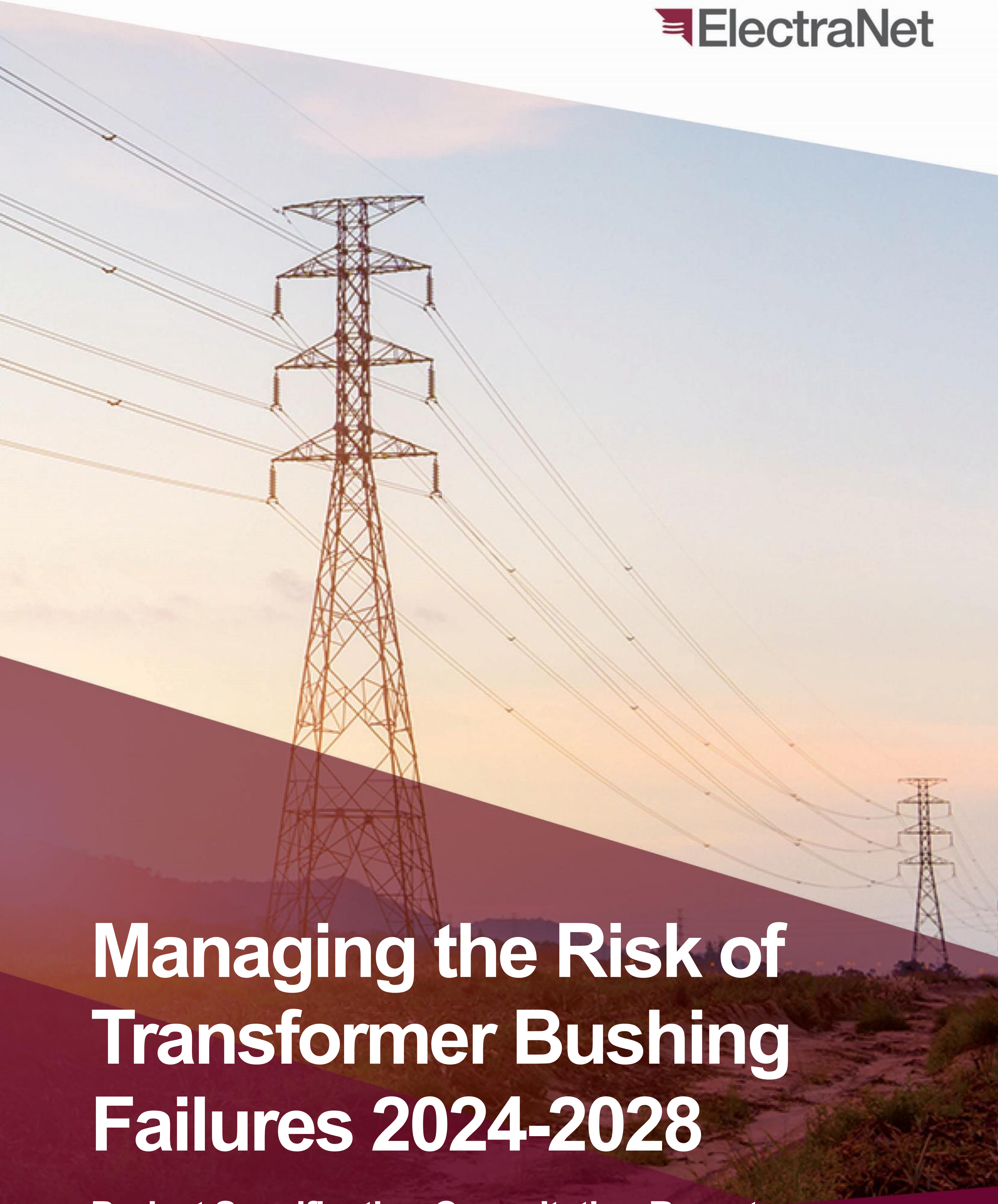


ElectraNet

Managing the Risk of Transformer Bushing Failures 2024-2028

Project Specification Consultation Report

28 JUNE 2024

EXECUTIVE SUMMARY

We are proposing to replace individual transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations to maintain safe and reliable electricity supply to customers.

This Regulatory Investment Test for Transmission (RIT-T) Project Specification Consultation Report (PSCR) identifies the need to replace transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations by 2028 as the preferred solution to manage the risk that these assets will fail.

The transformer and reactor bushings in question for this PSCR are between 37 and 47 years old and are in poor condition and have reached the end of their technical lives. There is an increasing risk of catastrophic failure of the associated transformers and reactors if these bushings are not replaced with consequential safety risks and the potential for involuntary load shedding on parts of the network.

The ‘identified need’ is to efficiently manage the risk of asset failure.

The identified need for this project is to continue to provide safe and reliable electricity transmission services in South Australia at a prudent and efficient cost. Specifically, the identified need for this Regulatory Investment Test for Transmission (RIT-T) is to efficiently manage the risk of failure of transformer and reactor bushings at 12 substations that are in poor condition and have reached the end of their technical lives.

We have classified this RIT-T as a ‘market benefits’ driven RIT-T as it is being progressed to manage the risk of asset failure and thereby deliver positive net benefits to customers.

A full cost benefit assessment has been undertaken, comparing the risk cost reduction benefits of bushing replacement with the cost of a base case ‘do nothing’ option, together with options considered but not being progressed.

Bushing replacement is the only credible option.

There is only one economically feasible option, which is to replace the end-of-life transformer and reactor bushings on the 13 transformers and two reactors at the 12 substations by 2028.

The estimated capital cost of this option is approximately $13.2 million.

This is below the threshold requiring us to complete a Project Assessment Draft Report (PADR) under NER clause 5.16.4(z1). This RIT-T is therefore exempt from the need to produce a PADR.

There is no feasible role for non-network options in addressing the identified need for this RIT-T.

ElectraNet does not consider that a non-network option can meet the identified need for this RIT-T. This is because of the specific role that the identified transformer and reactor bushings and the associated transformers and reactors play in the transmission of electricity and the relatively low-cost replacement cost of the bushings.

Nevertheless, for completeness and consistent with the requirements of the RIT-T this PSCR sets out the technical characteristics a non-network option would need to have.

Three different scenarios have been modelled to deal with uncertainty.

We have developed three reasonable scenarios for the economic assessment as shown in Table 1 below:

- a ‘central’ scenario reflecting our base case set of key assumptions;
- a ‘low benefits’ scenario – reflecting a pessimistic set of assumptions, which represents a lower bound on potential market benefits that could be realised; and

- a 'high benefits' scenario – reflecting an optimistic set of assumptions, which represents an upper bound on potential market benefits that could be realised.

