ElectraNet

MANAGING THE RISK OF AC BOARD FAILURE

Project Assessment Conclusions Report

14 January 2020

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Executive Summary

This report is the final stage of an investigation into the most economic option to address the risk of failure of AC boards (and associated assets)

This Project Assessment Conclusions Report (PACR) is the final step in the application of the Regulatory Investment Test (RIT-T)[1] to investigate options to address the risk of failure of Alternating Current (AC) boards together with a range of associated assets in substations across the South Australian electricity transmission network.

AC boards (also called changeover boards) are important devices used to direct electricity from one or more supply sources to a number of loads at a substation. AC boards provide all substations low voltage electricity for substation plant, building services, communications, control and protection, three phase outlets and lighting. Without AC boards the substation would not be able to operate safely and securely.

An initial report was released in October 2019 identifying a proposed solution

A Project Specification Consultation Report (PSCR) for this RIT-T was published on 14 October 2019 and outlined how there is only one technically and economically feasible option, which is to replace identified AC boards and associated assets with a capital cost of approximately $20.6 million.

Other options considered included the replacement of entire substations at a capital cost of approximately $20 to $40 million per substation, which is significantly more costly than the proposed solution and therefore is economically infeasible.

The PSCR assessed different timings of this replacement option and concluded that replacing the identified assets as soon as practicable is the preferred option on account of the expected reductions in injuries from asset failure, involuntary load shedding and damage to other substation assets.

The PSCR also explained why network support solutions are not expected to have a feasible role to play in addressing the identified need on account of the unique and specific role that AC boards and associated assets play in the transmission of electricity and their relatively low replacement cost.

No submissions were received on the PSCR.

This report maintains the initial conclusion that replacing the identified AC boards and associated assets as soon as possible is the preferred option[2]

The preferred option for addressing the identified need continues to be Option 1, i.e. replacing 24 AC boards and associated assets between 2020 and 2024.

The project completion date has been adjusted from July 2023 to October 2024 since publication of the PSCR after a detailed review of the project schedule.

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1 The Regulatory Investment Test for Transmission (RIT-T) is the economic cost benefit test that is overseen by the Australian Energy Regulator (AER) and applies to all major network investments in the National Electricity Market.

2 The preferred option is defined as the option that maximises net market benefits under the RIT-T framework.

This replacement work is estimated to have a total capital cost of approximately $20.6 million, which equates to approximately $860,000 for each of the 24 AC boards planned to be replaced.

We have undertaken a thorough sensitivity testing exercise to investigate the robustness of the RIT-T assessment to underlying assumptions about each of the key variables. For all sensitivity tests undertaken, the preferred option remains replacing the identified assets as soon as possible.

Next steps

ElectraNet intends to commence work on replacing the identified assets in early 2020.

The 24 AC boards and associated assets are distributed across 23 substations and we are planning to have all assets removed or replaced by October 2024.

Further details in relation to this project can be obtained from:

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Glossary of Terms

Term	Description
AC	Alternating Current
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ETC	Electricity Transmission Code
NPV	Net Present Value
NEM	National Electricity Market
NER, Rules	National Electricity Rules
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
PV	Present value
RET	Renewable Energy Target
RIT-T	Regulatory Investment Test for Transmission
TNSP	Transmission Network Service Provider
USE	Unserved Energy
VCR	Value of Customer Reliability

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1. Introduction

This Project Assessment Conclusions Report (PACR) represents the final step in the application of the RIT-T to address the risk of AC board failure at certain substations in the South Australian transmission network.

A Project Specification Consultation Report (PSCR) was released on 14 October 2019 that described the identified need we are seeking to address, set out the technical characteristics that a network support option would be required to deliver and outlined the credible option we consider addresses the identified need. The PSCR also set-out an economic assessment, along with a draft conclusion on the preferred option, as well as how ElectraNet was intending to apply the NER exemption from preparing a Project Assessment Draft Report (PADR) for this RIT-T.[3]

No submissions were received on the PSCR.

1.1 Why we consider this RIT-T is necessary

Changes to the National Electricity Rules (NER) in July 2017 extended the application of the RIT-T to replacement capital expenditure on 18 September 2017.[4] Accordingly, we have undertaken this RIT-T to consult on proposed expenditure related to replacing AC boards and associated equipment, as 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 National Transmission Network Development Plan (NTNDP) or Integrated System Plan (ISP) as these assets do not have a material impact on the main transmission flow paths between the NEM regions.

1.2 Next steps

ElectraNet intends to commence work on replacing the identified assets in early 2020. The 24 AC boards and associated assets are distributed across 23 substations. We are planning to have all assets removed or replaced by October 2024. The project completion date has changed slightly since publication of the PSCR from July 2023 to October 2024 after a detailed review of the project schedule.

Further details in relation to this project can be obtained from:

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3 In accordance with NER clause 5.16.4(z1).

4 The application of the RIT-T to replacement expenditure ('repex') commenced on 18 September 2017, however, all repex projects that were 'committed' by 30 January 2018 are exempt. See paragraph 18 of the AER's RIT-T for the definition of a 'committed project'. While the planning process for replacing the identified AC boards and equipment was well-advanced by 30 January 2018, the project was not yet 'committed'. Accordingly, we have subsequently undertaken this RIT-T to consult on its proposed expenditure related to replace the identified AC boards.

2. The identified need for this RIT-T is to ensure reliable and safe supply of electricity to South Australia

This section outlines the identified need for this RIT-T, as well as the assumptions that underpin the RIT-T. It first provides some background on the identified AC systems and their role in the wider transmission of electricity in South Australia.

2.1 Background to the identified need

AC boards (also called changeover boards) are devices used to direct electricity from one or more supply sources to a number of loads at a substation. ElectraNet's modern main AC boards are typically designed with three ports and allow for automatic supply changeover between two alternative supplies (where both exist) and also automatic changeover for sites with an installed diesel generator.

AC boards provide all substations low voltage electricity for substation plant, building services, communications, control and protection, three phase outlets and lighting. Without AC boards the substation would not be able to operate safely and securely.

Across the transmission network, we have identified 24 AC boards for replacement based on their condition and risk to safety. In particular, we have identified:

- 8 flat panel boards;
- 7 tunnel boards;
- 4 enclosed cubicle boards with poor segregation;
- 4 enclosed cubicle boards with good segregation; and
- 1 residential-style AC switchboard.[5]

When replacing the AC boards other associated assets are also required to be replaced as these associated assets will be incompatible with the new style boards which are physically larger in size and may be in a different location in the substation. Therefore, the following associated AC system assets also require replacement (or installation) where needed as a result of replacing the above AC boards:

- incomer 415V power supply cables;
- station TF CB cubicles with lockable CBs;
- distribution boards;
- cabling to external plant and equipment;
- switchyard power boxes;
- building power boxes;
- temporary AC diesel generator connection points for the 13 sites where no permanent diesel generator is installed;

