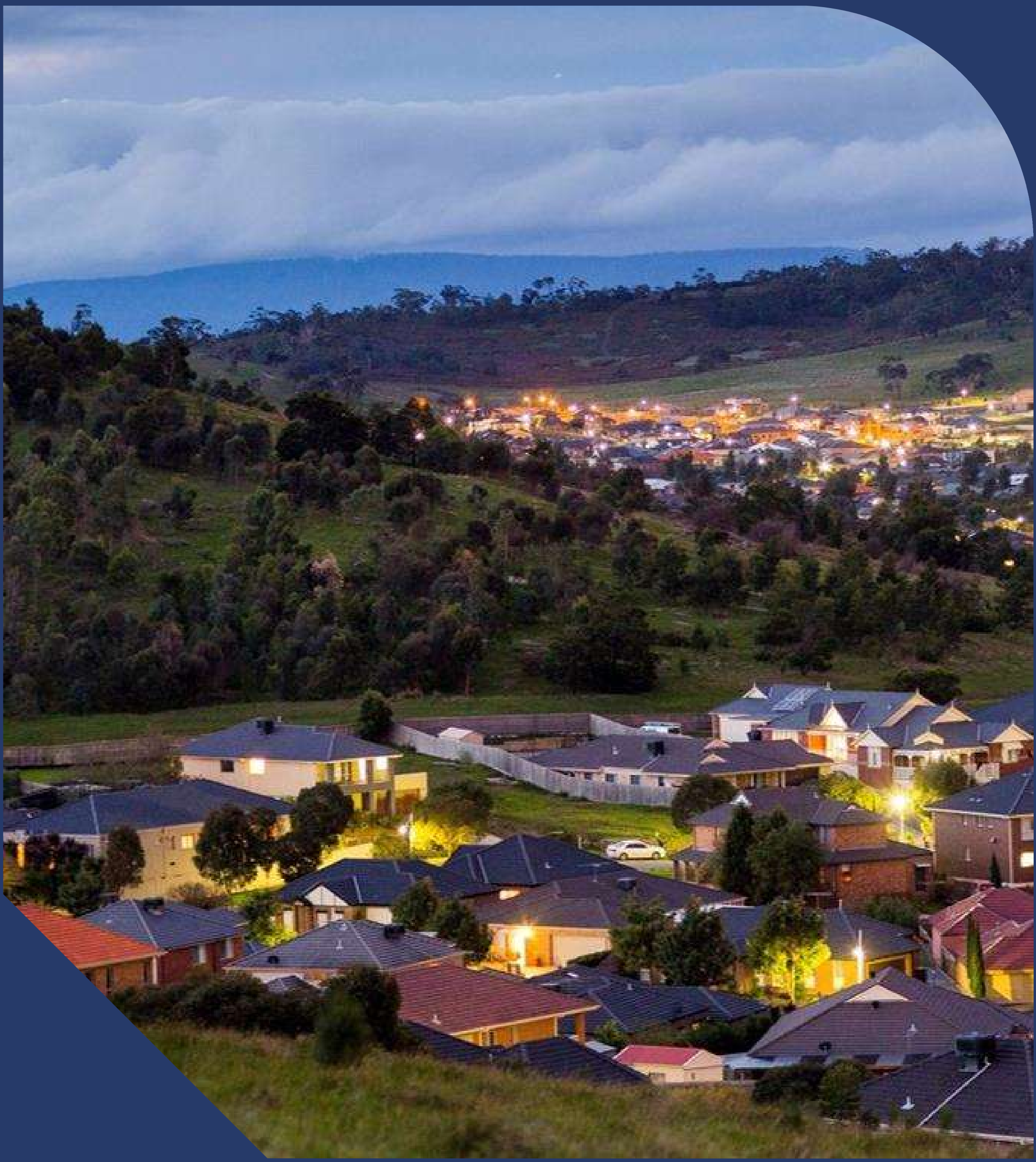
Transmission Line Insulator Replacement Program

Regulatory Investment Test for Transmission

Project Assessment Draft Report

Tuesday, 19 September 2023



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1. Executive summary

AusNet owns and operates the electricity transmission network in Victoria, which transports electricity from large coal, gas and renewable generators across Victoria and interstate, to terminal stations that supply large customers and the distribution networks.

The Regulatory Investment Test for transmission (RIT-T) is an economic cost-benefit test used to assess and rank potential investments capable of meeting an 'identified need'. 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 National Electricity Market (the preferred option).

This Project Assessment Draft Report (PADR) follows the publication of the Project Specification Consultation Report (PSCR), which is the first step in the RIT-T process. As explained in the PSCR, this project is concerned with our insulator replacement program. These assets are essential in ensuring the safe and efficient operation of the network by connecting conductors to towers, while electrically isolating the line from the ground.

Approximately 89,000 insulator strings are in service on the transmission network. Most insulator strings comprise several linked discs made from either porcelain or glass with steel pins to form a continuous string. Over time the condition of these assets deteriorates due to the environmental conditions that cause corrosion and mechanical loading.

The condition of transmission line insulators is assessed during regular tower inspections. Insulators are assigned a condition grade from a scale between C1 (best) to C5 (worst) against two different grading parameters, fitting wear and pin corrosion. The worst condition from both parameters is then used as the overall condition grade for each insulator string. A total of 2,289 insulator strings or 2.6% of the total insulator fleet currently belong to C4 condition which exhibits light rust, or <10% wear. While 291 insulator strings, or 0.3% of the total transmission insulator fleet exhibit levels of fitting wear or pin corrosion that are classified as C5 condition.