Table 1 - Summary of the three scenarios

Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Capital costs	130 per cent of base case estimate	Base case estimate	70 per cent of base case estimate
Commercial discount rate[1]	3.0%	7.0%	10.5%
Public injury risk	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Service interruption	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Unplanned replacement cost of entire transformer / reactor	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Bushfire / environmental risk	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates

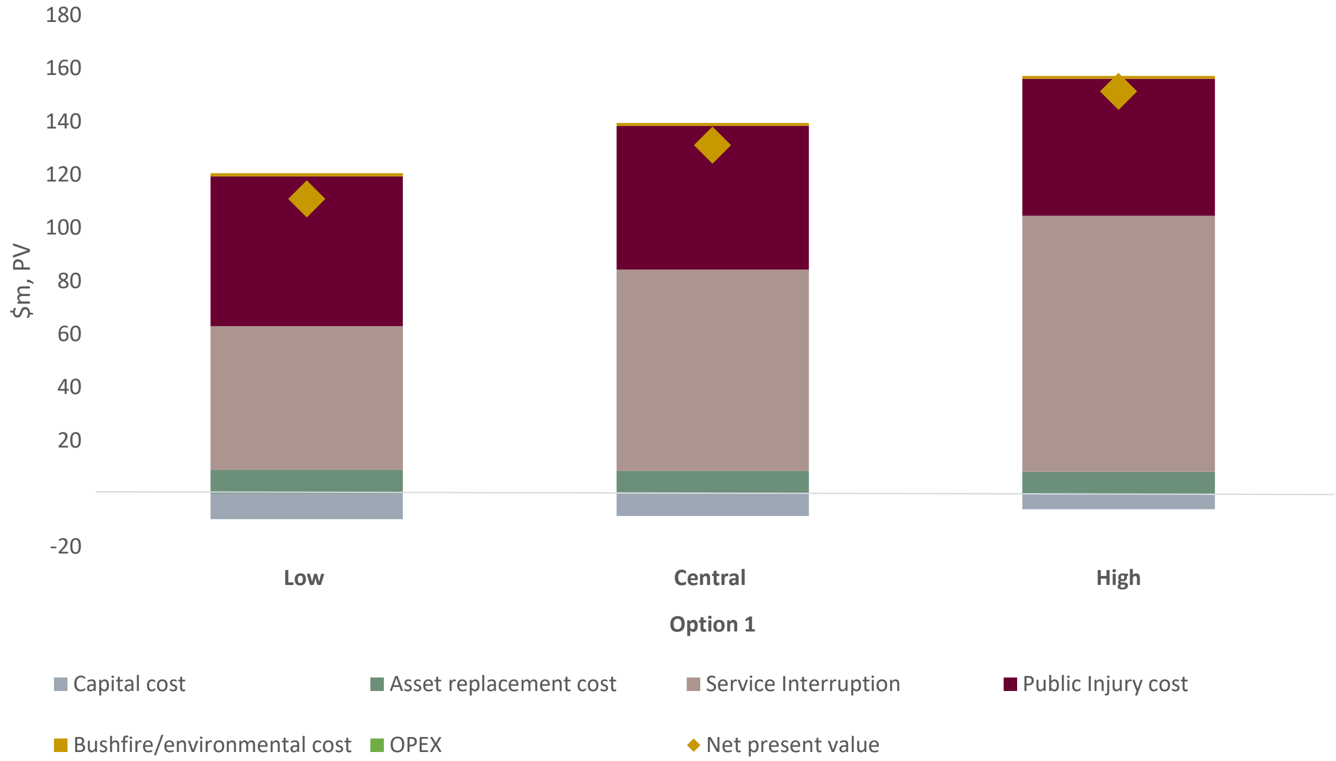
Completing the identified bushing replacements at 12 substations within the 2024-2028 regulatory period is the preferred option.

The preferred option that has been identified in this assessment for addressing the identified need is Option 1, which is to replace the 13 high voltage transformers and two reactors at 12 substations by 2028.

Most of the expected benefits are derived from the avoided risk of safety and cost of catastrophic failure, unplanned outages, and the reduced time and cost taken to resolve such failures.

[1] Expressed on a real, pre-tax basis

Figure 1 - Breakdown of present value gross economic benefits of the preferred option



On a weighted basis (i.e., weighted across the three scenarios investigated), the preferred option is expected to deliver approximately $131.1 million in net market benefits.

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

In particular, we have tested the optimal timing and the sensitivity of this timing to key variables. Under most sensitivities investigated, we find it optimal for the preferred option to be undertaken as soon as possible and the estimated net market benefits to be robust.

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Glossary

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
ALARP	As Low as Reasonably Practicable
ISP	Integrated System Plan
NPV	Net Present Value
NEM	National Electricity Market
NER	National Electricity Rules
PACR	Project Assessment Conclusions Report
PADR	Project Assessment Draft Report
PSCR	Project Specification Consultation Report
POF	Probability of Failure
RET	Renewable Energy Target
RIT-T	Regulatory Investment Test for Transmission
SFARP	So Far As is Reasonably Practicable
SVC	Static Var Compensator
TNSP	Transmission Network Service Provider
VCR	Value of Customer Reliability

1. Introduction

This Project Specification Consultation Report (PSCR) is the first step in the application of the Regulatory Investment Test for Transmission (RIT-T) addressing the risk of failure of individual transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations located across the South Australian transmission network.

This report:

- 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 network support option would be required to deliver to address this identified need;
- outlines the 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).

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 the estimated capital cost of at least one credible option exceeds $7 million.[2]

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

The credible option discussed in this PSCR 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.

1.2. Submissions and next steps

We welcome written submissions on this PSCR. Submissions are due on or before Friday, 20 September 2024. Submissions should be emailed to consultation@electranet.com.au

Submissions will be published on the ElectraNet website. If you do not want your submission to be published, please clearly specify this at the time of making it. Subject to submissions received on this PSCR, a Project Assessment Conclusions Report (PACR) is expected to be published in due course.

