Transgrid

People. Power. Possibilities.

Managing risk on Lines 21, 22, 959 & 92Z (conductor condition)

RIT-T Project Assessment Conclusions Report

Issue date: 30 May 2024

Disclaimer

This suite of documents comprises Transgrid's application of the Regulatory Investment Test for Transmission (RIT-T) which has been prepared and made available solely for information purposes. It is made available on the understanding that Transgrid and/or its employees, agents and consultants are not engaged in rendering professional advice. Nothing in these documents is a recommendation in respect of any possible investment.

The information in these documents reflect the forecasts, proposals and opinions adopted by Transgrid at the time of publication, other than where otherwise specifically stated. Those forecasts, proposals and opinions may change at any time without warning. Anyone considering information provided in these documents, at any date, should independently seek the latest forecasts, proposals and opinions.

These documents include information obtained from the Australian Energy Market Operator (AEMO) and other sources. That information has been adopted in good faith without further enquiry or verification. The information in these documents should be read in the context of the Electricity Statement of Opportunities, the Integrated System Plan published by AEMO and other relevant regulatory consultation documents. It does not purport to contain all of the information that AEMO, a prospective investor, Registered Participant or potential participant in the National Electricity Market (NEM), or any other person may require for making decisions. In preparing these documents it is not possible, nor is it intended, for Transgrid to have regard to the investment objectives, financial situation and particular needs of each person or organisation which reads or uses this document. In all cases, anyone proposing to rely on or use the information in this document should:

1. Independently verify and check the currency, accuracy, completeness, reliability and suitability of that information
2. Independently verify and check the currency, accuracy, completeness, reliability and suitability of reports relied on by Transgrid in preparing these documents
3. Obtain independent and specific advice from appropriate experts or other sources.

Accordingly, Transgrid makes no representations or warranty as to the currency, accuracy, reliability, completeness or suitability for particular purposes of the information in this suite of documents.

Persons reading or utilising this suite of RIT-T-related documents acknowledge and accept that Transgrid and/or its employees, agents and consultants have no liability for any direct, indirect, special, incidental or consequential damage (including liability to any person by reason of negligence or negligent misstatement) for any damage resulting from, arising out of or in connection with, reliance upon statements, opinions, information or matter (expressed or implied) arising out of, contained in or derived from, or for any omissions from the information in this document, except insofar as liability under any New South Wales and Commonwealth statute cannot be excluded.

Privacy notice

Transgrid is bound by the *Privacy Act 1988 (Cth)*. In making submissions in response to this consultation process, Transgrid will collect and hold your personal information such as your name, email address, employer and phone number for the purpose of receiving and following up on your submissions.

Under the National Electricity Law, there are circumstances where Transgrid may be compelled to provide information to the Australian Energy Regulator (AER). Transgrid will advise you should this occur.

Transgrid's Privacy Policy sets out the approach to managing your personal information. In particular, it explains how you may seek to access or correct the personal information held about you, how to make a complaint about a breach of our obligations under the Privacy Act, and how Transgrid will deal with complaints. You can access the Privacy Policy here (https://www.transgrid.com.au/Pages/Privacy.aspx).

Executive summary

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for remediating deteriorating conductor condition on four transmission lines in the Transgrid overhead transmission network (Line 21, Line 22, Line 959 and Line 92Z). Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Transgrid's overhead transmission network contains sections where the condition of conductors is deteriorating such that they have reached, or are close to reaching, end of life. The deteriorated condition of conductors can be caused by a variety of mechanisms such as:

- annealing due to bushfire exposure;
- corrosion initiated by bushfire exposure; and
- corrosion at mid-span joint locations.

We have undertaken analysis of conductor condition and deterioration mechanisms across its network, which identified approximately 1,100 km circuit length of conductors that have condition issues that require attention.

We have also undertaken analysis of bushfire impact history and mid-span joint locations, mapped against corrosion zones, and identified the locations that were likely exposed to the degradation mechanisms described above. Various inspections[1] have identified visual indicators of degradation such as broken strands, bulging, visible corrosion product, out of lay strands and discolouration.

Identified need: managing risks on Line 21, Line 22, Line 959 and Line 92Z

If action is not taken, the conductor deterioration is expected to expose us and our customers to increasing level of risks going forward, as the likelihood of failure increases. There are safety and bushfire risks under the 'do nothing' base case, as well as higher expected costs associated with reactive maintenance that may be required under emergency conditions ('financial risk'). The proposed investment will enable us to manage safety, bushfire and financial risks on the selected lines.

Options considered under this RIT-T have been assessed relative to a base case. Under the base case, no proactive capital investment is made and the condition of the lines will continue to deteriorate.

Further condition deterioration of the affected conductors would mean an increase in safety and bushfire risks as the likelihood of failure increases. If left untreated, conductor deterioration could result in incidents such as conductor drop. Such incidents could have considerable safety consequences for nearby residents and members of the public near the assets. These incidents also pose environmental risks through potential bushfires.

We manage and mitigate safety and environmental risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with our obligations under the *New South*

[1] Inspections include Smart Aerial Image Processing (SAIP), and ground and aerial based inspections.

Wales Electricity Supply (Safety and Network Management) Regulation 2014 and our Electricity Network Safety Management System (ENSMS).[2]

The proposed investment will enable us to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP, consistent with our obligations. Consequently, we consider it to be a reliability corrective action under the RIT-T. A reliability corrective action differs from a 'market benefits'-driven RIT-T in that the preferred option is permitted to have negative net economic benefits on account of it being required to meet an externally imposed obligation on the network business.

No submissions were received in response to the PSCR

We published a Project Specification Consultation Report (PSCR) on 14 February 2024 and invited written submissions on the material presented within the document. No submissions were received in response to the PSCR.

No material developments since publication of the PSCR

No additional credible options were identified during the consultation period following publication of the PSCR. In addition, no material changes have occurred since the PSCR that have made an impact on the preferred option.

One credible option has been considered

We consider that there is only one feasible option from a technical, commercial, and project delivery perspective that can be implemented in sufficient time to meet the identified need.

Option 1 involves a targeted replacement of existing conductors along Lines 21, 22, 959 and 92Z, which have been identified as priority lines based on expected NPV per kilometre and outage constraints. The cumulative length of all segments contained within this option is 51 km. The remediation includes replacement of all conductor compression fittings, suspension clamps/Armour Grip Suspension Units (AGSU), jumper connections, spacers and vibration dampers on relevant sections of lines.

The estimated capital cost of Option 1 is approximately $36.6 million. Table E-1 sets out the build period, year of commissioning, and cost of conductor replacement for each line under Option 1.

Table E-1 Build period, commissioning, and cost of each line under Option 1

Line	Build period	Commissioning	Capital expenditure
Line 21	2024/25 to 2025/26	2025/26	7.7
Line 22	2024/25 to 2026/27	2026/27	9.3
Line 959	2025/26 to 2026/27	2027/28	8.2
Line 92Z	2027/28 to 2029/30	2029/30	11.4
Total			**36.6**

Although the timeline for replacement varies for each line, the overall project is expected to commence in 2024/25 and conclude by 2029/2030.

[2] Our ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following a hierarchy of hazard mitigation approach.

Option 1 will not affect annual routine operating costs since it does not affect the frequency of inspections.

There is no expectation of needing to uprate the lines at this point in time

The proposed replacement works under Option 1 is focused on condition-based, like-for-like replacement. We do not expect the conductors included in this RIT-T need to be uprated at this point in time as we do not expect the line loadings to exceed their existing line ratings in the near future.

Lines 21 and 22, along with Lines 25, 26, 5A1 and 5A2, are the main transmission lines connecting generation in the Hunter and Central Coast regions to Sydney. The 500 kV lines (Line 5A1 and 5A2) will continue to take the majority of the flow from the Central Coast to Sydney. The line utilisation data in our 2023 Transmission Annual Planning Report shows Line 21 (330 kV) has a maximum utilisation rate of 34% and Line 22 (330 kV) has a maximum utilisation rate of 88% under credible contingency. Lines 959 and 92Z (both 132 kV lines) are in parallel with Line 27 and 28 (both 330 kV lines) between Sydney North and Sydney East. Lines 959 and 92Z have a maximum utilisation rate of 42% and 22% under credible contingency, respectively.[3]

Specifically, we consider that uprating would cost significantly more than Option 1 and not add a commensurate increase in estimated market benefit. Uprating is therefore not considered commercially feasible at this point in time.

Non-network options are not expected to be able to assist with this RIT-T

We do not consider non-network options to be commercially and technically feasible to assist with meeting the identified need for this RIT-T, as non-network options will not mitigate the safety, environmental and financial risks posed as a result of asset deterioration.

The option has been assessed against three reasonable scenarios

The credible option has been assessed under three scenarios as part of this PACR assessment, which differ in terms of the key drivers of the estimated net market benefits (ie, the estimated risk costs avoided).

Given that wholesale market benefits are not relevant for this RIT-T, the three scenarios assume the expected most likely scenario for the 2024 ISP (ie, the ‘Step Change’ scenario). The scenarios differ by the assumed level of risk costs. Risk cost assumptions do not form part of AEMO’s ISP assumptions and have been based on Transgrid’s analysis.