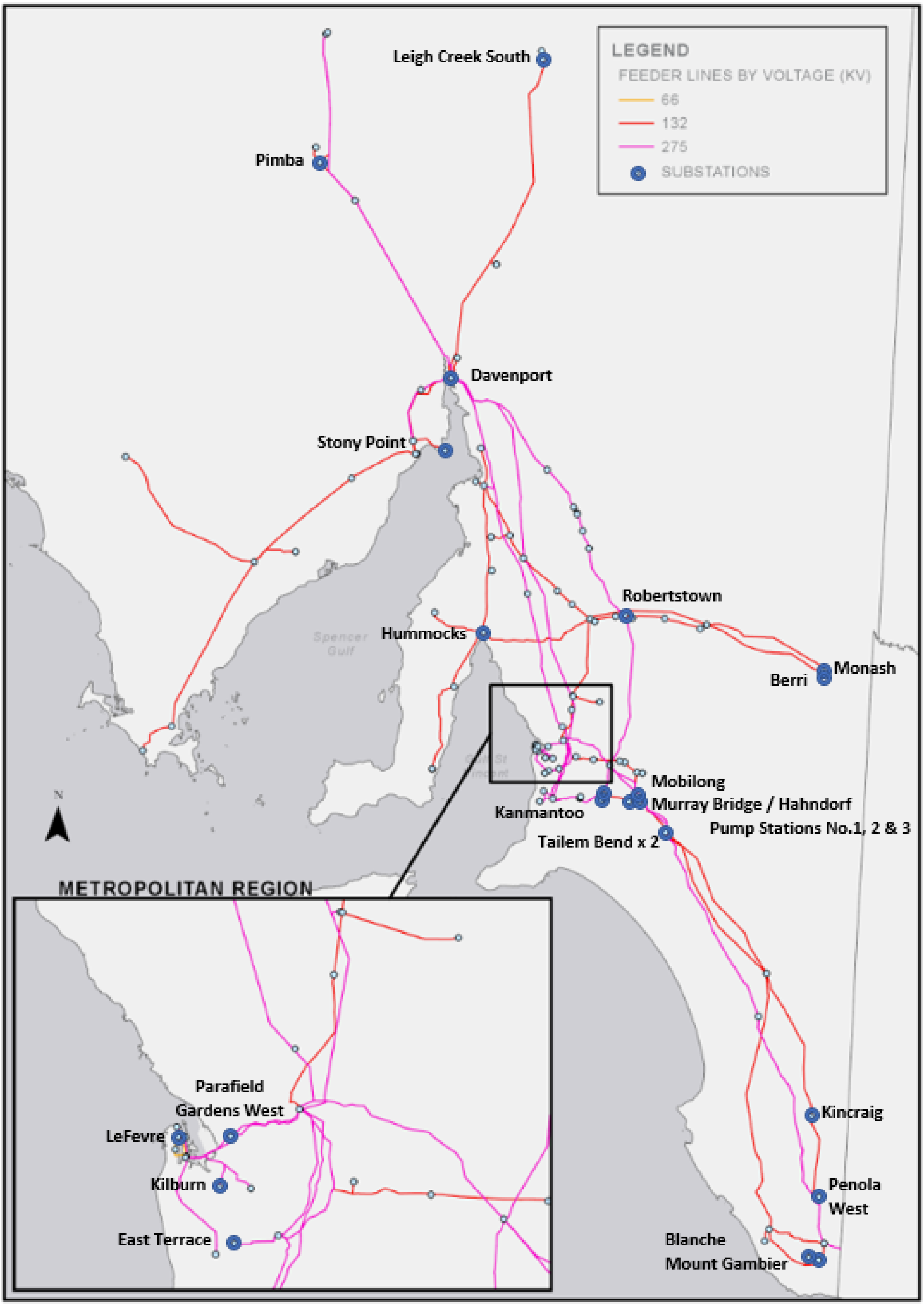
5 For the purposes of risk cost modelling, this board is considered a Flat Panel board.

- permanently connected AC diesel generators for two sites; and
- provision of clear, robust covers to existing equipment within the buildings and switchyards where exposed 230/400V terminals exist.

Wherever possible ElectraNet has sought to minimise these costs.

Figure 1 illustrates the distribution of the 23 substations where the 24 AC boards and associated assets are planned to be addressed. All substations have a single AC board identified for replacement except for Tailem Bend substation that has two AC boards planned to be replaced.

Figure 1 – Location of the AC boards that are being replaced



These AC boards have a standard life[6] of 44.8 years and are now, on average, 41 years old. These AC boards are planned to be replaced on a one for one basis with new AC boards.

If the replacement program is not implemented, it is increasingly likely that a number of these assets will fail going forward, which could result in:

- safety risks for substation personnel;
- the risk of involuntary load shedding on parts of the network due to the substations being damaged from a fire causing the loss of low voltage electricity necessary to control the substation; and
- damage to substation equipment if a fire occurs.

The design of these AC boards is now non-compliant with modern good electricity industry practice and current safety standards. While AS3000 compliance is not strictly mandatory for existing infrastructure in South Australia, safely maintaining and operating boards of this bespoke nature also relies on the availability of highly specialised electrical workers. Familiarity and knowledge concerning the older style non-compliant boards is decreasing as the workforce ages which is expected to substantially reduce the ability to operate and maintain them safely. In accordance with good electricity industry practice, in new substations ElectraNet requires AS3000 compliant substation low voltage AC Supplies[7].

Currently, removable covers are fitted behind the panels to act as barriers to prevent accidental contact and safe work methods are used to manage the risk. Replacement of these AC boards will reduce the possibility of personal injuries and substation damage if a fire occurred caused by the AC board igniting and/or the fire spreading beyond the cable trays. Furthermore, the existing AC boards have a much higher likelihood of failure than the new replacement AC boards.

The avoidance of such failures will also create cost savings across these areas during the delivery of the program (compared to a 'replace on failure' strategy, which is assumed under the base case in this RIT-T assessment).

2.2 Description of the identified need for this RIT-T

The identified need for this project is to efficiently manage the safety risks associated with individual AC boards and the associated assets that are no longer compliant with modern standards.

We have assessed the condition and timing to ultimately replace these assets as part of our ongoing asset management processes.

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6 The AER considers that repex involves replacing an asset or asset component with its modern equivalent where the asset has reached the end of its *economic* life, which takes into account the age, condition, technology, safety risks and operating environment of an existing asset (see: AER, *ElectraNet transmission determination 2018 to 2023*, Attachment 6 – Capital expenditure, Draft Decision, October 2017, p. 42.). We present here the standard technical lives of the AC boards for context and note that the assessment of replacing the identified AC Boards, both in the Revenue Proposal and this RIT-T, is consistent with the concept of economic life; ie, the expenditure decision is primarily based on the existing asset's inability to efficiently maintain its service performance requirement.

7 Substation LV AC Supplies- ElectraNet Document No: 1-11-FR-04, https://www.electranet.com.au/wp-content/uploads/2018/06/1-11-FR-04-Substation-LV-AC-Supplies.pdf

There is an increased likelihood that a number of these assets will fail in coming years, potentially resulting in personal injury to electrical workers and/or the unplanned unavailability to parts of the network.

We have classified this RIT-T as a 'market benefits' driven RIT-T as the economic assessment is not being progressed specifically to meet a mandated reliability standard but by the expected net benefits to customers.