Depending on their location, corroded insulators present a range of safety risks and may also impact the reliability of the transmission network. Our insulator replacement program is focused on replacing insulators in a timely and efficient manner having regard to risks such as line outages, third party damage for easements located in built-up areas, health and safety risks for motorists and members of the public, as well as potential fire starts which may result in bushfires.

In addition to the need for remedial action to mitigate these risks and consequences, AusNet must also ensure that it complies with its regulatory obligations, which include the Electricity Safety Act 1998. This Act requires AusNet to minimise hazards and risks to the safety of any person as far as reasonably practicable. The identified need, therefore, is to continue to address the risk of insulator failure through a condition-based replacement program.

As explained in the PSCR, we developed two options for this program.

- Option 1 would replace 773 disc insulators from 107 tower circuits, which have the highest risk of failure. In addition to replacing the insulators, approximately 3,000 vibration dampers would be installed on the phase conductors to ensure that strand breakage due to aeolian vibration is avoided. The capital expenditure for this option was estimated to be $7.48 million (nominal). The PSCR explained that this replacement program would constitute Phase One, and noted that Phase Two had not yet been fully scoped or costed.
- Option 2 would have a smaller scope than Option 1, as it would only provide for the replacement of insulators that are in the worst condition, being C5. As such, the replacement of any C4 insulators would be deferred. The estimated capital cost of this option would be approximately $5.8 million (nominal) compared to $7.48 million (nominal) for Option 1. As noted for Option 1, the PSCR explained that this option would also be followed by a second phase, which had not yet been fully scoped or costed.

The PSCR indicated that Option 1 would be the preferred option, as deferring C4 replacements would present an unacceptable risk for our customers and the broader community. We did not receive any submissions to the PSCR.

In accordance with the Rules and the AER RIT-T guidelines, the purpose of this PADR is to set out the detailed cost-benefit analysis to assess the credible options for addressing the identified need. This analysis confirms the provisional findings in our PSCR that Option 1 is strongly preferred to Option 2. At this stage, Phase Two of Option 1 has not yet been scoped or costed.

In summary, the preferred option is to

- Replace to 773 insulator strings from 107 transmission tower-circuits in the transmission network, including the installation of approximately 3,000 vibration dampers on the phase conductors.
- Of the 733 insulators, 341 insulators are classified as being in Condition 5 and 432 insulator strings are classified as being in Condition 4.

This option addresses the identified need and provides an efficient, targeted replacement. At this stage, we propose to commence the works in November 2023 for completion in December 2024. The analysis presented in this PADR complies with the AER's RIT-T guidelines. A compliance checklist is provided in section 6.

Stakeholder submissions, feedback or questions are invited by 3 November 2023 to rittconsultations@ausnetservices.com.au or please contact to Francis Lirios on (03) 9695 6000.

2. Background

Overhead bare conductors are insulated by the surrounding air, with the insulator strings preventing the conduction of electrical current to the steel structure that supports the transmission wire. Insulators are required at points where they are supported by poles or transmission towers. They are also required where the wire enters buildings or electrical assets such as transformers or circuit breakers.

Approximately 89,000 insulator strings are in service on the transmission network. Most insulator strings comprise several linked discs made from either porcelain or glass with steel pins to form a continuous string. Over time the condition of these assets deteriorates due to the environmental conditions that cause corrosion and mechanical loading.

There are a growing number of polymeric insulators in operation which consist of composite polymer material that has a fibreglass core with a sheath made from silicone rubber or ethylene propylene diene monomer (EPDM). AusNet has undertaken a large program of targeted insulator replacements which began in 2006. This program responded to increasing trends in disc insulator functional failures. Since then, approximately 25,000 porcelain insulator strings comprising 29% of the total insulator fleet have been replaced with polymeric insulators.

Since 2017, there have been two failures involving polymeric insulators on the No. 2 500kV line from Heywood Terminal Station to Alcoa, Portland Smelter. Both polymeric strings were from the same manufacturer (Sediver), all of which have now been removed from service from that circuit.

Insulators are currently assessed by visual inspection during condition assessment, and line and easement inspections undertaken either from the ground or a helicopter. Thermal cameras which are primarily used to inspect phase conductors and joints can be used on an ad hoc basis to assess polymeric insulators to identify any 'hot spots' caused in internal arcing.

AusNet must ensure that it complies with its regulatory obligations, which include the Electricity Safety Act 1998. This Act requires AusNet to minimise hazards and risks to the safety of any person as far as reasonably practicable.

AusNet has developed risk-based models to assist with the application of formal risk assessments as required by the Electricity Safety (Management) Regulations 2019. Implementation of this selective replacement strategy, addressing both failure frequency and consequences, is necessary to maintain public safety and assist in meeting the safety objectives set out in AusNet's MissionZero strategy.

This PADR relates to the first phase of our insulator replacement program. The second phase will be subject to a separate scoping exercise informed by the lessons learnt in the first phase.

3. Identified need

3.1. Description

Insulators are assigned a condition grade from a scale between C1 (best) to C5 (worst) against two different grading parameters, fitting wear and pin corrosion. The worst condition from both parameters is then used as the overall condition grade for each insulator string. The current condition assessment comprises:

- 2,289 insulator strings or 2.6% of the total insulator fleet being C4 condition; and
- 291 insulator strings, or 0.3% of the total transmission insulator fleet being C5 condition.