[3] Transgrid, *Transmission Annual Planning Report 2023*, p.155

Table E-2 Summary of scenarios

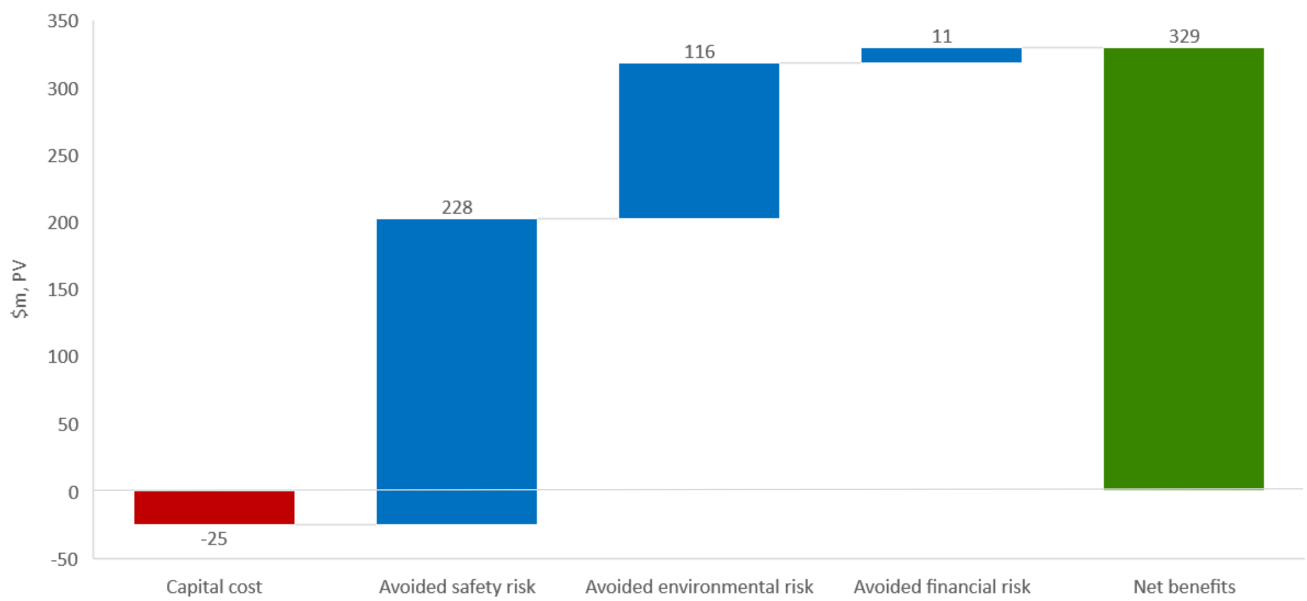
Variable / Scenario	Central	Low risk cost scenario	High risk cost scenario
Scenario weighting	*1/3*	*1/3*	*1/3*
Discount rate	7.0%	7.0%	7.0%
Network capital costs	Base estimate	Base estimate	Base estimate
Operating and maintenance costs	Base estimate	Base estimate	Base estimate
Safety, environmental, and financial risk benefit	Base estimate	Base estimate – 25%	Base estimate +25%

We have weighted the three scenarios equally given there is nothing to suggest an alternate weighting would be more appropriate.

Option 1 delivers significant net benefits

The costs under Option 1 are found to be significantly outweighed by the expected benefit of avoiding the risks in each scenario investigated. On a weighted basis, Option 1 is found to deliver net economic benefits of $329.5 million in present value terms.

Figure E-1 Net economic benefits of Option 1 ($m, PV)



Conclusion

This PACR has found that Option 1 is the preferred option coming out of this RIT-T. Option 1 involves the replacement of approximately 51 kilometres of conductors on Lines 21, 22, 959 and 92Z. Moving forward with this option is the most prudent and economically efficient solution to manage and mitigate safety and bushfire risk to ALARP. Consequently, it will ensure our obligations under the *New South Wales Electricity Supply (Safety and Network Management) Regulation 2014* and our ENSMS are met.

The estimated capital expenditure associated with the option is $36.6 million (in 2023/24 dollars) and the works are estimated to take place between 2024/25 and 2029/30.

Option 1 is found to have positive net benefits under all three scenarios investigated and, on a weighted basis, will deliver $329.5 million in net economic benefits (in present value terms).

Transgrid considers this conclusion to be robust to changes in capital cost inputs, estimated risk costs and underlying discount rates, noting that there would need to be unrealistic changes to these key assumptions for there to be no expected net benefits. Transgrid will however continue to monitor these key assumptions and will notify the AER if such changes do occur (or appear likely), which would constitute a material change in circumstance.

Next steps

This PACR represents the final step of the consultation process in relation to the application of the RIT-T process undertaken by Transgrid.

The second step of the RIT-T process, production of a Project Assessment Draft Report (PADR), was not required as Transgrid considers its investment in relation to the preferred option to be exempt from that part of the RIT-T process under NER clause 5.16.4(z1). Production of a PADR is not required due to:

- the estimated capital cost of the preferred option being less than $46 million;
- the PSCR stating:
  - the proposed preferred option, together with the reasons for the proposed preferred option;
  - the RIT-T is exempt from producing a PADR; and
  - the proposed preferred option and any other credible options will not have a material market benefit for the classes of market benefit specified in clause 5.15A.2(b)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding;
- no PSCR submissions identifying additional credible options that could deliver a material market benefit; and
- the PACR addressing any issues raised in relation to the proposed preferred option during the PSCR consultation (noting that no issues have been raised).

Parties wishing to raise a dispute notice with the AER may do so prior to 3 July 2024 (30 days after publication of this PACR).[4] Any dispute notices raised during this period will be addressed by the AER within 40 to 120 days, after which the formal RIT-T process will conclude.

Further details on the RIT-T can be obtained from Transgrid's Regulation team via regulatory.consultation@transgrid.com.au. In the subject field, please reference 'Conductor condition on Lines 21, 22, 959 and 92Z PACR'.

[4] Additional days have been added to cover public holidays

Contents

1. Introduction

We are applying the Regulatory Investment Test for Transmission (RIT-T) to options for remediating deteriorating conductor condition on four transmission lines in the Transgrid overhead transmission network (Line 21, Line 22, Line 959 and Line 92Z). Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

We manage and mitigate safety and environmental risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with our obligations under the *New South Wales Electricity Supply (Safety and Network Management) Regulation 2014* and our Electricity Network Safety Management System (ENSMS).

This RIT-T therefore examines options for addressing the asset condition issues so that network safety continues to meet a risk mitigation level of ALARP, consistent with our obligations. Consequently, we consider this to be a reliability corrective action under the RIT-T.

1.1. Purpose of this report

The purpose of this PACR[5] is to:

- set out the reasons why we propose that action be undertaken (the 'identified need');
- present the options that we consider address the identified need;
- present the economic assessment of all credible options, as well as the assumptions feeding into the analysis; and
- provide details of the ultimately proposed preferred option to meet the identified need.

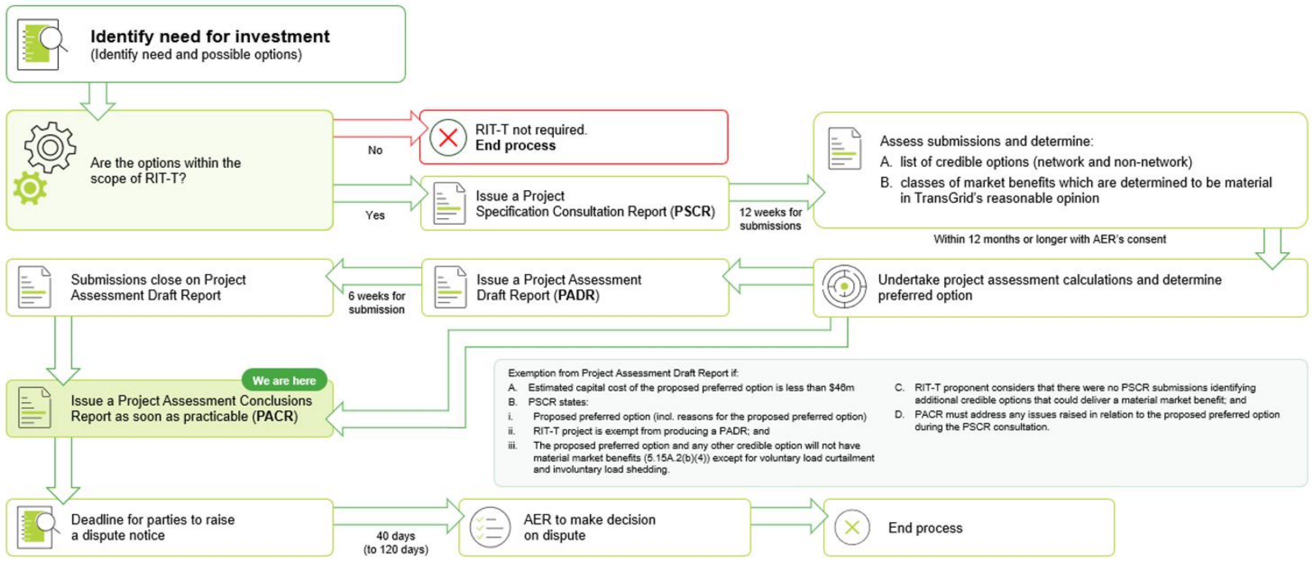
Overall, this report provides transparency into the planning considerations for investment options to ensure continuing reliable supply to our customers. A key purpose of this PACR, and the RIT-T more broadly, is to provide interested stakeholders the opportunity to review the analysis and assumptions, provide input to the process, and have certainty and confidence that the preferred option has been robustly identified as optimal.