Notwithstanding this, South Australian jurisdictional regulations require that:

- Substations must be designed, installed, operated and maintained to be safe for the electrical service conditions and the physical environment in which they will operate;[8] and
- ElectraNet institute a system of maintenance for substation buildings, enclosures and associated plant (which includes low voltage AC plant) that includes managed replacement programs for components approaching the end of their serviceable life.[9]

ElectraNet considers the targeted replacement of these assets will substantially reduce the risk of non-compliance with jurisdictional requirements. ElectraNet considers this RIT-T forms an important part of complying with this requirement and, more broadly, avoids a situation of run-to-failure for the identified assets (which would not constitute a compliant management strategy).

A full cost benefit assessment has been undertaken, comparing the risk cost reduction benefits of asset replacement options with the cost of those options.

8 *South Australia Electricity (General) Regulations 2012*, Regulation 51 - Substations.

9 *South Australia Electricity (General) Regulations 2012*, Schedule 3—Requirements for substations, clause 11(2)

3. Potential credible options to address the identified need

The analysis has identified that there is only one technically feasible option, which is to replace the non-compliant AC boards. This is because AC boards play a specific and important role in enabling substations to operate and to be maintained in a safe and timely manner and their replacement will minimise the risk of consequential supply interruptions impacting on downstream customers.

We have however investigated different assumed timings for this work in order to determine the optimal timing. This assessment is presented in section 4.5.

The option is considered to be technically and economically feasible and able to be implemented in sufficient time to meet the identified need.[10] In addition, all works are assumed to be completed in accordance with the relevant standards.

The PSCR set out that we do not consider network support solutions can assist with meeting the identified need for this RIT-T, given the unique and specific role that the identified AC boards and associated assets play in the transmission of electricity and their relatively low replacement cost. Notwithstanding, the PSCR set out the required technical characteristics for a network support option for completeness, consistent with the requirements of the RIT-T.

We did not receive any submissions on the PSCR.

3.1 Option 1 – Planned replacement of AC boards by 2024

Option 1 involves planned replacement of 24 AC boards and associated assets that have been identified due to their condition and risk to safety.

These replacements are planned to occur between 2020 and 2024. These replacements are to be performed at substation locations where the asset is not already scheduled to be replaced as part of a network project during this period.

All AC board replacement assets are assumed to have the same signal output levels, ratios, etc. as the original assets, negating the requirement to modify any secondary system inputs. Some additional assets will also be replaced or added when replacing the AC boards (as set out in section 2.1).

The estimated total capital cost of this option is approximately $20.6 million. This equates to approximately $860,000 for each of the 24 AC boards planned to be replaced.

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

It is estimated that the replacement time for each AC board and its associated assets is around 32 weeks, to be implemented on a staggered basis, or around four years in total across the replacement program. Therefore, implementing this option would involve design and construction at multiple sites concurrently.

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[10] In accordance with those identified in section 2.2.

3.2 Options considered but not progressed

We have also considered whether there are other credible options that would meet the identified need. However, the identified need to address non-compliant AC boards does not lend itself to any solution other than to replace the assets as the only technically and economically feasible option given the unique and specific function of these assets. Consequently, we have not identified other feasible options.

One option, for example, would be to replace the entire substation, as opposed to just the AC boards. However, the capital cost of this is expected to be in the order of $20-40 million per substation (i.e., $460-920 million in total), which is significantly more than the option outlined above and does not provide any additional market benefits. In addition, the condition of the other primary substation assets is such that they do not also require replacement in coming years. Therefore, this is not considered to be an economically feasible option.

Further, as set out in section 4 below, we do not consider that network support solutions can address, or help address, the identified need.

4. Assessment of the credible options

This section outlines the assessment we have undertaken of the credible network option. The assessment compares the option against a base case 'do nothing' option.

For clarity, this section re-presents the underlying assessment in the PSCR. There were no material changes since the PSCR that would affect the finding that Option 1 is preferred.

4.1 Description of reasonable scenarios

The RIT-T analysis is required to incorporate a number of different reasonable scenarios, which are used to estimate expected net market benefits. The number and choice of reasonable scenarios must be appropriate to the credible options under consideration.

For a market benefits driven RIT-T such as this, the choice of reasonable scenarios must reflect any variables or parameters that are likely to affect the ranking of the credible options, or the sign of the net economic benefits of any of the credible options.[11]

We have developed three scenarios for this RIT-T assessment:

- a 'central' scenario reflecting our base set of key assumptions;
- a 'low benefits' scenario – reflecting a conservative set of assumptions, which represents a lower bound on reasonably expected potential market benefits that could be realised; and
- a 'high benefits' scenario – reflecting an optimistic set of assumptions, which represents an upper bound on reasonably expected potential market benefits.

Given that the low and high benefits scenarios are less likely to occur, the scenarios have been weighted accordingly; 25 per cent – low benefits scenario, 50 per cent – central benefits scenario, and 25 per cent – high benefits scenario.

[11] AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 16, p. 7.

Table 1 – Summary of the three scenarios

Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Capital costs	130 per cent of capital cost estimate	Base estimate	70 per cent of capital cost estimate
Commercial discount rate[12]	8.95 per cent	5.90 per cent	2.85 per cent
Avoided corrective maintenance	70 per cent of base estimates	Base estimates	130 per cent of base estimates
Reduced personal injuries	70 per cent of base estimates	Base estimates	130 per cent of base estimates
Reduced fire damage	70 per cent of base estimates	Base estimates	130 per cent of base estimates
Cost of involuntary load shedding	70 per cent of base estimates	Base estimates	130 per cent of base estimates

4.2 Gross benefits for each credible option

The table below summarises the gross benefit estimated for Option 1 relative to the 'do nothing' base case in present value terms. The gross market benefit has been calculated for each of the three scenarios outlined in the section above.

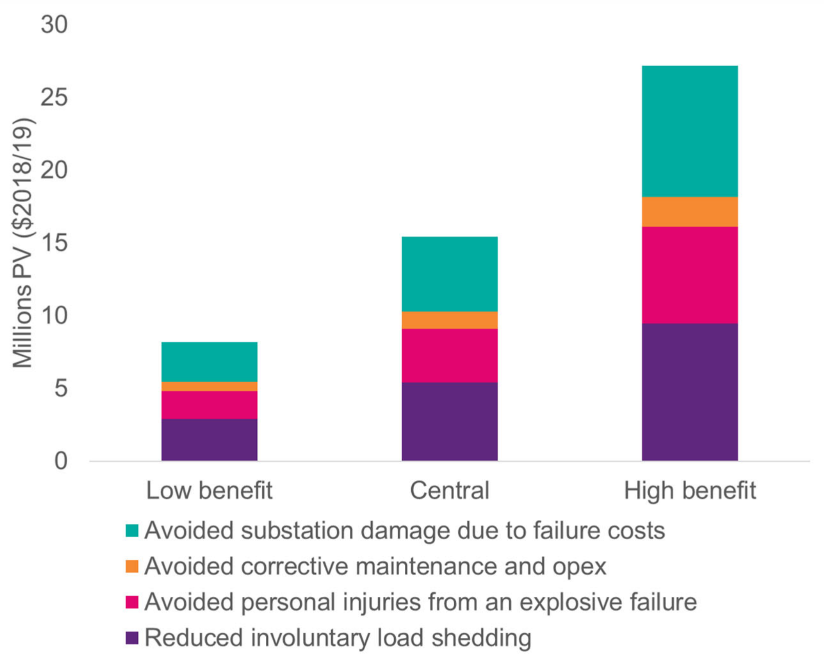
Table 2 – Estimated gross market benefit for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1 – Planned replacement of AC boards by 2023	8.2	15.4	27.2

The figure below provides a breakdown of benefits and shows that the overall level of benefits is primarily driven by expected reductions in injuries from asset failure, involuntary load shedding and damage to other substation assets.