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 for this RIT-T is to ensure safe and reliable supply of electricity in South Australia

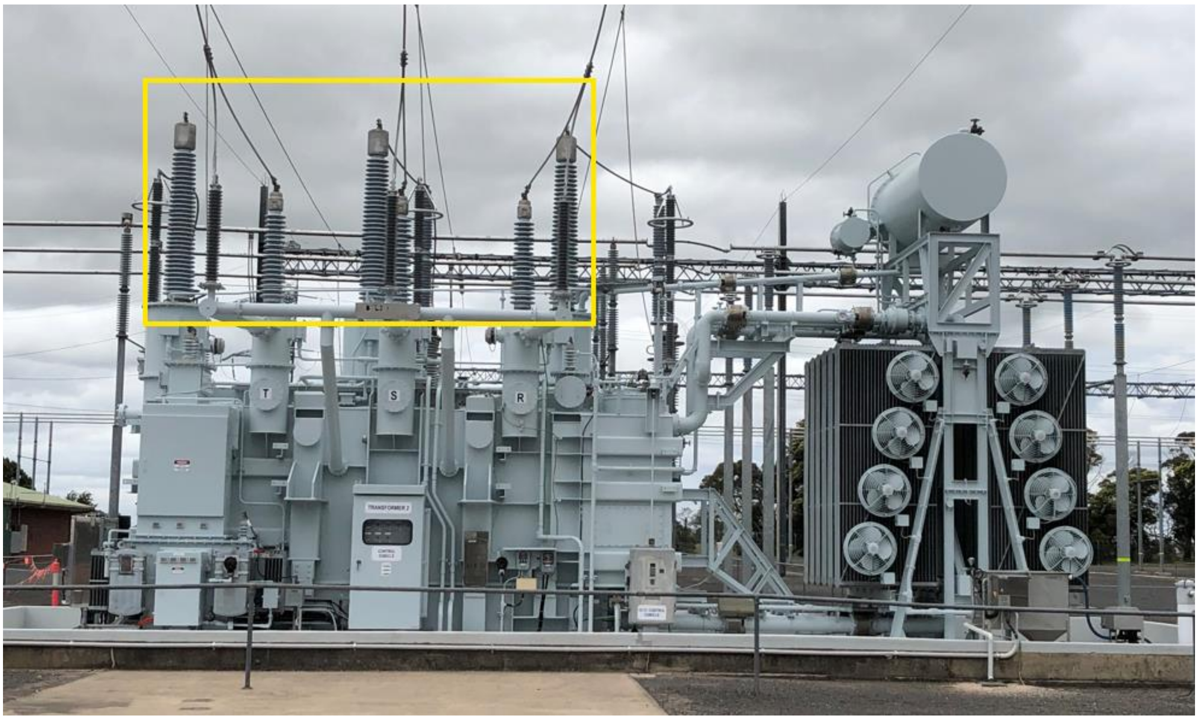
This section outlines the identified need and the assumptions underpinning it. It first provides some background on the identified bushings and their role in the wider transmission of electricity in South Australia.

2.1. Background to the identified need

Bushings are insulated devices that allow an electrical conductor to pass safely through a grounded conducting barrier such as the case of a transformer or reactor. Bushings have traditionally been made from porcelain, although other materials are now used such as polymers, which have lower risks of exploding (and lower consequential damage if they do explode).

Figure 2 illustrates bushings on transformer 2 at the South East substation that are planned to be replaced.

Figure 2 – Transformer 2 at South East substation.



Transformer bushings are essential to the task of transmitting electricity. Without them, transformers, and hence substations, cannot adjust the electrical voltage for efficient electrical power transportation to transmission and distribution customers.

Across our transmission network, we have identified 84 bushings fitted on 13 high voltage transformers and two reactors at 12 substations (refer Figure 3) that are now reaching, or past, the end of their technical lives and require replacement based on their condition. These bushings have a standard technical life of 40 years and are now aged between 37 and 47 years old. The condition of these bushing is such that they require replacement within 2024-2028 period.

The condition of the other components of the transformers and reactors in scope of this RIT-T are such that the replacement of the bushing will extend the life of these assets by a minimum of 20 years.

Figure 3 - Location of the transformers and reactors bushing replacements.

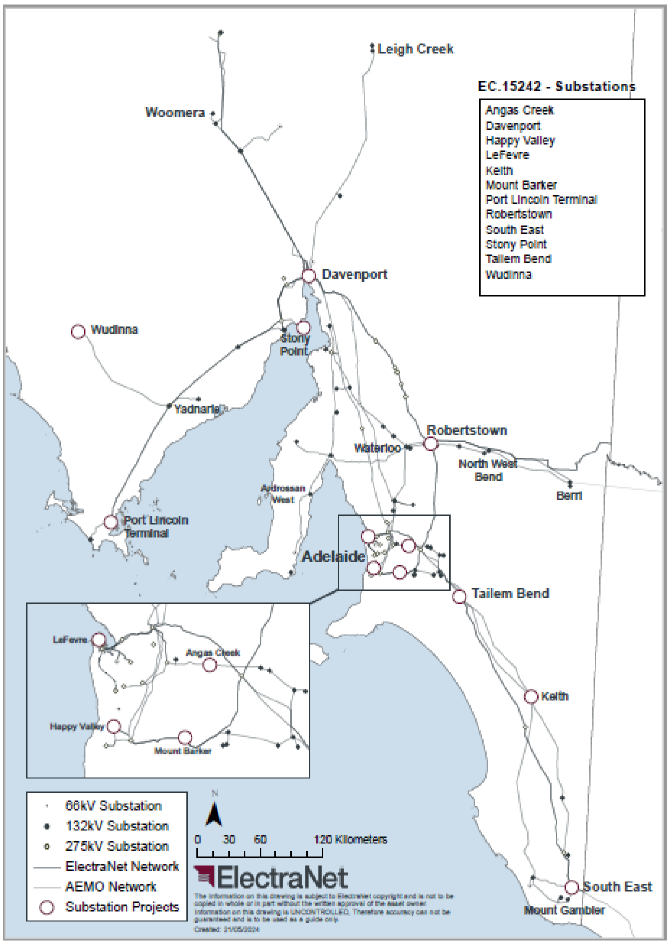


Table 2 – Transformer and reactor bushings planned for replacement below provides the details about the transformer and reactor bushings that are planned to be replaced including the locations, asset detail and number of bushings.

