to the RIT-T project.	N/A

ElectraNet