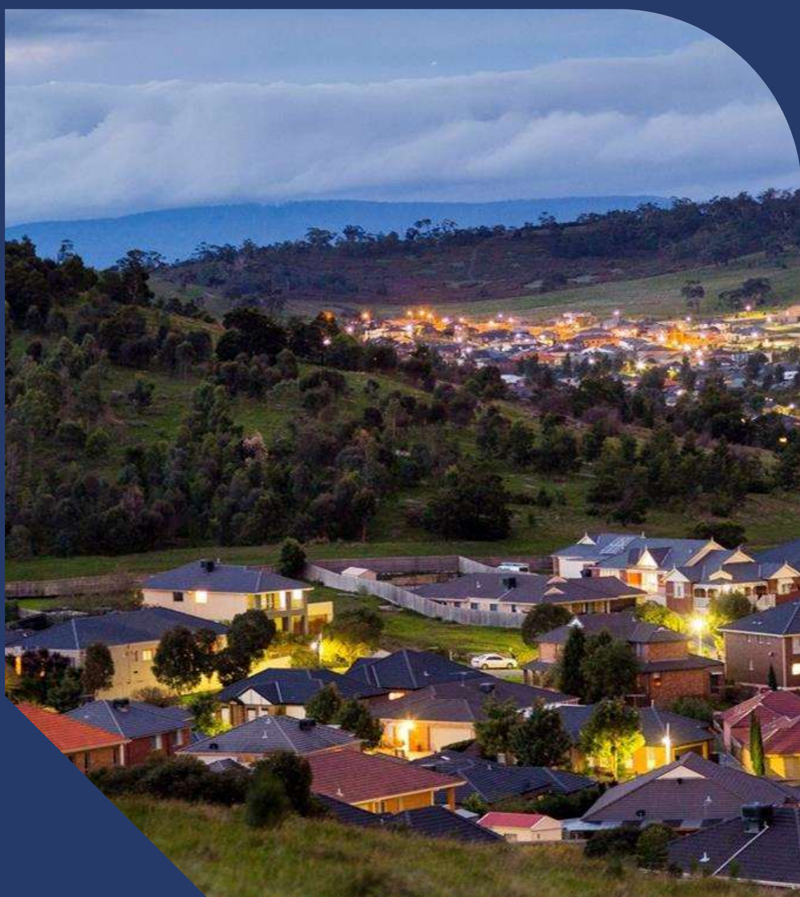
AusNet

Conductor & Ground Wire Replacement

Regulatory Investment Test for Transmission

Draft Project Assessment Report

Monday, 17 April 2023



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AusNet

1. Executive summary

AusNet Services 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 the 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 the replacement of phase conductors and ground wire (GW) assets. The primary function of phase conductors is to safely and efficiently transmit electrical energy between terminal stations. GW assets have two primary functions:

- Shielding phase conductors from lightning strikes; and
- Reducing voltage rise at structures by providing multiple paths for fault currents.

Where optical fibre ground wire (OPGW) is used, it also has the additional functionality of providing communication links between terminal stations.

Phase conductor and GW functional failures can present health and safety risks to members of the public, AusNet Services' employees and contractors accessing the transmission line easements. In addition to the need for remedial action to mitigate these risks and consequences, AusNet Services must also ensure that it complies with its regulatory obligations, which include the Electricity Safety Act 1998. This Act requires AusNet Services to minimise hazards and risks to the safety of any person as far as reasonably practicable. In summary, there is an 'identified need' for remedial action to mitigate the risks associated with the phase conductors and GW assets.

Based on a comprehensive risk assessment which considers conductor health score (wear out due to age, environmental conditions and mechanical loading) as a proxy for probability of failure, and consequence of failure (collateral damage, safety, market impact and bushfire ignition) 326 km of GW and 35 km of phase conductor have been identified for replacement.

As explained in the PSCR, we developed two options for this project which both involved two phases. At the time of publishing the PSCR, we highlighted two options for the project which we assessed against the 'Business as Usual (BAU)' option, which would involve replacing phase conductor and GW assets on failure. Each of the two option involved two phases, with the first phase involving replacement of 233 km of GW route length and the second phase replacing the remaining 93 km and 35 km of phase conductor, which would be subject to a later costing exercise for each option.