In 2006, AusNet introduced an insulator replacement program after several insulator failures resulted in conductor drop events. Successive replacement programs have continued to target the worst condition insulators in the fleet with the highest consequence of failure. The identified need, therefore, is to continue to address the risk of insulator failure through a condition-based replacement program.

3.2. Assumptions

In assessing the identified need, AusNet must consider the risk of asset failure and the likelihood of potential adverse consequences eventuating. Insulator failures could lead to four types of adverse consequences:

- Health and safety;
- Financial risk costs;
- Bushfire ignition; and
- Involuntary load shedding and market impact.

The assumptions underpinning each of these consequences of insulator failure are discussed briefly below.

3.2.1. Health and safety risks

The Electricity Safety Act 1998 requires AusNet to design, construct, operate, maintain, and decommission its network to minimise hazards and risks to the safety of any person as far as reasonably practicable or until the costs become disproportionate to the benefits from managing those risks. By implementing this principle for assessing safety risks from asset failures, AusNet uses:

- a value of statistical life to estimate the benefits of reducing the risk of death;[1]
- a value of lost time injury;[2] and
- a disproportionality factor.[3]

AusNet's approach to assessing the risk and consequence of asset failure, including the use of a disproportionality factor, is consistent with the guidance provided by the AER.[4]

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1 Department of the Prime Minister and Cabinet, Australian Government, "Best Practice Regulation Guidance Note: Value of statistical life," available at https://www.pmc.gov.au/resource-centre/regulation/best-practice-regulation-guidance-note-value-statistical-life.

2 Safe Work Australia, "The Cost of Work-related Injury and Illness for Australian Employers, Workers and the Community: 2012-13," available at https://www.safeworkaustralia.gov.au/system/files/documents/1702/cost-of-work-related-injury-and-disease-2012-13.docx.pdf.

3 Health and Safety Executive's submission to the1987 Sizewell B Inquiry suggesting that a factor of up to 3 (i.e. costs three times larger than benefits) would apply for risks to workers; for low risks to members of the public a factor of 2, for high risks a factor of 10. The Sizewell B Inquiry was a public inquiry conducted between January 1983 and March 1985 into a proposal to construct a nuclear power station in the UK.

4 Australian Energy Regulator, "Industry practice application note for asset replacement planning," available at https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/industry-practice-application-note-for-asset-replacement-planning.

3.2.2. Financial risk costs

In the event of an insulator failure, costs will be incurred in replacing the failed assets (and any consequential damage to other assets). The risk of this financial impact may vary for different credible options and, therefore, should be factored into the cost-benefit assessment.

3.2.3. Bushfire ignition

Faults on transmission line assets can result in discharges of energy which are capable of igniting ground fires. Some transmission lines are situated in easements through high density fuel loads in grasslands and forests. In extreme weather conditions ground fires started close to such fuel loads can quickly develop into widespread bushfires.

Bushfire loss consequence modelling performed by Dr. Kevin Tolhurst of Melbourne University has enabled the establishment of quantitative bushfire consequence values for transmission line assets. AusNet has regard to this analysis in assessing the potential consequences from bushfire ignition.

In 2007, a small grass fire was ignited following electrical failure of a porcelain insulator on the ROTS-SVTS No.2 line. A combination of pollution and morning fog on the insulator discs caused a flashover. The flashover caused a small amount of molten metal to fall to the ground resulting in a small grass fire. Moisture on the grass caused the fire to self-extinguish.

The first incident involving a polymeric insulator occurred in 2017 when a Sediver insulator along the HYTS-APD No. 2 500 kV line failed. A defect in the crimping process of the end-seals onto the fibre glass rod caused moisture ingress into the rod causing internal arcing until it failed which resulted in the phase conductor dropping across an arterial road. The conductor contacted a steel fence which caused a small grass fire. The fire was extinguished by the property owner.

In light of these historical events and the known risks, AusNet regards a proactive asset inspection and replacement program as essential in continuing to minimise bushfire risk in accordance with our regulatory obligations and community expectations.

3.2.4. Involuntary load shedding and market impact

The electricity transmission lines forming the National Electricity Market (NEM) have high levels of redundancy under average loading conditions. However, at peak loading periods, transmission line failures can constrain generator connections causing a re-scheduling of generators. Market modelling would be required to estimate the expected adverse impact on dispatch costs following an insulator failure.

In addition to higher dispatch costs, it is conceivable that an insulator failure could lead to involuntary load shedding. The expected cost of unserved energy is the probability of an event occurring multiplied by the cost of the expected unserved energy that would result from that event, where the expected unserved energy is costed in accordance with the AER's estimated Value of Customer Reliability (VCR).

In relation to this project, the selection of the preferred option can be determined without undertaking the market modelling required to calculate the costs associated with involuntary load shedding and the market impact of increased dispatch costs. This is because the safety consequences associated with insulator failures are sufficiently large to justify either Option 1 or 2 in preference to the 'Do Nothing/BAU' option. Furthermore, as detailed in section 5 of this PADR, the additional safety risks associated with Option 2 mean that Option 1 is strongly preferred, without having to consider the additional benefits of reducing involuntary load shedding and the costs associated with sub-optimal dispatch.

4. Potential Credible Options

This section describes the credible options that have been considered to address the identified need, including:

- the technical characteristics of each option;
- the estimated construction timetable and commissioning date; and
- the total indicative capital and operating and maintenance costs.

The purpose of the RIT-T is to identify the credible option for addressing an identified need that maximises the net market benefit. An important aspect of this task is to consider non-network and network options on an equal footing, so that the optimal solution can be identified.