Table 2 – Transformer and reactor bushings planned for replacement

Substation	Transformers / Reactors	Number of identified bushings
Angas Creek	132/33 kV transformer 1	3
Davenport	275/132 kV transformer 1	3
Happy Valley	275/66 kV transformer 2	7
LeFevre	275/66 kV transformer 4	7
Keith	132/33 kV transformer 2	8
Mount Barker	132/66 kV transformer 1	7
Port Lincoln Terminal	132/33 kV transformer 1	8

Substation	Transformers / Reactors	Number of identified bushings
	132/33 kV transformer 2	8
Robertstown	275/132 kV transformer 2	6
South East	275/132 kV transformer 2	6
Stony Point	132/11 kV transformer 2	4
	132/11 kV transformer 3	4
Tailem Bend	South East reactor 1	3
	South East reactor 2	3
Wudinna	132/66 kV transformer 1	7
Total bushing replacements		**84**

If the identified bushings remain in service, it is likely that a number of these assets will fail during the next 5-10 years, which may result in unplanned outages on parts of the network.

If a bushing fails, the affected transformer or reactor can experience an oil-fuelled fire, which causes consequential damage to the transformer or reactor and other equipment, as well as safety risk to network personnel and the wider community.

During the 2018-2023 period, we experience three such transformer bushing failures. The details of these failures are:

1. On 3 August 2018, one of the 132 kV bushings on transformer 3 at Snuggery substation failed explosively as shown in Figure 4. This failure did not result in significant collateral damage and no personnel were on site. All high voltage bushings on the Snuggery transformer were replaced, and the transformer was returned to service.
2. On 17 July 2020, one of the bushings on SVC 1 transformer at Para substation failed catastrophically. This failure resulted in a transformer fire that caused major collateral damage to this transformer requiring the replacement of the transformer in its entirety. As result of this failure, the import and export capacity of the Heywood interconnector between SA and Victoria was constrained[3] until the SVC transformer was returned to service.
3. On 4 January 2022, one of the bushings on the SVC 2 transformer at Para substation failed catastrophically. This failure also resulted in transformer fire that caused major collateral damage to this transformer and to the adjoining equipment. As with the failure of SVC 1 transformer, the interconnector between SA and Victoria was constrained until this transformer and the adjoining equipment were replaced. In all instances, no network personnel or members of the public were injured.

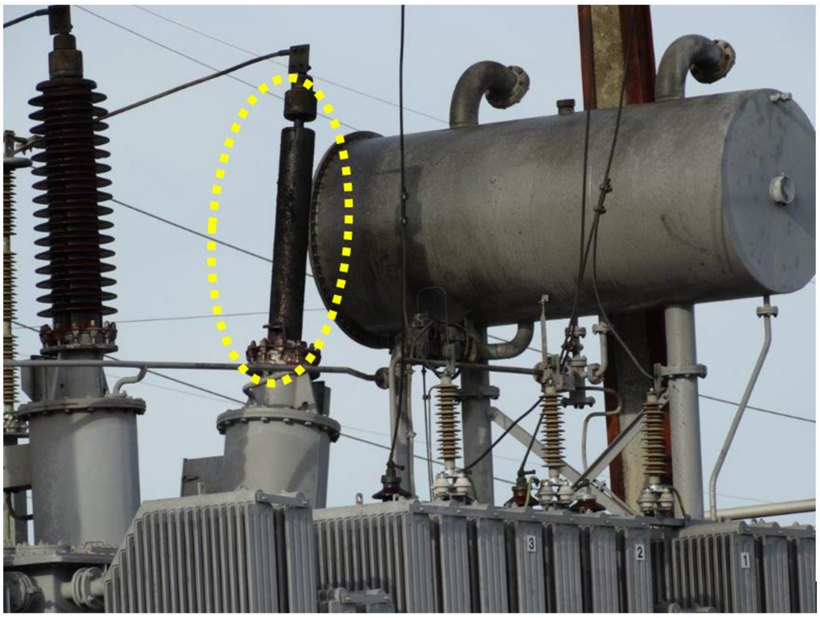
ElectraNet has four SVC transformers within its network, two Para and two at South East substation. All these transformers were from the same manufacturer, similar size, configuration, age and condition. Following the failure of the second transformer at Para, we

[3] The SVC transformers located at Para and South East substation enable a higher transfer capacity between SA and Victoria that otherwise would not be possible if these were not in service. When any one of these transformers are out of service, it reduces both the import and export capability available on the Heywood-South East (HESE) Interconnector. This capacity reduction is the result of removing +80 MVAr to -80MVAr of dynamic shunt compensation from the ElectraNet 275 kV transmission system.

pre-emptively replaced the transformer bushings on the two remaining SVC transformers located at South East substation to mitigate the risk of future failures. We also procured a universal spare SVC transformer to enable rapid replacement / restoration should any of these SVC transformers fail in the future.

If the transformer and reactor bushings in scope of this RIT-T are not replaced it is increasingly likely that similar failures will occur with similar consequences.

Figure 4 - Snuggery substation transformer number 3 after explosive bushing failure



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

The identified need is to efficiently manage the risk of failure of individual transformer and reactor bushing failure on 13 high voltage transformers and two reactors at 12 substations that are in poor condition and have reached the end of their technical lives.

We have assessed the condition of all our transformers and reactors as part of our ongoing asset management processes. There is an increased likelihood that several of the bushings identified will fail in coming years given their current condition. Failure could result in safety risk to network personnel and the wider community, environmental impact risk, increase cost to reactively replace upon failure and in a severe scenario unserved energy for electricity customers because of the transformer itself completely failing.

In its Industry Practice Note for asset replacement planning, the Australian Energy Regulator says that Network Service Providers should apply the As Low as Reasonably Practicable (ALARP) approach to safety matters.[4] This is consistent with South Australia's Workplace Health and Safety Act, which requires us to ensure, So Far As is Reasonably Practicable (SFARP), the health and safety of workers at our various sites and of the public generally. It is also consistent with our Safety, Reliability and Maintenance Technical Management Plan and with the obligation in our transmission licence to ensure that we operate the network in a manner consistent with good electricity industry practice.

[4] Australian Energy Regulator, "Industry practice application note Asset replacement planning", p.51, available from www.aer.gov.au, retrieved 2 April 2024.

Further, the Electricity (General) Regulations (the Regulations) 2012 require that:

51. Substations

(1) 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.

(2) Schedule 3 applies in relation to substations installed after 1 July 1997

These obligations have been taken in to account in quantifying the benefits of this project which is classified as a 'market benefits' RIT-T. It is being progressed to deliver positive net benefits to customers by managing the risk of asset failure.

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

2.3. Assumptions underpinning the identified need

This section summarises the key assumptions from the risk cost modelling and other key assumptions that underpin the identified need for this RIT-T. Section 6 provides further detail on the general modelling approaches applied, including additional detail on the risk cost modelling framework.