The PSCR concluded the preferred option would involve the replacement of selected existing steel GW with OPGW where a communication link upgrade is required. We explained that the current radio network does not have sufficient bandwidth to handle SCADA. By taking the opportunity to replace steel GW with OPGW, this option would improve the reliability of the data communications network and provide improved bandwidth for SCADA. This option was preferred to replacements on a like-for-like basis. We did not receive any submissions on the PSCR.

In this PADR, the cost-benefit analysis of the alternative options includes both phases of the project. The analysis confirms the provisional findings in our PSCR that the replacement of selected existing steel GW with OPGW is preferable to the like-for-like replacement of GW. In relation to Phase Two of the project, however, we have concluded that it is more cost effective to repair the 35 km of phase conductor, rather than replace it. This is because an overnight outage is not available, which makes the costs of replacing the phase conductor prohibitively expensive. To address this issue, we have modified the options described in the PSCR to recognise that repair of the conductors is the only credible option from a cost perspective.

In summary, the preferred option is to

- Replace 326km of GW and repair 35km of phase conductor which have been identified for remediation in the Transmission Conductors and Ground Wires Asset Management Strategy; and
- Upgrade the telecommunications network by replacing existing GW with OPGW where:
  - the circuit is located in an area in the transmission network where one of the communication routes is radio and one optical fibre; or
  - the radio route in the identified area is obsolete and/or in poor condition and needs replacement.

This option addresses the identified need and provides an efficient, targeted upgrade to our telecommunications network. This option removes the need to undertake capital expenditure to upgrade the existing radio communications network, which would be a higher cost option. At this stage, we propose to commence the works in April 2023 for completion in March 2027.

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 31 May 2023 to rittconsultations@ausnetservices.com.au or please contact to Auras Bugheanu on (03) 9695 6000.

2. Background

Our transmission system contains approximately 6,500 km of phase conductors, consisting of over 17,300 circuit spans. There are three different types of phase conductors in use on our transmission network, being aluminium conductor steel reinforced (ACSR), all aluminium conductor (AAC) and all aluminium alloy conductor (AAAC). All phase conductors are manufactured and tested in accordance with the relevant standards.[1]

Transmission line ground wire (GW) are bare conductors supported at the top of transmission towers. As already noted, a primary purpose of GW is to shield the transmission line and intercept lightning strikes before they reach the phase conductors, reducing the likelihood of lightning induced damage (e.g. current and voltage surges). The GW is securely earthed at each tower, to allow an electrical path for the lightning to earth and prevent interference with the phase conductors.

GW made of steel is used as lightning protection/shield for phase conductors. OPGW is a composite wire that incorporates optical fibres in its core and is used both as lightning protection/shield for phase conductors as well as a communications data transfer route used for SCADA.

To assess the condition of these assets, Ausnet employs routine tower climbing and easement inspections. In addition, an improved visual inspection technique, known as Smart Aerial Image Processing (SAIP), was introduced in 2015. The SAIP system includes capture of continuous high-resolution conductor images from a helicopter and the use of automatic image recognition technology to locate and prioritise repair and replacement of conductors.

This technology enables the efficient capture of conductor images spanning long distances of transmission lines. Images captured are analysed using machine learning software which aims to automate the identification of signs of corrosion including the presence of white powder, conductor bulging or broken strands. This technology will continue to allow us to ensure that future conductor replacements are even more closely aligned to condition, rather than age-based.

Our asset condition data indicates that only a small percentage, approximately 0.25% of the total phase conductor spans and 2.35% of GW spans are categorised as condition C4 or C5, which are the poorest condition categories. While this is a small percentage of the asset population, functional failure of a phase conductor or GW asset has potential negative outcomes for our customers, our staff and contractors in terms of health and safety risk; bushfire ignition risk; and market impacts.