As the identified need in this case arises from the condition of insulators, there are no credible non-network options that could address the identified need. In effect, the nature of the risks is asset-related and cannot be mitigated by a non-network option given the significant costs of retiring the assets.

The credible options are:

- Option 1: Planned replacement of C5 and C4 insulators; and
- Option 2: Planned replacement of C5 insulators only.

Our cost-benefit assessment assesses the costs of each credible option compared to the costs of a base case 'Business as Usual' (BAU) option, where insulators are replaced on failure. It should be noted, however, that the BAU option is not regarded as a credible option as it would expose our customers, staff and contractors to unacceptable risks. The BAU option, however, provides a reference point for assessing the net benefits provided by Options 1 and 2.

Neither credible option is expected to have an inter-regional impact. Each credible option is discussed in further detail below.

4.1. Option 0: Do Nothing/BAU

The Do Nothing/BAU option assumes that AusNet would not undertake any investment, outside of the normal operational and maintenance processes. The Do Nothing/BAU option establishes the base level of risk and provides a basis for comparing other credible options.

Whilst the direct capital cost of this option is zero, the continued exposure to residual risks means that this option has significant risk costs associated with it. In relation to this project, 'do nothing' is not a credible option.

4.2. Option 1: Planned replacement of C5 and C4 insulators

This option reduces the risks associated with a potential failure of a deteriorated/corroded insulator resulting in a conductor drop event. The planned replacement of insulators is the most efficient and cost-effective method compared to replacing on failure. Planned replacement allows for the most efficient mobilisation of resources to carry out the replacement, under planned outages to assure the safety of line workers.

The scope of work for this option would include:

- Replace existing disc insulators with composite silicone rubber insulators, excepting the bridging string insulators for strain towers which shall be replaced with disc insulator.
- The replacement of all hardware, fittings, and if necessary, add vibration dampers.
- The data of the new insulators, i.e., manufacturer, type and quantity per tower-circuit shall be updated in AusNet's Asset Management System, SAP.
- Desktop assessment of the insulator fleet to identify the cohort that will be tested for the insulators' performance and remaining service life.

- Testing of the target porcelain disc insulators will be performed to ascertain the strings' remaining life. Samples will be collected from target tower circuits and sent to a specific test facility for testing.

Phase One of this option would replace 773 insulators from 107 tower circuits, which have the highest risk of failure. In addition to replacing the insulators, approximately 3,000 vibration dampers would be installed on the phase conductors to avoid strand breakage due to aeolian vibration. Phase Two of this option has not yet been fully scoped or costed.

The capital expenditure for this option is $7.48 million (nominal), with planned construction commencing in November 2023 and concluding in December 2024. In relation to operating expenditure, we note that it would avoid the operating expenditure increases that would arise in the do nothing/BAU option. However, when compared to our actual historical operating expenditure, we would not expect this option to have a material impact on our operating expenditure.

4.3. Option 2: Planned replacement of C5 insulators only

Under this option, the replacement volume would be reduced compared to Option 1 because only those insulators that are in the worst condition, being C5, would be replaced. As a result, the estimated capital expenditure associated with this option would be lower than Option 1, being approximately $5.8 million (nominal) compared to $7.48 million (nominal).

As noted in relation to Option 1, this option would also have a second phase which has not been fully costed. Evidently, this option has increased risks associated with the lower replacement volume. Therefore, the cost-benefit analysis, which is presented in the next two chapters of this PADR, examines the trade-off between the lower direct costs associated with this option compared to the increased indirect costs associated with increased risk.

The construction timeframes for this option would be similar to Option 1 and, for the purpose of this PADR, has been assumed to be the same.

5. Economic assessment of the credible options

5.1. Market benefit

Clause 5.16.4 (b)(6)(iii) of the NER requires the RIT-T proponent to consider whether each credible option provides the classes of market benefits described in clause 5.15A.2(b)(4). To address this requirement, the table below discusses our approach to each of the market benefits listed in that clause for both credible options.

Table 1: Analysis of Market Benefits

Class of Market Benefit	Analysis
(i) changes in fuel consumption arising through different patterns of generation dispatch;	The credible options may affect the costs of dispatch by avoiding network constraints as a result of an asset failure compared to the BAU option. As explained in section 3.2.4, for this project this benefit will not affect the selection of the preferred option and, therefore, is not considered further.
(ii) changes in voluntary load curtailment;	The credible options are not expected to lead to changes in voluntary load curtailment.
(iii) changes in involuntary load shedding with the market benefit to be considered using a reasonable forecast of the value of electricity to consumers;	The credible options may reduce involuntary load shedding, by reducing the risk of asset failure. As explained in section 3.2.4, for this project this benefit will not affect the selection of the preferred option and, therefore, is not considered further.
(iv) changes in costs for parties, other than the RIT-T proponent, due to differences in: *(A) the timing of new plant;* *(B) capital costs; and* *(C) the operating and maintenance costs;*	There is not expected to be any difference between the credible options.
(v) differences in the timing of expenditure;	There is not expected to be any difference between the credible options.
(vi) changes in network losses;	The credible options will not result in changes to electrical energy losses.
(vii) changes in ancillary services costs	The credible options will not have any impact on ancillary service costs.
(viii) competition benefits	The credible options will not provide any competition benefits.
(ix) any additional option value (where this value has not already been included in the other classes of market benefits) gained or foregone from implementing the credible option with respect to the likely future investment needs of the National Electricity Market;	There will be no impact on the option value in respect of the likely future investment needs of the NEM.
(x) any other class of market benefit determined to be relevant by the AER.	There are no other classes of market benefit that are relevant to the credible options.