1.2. Next steps

This PACR represents the final step of the consultation process in relation to the application of the RIT-T process undertaken by Transgrid.

[5] See Appendix A for the National Electricity Rules requirements.

Figure 1-1 This PACR is the final stage of the RIT-T process



Parties wishing to raise a dispute notice with the AER may do so prior to 3 July 2024 (30 days after publication of this PACR).[6] Any dispute notices raised during this period will be addressed by the AER within 40 to 120 days, after which the formal RIT-T process will conclude.

Further details on the RIT-T can be obtained from Transgrid's Regulation team via regulatory.consultation@transgrid.com.au. In the subject field, please reference 'Conductor condition on Lines 21, 22, 959 and 92Z PACR'.

[6] Additional days have been added to cover public holidays

2. The identified need

This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it. It first sets out background information related to the conductors.

2.1. Background to the identified need

Transgrid's overhead transmission network contains sections where the condition of conductors are deteriorating such that they have reached, or are close to reaching, end of life. The deteriorated condition of conductors can be caused by a variety of mechanisms such as:

- annealing due to bushfire exposure;
- corrosion initiated by bushfire exposure;[7] and
- corrosion at mid-span joint locations.[8]

We have undertaken analysis of conductor condition and deterioration mechanisms across its network, which identified approximately 1,100 km circuit length of conductors that have condition issues that require attention.

We have also undertaken analysis of bushfire impact history and mid-span joint locations, mapped against corrosion zones, and identified the locations that were likely exposed to degradation mechanisms described above. Various inspections[9] have identified visual indicators of degradation such as broken strands, bulging, visible corrosion product, out of lay strands and discolouration.

Material testing of conductor samples from the locations identified through Transgrid's analysis and inspections confirmed a range of conductor condition issues, including:

- aluminium and zinc oxides were contained within the white surface product, partial loss of the galvanising layer on the steel strands, and reduction in the cross section of inner aluminium strands;
- loss of tensile strength at the locations on the conductor where strands were out of lay; and
- migration of the conductor grease away from the inner layers of the conductor at locations where surface deposits and discolouration was observed.

The three figures below illustrate conditions issues identified by our on-the-ground asset management team.

7 The conductor grease forms a barrier layer between the aluminium outer strands and protective galvanizing layer of the inner steel strands. Exposure to bushfire can cause the conductor grease to migrate from the inner strands to the surface, the zinc then becomes a sacrificial anode in the galvanic cell formed between it and the aluminium leading to a loss of galvanizing and initiation of corrosion.

8 Mid-span joints are collection points for contaminants deposited on conductors, these contaminants accelerate the corrosion process.

9 Inspections include Smart Aerial Image Processing (SAIP), and ground and aerial based inspections.

Figure 2-1 Out of lay conductor strands

Figure 2-2 Conductor discolouration

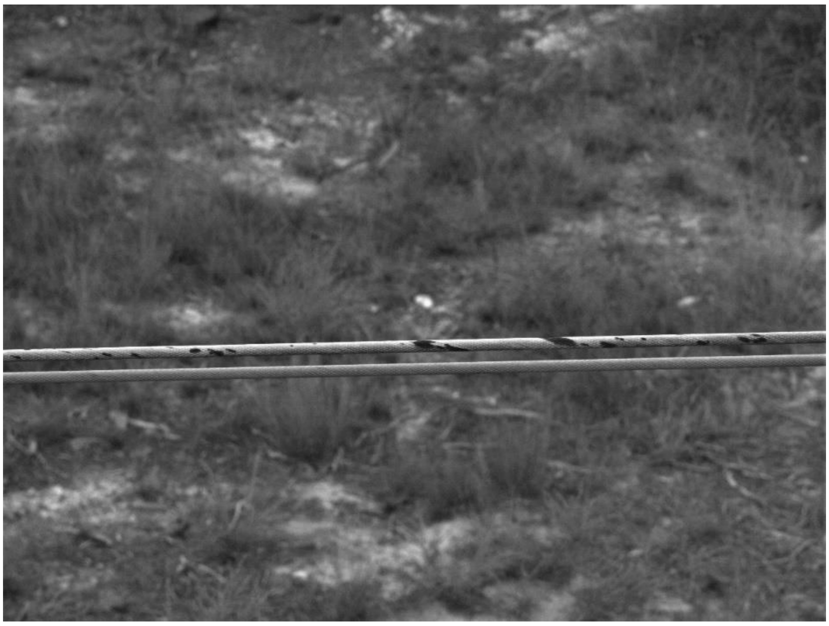


Figure 2-3 Corrosion products

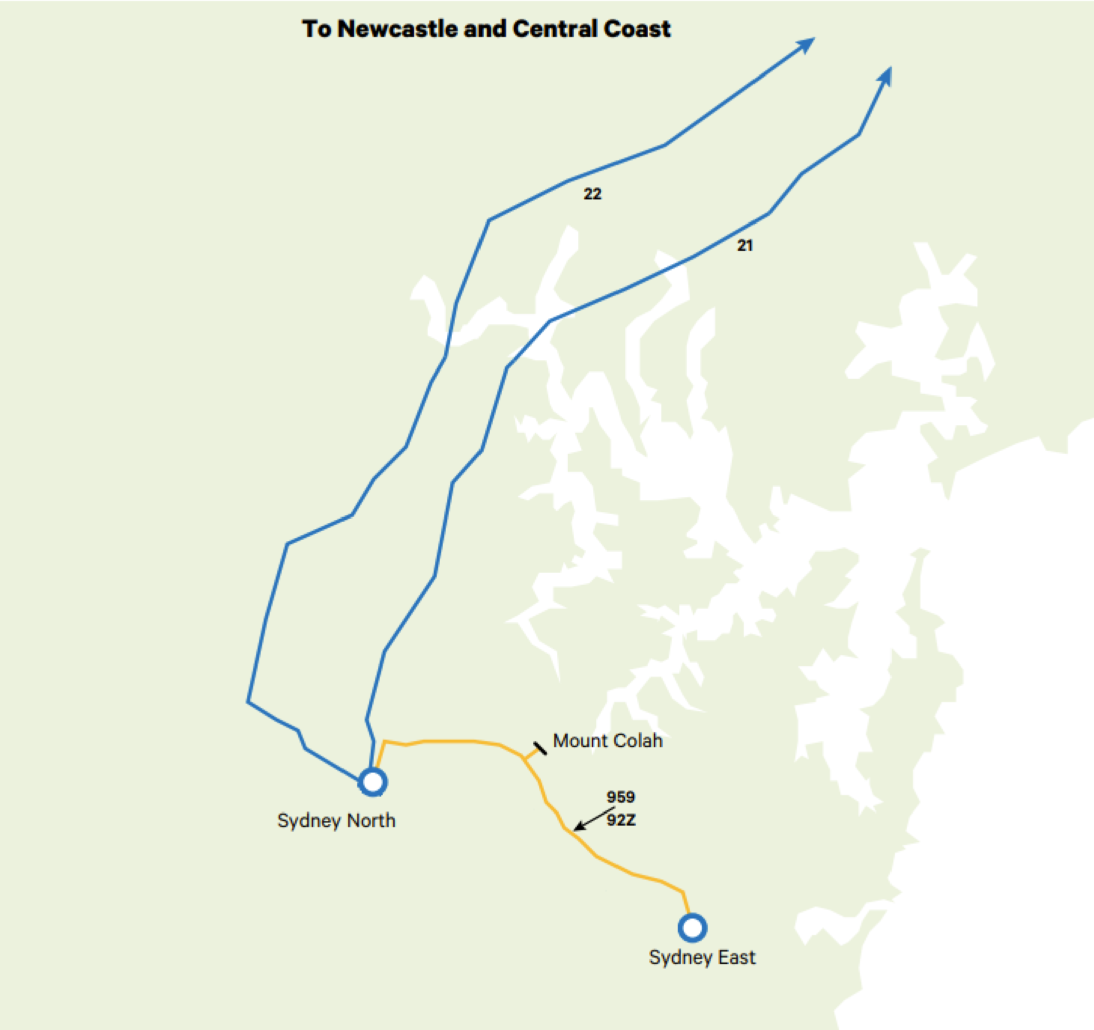
Conductor degradation greatly increases the likelihood of conductor drops and consequently presents safety and bushfire risk to the public. If these condition issues are not addressed through the timely implementation of the preferred technically and commercially feasible remediation option, then the affected lines will operate with increasing probability of failure as it continues to deteriorate

Transgrid has identified four lines with conductors that must be replaced:[10]

- Line 21 – Tuggerah 300kV and Sydney North 330 kV;
- Line 22 – Vales Point Power Station to Sydney North 330 kV;
- Line 959 – Sydney North 330kV to Sydney East 330 kV; and
- Line 92Z – Sydney North 330kV to Sydney East 330 kV.

[10] As discussed in section 3.2 below, works on lines 21, 22 and 959 would occur in the 2024-28 regulatory period under the sole credible option considered in this RIT-T. Works on line 92Z would take place in the subsequent regulatory period.