In order to manage these risks effectively, AusNet Services adopts a proactive approach to asset replacement of phase conductor and GW assets, taking into account the risk and consequences of asset failure. This PADR explains our proposed project in relation to the proactive replacement of these assets. Our plans are consistent with our asset management strategy (AMS) for these assets.[2]

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1 AS/NZS 3607.1989 Conductors – Bare Overhead – Aluminium and aluminium alloy – Steel reinforced; and AS/NZS 1531.1991 Conductors – Bare Overhead – Aluminium and aluminium alloy.

2 AusNet Services, AMS 10-79 Transmission Line Conductors and Ground Wires, July 2020.

3. Identified need

3.1. Description

Our fleet of transmission line conductors and ground wires are ageing. Approximately 55 per cent of the population has been in service for more than 50 years, this figure will increase to 60 per cent by 2025. While phase conductor and GW assets are generally in good condition, some assets are showing signs of corrosion-based deterioration. The two factors which have the greatest impact on levels of corrosivity include salt deposition experienced in coastal regions and air pollution caused by emissions from heavy industry.

As phase conductor and GW assets deteriorate, the risk of a functional failure increases. The majority of phase conductor and GW functional failures result in loss of mechanical function followed by loss of electrical/communication function, i.e. phase conductor or GW falling to ground or onto phase conductors below.

Phase conductor and GW functional failures can lead to three types of adverse consequences for our customers, staff and contractors:

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

The identified need in relation to phase conductor and GW assets, therefore, is driven by the need to actively manage the risks and consequences of asset failure.

In addition to the need for remedial action to mitigate these risks and consequences, AusNet Services must also ensure that it complies with its regulatory obligations, which include the Electricity Safety Act 1998. This Act requires AusNet Services to minimise hazards and risks to the safety of any person as far as reasonably practicable. In relation to phase conductor and GW assets, compliance with this Act (and other regulations) contribute to the identified need.

3.2. Assumptions

In assessing the identified need, AusNet Services must consider the risk of asset failure and the likelihood of potential adverse consequences eventuating. The assumptions underpinning each of the three consequences of conductor and GW functional failure are discussed briefly below.

3.2.1. Health and safety risks

Phase conductor and GW functional failures can present health and safety risks to members of the public, AusNet Services' employees and contractors accessing the transmission line easements. The Health and Safety asset criticality is quantified at span level by a combination of two characteristics:

- Easement type; and
- Line crossings.

Transmission line easements traverse lands with various use types. Easements are classified into three easement types:

- Urban;
- Rural developed; and
- Rural not-developed.

The Electricity Safety Act 1998 requires AusNet Services 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 Services uses:

- a value of statistical life to estimate the benefits of reducing the risk of death;[3]

[3] 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.

- a value of lost time injury;[4] and
- a disproportionality factor.[5]

AusNet Services' 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.[6]

3.2.2. 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 Services has regard to this analysis in assessing the potential consequences from bushfire ignition.

Historically, there have been no incidents of bushfire ignition from transmission line conductor or GW assets on the Victorian transmission network. The following factors have contributed to the absence of bushfire ignition:

- Low incidence of conductor to ground faults on transmission lines, which reduces the risk of fire start;
- Transmission lines protection systems are very quick to interrupt the current flow into a fault; and
- Transmission lines easements are wide and well managed, which reduces the risk of ignition and fire spread.

While there have been no historical instances of transmission line conductor or GW failures leading to bushfire ignition, a proactive asset inspection and replacement program is essential in continuing to minimise bushfire risk in accordance with our regulatory obligations and community expectations.

3.2.3. Involuntary load shedding and market impact

The electricity transmission lines forming the National Electricity Market 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 and load shedding may be required to provide network security for a subsequent unrelated failure.

Market modelling is required to estimate the expected adverse impact on dispatch costs as a result of a ground wire failure on a phase conductor. In relation to unserved energy, the supply risk costs 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).