5.2. Methodology

The purpose of this section is to provide a high-level explanation of our methodology for identifying the preferred option. As a general principle, it is important that the methodology takes account of the identified need and the factors that are likely to influence the choice of the preferred option. As such, the methodology is not a 'one size fits all' approach, but one that is tailored to the particular circumstances under consideration.

In general, the identified need for a project can be described in terms of two types of risk:

- supply risk, where an asset failure may lead to a loss of supply to customers; and
- non-supply risk, which captures the potential consequences of an asset failure, which may include safety and bushfire risk, in addition to damage to adjacent assets or property.

In relation to supply risk, we typically adopt a probabilistic planning methodology which considers the likelihood and severity of critical network conditions and outages. The expected annual cost to customers associated with supply risk is calculated by multiplying the expected unserved energy (the expected energy not supplied based on the probability of the supply constraint occurring in a year) by the value of customer reliability (VCR).

In relation to non-supply risks, our approach monetises this risk by multiplying the following parameter estimates:

- the probability of asset failure;
- the cost of consequence of the asset failure;
- the likelihood of the consequence given the failure has occurred; and
- the number of assets to which the analysis relates.

For this project, the cost benefit analysis that underpins the RIT-T assessment assesses whether there is a cost-effective option to mitigate the sum of the non-supply risks (the aggregate 'risk-cost'), which comprises the safety, financial and bushfire risk-cost in this case.

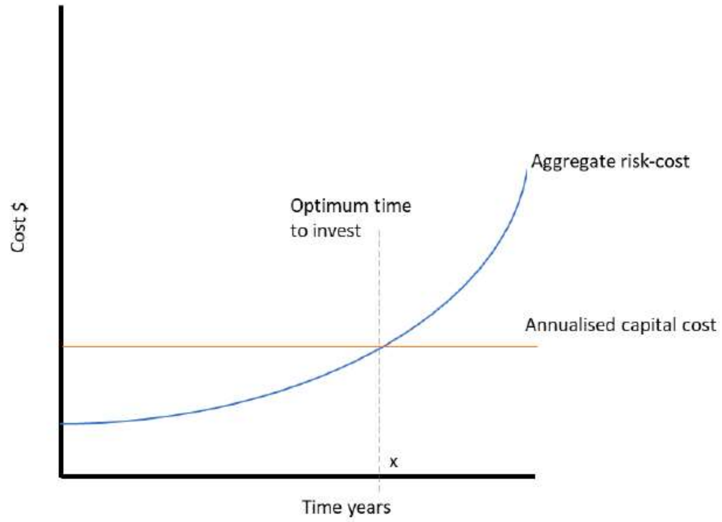

Figure 1: Increasing risk-cost over time and optimal project timing[5]

In the absence of remedial action,

Figure 1 shows how the aggregate risk-cost will typically increase as the risk of asset failure increases over time. The optimal timing of the preferred option occurs when the annualised capital cost of that option (or the operating cost for a non-network option) is equal to the aggregate risk-cost.

The preferred option delivers the lowest total cost to customers, which is the sum of the cost of implementing that option and any residual risk-cost. The identification of the preferred option is complicated by the fact that the future is uncertain and that various input parameters are 'best estimates' rather than known values. Therefore, the RIT-T analysis must be conducted in the face of uncertainty.

To address uncertainty in our assessment of the credible options, we use sensitivity analysis and scenario analysis in our cost benefit assessment. As recommended by the AER's application guidelines, we use sensitivity analysis to assist

5 This figure is reproduced from the AER's Industry practice application note, Asset replacement planning, January 2019, figure 8. This figure assumes that the option eliminates the aggregate risk-cost in full, which may not be the case.

in determining a set of reasonable scenarios.[6] The relationship between sensitivity analysis and scenarios is best explained by the AER's practice note:[7]

> *Scenarios should be constructed to express a reasonable set of internally consistent possible future states of the world. Each scenario enables consideration of the prudent and efficient investment option (or set of options) that deliver the service levels required in that scenario at the most efficient long run service cost consistent with the National Electricity Objective (NEO).*
>
> *Sensitivity analysis enables understanding of which input values (variables) are the most determinant in selecting the preferred option (or set of options). By understanding the sensitivity of the options model to the input values a greater focus can be placed on refining and evidencing the key input values. Generally the more sensitive the model output is to a key input value, the more value there is in refining and evidencing the associated assumptions and choice of value.*
>
> *Scenario and sensitivity analyses should be used to demonstrate that the proposed solution is robust for a reasonable range of futures and for a reasonable range of positive and negative variations in key input assumptions. NSPs should explain the rationale for the selection of the key input assumptions and the variations applied to the analysis.*

In applying sensitivities and scenarios to our cost benefit assessment, we have regard to the different circumstances that may eventuate that would affect the choice of the preferred option. Where our analysis shows that an option is clearly preferred, we will not undertake further testing. This approach is consistent with clause 5.15A.2(b)(2) of the Rules, which states that the RIT–T must not require a level of analysis that is disproportionate to the scale and likely impact of each credible option considered.

In preparing the RIT-T, we have also had regard to AEMO's 2023 Inputs, Assumptions and Scenarios Report (IASR) and its 2022 Integrated System Plan (ISP), being the latest ISP. We note that the scenarios adopted by AEMO in its 2023 IASR are focused particularly on the matters that are relevant to major transmission investments, rather than smaller transmission investments of the type considered in this report. Accordingly, we have adopted an approach that is appropriate to the specific circumstances described in this report relating to the identified need and the credible options.