For the purposes of this assessment, the risk cost model focuses on a single mode of failure, an explosive failure of a transformer bushing, due to the potential for wide-ranging consequences including unserved energy, collateral equipment damage and personal injury and environmental costs as explained in section 2.3.2

2.3.1. The probability of failure

The probability of bushing failure is estimated by considering ElectraNet's historical data, manufacturers' specifications, and industry research and experience. The risk cost model assumes that one of the identified transformer bushings will suffer an explosive failure over the next 6 years (corresponding to an annual explosive failure rate of 0.17 per cent). The transformer bushing failure rate is assumed to increase progressively from year 7.

2.3.2. The consequences of failure

The potential adverse consequences resulting from the occurrence of a bushing failure include electricity service interruption, bushfire, personal injury, repair cost, service level breaches and environmental damage. When a transformer bushing fails, the affected transformer can experience an oil-fuelled fire, which causes consequential damage to the transformer and other equipment. In a severe scenario, the failed bushing can result in unserved energy for electricity customers because of the transformer itself completely failing.

Explosive bushing failures can also result in projectiles and oil spills, which present a safety risk to those in the immediate, or potentially wider area. The failure of critical transformers can result in additional costs associated with asset replacement and repair, collateral damage to other plant/equipment, and costs associated with injuries/fatalities to those surrounding the incident.

Our risk cost model defines the following effects that could occur from a transformer bushing failure:

- Unserved energy to electricity customers during the time taken to:
    - restore (or replace) the transformer(s); and

    - isolate the affected substation to control any explosion and fire.
- Costs associated with having to repair (or replace) damaged transformers including bushings;
- Personal injury costs associated with explosive failures; and
- Environmental costs associated with oil leaks, fire start etc.

2.3.3. The likelihood and cost of bushing failure

Our risk cost model analyses the consequences listed in section 2.3.2. It estimates the 'likelihood of consequence' (LoC) and 'cost of consequence' (CoC) of bushing failures.

Outage duration is based on the typical time to replace a bushing following a failure.

Outage cost is based on the Australian Energy Regulator's (AER) estimated Value of Customer Reliability (VCR) which is expressed in dollars per kilowatt-hour (kWh) and reflect the value different customer types place on reliable electricity supply. All loads are based on a representative load trace taken from 2019-20 escalated to 2023 dollars based on the Consumer Price Index for that year.

The following 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. These include damage to adjoining infrastructure and the cost of emergency response in the case of catastrophic failure.

Further, the analysis does not assign value to redundancy, despite the transmission network being designed to provide redundancy in many ways. There is clearly value in redundancy, but there is no accepted way to quantify it.

Section 7 demonstrates these additional benefits would not change the preferred option and so they are not considered material in the context of this RIT-T.

3. Potential credible options to address the identified need

There is only one economically feasible option, which is to replace the identified transformer and reactor bushings.

We have however investigated different timings for this work in order to determine the optimal timing. This assessment is presented in section 7.

The option is technically and economically feasible and able to be implemented in sufficient time to meet the identified need.[5]

3.1. Option 1 – Planned replacement of transformer and reactor bushings by 2028

Option 1 involves replacing the transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations as identified in section 2.1.

The existing bushings are planned to be replaced with a newer technology, which uses polymer instead of porcelain. Polymer bushings have a lower risk of exploding when they fail than porcelain bushings and, if they do explode, the risk of consequential damage and injury is contained and far lower. The replacement of these bushings is planned to occur between 2025 and 2028.

ElectraNet has prepared an estimate of the cost of implementing this option which is $13.2 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 3 years. We estimate that all the bushings could be replaced and commissioned by 2028 under this option.

3.2. Options considered but not progressed

We have not identified other credible options that would meet the identified need.

3.3. There is not expected to be a material inter-network impact

We have considered whether the credible option will have a material inter-regional impact.[6].

By reference to AEMO's screening test for an inter-network impact[7], a material inter-regional impact arises if the option:

- involves a series capacitor or modification near an existing series capacitor;
- 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.

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5 In accordance with those identified in section 2.2

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

7 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.

None of these criteria are satisfied for the project discussed here. Therefore, ElectraNet does not consider there are any associated material inter-network impacts.

4. Required technical characteristics of network support options

ElectraNet does not consider that a non-network option can provide a solution that is both technically and economically feasible.

For clarity, a non-network solution must be capable of providing the same services at a lower long run cost as Option 1, which is to replace the transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations by 2028.

Any non-network solution that avoids replacement of transformer and reactor bushings in scope must be able to replicate the functionality, capacity and reliability of the entire substation that these transformers and reactors are located.

We are not aware of non-network options that are capable of doing this, but invite submissions on this point from proponents of such options if they do exist.

5. Materiality of market benefits for this RIT-T assessment

The section outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T.[8]

The bulk of the benefits associated with the preferred option are captured in the expected costs avoided by the option (i.e., the avoided expected costs compared to the base case). These include avoided risk costs as described above.

Of these avoided costs only unserved energy due to involuntary load shedding is considered a market benefit category under the NER.

5.1. Avoided involuntary load shedding is the only relevant market benefit

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

5.2. Market benefits relating to the wholesale market are not material

The AER has recognised that a number of classes of market benefits will not be material in a RIT-T assessment if the credible options considered will not have an impact on the wholesale market. In this case the impacts do not need to be estimated.[9]

The preferred option would not affect network constraints between competing generating centres so it would not change dispatch outcomes or wholesale market prices.

Therefore, we consider the following classes of market benefits to be immaterial 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);
- changes in ancillary services costs;
- competition benefits; and
- Renewable Energy Target (RET) penalties.

5.3. 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.

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8 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 5.16.2(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.

9 AER, *Regulatory Investment Test for Transmission Application Guidelines*, August 2020, p. 29.

We consider that none of these are material for this RIT-T assessment for the reasons set out in Table 4.

Table 3 - 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.
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.[10] 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.

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

6. Description of the modelling methodologies applied

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

6.1. Overview of the risk cost modelling framework

We have applied an asset 'risk cost' evaluation framework to quantify the risk cost reduction associated with replacing the identified transformer and reactor bushings.

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; 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.

The approach we apply to quantifying risk was presented as part of our Revenue Proposal for the 2024-2028 regulatory control period. In its Draft Decision on that proposal, the AER found it to be consistent with good industry practice and to generally reflect reasonable inputs and assumptions.[11]

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.[12]

6.2. 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.

The asset life of the transformer and reactor bushings are more than 20 years. We have taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of each option is appropriately captured in the 20-year assessment period.