12 Expressed on a real, pre-tax basis

Figure 2 – Breakdown of present value gross economic benefits of Option 1



4.3 Estimated costs for each credible option

The table below summarises the capital costs of Option 1, relative to the base case, in present value terms.

Table 3 – Estimated capital cost for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1 – Planned replacement of AC boards by 2023	-16.3	-12.2	-7.4

4.4 Net present value assessment outcomes

Table 4 summaries the net market benefit in NPV terms for Option 1 across the three scenarios, as well as on a weighted basis. The net market benefit is the gross benefits (as set out in section 4.2 above) minus the cost (as outlined in section 4.3 above), all expressed in present value terms.

The table shows that Option 1 provides a strong expected net economic benefit on a probability-weighted basis, as well as under the central and high scenarios.

While the low benefits scenario shows negative expected market benefits, this scenario is considered highly unlikely since it is comprised of the lower bound of each expected net market benefit applied simultaneously. As outlined above, the low scenario includes 30 per cent higher capital costs, a commercial discount rate of 8.95 per cent and 30 per cent lower benefits (across all types of benefits).

We have also been conservative in our modelling approach and have not included the additional adverse effects discussed in section 2.3.4 that would be avoided under Option 1, and thereby add to the net benefits of the Option 1.

Table 4 - Estimated net market benefit for each option, PV $m [13]

Option	Low benefits scenario	Central scenario	High benefits scenario	Weighted
Option 1 – Planned replacement of AC boards by 2023	-8.2	3.2	19.8	4.5

4.5 Sensitivity testing

We have undertaken a thorough sensitivity testing exercise to understand the robustness of the RIT-T assessment to underlying assumptions about key variables.

In particular, we have tested the optimal timing of the project, and the sensitivity of this timing to key variables.

We have then tested the sensitivity of the total net market benefit to variations in the key factors underlying the assessment, such as for example the sensitivity of the project to increases in capital costs.

4.5.1 Sensitivity testing of the assumed optimal timing for the credible option

We have estimated the optimal timing for Option 1 based on the year in which the present value of the benefits exceeds the present value of the replacement project costs,[14] which is consistent with when the expected NPV is maximised. This process was undertaken for both the central set of assumptions and also a range of alternative assumptions for key variables.

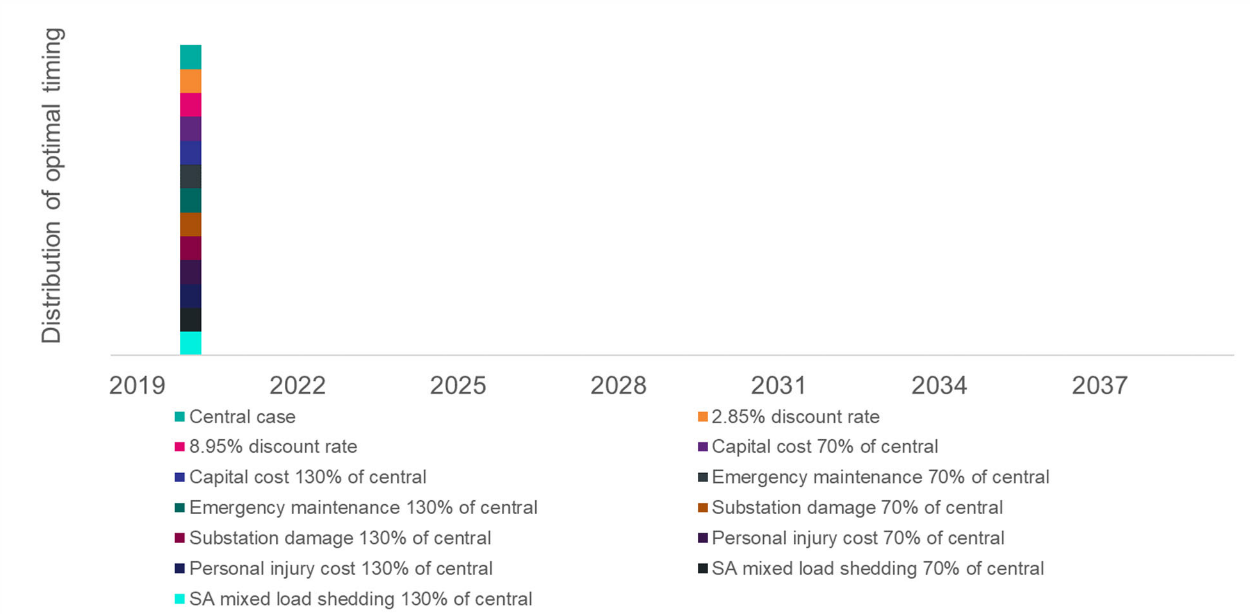
Figure 3 outlines the impact on the optimal year to commence the program, under a range of alternative assumptions. Specifically, it shows, for each set of sensitivities/assumptions, the year that results in the highest expected net market benefits, all else being equal.

The figure illustrates that the optimal date is found to be in 2020 for all of the sensitivities investigated. It is noted that figure 3 shows the optimal year to *commence* the program of replacement, whilst recognising that it will take four years to complete the replacement works (i.e., the earliest all AC boards can be replaced is 2024).

[13] There has been an amendment to the PSCR capital cost and benefit calculation resulting in minor variations to the low and high scenarios in this PACR

[14] We note that this approach is consistent with the AER RIT-T Guidelines (see: AER, *Regulatory Investment Test for Transmission*, Application Guidelines, December 2018, p. 21).