The assumption used for the VCR calculation is that a line outage will lead to a terminal station black if all other lines are unavailable . It is also assumed that one line can supply the entire load of the terminal station. The general equation for the hourly VCR costs for a line element resulting in a terminal station black is:

$$\$/h/floc = (TS\ Black\ \$/h) \times (Average\ Total\ Line\ Unavailability)_{(Redundant\ Lines)}$$

In relation to this calculation, it is noted that average line unavailability statistics are provided by AEMO; the TS Black $/h is published in the Transmission Connection Planning Report (TCPR); and the number of redundant lines are the number of lines feeding a station minus 1.

In relation to the market impact costs, the calculation comprises two components:

- Indirect VCR, which is the customer load that would have to be shed in order to maintain a stable network; and
- Value of binding generation constraints, which is the increased cost of fuel required to supply the load in the absence of a constrained generator. Typically, this is the cost of running a gas fired power station instead of renewable generation.

The value of binding generation constraints requires market modelling using load flow studies.

Both the VCR – direct and indirect – and the value of binding generation constraints are summated for a line. The line is then mapped to the individual elements including wire segments and towers.

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4 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.

5 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.

6 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.

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 phase conductors and GW assets that are integral to the safe and reliable supply of electricity through the transmission network, there are no credible non-network options that could address this identified need. Specifically, 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 therefore:

- Option 1: Replace GW on a like-for-like basis and repair phase conductors that are in poor condition; and
- Option 2: As per Option 1, plus replace selected steel GW with OPGW to upgrade the telecommunication network.

Our cost-benefit assessment, will assess the costs of each credible option compared to the costs of a base case 'Business as Usual' (BAU) option, where phase conductor and GW assets 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 Services 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: Replace GW on a like-for-like basis and repair phase conductors that are in poor condition

Based on a comprehensive risk assessment which considers conductor health score as a proxy for probability of failure, and consequence of failure (collateral damage, safety, market impact and bushfire ignition) 326 km of GW and 35 km of phase conductor have been identified for remedial action in the Transmission Conductors and Ground Wires Asset Management Strategy (AMS 10-79). This option would involve the replacement of the GW on a like-for-like basis and repair of the phase conductor.

Our PSCR described this option as replacing the phase conductors on a like-for-like basis. However, following the publication of the PSCR, we found that an overnight outage required to replace the phase conductors would not be available as a result of market conditions. As a consequence, phase conductor replacement could only be achieved by building a line bypass, which would involve purchasing additional Emergency Restoration Service masts, landowner compensation and new tower erection. This work would be prohibitively expensive. As a consequence, we are now proposing repair as part of the planned maintenance activity of localised phase conductor defects and insulators, and monitoring condition through planned condition inspection and aerial SAIP inspection.

The total direct capital cost of this option is $24.7 million ($, nominal). In relation to operating expenditure, we expect this option to avoid operating expenditure increases that would otherwise arise in relation to BAU.

Commented [AB1]: This is direct expenditure

4.3. Option 2: As per Option 1, plus replace selected steel GW with OPGW to upgrade the telecommunication network

Under this option, in addition to the work described in Option 1, selected existing steel GW would be replaced by OPGW where a communication link upgrade is required. The current radio network does not have sufficient bandwidth to handle SCADA. By taking the opportunity to replace steel GW with OPGW, this option will improve the reliability of the data communications network and provide improved bandwidth for SCADA. The direct costs of delivering this option is approximately $30.8 million ($, nominal), which is higher than Option 1 but provides the additional benefit of an upgraded telecommunications network.

Commented [AB2]: This is direct expenditure

As explained in the cost benefit analysis in the next section, our assessment is that the incremental costs of replacing steel GW with OPGW at selected locations will be more than offset by the benefits of a more reliable communications network with improved bandwidth. In the absence of the targeted replacement of steel GW with OPGW, it would be necessary to upgrade the radio network. Our assessment is that installing OPGW is more cost efficient and offers net superior reliability and bandwidth compared to upgrading the radio network.

The construction timeframes for this option would be similar to Option 1. As noted in relation to Option 1, we expect this option to avoid operating expenditure increases that would otherwise arise in relation to BAU.

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. It is noted that this market benefit will be the same for each of the credible options. Our approach to estimating this market benefit is explained in section 3.2.3.
(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. It is noted that this market benefit will be the same for each of the credible options. Our approach to estimating this market benefit is explained in section 3.2.3.
(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.