We have adopted a real, pre-tax discount rate of 7.0 percent as the central assumption for the analysis presented in this report, consistent with AEMO's most recent Inputs, Assumptions and Scenarios Report.[13] 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.

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11 AER, *ElectraNet transmission determination 2023 to 2028*, Draft Decision, Attachment 5 – Capital expenditure, September 2022

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

13 AEMO, Inputs, Assumptions and Scenarios Report, July 2023, p. 123.

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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.[14]

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 3.0 percent, and an upper bound discount rate of 10.5 percent.[15]

6.3. Description of reasonable scenarios

A RIT-T analysis is required to incorporate several 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.

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 more extreme pessimistic set of assumptions, which represents a lower bound on potential market benefits that could be realised; and
- a 'high benefits' scenario – reflecting a more extreme optimistic set of assumptions, which represents an upper bound on potential market benefits that could be realised.

Table 4 summarises the key assumptions making up each scenario.

Given that the low and high benefits scenarios are more unlikely to occur the scenarios have been weighted accordingly; 33% - low benefits scenario, 33% - central benefits scenario, and 33% - high benefits scenario.[16]

Table 4 - Summary of the three scenarios

Key variable/parameter	Low benefits scenario	Central scenario	High benefits scenario
Capital costs	130 per cent of base case estimate	Base case estimate	70 per cent of base case estimate
Commercial discount rate[17]	3.0%	7.0%	10.5%
Public injury risk	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Service interruption	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Unplanned replacement cost of entire transformer / reactor	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates
Bushfire / environmental risk	70 per cent of base case estimates	Base case estimates	130 per cent of base case estimates

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

[15] AEMO*, Inputs, Assumptions and Scenarios Report*, July 2021, p. 104.

[16] In accordance with paragraph 4(a) of the RIT-T.

[17] Expressed on a real, pre-tax basis

7. Assessment of the credible options

This section outlines the assessment we have undertaken of the credible network option and the option to delay the project by 5 years. The assessment compares these options against a 'do nothing' base case option.

7.1. Gross benefits for each credible option

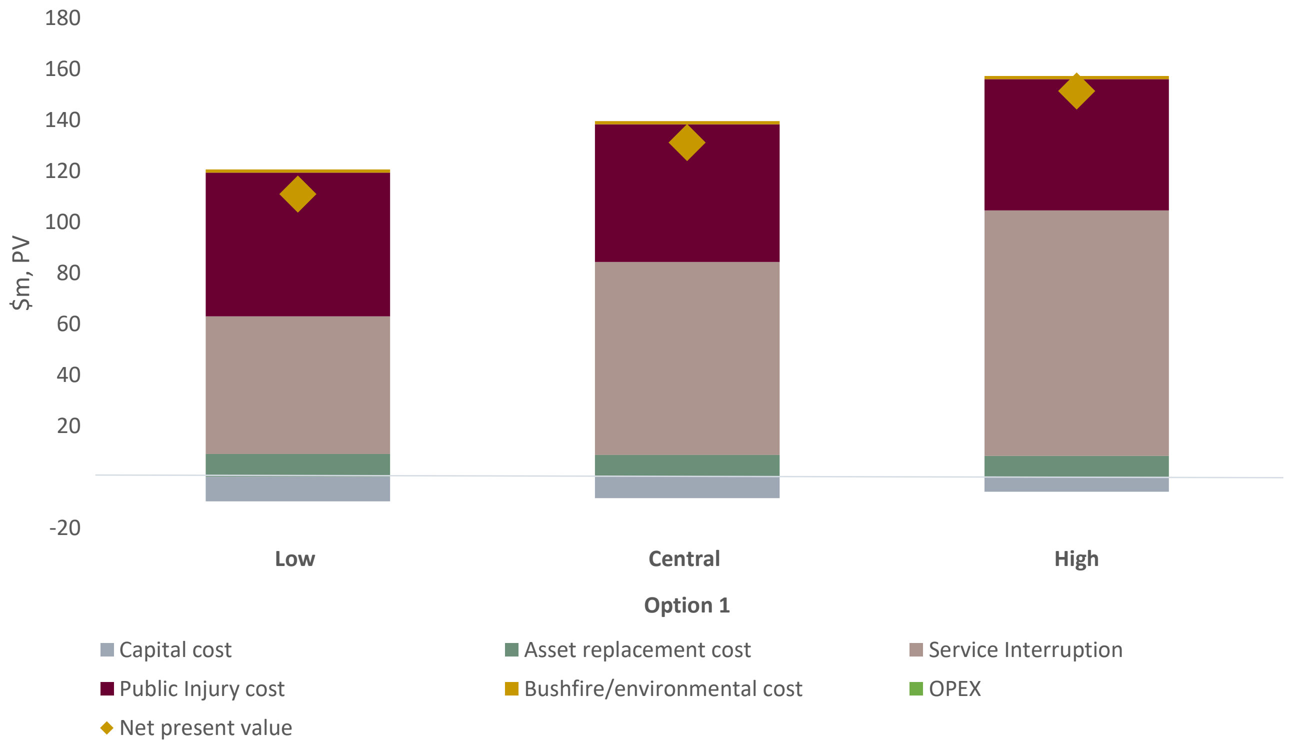
Table 5 summarises the gross benefit estimated for the preferred option, Option 1 to replace the identified bushings by 2028 and Option 2, delaying the replacement of the bushings by 5 years, relative to the 'do nothing' base case in present value terms. The gross market benefit has been calculated for each of the three scenarios outlined in Table 4.

Table 5 - Estimated gross market benefit for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1 – Planned replacement of bushings by 2028	120.6	139.5	157.2
Option 2 – Delay replacement of bushings by 5 years	84.7	88.2	89.6

Figure 5 provides a breakdown of benefits. It shows that the benefits are derived from the avoided risk of bushing failure and the reduced time taken to resolve such failures.

Figure 5 - Breakdown of present value gross economic benefits of the preferred option



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7.2. Estimated costs for each credible option

Table 6 summarises the capital costs of the preferred Option 1 and Option 2, relative to the base case, in present value terms for the different scenarios as described in Table 4.

Table 6 - Estimated capital cost for each option, PV $m

Option	Low benefits scenario	Central scenario	High benefits scenario
Option 1 – Planned replacement of bushings by 2028	-9.6	-8.4	-5.9
Option 2 – Delay replacement of bushings by 5 years	-6.6	-5.2	-3.3

7.3. Net present value assessment outcomes

Table 7 summarises the net market benefit for Option 1 and Option 2 across the three scenarios, as well as on a weighted basis. The net market benefit is the gross benefit (as outlined in section 7.1) minus the cost (as outlined in section 7.2), all expressed in present value terms.