5.3. Key variables and assumptions

Table 2 below lists the key variables and assumptions applied in the economic assessment, which are essential inputs to our methodology for the purpose of this PADR. The table also sets out the upper and lower bounds of the range of forecasts adopted for each of these variables. The lower bound and upper bound estimates are used to undertake sensitivity testing and scenario analysis. The detailed results of this modelling are provided in section 5.4.

In relation to the discount rate, we have adopted central, upper and lower bound estimates that are consistent with AEMO's IASR in July 2023. We note that discount rates are subject to change, particularly in the current economic climate. As such, the rates employed in this PADR are considered reasonable in exploring the impact of different rates on the cost-benefit assessment of the competing options to address the identified need.

In relation to the 'probability or consequence' of asset failure, the parameter description recognises that different aspects of the risk-cost could be varied to deliver a higher or lower expected cost. For example, an increase in the risk-cost could reflect an increased risk of asset failure or an increase in the consequence of an asset failure, or a combination of the two. The same observation applies to a reduction in the risk-cost, which is also considered in the sensitivity testing.

Table 2: Key variables and assumptions

Variable / assumption	Lower bound	Central estimate	Upper bound
Demand forecasts	This parameter is not relevant to this PADR, as the non-supply risks are not affected by the demand forecasts.		
Cost of involuntary supply interruption	This parameter is not relevant to this PADR for the reasons explained in section 3.2.4.		
Safety cost	Central Estimate	Value of statistical life of $4.5 million[8]	Central estimate
Safety cost Disproportionate Factor	Central estimate	Factor of 3	Central estimate

[6] AER, Application guidelines, Regulatory investment test for transmission, August 2020, page 43.
[7] AER, Asset replacement planning, January 2019, page 36.
[8] Best Practice Regulation Guidance Note Value of statistical life, December 2014, escalated.

Variable / assumption	Lower bound	Central estimate	Upper bound
Option cost	15% reduction in central estimate	In-house cost estimates using detailed and high-level project scopes	15% increase in central estimate
Real pre-tax discount rates	3.0%[9]	7.0%[10]	10.5%[11]
Probability or consequence of asset failure	25% reduction in central estimate	Historical asset performance data, plus forecasts based on condition monitoring and CBRM modelling	25% increase in central estimate

5.4. Cost benefit analysis

The economic analysis allows comparison of the economic cost and benefits of each option to rank the options and to determine the optimal timing of the preferred option. It quantifies the capital costs and the cost of the residual risk for each option, to determine a total cost for each option. The net economic benefit for each credible option is the total cost associated with that option minus the costs of the Do Nothing/BAU option.

We present our analysis as follows:

- Section 5.4.1 presents the NPV analysis using central estimates; and
- Section 5.4.2 presents the sensitivity testing and scenarios analysis.

5.4.1. Net present value analysis

The table below sets out the present value net economic benefit of each credible option.

- Option 1: Planned replacement of C5 and C4 insulators; and
- Option 2: Planned replacement of C5 insulators only.

Table 3: Costs and net economic benefit for each option in present value terms ($M, real 2022)[12]

	Option 0 – Do Nothing/BAU	Option 1 – Planned replacement of C5 and C4 insulators	Option 2 – Planned replacement of C5 insulators only
Capital expenditure	$0m	$6.89m	$5.85m
Operating expenditure	$0m	$0m	$0m
Financial risk-cost	$1.48m	$0.52m	$0.98m
Safety and Bushfire risk costs	$66.13m	$14.28m	$38.33m
Total costs	$67.61m	$21.69m	$45.15m
Net benefit compared to BAU	-	$45.93m	$22.46m

The analysis shows that Options 1 and 2 deliver significant net benefits compared to the BAU option. The primary difference between Options 1 and 2 is that the latter has lower capital expenditure, but much higher risk-related costs which more than offsets these savings. As a consequence, Option 1 is expected to provide a substantially higher net benefit than Option 2, being $45.93 million compared to $22.46 million in present value terms.

9 AEMO, Inputs, Assumptions and Scenario Report 2023, July 2023, page 123.
10 Ibid.
11 Ibid.
12 Totals may not add due to rounding.

5.4.2. Sensitivity analysis and scenario testing

The table below shows the net economic benefit for each credible option applying sensitivity analysis.

Table 4: Net economic benefit for each option in present value terms ($M, real 2022)[13]

	Central Case	High failure risk or consequence	Low failure risk or consequence	High option cost	Low option cost	High discount rate	Low discount rate
Option 1	45.93	46.96	58.89	44.89	46.96	30.20	54.32
Option 2	22.46	22.60	29.42	21.59	22.60	12.82	27.94

Source: AusNet

The sensitivity analysis shows that Option 1 is preferred to Option 2 for each sensitivity. The magnitude of the net benefit is also material, especially compared to the project costs. This analysis provides very strong evidence to support Option 1 being the preferred option.

For completeness, we have also conducted scenario analysis to further test this proposition. The current IASR scenarios – which relate principally to changes in the wholesale generation market – are not relevant to this investment decision. Specifically, the IASR scenarios – progressive change, step change and green energy exports – are expressed in terms of their respective contributions to Australia's possible decarbonisation future, as depicted in the figure below. While critical to ISP projects, these dimensions have no practical bearing on the asset replacement decision that is being considered in this RIT-T.