As explained in the above table, the relevant market benefits are changes in fuel costs and involuntary load shedding. In both cases, the value of these market benefits will be the same for each credible option. As such, it would be reasonable not to estimate the market benefits as this information will not inform the choice between the two options. Notwithstanding this observation, we have estimated the market benefits to provide a more complete assessment of the expected net benefits of proceeding with a credible option compared to BAU.

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 for 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). As explained in the previous section, however, the supply risk in this instance is expected to be the same for each of the credible options. For that reason, it does not need to be explored further in this PADR.

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.

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

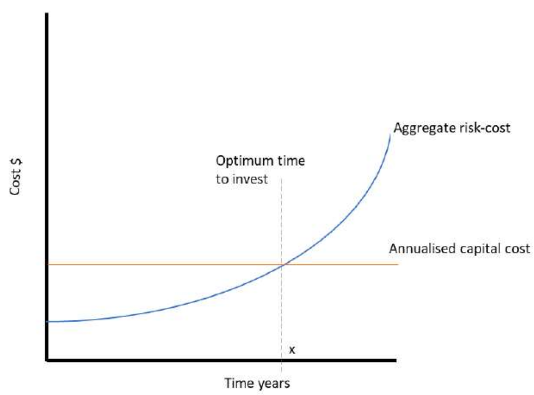

Figure 1: Increasing risk-cost over time and optimal project timing[7]

In the absence of remedial action,

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Figure 1Figure 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

[7] 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.

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 in determining an appropriate set of reasonable scenarios.[8] The relationship between sensitivity analysis and scenarios is best explained by the AER's practice note:[9]

> *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 particular circumstances to ensure that the approach is appropriate. 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 2021 Inputs, Assumptions and Scenarios Report and its 2022 Integrated System Plan (ISP). We note that the scenarios adopted by AEMO 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~~Table 2~~ below lists the key variables and assumptions applied in the economic assessment, which are essential inputs to our methodology for this 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. As explained above, 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 upper and lower bound estimates that are consistent with AEMO's Inputs, Assumptions and Scenarios Report in July 2021. The central case is 4.68%, which reflects the discount rate that we applied in our internal business case assessment and is almost the midpoint between AEMO's upper and lower bound estimates. 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 either aspect of the risk-cost could be varied to deliver a higher or lower expected cost.

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, as the non-supply risks are not affected by the value of customer reliability.		

8 AER, Application guidelines, Regulatory investment test for transmission, August 2020, page 43.
9 AER, Asset replacement planning, January 2019, page 36.

Variable / assumption	Lower bound	Central estimate	Upper bound
Safety cost	Central Estimate	Value of statistical life of $4.5 million[10]	Central estimate
Safety cost Disproportionate Factor	Central estimate	Factor of 3	Central estimate
Option cost	15% reduction in central estimate	In-house cost estimates using detailed and high-level project scopes	15% increase in central estimate
Real discount rates	2.0%	4.68%	7.5%
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.

As each of the credible options involves the replacement of existing assets, we have assumed that the operating cost for each option is slightly lower than the 'Business as Usual' option. This saving reflects the lower repair costs associated with these options.

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 presents the present value net economic benefit of each credible option. Costs and risks are over the lifetime of the assets.

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

	Option 0 – Do Nothing/BAU	Option 1 – Like-for-like GW replacement and conductor repair	Option 2 – Option 1 plus selective upgrade to OPGW to provide telecoms
Capital expenditure	$0m	$19.7m	$24.5m
Radio Network	$10.2m	$10.2m	$0m
Operating expenditure (Opex – Repairs)	$0.3m	$0m	$0m
Risk costs - Safety Bushfire and Collateral	$149.0m	$46.6m	$46.6m
Risk costs - Market impacts	$9.1m	$3.0m	$3.0m
Total costs	$168.6m	$79.5m	$74.1m
Net benefit compared to BAU	-	$89.2m	$94.6m

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 avoids the need for the upgrade of the radio network, which would otherwise cost $10.2 million. The additional capital cost of Option 2 compared to Option 1 is approximately

10 Best Practice Regulation Guidance Note Value of statistical life, December 2014, escalated.

$4.8 million, which less than this cost saving. As a consequence, Option 2 is expected to provide a higher net benefit than Option 1.