The table demonstrates that Option 1 provides a strong expected net economic benefit on a probability-weighted basis in all scenarios.

Table 7 - Estimated net market benefit for each option, NPV $m

Option	Low benefits scenario	Central scenario	High benefits scenario	Weighted
Option 1 – Planned replacement of bushings by 2028	111.0	131.1	157.2	131.1
Option 2 – Delay replacement of bushings by 5 years	78.1	83.0	86.3	82.5

We have been conservative in our approach by not including the additional benefits of this option discussed in section 3.3.

7.4. 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 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 and optimal timing.

Our assessment demonstrates that undertaking the project in the 2024-2028 period has a higher NPV benefit compared to delaying the project to the 2029-2033 period. This timing enables us to manage the risk of transformer bushing failures.

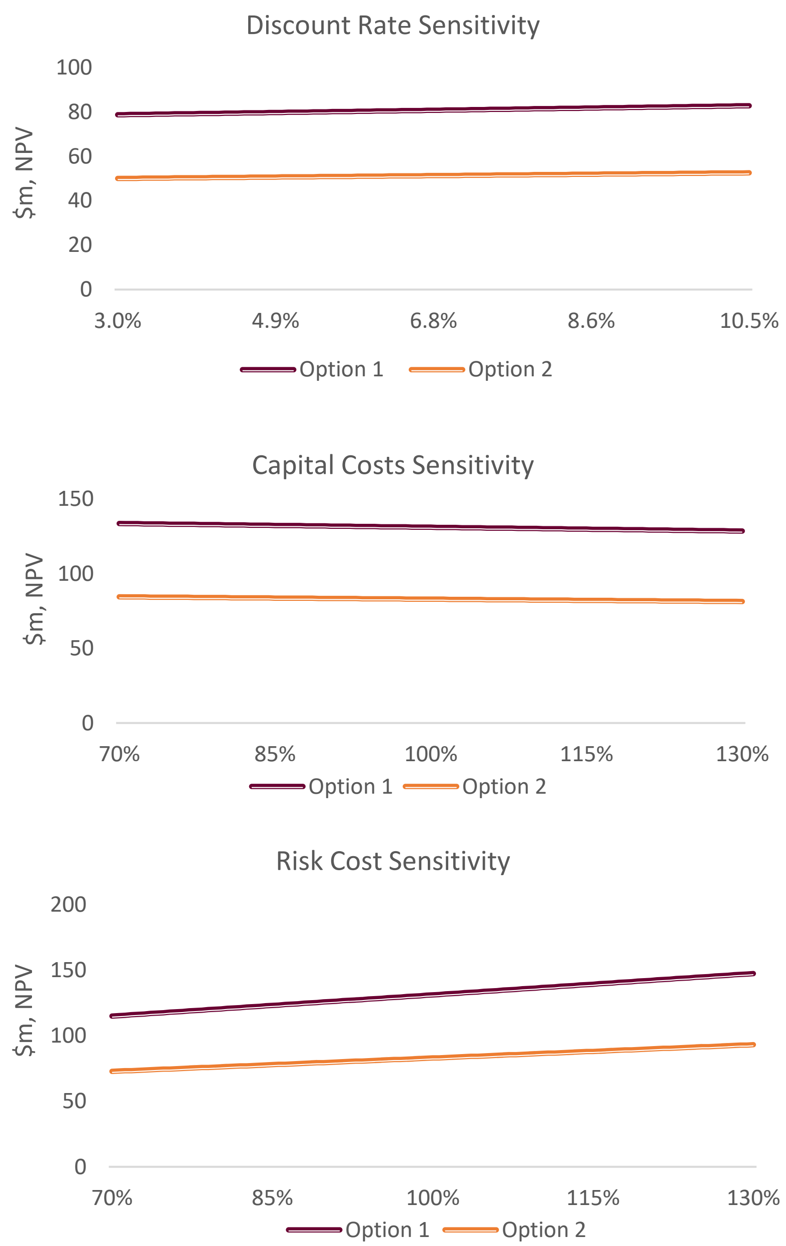
7.4.1. Sensitivity of the overall net market benefit

We have also reviewed the consequences for the preferred option of 'getting it wrong' if the key underlying input assumptions are not accurate.

The charts in Figure 6 illustrate the estimated net market benefits for each option if the three separate key assumptions in the central scenario are varied individually. Importantly, for all sensitivity tests shown below, the estimated net market benefit of Option 1 to replace transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations by 2028 is found to be strongly positive and higher than Option 2 of delaying the project by 5 years across all three key assumptions compared to the 'do nothing' base case option.

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

Figure 6 - Sensitivity testing of the NPV of net market benefits



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8. Draft conclusion and exemption from preparing a Project Assessment Draft Report

The preferred option that has been identified in this assessment for addressing the identified need, as detailed in section 7, is Option 1, i.e. replacing the transformer and reactor bushings on 13 high voltage transformers and two reactors at 12 substations by 2028. This option is described in section 3 and is estimated to have a capital cost of $13.2 million.

Option 1 is the preferred option in accordance with NER clause 5.16.2(c) 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.

NER clause 5.16.4(z1) provides for a TNSP to be exempt from producing a PADR for a RIT-T application, in the following circumstances:

- if the estimated capital cost of the preferred option is less than $46 million;
- if the TNSP identifies in its PSCR its proposed preferred option, together with its reasons for the preferred option and notes that the proposed investment has the benefit of the clause 5.16.4(z1) exemption; and
- if the TNSP considers that the proposed preferred option and any other credible options in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.2(c)(4), except for market benefits arising from changes in voluntary and involuntary load shedding.

We consider that this assessment is exempt from the requirement for a PADR under NER clause 5.16.4(z1) based on meeting each of the criteria above.

In accordance with NER clause 5.16.4(z1)(4), the exemption from producing a PADR will no longer apply if we consider that an additional credible option that could deliver a material market benefit is identified during the consultation period.

Accordingly, if we conclude that any additional credible options are identified, we will produce a PADR which includes an NPV assessment of the net market benefit of each additional credible option.

Should we conclude that no additional credible options were identified during the consultation period, we intend to produce a PACR that addresses all submissions received during the consultation period including any issues in relation to the proposed preferred option.[18]

18 In accordance with NER clause 5.16.4(z2).

City West Substation

Appendices

Appendix A Compliance Checklist

This section sets out a compliance checklist which demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the NER version 210.