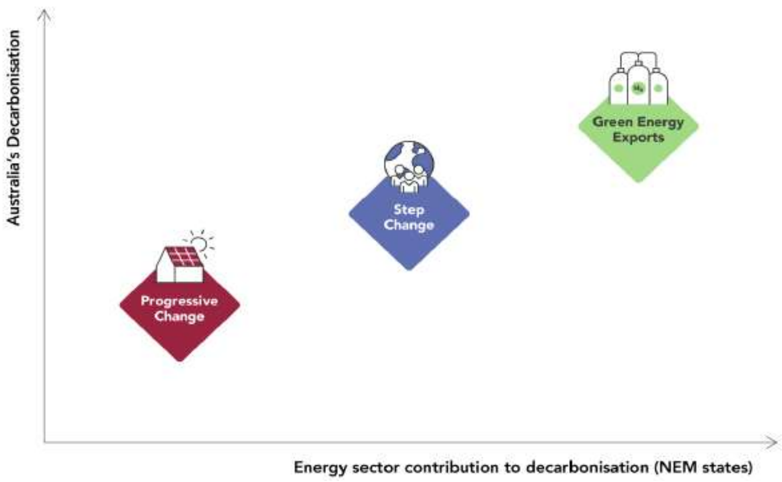

Figure 2: AEMO's scenarios for its 2023 IASR[14]

In our view, the scenarios developed below comply with the requirements of the RIT-T application guidelines, noting that they describe different sets of states of the world that are relevant to the investment decision that is being addressed in this PADR. In reaching this conclusion and in establishing the scenarios for this PADR, we note that the AER's RIT-T Application Guidelines explains:[15]

> Under the RIT–T instrument, the number and choice of reasonable scenarios must be appropriate to the credible options under consideration. Specifically, the choice of reasonable scenarios must reflect any variables or parameters that are likely to affect:
>
> – the ranking of the credible options, where the identified need is for reliability corrective action, inertia network services or system strength services. In these cases, only the ranking (as opposed to the sign) of credible options' net economic benefits is important; and
>
> – the ranking or sign of the net economic benefit of any credible option where the identified need is not for reliability corrective action, inertia network services or system strength services. In these cases, the preferred option must have a positive net economic benefit.
>
> The appropriate number and choice of reasonable scenarios could vary depending on the credible options under consideration. This recognises that NER clause 5.15A.2(b)(2) requires RIT–T proponents to apply the RIT–T to a level of analysis that is proportionate to the scale and likely impact of each credible option.

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13 Totals may not add due to rounding.
14 AEMO, Inputs, Assumptions and Scenario Report 2023, July 2023, page 4.
15 Australian Energy Regulator, Application guidelines – Regulatory investment test for transmission, August 2020, page 41.

Table 5 below defines the scenarios that we have adopted for the purpose of this PADR.

Table 5: Definition of reasonable scenarios

Scenario	Failure risk or consequence	Option Cost	Discount rate
Central Case	Central estimate	Central estimate	Central estimate
Climate concern	Upper bound	Central estimate	Central estimate
Weak economic growth	Central estimate	Lower bound	Lower bound
High delivery costs	Central estimate	Upper bound	Upper bound

Table 6 below provides a brief description of each scenario.

Table 6: Guide to scenarios

Scenario	Description
Central Case	This scenario adopts the central estimate for each variable in the economic assessment. It represents the most likely outcome.
Climate concern	This scenario represents an upward reappraisal of bushfire risk, as a result of climate change. It adopts a high failure consequence, with all other parameters central.
Weak economic growth	This scenario reflects weak economic growth, following a sustained period of higher interest rates compared to those during and immediately prior to the Covid-19 pandemic. It has lower costs of delivering the option and a lower discount rate.
High delivery costs	This scenario represents an economic rebound and continuing supply side issues. It is characterised by higher costs of delivering the option and an upper bound discount rate.

The table below shows the sensitivity of the NPV to variations in market conditions. Scenarios may incorporate variations in multiple input factors to the NPV.

Table 7: Net benefit for each scenario in present value terms ($M, real 2022)

	Central case	Climate concern	Weak economic growth	High delivery costs
Option 1	44.89	58.89	55.38	29.23
Option 2	21.59	29.42	28.09	12.11

Source: AusNet

The scenario analysis confirms the findings from our sensitivity analysis, which is that Option 1 is strongly preferred for each scenario.

5.5. Preferred option

Our preferred option (Option 1) is to:

- Replace to 773 insulator strings from 107 transmission tower-circuits in the transmission network, including the installation of approximately 3,000 vibration dampers on the phase conductors.
- Of the 733 insulators, 341 insulators are classified as being in Condition 5 (worse condition) and 432 insulator strings are classified as being in Condition 4.

The construction would commence in November 2023, with project completion expected by December 2024. The estimated capital cost of this option is $7.8 million (nominal).

In accordance with the RIT-T, this option is expected to maximise the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM.

5.6. Capital and operating costs of the preferred option

The direct capital expenditure of the preferred option (Option 1) is $7.8 million ($, nominal). The principal capital expenditure elements, expressed in nominal terms, are:

- Design and internal labour, $0.99 million;
- Materials, $0.77 million;
- Plant and equipment, $1.12 million;
- Contracts, $3.58 million; and
- Other, $0.99 million.

It is assumed that the future operating expenditure relating to the replaced insulator assets will be negligible.