Figure 3 – Distribution of optimal timing for Option 1 under different key assumptions

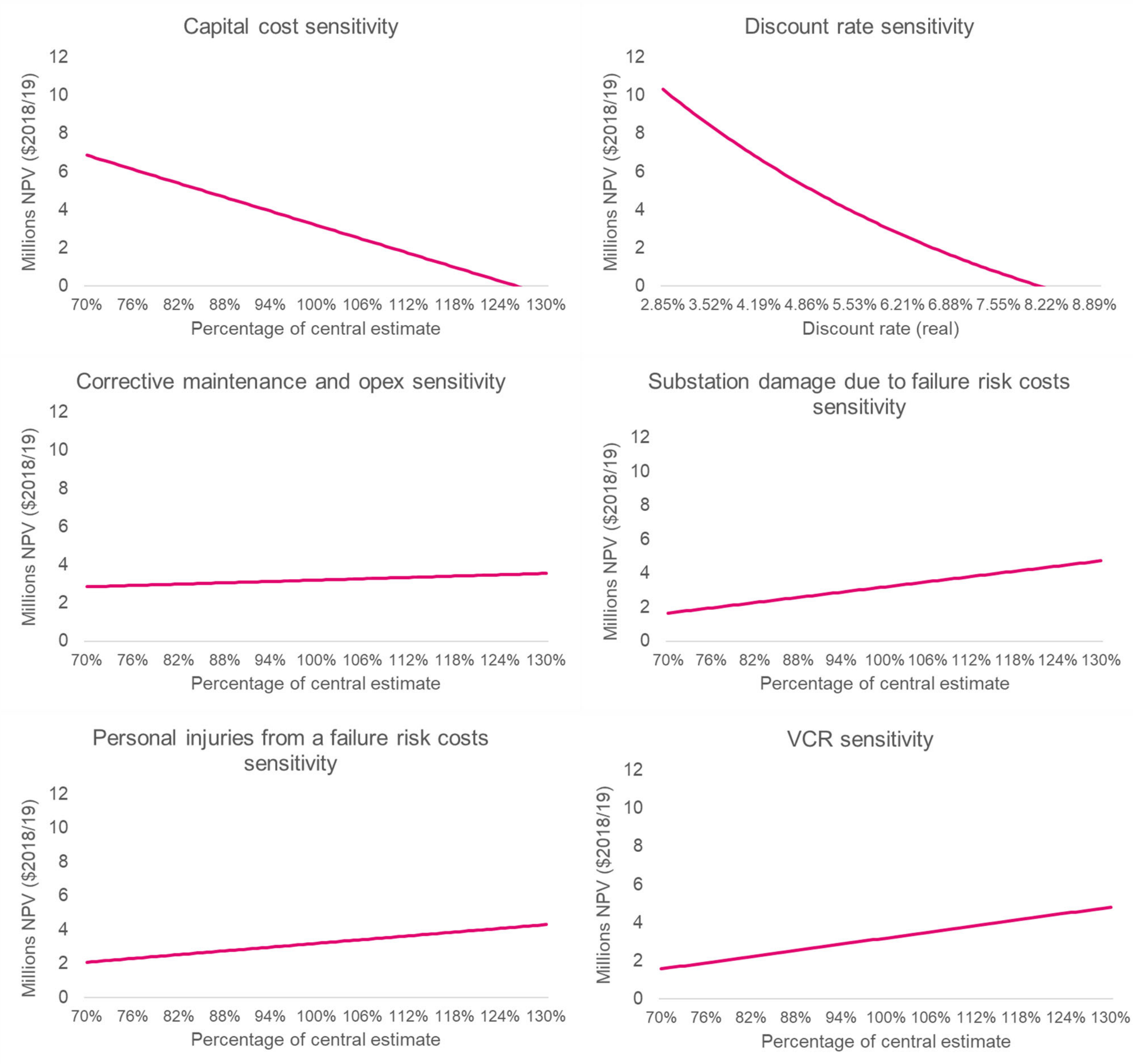


4.5.2 Sensitivity of the overall net market benefit

We have also looked at the consequences for the credible option of ‘getting it wrong’ if the key underlying assumptions are not accurate.

The six figures below illustrate the estimated net market benefits for each option if the six separate key assumptions in the central scenario are varied individually. Importantly, for all sensitivity tests shown below, with the exception of high discount rates and high capital costs, the estimated net market benefit of Option 1 remains strongly positive.

Figure 4 – Sensitivity testing of the NPV of net market benefits



The table below sets out the 'threshold' values for each of the key variables in the economic assessment, i.e., how much would each key variable need to change for Option 1 to no longer have positive net market benefits and be the preferred option.

Table 5 – Threshold values of key variables that would change preferred option

Key variable/parameter	Threshold value
Capital cost	126% of central estimate
Commercial discount rate (real, pre tax)	8.12%
Value of customer reliability	41% of central estimates
Corrective maintenance	No value
Substation damage	38% of central estimate
Personal injury risk cost	14% of central estimate

In addition, we find that the modelled failure rate implicit in the risk cost modelling would need to fall to approximately 79 per cent of the central estimate for there to be zero estimated net market benefits under the central scenario.

ElectraNet does not consider that any of these threshold values can be reasonably expected and, thus, considers that the expected net market benefits of Option 1 have been demonstrated to be robust to a range of alternate assumptions.