Figure 2-4 Location of Line 21, Line 22, Line 959, and Line 92Z



2.2. Description of identified need

The proposed investment will enable us to manage safety, bushfire and financial risks on the selected lines.

Options considered under this RIT-T have been assessed relative to a base case. Under the base case, no proactive capital investment is made and the condition of the lines will continue to deteriorate.

Further condition deterioration of the affected conductors would mean an increase in safety and bushfire risks as the likelihood of failure increases. If left untreated, conductor deterioration could result in incidents such as conductor drop. Such incidents could have considerable safety consequences for nearby residents and members of the public near the assets. These incidents also pose environmental risks through potential bushfires.

We manage and mitigate safety and environmental risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with our obligations under the *New South*

Wales Electricity Supply (Safety and Network Management) Regulation 2014 and our Electricity Network Safety Management System (ENSMS).[11]

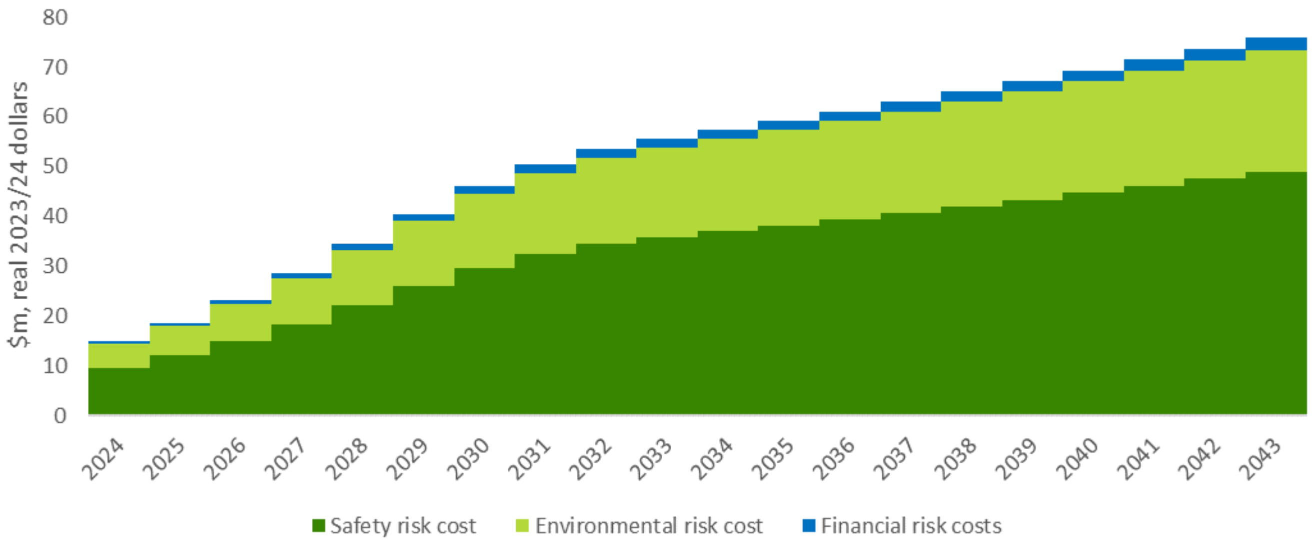
The proposed investment will enable us to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP, consistent with our obligations. Consequently, we consider this to be a reliability corrective action under the RIT-T. A reliability corrective action differs from a 'market benefits'-driven RIT-T in that the preferred option is permitted to have negative net economic benefits on account of it being required to meet an externally imposed obligation on the network business.

2.3. Assumptions underpinning the identified need

We adopt a risk cost framework to quantify and evaluate the risks and consequences of increased failure rates. Appendix B provides an overview of our risk assessment methodology.

The figure below summarises the increasing risk costs over the assessment period under the base case.

Figure 2-5 Estimated risk costs



This section describes the assumptions underpinning our assessment of the risk costs, i.e., the value of the risk avoided by undertaking the credible option. The aggregate risk cost under the base case is currently estimated in 2023/24 dollars at around $12.0 million in 2023/24. This is expected to increase going forward if action is not taken and the line is left to deteriorate further, reaching approximately $75.8 million by the end of the 20-year assessment period (2043/44).

11 Our ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following a hierarchy of hazard mitigation approach.

2.3.1. Asset health and the probability of failure

Our asset health modelling aligns with Chapter 5.2 of the AER's Asset replacement planning guideline.[12] Condition information for each asset is assessed to generate an asset health index and assets in relatively poor condition, as identified through the asset health index, are candidates for a replacement or refurbishment intervention.

The asset health issues associated with deteriorating conductors identified on Line 21, Line 22, Line 959, and Line 92Z are summarised in the table below.

Table 2-1 Asset health issues along Line 21, Line 22, Line 959, and Line 92Z and their consequences

Issue	Consequences if not addressed
Loss of strength in conductors	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Potential network reliability impacts
Deteriorated conductor and earthwire dampers and fittings	

Asset health is used to estimate the remaining serviceable life of an asset and forecast the associated probability of failure (PoF) of the asset now and into the future. The future health of an asset (health forecasting) is a function of its current health and any factors causing accelerated (or decelerated) degradation or 'age shifting' of one or more of its components. Such moderating factors can represent the cumulative effects arising from continual or discrete exposure to unusual events, external stresses, overloads and faults.

Asset condition information is the primary source of information on the current health of the transmission line and its components. Condition information obtained through routine inspections of the transmission line, such as condition rating of each component, and asset information, such as natural age, location and ideal life expectancy, form the basis for deriving current health.

The PoF is the likelihood that an asset will fail during a given period resulting in a particular adverse event. The probability of each failure mode is calculated using reliability engineering techniques that take into account conditional age (chronological age moderated by asset health), failure and defect history, and industry benchmarking studies. We screen out failures that are not related to end-of-life when quantifying risk for replacement projects because such risks are not addressed by these works.

2.3.2. Safety risk

This risk refers to the safety consequence to members of the public of an asset failure whose failure modes can create harm. The estimated value accounts for the cost associated with a fatality or injury including compensation, loss of productivity, litigation fees, fines and any other related costs.

Our safety model underwent a comprehensive update during 2021 and was developed in conjunction with asset management specialist consultancy AMCL.[13] The main changes to the model relate to consequence

[12] AER, *Industry practice application note – Asset replacement planning*, January 2019.
[13] Refer to Network Asset Criticality Framework

and likelihood quantifications with our safety risk now considering a range of consequences, from minor injury to fatality, and the likelihood of each based on historical events, human movement data and land use.

Consistent with our ALARP obligations, we apply a disproportionality factor of 'six' to the public safety component and 'three' to the worker safety component of safety risk.

Safety risk makes up approximately 64 per cent of the total estimated risk cost in present value terms.

2.3.3. Environmental risk

This risk refers to the consequence to the community of an asset failure that results in a bushfire starting. We undertook detailed assessment with the University of Melbourne[14] in 2021 to improve our quantification of bushfire risks across our network, including the moderation of risk costs, using an electricity industry-developed approach.

The bushfire risk model:

- models the potential spread from a fire started at each asset in the network using recognised fire modelling software;
- calculates the consequence based on the number of houses, agricultural and forestry land use (and other infrastructure in the predicted burn area);
- moderates the consequence using a statistical distribution of fire conditions across the year to come up with a most likely consequence to be used in the investment decision;
- moderates this likely consequence by the likelihood of network assets igniting a fire in the event a catastrophic asset failure occurs (ie, not all asset failures will ignite a fire); and
- further moderates this likely consequence taking into account the expected emergency services response to a fire based on the proximity to population (ie, locations close to population centres have the highest moderation of likely consequence as the emergency services response is expected to be relatively expeditious).

Consistent with our ALARP obligations, we apply a disproportionality factor of 'six' to the safety component of bushfire risk (ie, loss of life).[15]

Environmental risk makes up approximately 33 per cent of the total estimated risk cost in present value terms.

2.3.4. Financial risk

This risk refers to the direct financial consequence arising from the failure of an asset including the cost of replacement or repair of the asset (reactive maintenance), which may need to be under emergency conditions.

Financial risk is the smallest of all risks quantified under the base case for this RIT-T, making up 3 per cent of the total estimated risk cost in present value terms.

[14] Refer to Network Asset Criticality Framework
[15] Refer to section 6.2.5 of the Network Risk Assessment Methodology

3. Potential credible options

This section describes the option we have investigated to address the need, including the scope and the associated costs.

We consider that there is only one feasible option from a technical, commercial, and project delivery perspective that can be implemented in sufficient time to meet the identified need. Four other options were considered but not progressed for various reasons that are outlined in section 3.3.

All costs and benefits presented in this PACR are in 2023/24 dollars, unless otherwise stated.

3.1. Base case

The costs and benefits in this PACR are compared against those of a 'do nothing' base case. Under this base case, no proactive capital investment is made to address the deterioration of conductors on Line 21, Line 22, Line 959 and Line 92Z. Assets are left in service until they fail and require replacement.

While the base case is not a situation we plan to encounter, and this RIT-T has been initiated specifically to avoid it, the RIT-T assessment is required to use this base case as a common point of reference when estimating the net benefits of each credible option.

The regular maintenance regime will not be able to mitigate the risk of asset failure that will expose Transgrid and end-customers to approximately $57.5 million in safety, environmental, and financial risk costs by 2035, rising to $75.8 million by the end of the assessment period in 2043/44.[16] The environmental and safety risk costs are mainly due to the consequences of a bushfire event resulting from conductor drop. Under the base case, all of these risks will continue to increase.