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)

	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	$89.2m	$116.3m	$62.0m	$86.2m	$92.1m	$91.6m	$86.4m
Option 2	$94.6m	$121.7m	$67.4m	$92.4m	$96.7m	$96.7m	$92.1m

Source: AusNet Services

The sensitivity analysis shows that option 2 is preferred to Option 1 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 2 being the preferred option.

For completeness, we have also conducted scenario analysis to further test this proposition, applying the definitions set out below. In our view, these scenarios 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. The current ISP scenarios – which relate principally to changes in the wholesale generation market – are not relevant to this investment decision.

Table 5: Definition of reasonable scenarios

Scenario	Failure risk or consequence	Option Cost	Forecast Demand	VCR	Discount rate
Central Case	Central estimate	Central estimate	Central estimate	Central estimate	Central estimate
Climate concern	Upper bound	Central estimate	Central estimate	Central estimate	Central estimate
Weak economic growth	Central estimate	Lower bound	Central estimate	Central estimate	Lower bound
High demand	Central estimate	Upper bound	Central estimate	Central estimate	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, possibly due to the international resurgence of COVID-19. It has lower costs of delivering the option, lower demand and a lower discount rate
High project demand	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 project demand
Option 1	$89.2m	$116.3m	$89.9m	$89.0m
Option 2	$94.6m	$121.7m	$94.6m	$94.9m

Source: AusNet Services

5.5. Preferred option

Our preferred option (Option 2) is to:

- Replace 326km of GW and repair 35km of phase conductor which have been identified for remediation in the Transmission Conductors and Ground Wires Asset Management Strategy; and
- Upgrade the telecommunication network by replacing existing GW with OPGW where:
  - the circuit is located in an area in the transmission network where one of the communication routes is radio and one optical fibre; or
  - the radio route in the identified area is obsolete and/or in poor condition and needs replacement.

The construction would commence in April 2023, with project completion expected by March 2027. The estimated capital cost of this option is $30.8 million ($, 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 2) is $30.8 million ($, nominal). The principal capital expenditure elements, expressed in nominal terms, are:

- Design and internal labour, $1.9 million;
- Materials, $3.3 million;
- Plant and equipment, $2.2 million;
- Contracts, $21.0 million; and
- Other, $2.5 million.

It is assumed that the Opex related to Ground Wire repair will be mitigated by the capital replacement. The present value of future Opex is 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 89: Compliance with regulatory requirements

Requirement	Section
5.16.4(v) The project assessment conclusions 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;	Appendix
(ii) the estimated construction timetable and commissioning date;	Section 4.3
(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

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Appendix – Technical characteristics

Technical risks

The following risks have been identified to impact the scope, cost, and delivery schedule.

- Structure upgrades may be required for construction loading (i.e., square rigging at structures adjacent to stringing equipment, suspension structures used as temporary termination) however is unknown until determined during detailed design.
- Original tower design did not allow for square rigging loads which may cause areas of tower overstress.
- If there is unknown presence of ancillary equipment on the GW peak that will impact the GW stringing procedures and trigger potential structure modifications.
- If the site access is compromised due to community and physical restrictions, additional works and costs may be required.
- Works on existing sites with older assets, will require careful construction planning and safety reviews. (i.e., structure has additional defects to those documented in AusNet systems).
- Incomplete technical data (i.e., line schedule, tower drawings etc.) may impact the scope and costs.
- Design related changes requested from construction post detailed design that are over and above approved standards and work methods (i.e., ISP proposed alternative work methods due to site specific constraints etc.)
- COVID-19.
- If system outages are not readily available when required due to limitations driven by market availability. SMTS-MYTS is a critical 500kV link and will have restrictive outage restraints in terms of number of outages available, length of outage available and requirements to bring back into service at short notice.