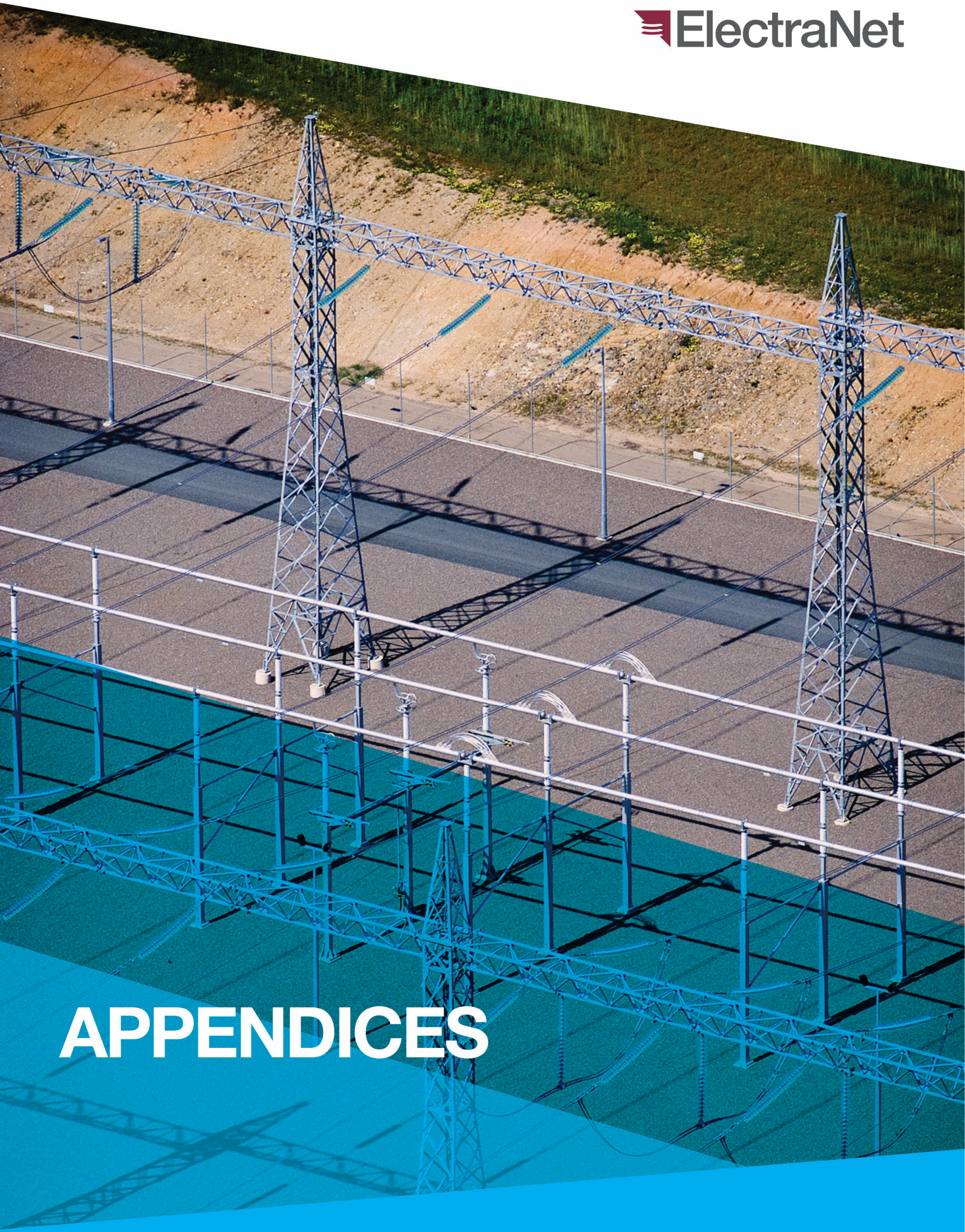
5. Conclusion on the preferred option

The preferred option that has been identified in this assessment to meet the identified need is Option 1, which is to replace the identified AC boards and associated assets between 2020 and 2024. This option is described in section 3 and is estimated to have a capital cost of approximately $20.6 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.

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

ElectraNet intends to commence work on replacing the identified assets in early 2020. The 24 AC boards (and associated assets) are distributed across 23 substations and we are planning to have all assets removed or replaced by October 2024.



APPENDICES

Appendix A 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 Rules version 126.

Rules clause	Summary of requirements	Relevant section(s) in PACR
5.16.4(v)	The project assessment conclusions report must include:	-
	(1) the matters detailed in the project assessment draft report as required under paragraph (k)	See below.
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought	NA
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 E & Appendix F
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	Appendix E
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	Appendix E
	(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
	(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

Appendix B Definitions

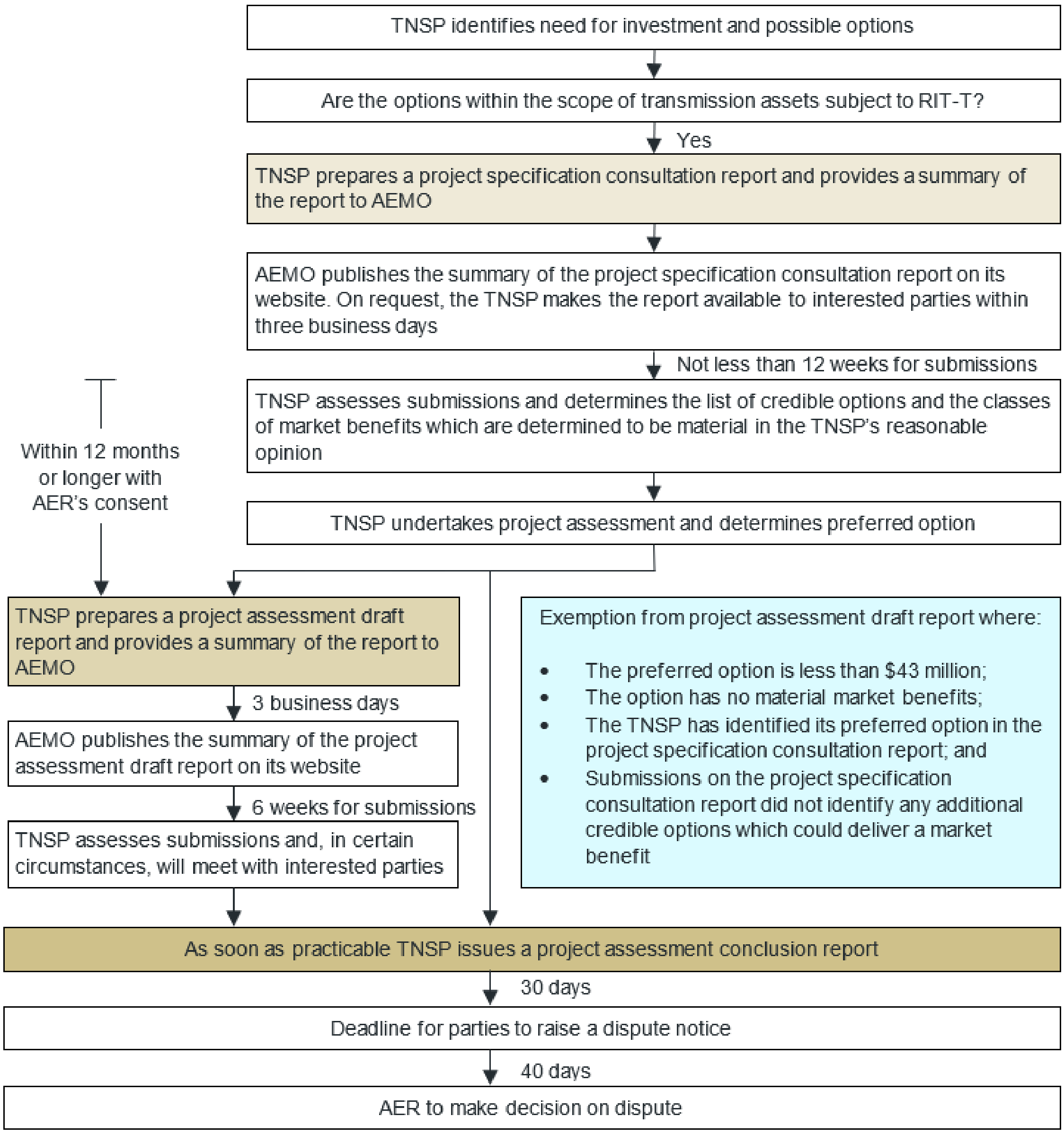
All laws, regulations, orders, licences, codes, determinations and other regulatory instruments (other than the NER) which apply to Registered Participants from time to time, including those applicable in each participating jurisdiction as listed below, to the extent that they regulate or contain terms and conditions relating to access to a network, connection to a network, the provision of network services, network service price or augmentation of a network.

Applicable regulatory instruments	
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: 1. address the identified need; 2. is (or are) commercially and technically feasible; and 3. 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.
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.

Appendix C Process for implementing the RIT-T

For the purposes of applying the RIT-T, the NER establishes a typically three stage process, ie: (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 has applied (in blue).

Figure 5 The RIT-T assessment and consultation process



Appendix D Assumptions underpinning the identified need

This appendix summarises the key assumptions from the risk cost modelling and other key assumptions that underpin the identified need for this RIT-T. Appendix F provides further detail on the general modelling approaches applied, including additional detail on the risk cost modelling framework.

In light of the uncertainties inherent in all assumptions, we have undertaken a range of sensitivity and 'threshold' tests in order to test the robustness of the preferred option. These are outlined in section 4 above.