3.2. Option 1 – Replace conductors on Lines 21, 22, 959 and 92Z

Option 1 involves a targeted replacement of existing conductors along Lines 21, 22, 959 and 92Z, which have been identified as priority lines based on expected NPV per kilometre and outage constraints. The cumulative length of all segments contained within this option is 51 km. The remediation includes replacement of all conductor compression fittings, suspension clamps/Armour Grip Suspension Units (AGSU), jumper connections, spacers and vibration dampers on relevant sections of lines.

The estimated capital cost of Option 1 is approximately $36.6 million, which is comprised of:

- $9.2 million in labour costs;
- $24.4 million materials costs; and
- $3.0 million in expenses.

The table below sets out the build period, year of commissioning, and cost of conductor replacement for each line under Option 1.

[16] This determination of yearly risk costs is based on our network asset risk assessment methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

Table 3-1 Build period, commissioning, and cost of each line under Option 1

Line	Build period	Commissioning	Capital expenditure
Line 21	2024/25 to 2025/26	2025/26	7.7
Line 22	2024/25 to 2026/27	2026/27	9.3
Line 959	2025/26 to 2026/27	2027/28	8.2
Line 92Z	2027/28 to 2029/30	2029/30	11.4
Total			**36.6**

Although the timeline for replacement varies for each line, the overall project is expected to commence in 2027/28 and conclude by 2029/30.

All works would be completed in accordance with the relevant standards with minimal modification to the wider transmission assets. Necessary outages of affected line(s) in service would be planned appropriately in order to complete the works with minimal impact on the network.

Option 1 will not affect annual routine operating costs (i.e., the cost is the same as under the base case) since it does not affect the frequency of inspections.

3.3. Options considered but not progressed

We considered several additional options to meet the identified need in this RIT-T. The table below summarises the reasons the following options were not progressed further.

Table 3-2 Options considered but not progressed

Description	Reason(s) for not progressing
Uprating the existing lines	We do not expect the conductors included in this RIT-T need to be uprated as we do not expect the line loadings to exceed their existing line ratings in the near future. Lines 21 and 22, along with Lines 25, 26, 5A1 and 5A2, are the main transmission lines connecting generation in the Hunter and Central Coast regions to Sydney. The 500 kV lines (Line 5A1 and 5A2) will continue to take the majority of the flow from the Central Coast to Sydney. The line utilisation data in our 2023 Transmission Annual Planning Report shows Line 21 (330 kV) has a maximum utilisation rate of 34% and Line 22 (330 kV) has a maximum utilisation rate of 88% under credible contingency. Lines 959 and 92Z (both 132 kV lines) are in parallel with Line 27 and 28 (both 330 kV lines) between Sydney North and Sydney East. Lines 959 and 92Z have a maximum utilisation rate of 42% and 22% under credible contingency, respectively.[17] We consider that uprating would cost significantly more than Option 1 and not add a commensurate increase in estimated market benefit. Uprating is therefore not considered commercially feasible.
Increased inspections	The condition issues have already been identified and cannot be rectified through increased inspections. This option is therefore not technically feasible.
Elimination of all associated risk	This can only be achieved through retirement and decommissioning of the associated assets. This option is therefore not technically feasible.

[17] Transgrid, *Transmission Annual Planning Report 2023*, p.155

New transmission lines	New transmission lines to replace the four lines identified is not considered commercially feasible given the significant cost.
Non-network solutions	We do not consider non-network options to be commercially and technically feasible to assist with meeting the identified need, as non-network options will not mitigate the safety, environmental and financial risks posed as a result of asset deterioration.

3.4. No material inter-network impact is expected

We have considered whether the credible options listed above is expected to have material inter-regional impact.[18] A 'material inter-network impact' is defined in the NER as:

> *"A material impact on another Transmission Network Service Provider's network, which impact may include (without limitation): (a) the imposition of power transfer constraints within another Transmission Network Service Provider's network; or (b) an adverse impact on the quality of supply in another Transmission Network Service Provider's network."*

AEMO's suggested screening test to indicate that a transmission augmentation has no material inter-network impact is that it satisfies the following:[19]

- a decrease in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW;
- an increase in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3% of the maximum transfer capability and 50 MW;
- an increase in fault level by less than 10 MVA at any substation in another TNSP's network; and
- the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

We note that each credible option satisfies these conditions as it does not modify any aspect of electrical or transmission assets. By reference to AEMO's screening criteria, there is no material inter-network impacts associated with any of the credible options considered.

18 As per clause 5.16.4(b)(6)(ii) of the NER.

19 Inter Regional Planning Committee, *Final determination: Criteria for assessing material inter-network impact of transmission augmentations*, 2004, pp 16-18.

4. Materiality of market benefits

This section outlines the categories of market benefits prescribed in the National Electricity Rules (NER) and whether they are considered material for this RIT-T.[20]

4.1. Wholesale electricity market benefits are not material

The AER has recognised that if the credible options considered will not have an impact on the wholesale electricity market, then a number of classes of market benefits will not be material in the RIT-T assessment, and so do not need to be estimated.[21]

The credible options considered in this RIT-T will not address network constraints between competing generating centres and are therefore not expected to result in any change in dispatch outcomes and wholesale market prices. We therefore consider that the following classes of market benefits are not material for this RIT-T assessment:

- changes in fuel consumption arising through different patterns of generation dispatch;
- changes in voluntary load curtailment (since there is no impact on pool price);
- changes in costs for parties other than the RIT-T proponent;
- changes in ancillary services costs;
- changes in network losses; and
- competition benefits.

4.2. No other classes of market benefits are material

In addition to the classes of market benefits listed above, NER clause 5.15A.2(b)(6) requires that we consider the following classes of market benefits arising from each credible option. We consider that none of the classes of market benefits listed are material for this RIT-T assessment for the reasons in the table below.

[20] The NER requires that all classes of market benefits identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific class (or classes) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.15A.2(b)(6). See Appendix A for requirements applicable to this document.

[21] AER, *Regulatory investment test for transmission application guidelines – October 2023*, p 31.

Table 4-1 Reasons non-wholesale electricity market benefits are considered immaterial

Market benefits	Reason
Changes in involuntary load curtailment	Since the lines form part of a meshed network required to supply Sydney, a failure of one line due to condition issues results in a negligible chance of unserved energy.
Differences in the timing of expenditure	The option considered is unlikely to affect decisions to undertake unrelated expenditure in the network. Consequently, material market benefits will neither be gained nor lost due to changes in the timing of other network expenditure from the option considered.
Option value	We note the AER's view is that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available is likely to change in the future, and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[22] We also note the AER's view is that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. We note that the credible option is not sufficiently flexible to respond to change or uncertainty for this RIT-T. Specifically, it is focused on proactively replacing deteriorating assets ahead of when they fail.
Changes in Australian greenhouse gas emissions	The sole credible option is not expected to induce a material change in Australia's greenhouse gas emissions.

[22] AER, *Regulatory investment test for transmission application guidelines – October 2023*, p 101.

5. Overview of the assessment approach

This section outlines the approach that we have applied in assessing the net benefits associated with the credible option against the base case.

5.1. Description of the base case

The costs and benefits of Option 1 are compared against the base case. Under this base case, no proactive investment is undertaken, and the line will continue to operate with an increasing level of risk.

We note that this course of action is not expected in practice. However, this approach has been adopted since it is consistent with AER guidance on the base case for RIT-T applications.[23]

5.2. Assessment period and discount rate

A 20-year assessment period from 2023/24 to 2042/43 has been adopted for this RIT-T analysis. This period takes into account the size, complexity and expected asset life of the options.

Where the capital components of the credible options have asset lives extending beyond the end of the assessment period, the NPV modelling includes a terminal value to capture the remaining functional asset life. This ensures that the capital cost of long-lived options over the assessment period is appropriately captured, and that all options have their costs and benefits assessed over a consistent period, irrespective of option type, technology or serviceable asset life. The terminal values are calculated as the undepreciated value of capital costs at the end of the analysis period.

A real, pre-tax discount rate of 7.0 per cent has been adopted as the central assumption for the NPV analysis presented in this PACR, consistent with AEMO's latest Input Assumptions and Scenarios Report (IASR).[24] The RIT-T requires that sensitivity testing be conducted on the discount rate and that the regulated weighted average cost of capital (WACC) be used as the lower bound. We have therefore tested the sensitivity of the results to a lower bound discount rate of 3.63 per cent.[25] We have also adopted an upper bound discount rate of 10.5 per cent (ie, the upper bound in the latest IASR).[24]

5.3. Approach to estimating option costs

We have estimated the capital costs based on the scope of works necessary together with costing experience from previous projects of a similar nature.

All costs estimated by Transgrid's project development team use the estimating tool 'MTWO'. The MTWO cost estimating database reflects actual outturn costs built up over more than 10 years from:

- Period order agreement rates and market pricing for plant and materials.
- Labour quantities from recently completed project.

[23] We note that the AER RIT-T Guidelines state that the base case is where the RIT–T proponent does not implement a credible option to meet the identified need, but rather continues its 'BAU activities'. The AER define 'BAU activities' as ongoing, economically prudent activities that occur in the absence of a credible option being implemented. AER, *Regulatory investment test for transmission application guidelines – October 2023*, p 22.