NER clause	Summary of requirements	Relevant section(s) in PSCR
5.16.4 (b)	A RIT-T proponent must prepare a report (the project specification consultation report), which must include:	–
	(1) a description of the identified need;	2.2
	(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	2.3
	(3) the technical characteristics of the identified need that a non-network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	4
	(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent Integrated System Plan;	1.1
	(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alternative transmission options, interconnectors, generation, system strength services, demand side management, market network services or other network options;	3
	(6) for each credible option identified in accordance with subparagraph (5), information about: (i) the technical characteristics of the credible option; (ii) whether the credible option is reasonably likely to have a material inter-network impact; (iii) the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.2(b)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefit are not likely to be material; (iv) the estimated construction timetable and commissioning date; and (v) to the extent practicable, the total indicative capital and operating and maintenance costs.	3 & 5

NER clause	Summary of requirements	Relevant section(s) in PSCR
5.16.4(z1)	A RIT-T proponent is exempt from paragraphs (j) to (s) if: (1) the estimated capital cost of the proposed preferred option is less than $46 million (as varied in accordance with a cost threshold determination); (2) the relevant Network Service Provider has identified in its project specification consultation report: (i) its proposed preferred option; (ii) its reasons for the proposed preferred option; and (iii) that its RIT-T project has the benefit of this exemption; (3) the RIT-T proponent considers, in accordance with clause 5.15A.2(b)(6), that the proposed preferred option and any other credible option in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.15A.2(b)(4) except those classes specified in clauses 5.15A.2(b)(4)(ii) and (iii), and has stated this in its project specification consultation report; and (4) the RIT-T proponent forms the view that no submissions were received on the project specification consultation report which identified additional credible options that could deliver a material market benefit.	8

Appendix B Definitions

This appendix defines the terms used in the economic assessment.

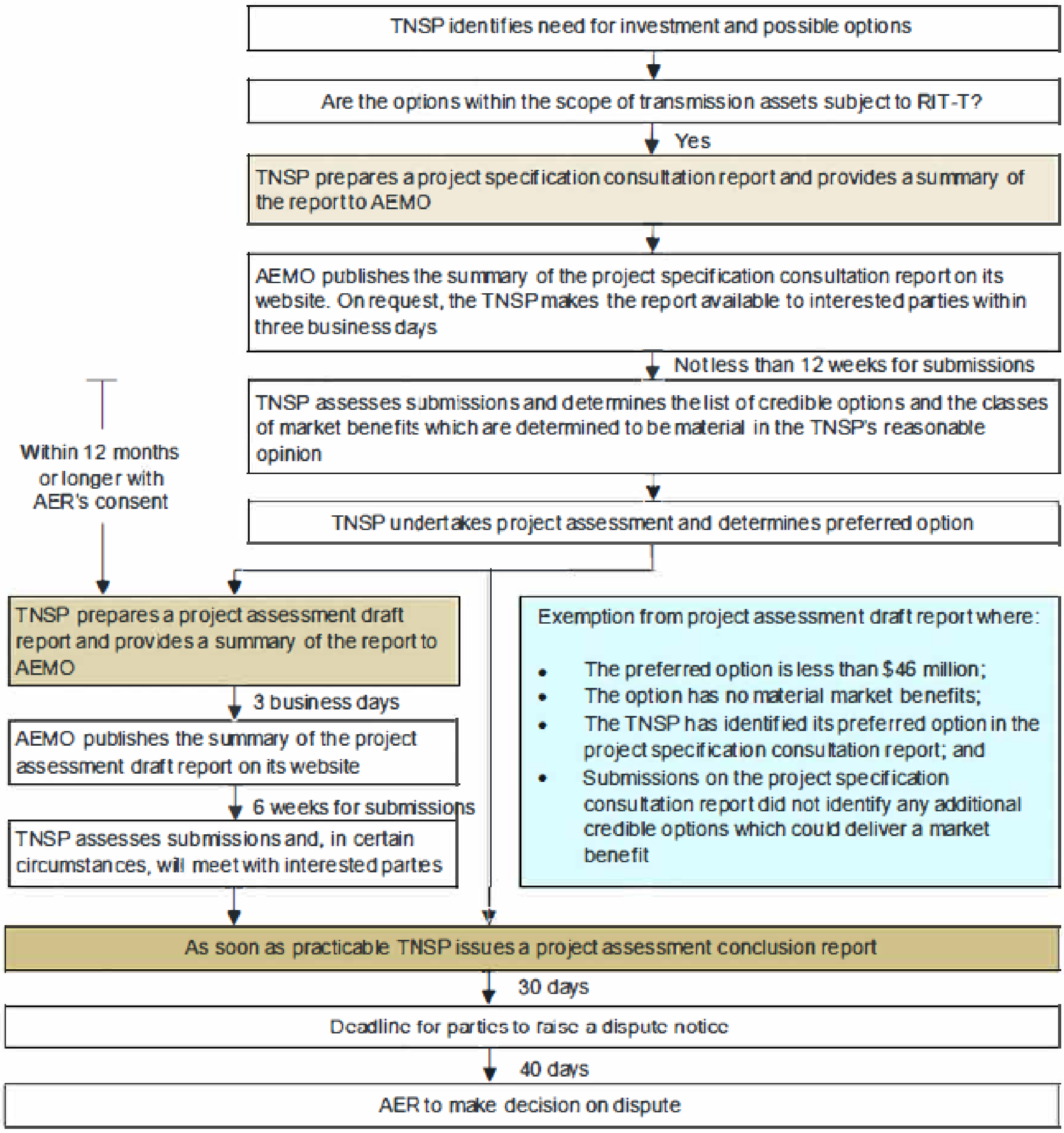
Definitions	
AEMO	Australian Energy Market Operator
Base case	A situation in which no option is implemented by, or on behalf of the transmission network service provider.
Commercially feasible	An option is commercially feasible if a reasonable and objective operator, acting rationally in accordance with 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: address the identified need; is (or are) commercially and technically feasible; and 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 NER 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.

Definitions	
Market benefit	Market benefit must be: the present value of the benefits of a credible option calculated by: comparing, for each relevant reasonable scenario: the state of the world with the credible option in place to the state of the world in the base case, And weighting the benefits derived in sub-paragraph (i) by the probability of each relevant reasonable scenario occurring. 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.
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 C 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 7 - The RIT-T assessment and consultation process



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