D1 Failure modes

For the purposes of this assessment, the risk cost model focuses on five modes of failure, being:

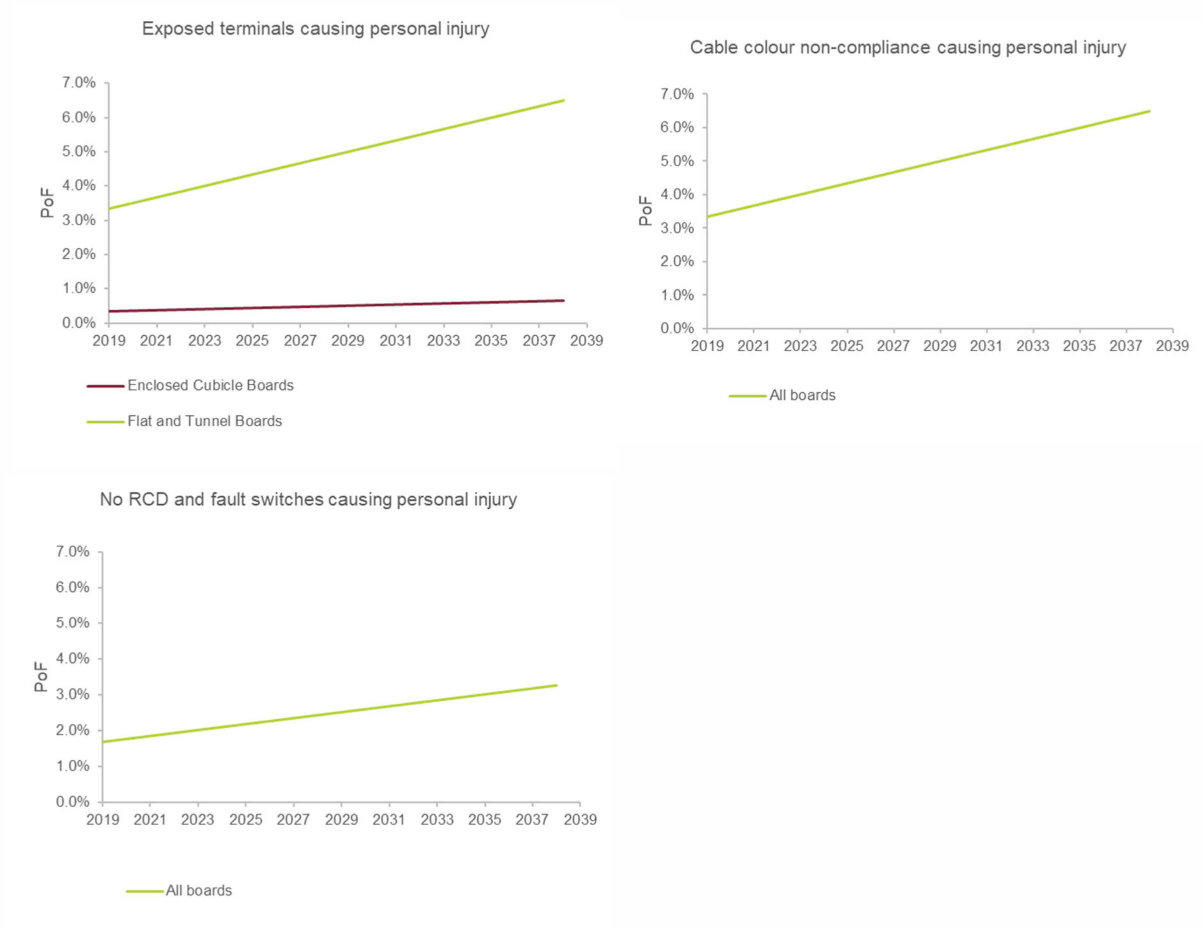
- a personal injury from touching exposed terminals in the AC board;
- a personal injury due to the absence of a Residual Current Device and, or fault switches, because a worker makes an error;
- a personal injury from non-compliant cable colouring because a worker makes an error;
- a fire igniting in the AC board from a range of defects; and
- a fire igniting in the cable trays of the AC board from a range of defects.

Each of these failure modes has different characteristics and consequent likelihoods of occurring, as is detailed in the section below. The economic assessment tests a wide range of alternate assumptions regarding the expected risk costs associated with the identified need in order to test the robustness of the identified preferred option.

D2 The probability of failure modes

ElectraNet has identified that the AC boards in their current condition could cause a personal injury from three separate events. The different probabilities associated with each event and the current AC boards to be replaced are illustrated in Figure 6 which demonstrates an increased risk of possible personal injuries into the future.

Figure 6 – The different probabilities of failure associated with events causing personal injuries



These probabilities of failure have been determined from field staff and the increasing lack of familiarity and knowledge that exists concerning the older style non-compliant boards identified to be replaced as the workforce ages.

ElectraNet has also estimated the probability of failure (PoF) for a fire to occur in the AC board through extensive site visits that have assessed the current deterioration level of the insulation, build-up of flammable material (i.e. dust), and an increase in other defects in proximity to the AC boards proposed to be replaced, which could cause the cells to short out and ignite.

D3 The adverse consequences resulting from failure

The potential adverse consequences resulting from the occurrence of an AC board failure include:

- the likelihood of serious personal injuries to ElectraNet personnel and electrical workers;
- periods of unserved energy to electricity customers during the time taken to establish a temporary connection in response to a failure;
- increased operating expenditure required to manage the network during an outage event;

- additional corrective maintenance costs associated with having to repair or replace the AC board in an unplanned emergency situation; and
- extensive damage due to a substation fire.

D4 The likelihood and cost of negative consequences of an AC board failure

Our risk cost model, models each of the adverse effects outlined above that could occur from the identified AC assets failing. Specifically, the risk cost model individually defines a set of assumptions for the adverse effects, which allows the 'likelihood of consequence' (LoC) and 'cost of consequence' (CoC) to be estimated for asset failures.

We note that the likelihood of a personal injury from an AC board due to either touching exposed terminals, a lack of RCD and or fault switches and non-compliant cable colours has been determined based on the size of the substation. It is assumed based on standard maintenance practices that larger substations are more likely to be attended by industry workers on a regular basis and therefore have a higher LoC.

We have used the Value of Statistical Life[15] (VSL), escalated to today's dollars and multiplied by a relevant disproportionate factor, in order to quantify these avoided consequences. It has been assumed that any such events will incur additional costs such as legal, compensation and investigation costs (which have been estimated using Safe Work Australia reports).[16]

However, it has been assumed that only a small number of personal injuries will result in a fatality, as unlike our other assets AC boards are low voltage. The VSL and the additional costs for personal injuries have therefore been adjusted to represent not just a possible fatality but also possible permanent injuries, lost time injuries and medical treatment injuries.

While one of the largest expected sources of benefit from the planned replacement comes from avoided outages following an AC board or cable tray fire, we note that most failures of AC boards will not result in an outage.

The likelihood that a fire in the AC board will cause wider adverse effects is based on the level of separation between components within the AC board and other assets at the substation. The LoC that a fire would ignite the whole AC board is estimated to be higher for tunnel or flat panel boards, than enclosed cubicle boards with poor electrical separation.