Technical assumptions & clarifications

The following technical assumptions and clarifications are made:

- Required outages are granted.
- Structure upgrades may be required for OPGW installation.
- Extra stringing loads such as square rigging or temporary terminations which were not in the original design criteria may require additional upgrades.
- Stringing loads to be kept within original design loads where possible to minimise structure upgrades.
- OPGW to be selected as close as possible to equivalent size/tension weight etc to existing GW.
- Existing ground wire has enough capacity to be used as pilot wire during stringing.
- All fittings/hardwares will be replaced for the spans with GW replacement.
- Structures to be structurally checked in accordance with their original design criteria plus any additional construction loads imposed by this project.
- Free and unhindered access to required sites at all times.
- No out of the ordinary environmental, site or client concerns.
- Any changes to the original scope agreement may result in additional charges being applied for variations to the original scope.
- All other Authorities providing approvals as requested within standard response times.
- Design and Construction of this project will utilise Network Engineering Technical Standards.

Technical exclusions

The following technical exclusions from the scope and estimate are:

- Replacement of any corroded members and connections not identified as part of the scope for this project.
- Design and construction of temporary works (hurdles and cradle blocks) other than suspension towers to be used as temporary termination during stringing.

- Any works not specifically mentioned in this scope of works.
- No allowance for vegetation control has been allowed for access to site.
- No structure upgrades are required for conductor or GW like for like replacement, except for suspension towers to be used in stringing as temporary termination.
- No foundation upgrades required.

Risk identification and mitigation

The table below sets out the risk description, unmitigated risk consequence, mitigation measures and potential mitigated risk consequence and likelihood. Based on this risk assessment, the residual project risk is considered to be low and manageable.

Risk Description	Potential unmitigated risk consequence	Mitigations	Potential mitigated risk consequence	Likelihood of impact
Drawings of the relevant structures in Objective may not be accurate or updated which will increase the scope of the project and may delay the implementation.	Cost overruns due to rework	Detailed survey of towers prior to the commencement of design work	<$50k in additional expenditure	Low
Delivery partners' human resources may not be available to deliver the project on time. If labour is to be sourced from interstate, it could raise the unit cost for each tower.	Significant cost overruns	Stakeholder engagement with contractors to ensure their ability to deliver	<$100k in additional expenditure	Low
Materials for GW may not be available locally and may need to be imported, which cause delays	Project delays and cost overruns	Complete all procurement of materials prior to beginning installation.	<50k in additional expenditure	Low
Construction works may be delayed due to extreme weather days resulting in increased cost.	Project delays and cost overruns	Sufficient weather allowances in the project schedule to allow for weather delays	<$100k in additional expenditure	Low
Ground conditions may require additional works to be completed for mobilisation of plants and equipment.	Significant cost overruns due to rework	Detailed survey of towers prior to the commencement of design work	<$100k in additional expenditure	Low
Outages may be required based on the outcome of the site-specific circumstances.	Penalties associated with outages experienced by customers	Consultation with AEMO in advance to schedule outages to minimise impact. Risk allowances have been made in expenditure for outages.	<$100k in additional expenditure	Low

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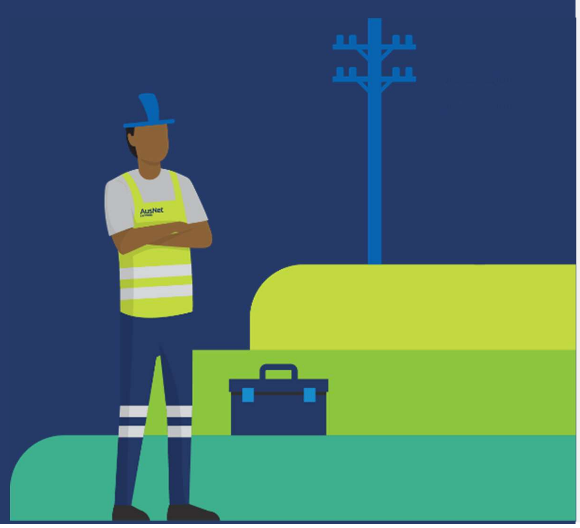

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