[24] AEMO, 2023 Inputs, Assumptions and Scenarios Report | Final report, July 2023, p 123.

[25] This is equal to WACC (pre-tax, real) in the latest final decision for a transmission business in the NEM (Transgrid) as of the date of this analysis, see: AER, *TasNetworks – 2024-29 – Final decision – PTRM*, April 2024, WACC sheet.

- Construction tender and contract rates from recent projects.

The MTWO estimating database is reviewed annually to reflect the latest outturn costs and confirm that estimates are within their stated accuracy range and represent the most likely expected cost of delivery (P50 costs[26]). As part of the annual review, Transgrid benchmarks the outcomes against independent estimates provided by various engineering consultancies.[27]

Transgrid does not generally apply the Association for the Advancement of Cost Engineering (AACE) international cost estimate classification system to classify cost estimates. Doing so for this RIT-T would involve significant additional costs, which would not provide a corresponding increase in benefits compared with the use of MWTO estimates and so this has not been undertaken.

We estimate that actual costs will be within +/- 25 per cent of the central capital cost estimate. While we have not explicitly applied the AACE cost estimate classification system, we note that an accuracy of +/- 25 per cent for cost estimates is consistent with industry best practice and aligns with the accuracy range of a 'Class 4' estimate, as defined in the AACE classification system.

No specific contingency allowance has been included in the cost estimates.

All cost estimates are prepared in real, 2023/24 dollars based on the information and pricing history available at the time that they were estimated. The cost estimates do not include or forecast any real cost escalation for materials.

5.4. The option has been assessed against three reasonable scenarios

The RIT-T is focused on quantifying the net benefits of the sole credible option. However, uncertainty exists in terms of estimating future inputs and variables (termed future 'states of the world').

To deal with this uncertainty, the NER requires that costs and market benefits for each credible option are estimated under reasonable scenarios and then weighted based on the likelihood of each scenario to determine a weighted ('expected') net benefit. It is this 'expected' net benefit that is used to rank credible options and identify the preferred option.

The credible option has been assessed under three scenarios as part of this PACR assessment, which differ in terms of the key drivers of the estimated net market benefits (ie, the estimated risk costs avoided).

Given that wholesale market benefits are not relevant for this RIT-T, the three scenarios assume the expected most likely scenario for the 2024 ISP (ie, the 'Step Change' scenario). The scenarios differ by the assumed level of risk costs, given that these are key parameters that may affect the ranking of the credible options. Risk cost assumptions do not form part of AEMO's ISP assumptions, and have been based on Transgrid's analysis, as discussed in section 2.

[26] i.e., there is an equal likelihood of over- or under-spending the estimate total.

[27] For further detail on our cost estimating approach refer to section 7 of our Augmentation Expenditure Overview Paper submitted with our 2023-28 Revenue Proposal.

How the NPV results are affected by changes to other variables (including the discount rate and capital costs) has been investigated in the sensitivity analysis. We consider this is consistent with the latest AER guidance for RIT-Ts of this type (ie, where wholesale market benefits are not expected to be material).[28,29]

Table 5-1 Summary of scenarios

Variable / Scenario	Central	Low risk cost scenario	High risk cost scenario
Scenario weighting	*1/3*	*1/3*	*1/3*
Discount rate	7.0%	7.0%	7.0%
Network capital costs	Base estimate	Base estimate	Base estimate
Operating and maintenance costs	Base estimate	Base estimate	Base estimate
Safety, environmental, and financial risk benefit	Base estimate	Base estimate – 25%	Base estimate +25%

We have weighted the three scenarios equally given there is nothing to suggest an alternate weighting would be more appropriate.

5.5. Sensitivity analysis

In addition to the scenario analysis, we have also considered the robustness of the outcome of the cost benefit analysis through undertaking various sensitivity testing.

The range of factors tested as part of the sensitivity analysis in this PACR are:

- lower and higher assumed capital costs;
- lower and higher estimated safety, environmental, and financial risk benefits; and
- alternate commercial discount rate assumptions.

The results of the sensitivity tests are set out in section 6.4.

28 AER, *Regulatory investment test for transmission application guidelines – October 2023*, p 26.

29 See: AER, *Decision: North West Slopes and Bathurst, Orange and Parkes Determination on dispute - Application of the regulatory investment test for transmission*, November 2022, pp. 18-20 & 31-32, as well as with the AER's RIT-T Guidelines.

6. Assessment of credible options

This section outlines the assessment we have undertaken for the credible network option. The assessment compares the costs and benefits of the credible option to the base case. The benefits of the credible option are represented by a reduction in costs or risks compared to the base case.

6.1. Estimated gross benefits

The table below summarises the present value of the gross benefit estimates for Option 1 relative to the base case under the three scenarios. The benefits included in this assessment consist only of avoided risk, i.e., a reduction in safety, environmental and financial risks.

Table 6-1 Estimated gross benefits from credible options relative to the base case ($m, PV)

Option/scenario	Central	Low risk cost scenario	High risk cost scenario	Weighted
Scenario weighting	*1/3*	*1/3*	*1/3*	
Option 1	354.8	266.1	443.5	354.8

6.2. Estimated costs

Option 1 has a capital cost of $25.4 million in present value terms across all scenarios, consisting of direct capital costs relative to the base case. As noted in section 3.2, there is no change in operating costs from the base case for Option 1.

6.3. Estimated net economic benefits

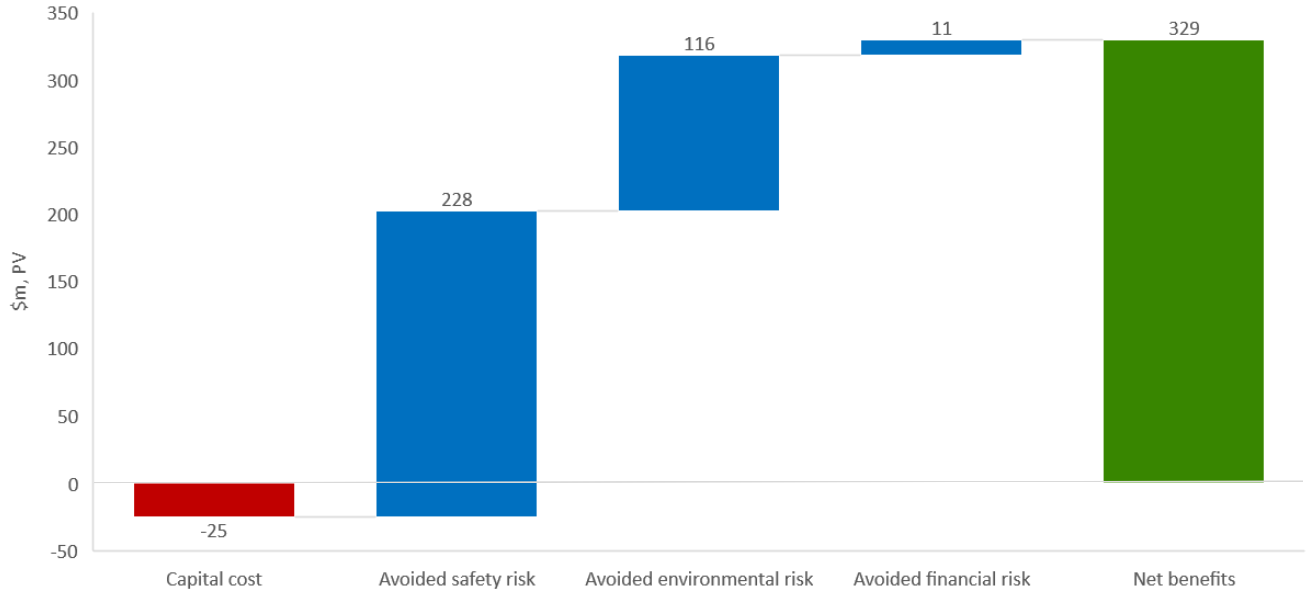
The net economic benefits are the differences between the estimated gross benefits and the estimated costs. The table below summarises the present value of the net economic benefits for the credible option across the three scenarios and the weighted net economic benefits.

Table 6-2 Net economic benefits for Option 1 relative to the base case ($m, PV)

Option/scenario	Central	Low risk cost scenario	High risk cost scenario	Weighted
Scenario weighting	*1/3*	*1/3*	*1/3*	
Option 1	329.5	240.8	418.2	329.5

On a weighted basis, Option 1 is found to deliver net economic benefits of $329.5 million in present value terms.

Figure 6-1 Net economic benefits ($m, PV) – weighted results



6.4. Sensitivity testing

We have undertaken sensitivity testing to understand the robustness of the RIT-T assessment to underlying assumptions about key variables. In particular, we have undertaken two sets of sensitivity tests:

- Step 1 – testing the sensitivity of the optimal timing of the project ('trigger year') to different assumptions in relation to key variables; and
- Step 2 – once a trigger year has been determined, testing the sensitivity of the total NPV benefit associated with the investment proceeding in that year, in the event that actual circumstances turn out to be different.

The application of the two steps to test the sensitivity of the key findings is outlined below.

6.4.1. Step 1 – Sensitivity testing of the optimal timing

This section outlines the sensitivity of the identification of the commissioning year to changes in the underlying assumptions. Each timing sensitivity has been undertaken on the central scenario.