Similarly, ElectraNet estimates that the LoC for a fire in the cable trays of an AC board is likely to be significantly higher for flat panel boards, than tunnel boards and enclosed cubicle boards with poor electrical separation.

A fire igniting the whole AC board or a cable tray fire is unlikely for an enclosed cubicle board that has good electrical separation.

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[15] Department of the Prime Minister and Cabinet, *Best Practice Regulation Guidance Note Value of statistical life*, October 2018.

[16] Average Indirect Costs for work-related incidents, Australia in June 2013$, The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13, Safe Work Australia, p.26

Losing load is considered likely at substations that are not meshed or able to be energised through alternative switching. The likelihood of losing load at substations that are meshed or can be energised through alternative switching is assumed to be very low. It is assumed if an outage did occur it would occur for 48 hours.

In calculating outage costs, the AEMO estimated value of customer reliability (VCR) of a mixed load for South Australia, escalated to 2019 dollars, has been applied for all connection points when the connection point is not directly connected to a customer. When the connection point is directly connected to a customer the value of customer reliability of a direct connect load has been applied. All loads are based on the average load from the financial year 2017-18.

We note that, should an AC board fail, there may also be wider outages than the load we have considered and/or planned outages for operational and capital work may have to be postponed. These additional adverse effects have not been captured in our risk cost modelling but are expected to further increase the net market benefits associated with Option 1. As shown in section 4, estimating these additional benefits would not change the identified preferred option and so they are not considered material in the context of this RIT-T.

Unplanned outages require ElectraNet to incur further operating expenditure relating to the management of our network, including communication, legal and investigation costs. These costs have been estimated based on historical information and experience.

The costs associated with the negative consequences of an AC board failure are material assumptions for undertaking the project. We have therefore included a range of sensitivity tests on these as part of the economic assessment (see section 4.5).

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

The appendix outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T assessment.[17]

Many of the expected benefits associated with Option 1 are captured in the expected costs avoided by each option (i.e., the avoided expected costs compared to the base case) as described above, these include avoided risk costs.

Only unserved energy through involuntary load shedding of these avoided costs, is considered a market benefit category under the NER.

E1 Avoided involuntary load shedding is the only relevant market benefit

We consider that the only relevant market benefit for this RIT-T relates to changes in involuntary load shedding. The expected unserved energy under the base case has been estimated as part of our risk cost modelling framework, which is avoided under Option 1.

The benefit associated with the reduction in unserved energy is valued using VCR, expressed in $/MWh. A VCR measure estimates the value customers place on having reliable electricity supplies. The risk cost modelling has applied a VCR value of approximately $37,000/MWh for mixed loads, which is an escalation of the value sourced from AEMO's 2014 Value of Customer Reliability Review,[18] for South Australia, and a VCR of $6,500 for direct connections. These VCR values are largely consistent with the recent AER VCR review, which we will be applying in the future.

E2 Market benefits relating to the wholesale market are not material

The Australian Energy Regulator (AER) has recognised that if the credible options considered will not have an impact on the wholesale market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated.[19]

Option 1 does not address network constraints between competing generating centres and is therefore not expected to result in any change in dispatch outcomes and wholesale market prices.

We therefore consider that the following classes of market benefits are not material for this RIT-T assessment:

- changes in fuel consumption arising through different patterns of generation dispatch;
- changes in voluntary load curtailment (since there is no impact on pool price);
- changes in costs for parties, other than for ElectraNet (since there will be no deferral of generation investment);

[17] The NER requires that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.16.1(c)(6). Under NER clause 5.16.4(b)(6)(iii), the PSCR should set out the classes of market benefit that the RIT-T proponent considers are not likely to be material for a particular RIT-T assessment.

[18] AEMO, *Value of Customer Reliability Review for South Australia*, September 2014, p. 31 and p. 40.

[19] AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, December 2018, p. 32.

- changes in ancillary services costs;
- competition benefits; and
- Renewable Energy Target (RET) penalties.

E3 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 the three classes of market benefits listed above are material for this RIT-T assessment for the reasons set out below.

We do not consider that there are any other classes of market benefits, which are material for the purposes of this RIT-T assessment.

Table 6 – 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	Option 1 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.
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.[20] 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 condition and safety risks 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 Option 1 maintains the same network capacity as current at the same location, there are not expected to be any differences in network losses.

[20] AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, December 2018, p. 95.

Appendix F Description of the modelling methodologies applied

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

F1 Overview of the risk cost modelling framework

We have applied an asset 'risk cost' evaluation framework to quantify the risk cost reductions associated with replacing the identified AC boards that are primarily focused on mitigating risk as inputs to economic evaluation and options analysis.

The 'risk cost reductions' have been calculated as the product of:

- probability of failure (PoF) of an asset, which is the probability of a failure occurring based on asset failure history information and industry data;
- likelihood of consequence (LoC), which is the likelihood of an adverse consequence of the failure event based on historical information and statistical factors and assumptions; and
- cost of consequence (CoC), which is the estimated cost of the adverse consequence based on modelled assumptions.

These three variables allow the expected risk cost benefits to be quantified and an assessment against the cost of doing so to be undertaken. Avoided risk cost values are the difference between risk costs incurred under the base case and Option 1.

The approach we continue to apply in quantifying risk was presented as part of our Revenue Proposal for the 2018-2023 regulatory control period and continues to be applied in replacement asset decision making, including RIT-T assessments. The AER has reported it to be consistent with good industry practice and to generally reflect reasonable inputs and assumptions.[21]

More detail on the key inputs and assumptions made for individual asset risk cost evaluations can be found in ElectraNet's asset risk cost modelling guideline.[22]

F2 The discount rate and assessment period

The RIT-T analysis has been undertaken over a 20-year period from 2019 to 2038, which considers the size, complexity and expected life of each option to provide a reasonable indication of its cost.

The new AC boards have standard asset lives of 44.8 years. We have taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of the replacement program is appropriately captured in the 20-year assessment period.

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[21] AER, *ElectraNet transmission determination 2018 to 2023*, Draft Decision, Attachment 6 – Capital expenditure, October 2017, p. 4.

[22] Available at https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/electranet-determination-2018-23/proposal#step-50979.

We have adopted a real, pre-tax discount rate of 5.9 per cent as the central assumption for the NPV analysis presented in this report, consistent with Energy Network Australia's (ENA) 2019 RIT-T Economic Assessment Handbook.[23] 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 regulated real, pre-tax weighted average cost of capital (WACC) be used as the lower bound discount rate in the sensitivity testing.[24]

We have therefore tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound discount rate of 2.85 per cent,[25] and an upper bound discount rate of 8.95 per cent (i.e. a symmetrical adjustment upward).

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23 ENA, *RIT-T Economic Assessment Handbook*, 15 March 2019, p. 67.

24 AER, *Final Regulatory Investment Test for Transmission*, June 2010, version 1, paragraph 15, p. 7.

25 This is equal to WACC (pre-tax, real) in the latest Final Decision for a transmission business in the NEM, see: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/tasnetworks-determination-2019-24/final-decision

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