6. Satisfaction of the RIT-T

In accordance with clause 5.17.4(j)(11)(iv) of the Rules, we certify that the proposed option satisfies the regulatory investment test for transmission. The table below shows how each of these requirements have been met by the relevant section of this report.

Table 8: Compliance with regulatory requirements

Requirement			Section
5.16.4(v) The project assessment draft report must set out the matters detailed in the project assessment draft report as required under paragraph (k) (below).			Noted. See details below.
(1)	a description of each credible option assessed;		Section 4.
(2)	a summary of, and commentary on, the submissions to the project specification consultation report		No submissions were received.
(3)	a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;		Section 4
(4)	a detailed description of the methodologies used in quantifying each class of material market benefit and cost;		Sections 5.1 and 5.2
(5)	reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;		Section 5.1
(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);		Not applicable
(7)	the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results);		Section 5.4.
(8)	the identification of the proposed preferred option;		Section 5.5
(9)	For the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide:		
	(i)	details of the technical characteristics;	Section 4.2 and Appendix
	(ii)	the estimated construction timetable and commissioning date;	Section 4.2
	(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	Not applicable
	(iv)	a statement and the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission	Section 5.5

Appendix – Technical characteristics

Project description

AMS 10-75: Transmission Line Insulators identifies that there are 773 insulator strings which are in Risk Level A, i.e. the highest risk. These insulators can be broken down into 341 insulators in Condition 5 (worse condition) which are in Criticality 1 to Criticality 5; and 432 insulator strings in Condition 4 which are in Criticality 4 to Criticality 5.

This project will replace transmission insulators from 107 tower-circuits belonging to various voltage ratings in the transmission network, composed of all Condition 5 strings plus insulators in Condition 4 which are in Criticality 5 (i.e., Criticality 4 strings will be replaced at a different time via a different project).

These insulators are located in critical circuits (i.e., interconnectors with New South Wales and South Australia), road crossings, and built-up areas where a failure exposes the business to unacceptable risks associated with an outage, a conductor drop event, injury to the public and a fire start.

Included in the replacement of the insulators, approximately 3,000 vibration dampers will be installed on the phase conductors to assure strand breakage is avoided due to aeolian vibration.

As part of this project, the oldest disc insulator strings installed in the network will be tested for inherent deterioration associated with aged cement grout inside the discs, such as dye penetration and loss of insulation. During line fault events, these defects can lead to catastrophic failure causing separation of the discs.

Key risks and constraints

Replacing insulators which have the highest risk in the transmission network will alleviate risks such as line outages, third party damage for easements located in built-up areas, health and safety risks for motorists and members of the public, as well as potential fire starts which may result into a bushfire.

Availability of line outages will be a constraint to the project, as AEMO may cancel scheduled outages in short notice depending on the market conditions, including availability & capacity of generators.

Another risk to the project is availability of linecrews with appropriate skill set to undertake live-line replacement on suspension towers. The use of live-line techniques will avoid the outage constraints however, the availability of this skill set is limited within the Victorian contractors.

The full set of risks and mitigation measures are included in AusNet's business case for this project.

Scope inclusions

The scope includes the following:

- Replace existing disc insulators with composite silicone rubber insulators, excepting the bridging string insulators for strain towers which shall be replaced with disc insulator.
- Include the replacement of all hardware, fittings, and if necessary, add vibration dampers.
- The data of the new insulators, i.e., manufacturer, type and quantity per tower-circuit will be updated in SAP.
- Included in this project is the desktop assessment of the insulator fleet – to identify the cohort which will be tested for the insulators' performance and remaining service life. This task will be undertaken by Asset Engineering.
- Testing of the porcelain disc insulators will be performed to ascertain that the strings have reached their end-of-life. Samples will be collected from target tower-circuits and sent to a specific manufacturer for testing.

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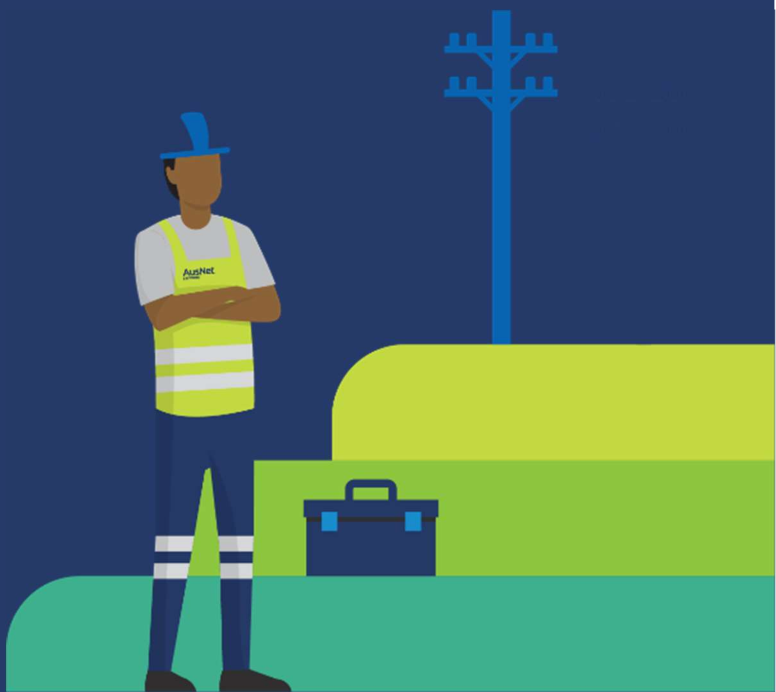

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