The optimal timing of Option 1 is found to be invariant to the assumptions of:

- a 25 per cent decrease or increase in the assumed network capital costs;
- lower and higher assumed safety, environmental and financial risks; and
- lower discount rate of 3.63 per cent as well as a higher rate of 10.50 per cent.

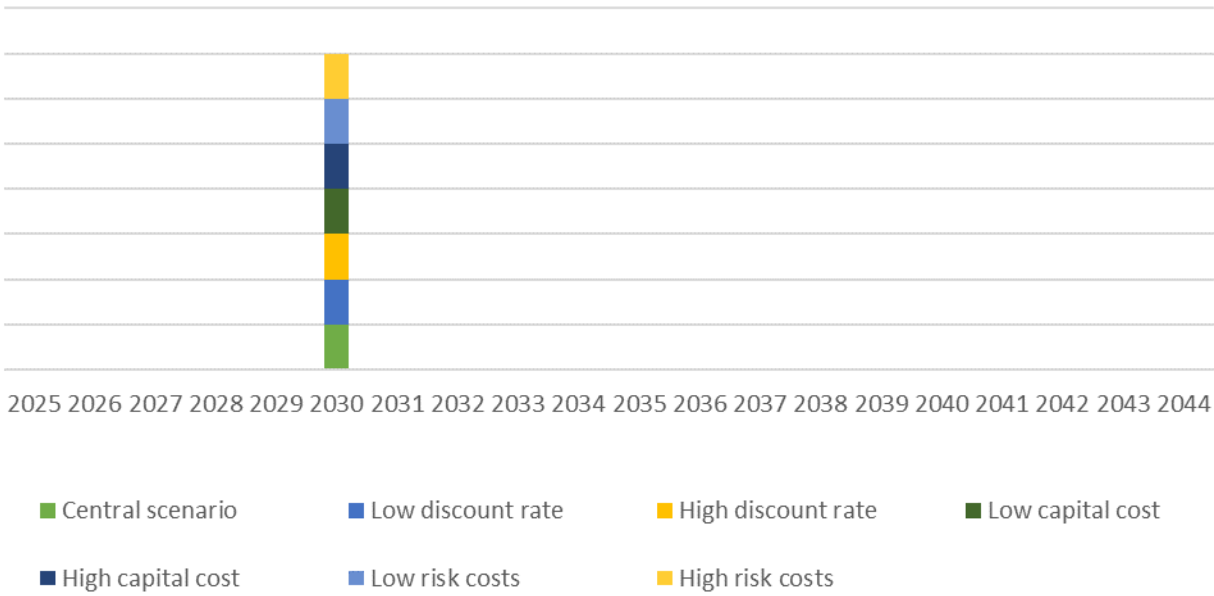
The figures below outline the impact on the optimal commissioning year for each line, under a range of alternative assumptions. It illustrates that the optimal commissioning dates for lines 21, 22, 959 and 92Z are FY26, FY28, FY28 and FY30 respectively.

Figure 6-2 Optimal timing for Line 21

Figure 6-3 Optimal timing for Line 22

Figure 6-4 Optimal timing for Line 959

Figure 6-5 Optimal timing for Line 92Z



While the optimal commissioning date for Line 22 and Line 959 is one year later than what has been planned for (and modelled in the core NPV assessment), we consider the planned commissioning optimal given the optimal timing for the other two lines and the overlap in costs (e.g., mobilisation costs) and scheduling required given their locations.

6.4.2. Step 2 – Sensitivity of the overall net benefit

We have conducted sensitivity analysis on the present value of the net economic benefit, based on undertaking the project in 2024/25 and completion in 2029/30. Specifically, we have investigated the same sensitivities under this step as in the first step:

- a 25 per cent increase/decrease in the assumed network capital costs;

- lower (or higher) assumed safety, environmental and financial risks; and
- lower discount rate of 3.63 per cent as well as a higher rate of 10.5 per cent.

All these sensitivities investigate the consequences of 'getting it wrong' having committed to a certain investment decision.

The figures below illustrate the estimated net economic benefits for Option 1 if separate key assumptions in the central scenario are varied individually.

Option 1 delivers positive benefits under all scenarios. We do not expect Option 1 to exhibit net costs within reasonable capital cost, risk cost and discount rate sensitivities.

Figure 6-6 Capital cost sensitivity

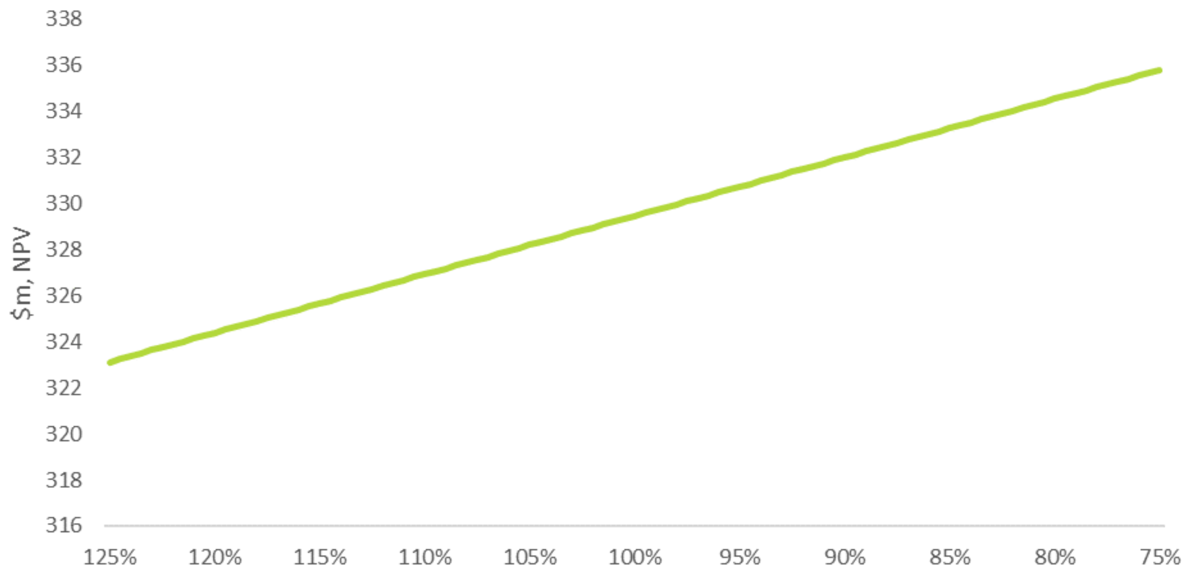


Figure 6-7 Risk cost sensitivity

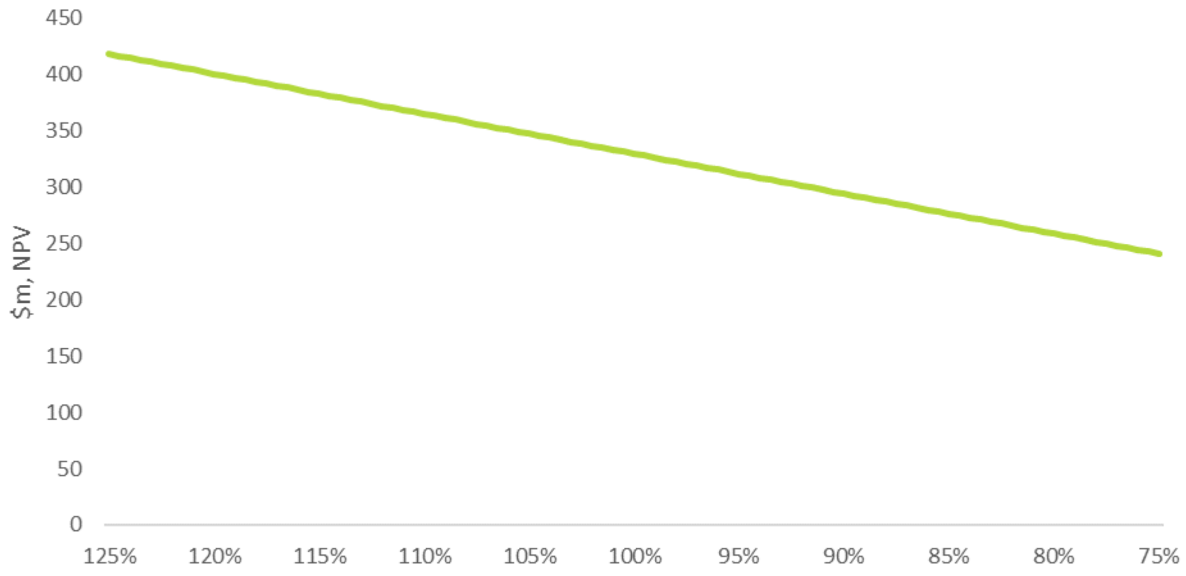
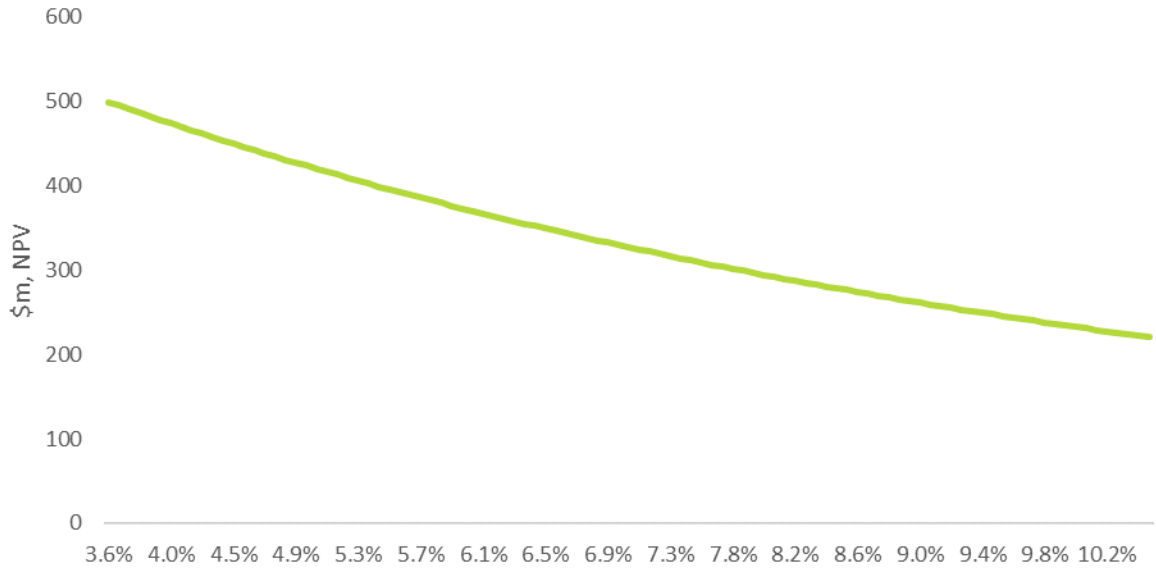


Figure 6-8 Commercial discount rate sensitivity



In terms of boundary testing, we find that the following would need to occur for Option 1 to have zero net benefits:

- assumed network capital costs (for all options) would need to increase by 1,300 per cent;
- the estimated risk costs (in aggregate) would need to decrease by 93 per cent; and
- a discount rate of 61.8 per cent.

These boundaries where Option 1 would no exhibit net benefits are extreme and are unlikely to eventuate. We therefore consider the finding that Option 1 is expected to provide positive net benefits is robust.

7. Final conclusion on the preferred option

This PACR has found that Option 1 is the preferred option at this draft stage of the RIT-T. Option 1 involves the replacement of approximately 51 kilometres of conductors on Lines 21, 22, 959 and 92Z.

The estimated capital expenditure associated with the option is $36.6 million (in 2023/24 dollars) and the works are estimated to take place between 2024/25 and 2029/30.

Option 1 is the preferred option in accordance with NER clause 5.15A.2(b)(12) because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. The analysis undertaken and the identification of Option 1 as the preferred option satisfies the RIT-T.

Transgrid considers this conclusion to be robust to changes in capital cost inputs, estimated risk costs and underlying discount rates, noting that there would need to be unrealistic changes to these key assumptions for there to be no expected net benefits (as shown via the boundary testing at the end of section 6). Transgrid will however continue to monitor these key assumptions and will notify the AER if such changes do occur (or appear likely), which would constitute a material change in circumstance.

Appendix A Compliance checklist

This appendix sets out a checklist which demonstrates the compliance of this PACR with the requirements of the National Electricity Rules version 210.

Rules clause	Summary of requirements	Relevant section(s) in the PACR
5.16.4(v)	The project assessment conclusions report must set out:	–
	(1) the matters detailed in the project assessment draft report as required under paragraph (k); and	See below.
	(2) a summary of, and the RIT-T proponent's response to, submissions received, if any, from interested parties sought under paragraph (q).	NA
5.16.4(k)	The project assessment draft report must include:	–
	(1) a description of each credible option assessed;	3
	(2) a summary of, and commentary on, the submissions to the project specification consultation report;	NA
	(3) a quantification of the costs, including a breakdown of operating and capital expenditure, and classes of material market benefit for each credible option;	3 & 6
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	4 & 5
	(5) reasons why the RIT-T proponent has determined that a class or classes of market benefit are not material;	4
	(6) the identification of any class of market benefit estimated to arise outside the region of the Transmission Network Service Provider affected by the RIT-T project, and quantification of the value of such market benefits (in aggregate across all regions);	NA
	(7) the results of a net present value analysis of each credible option and accompanying explanatory statements regarding the results;	6
	(8) the identification of the proposed preferred option;	7
	(9) for the proposed preferred option identified under subparagraph (8), the RIT-T proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date; (iii) if the proposed preferred option is likely to have a material inter-network impact and if the Transmission Network Service Provider affected by the RIT-T project has received an augmentation technical report, that report; and (iv) a statement and the accompanying detailed analysis that the preferred option satisfies the regulatory investment test for transmission.	3 & 7

Appendix B Risk assessment methodology

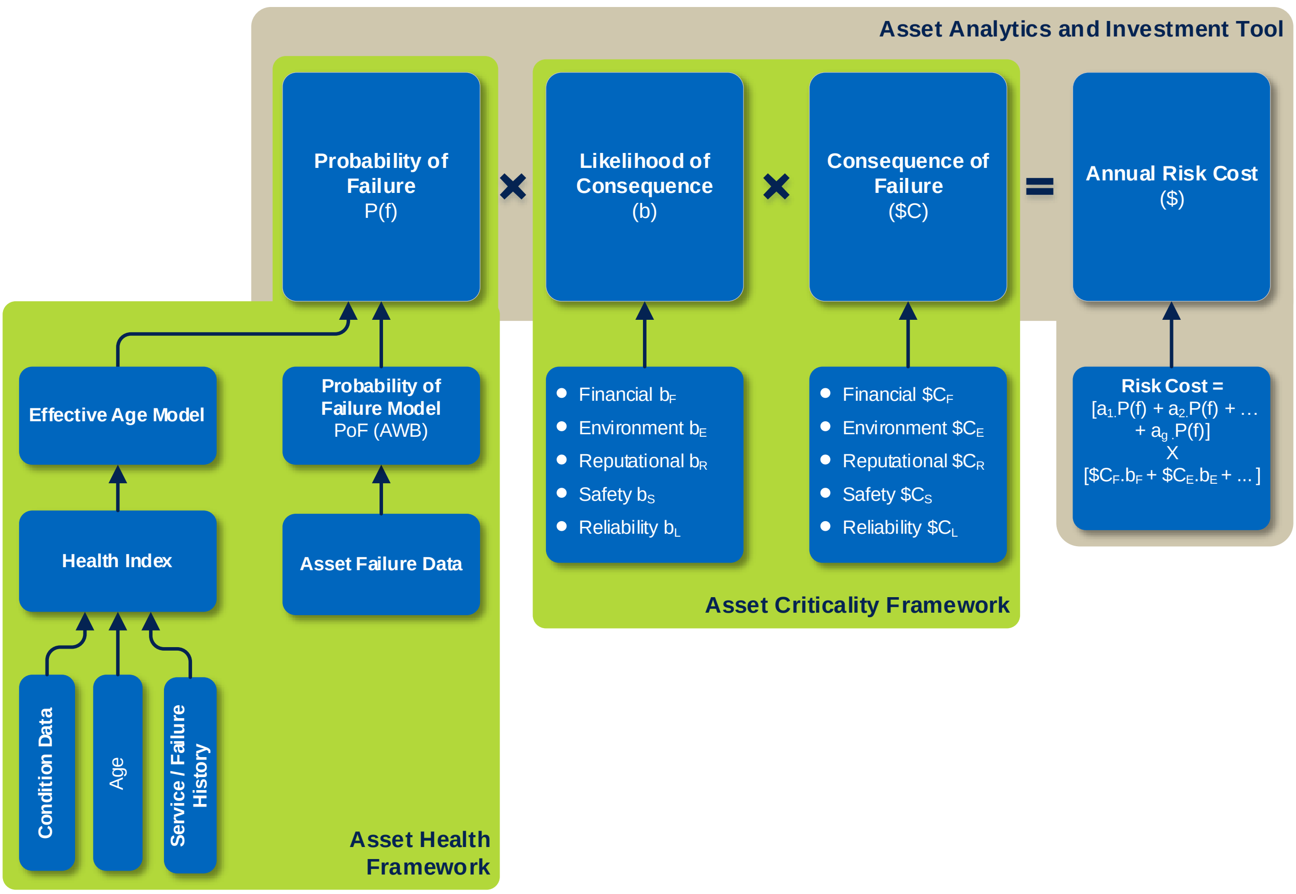
This appendix summarises our network risk assessment methodology that underpins the identified need for this RIT-T. Our risk assessment methodology is aligned with the AER's Asset Replacement Planning guideline[30] and its principles.

A fundamental part of the risk assessment methodology is calculating the annual 'risk costs' or the monetised impacts of the environmental, safety and financial risks.

The monetary value of risk (per year) for an individual asset failure resulting in an undesired outcome, is the likelihood (probability) of failure (in that year with respect to its age), as determined through modelling the failure behaviour of an asset (Asset Health), multiplied by the consequence (cost of the impact) of the undesired outcome occurring, as determined through the consequence analysis (Asset Criticality).

Figure B-1 below summarises the framework for calculating the 'risk costs', which has been applied on our asset portfolio considered to need replacement or refurbishment.

Figure B-1 Risk cost calculation



Economic justification of repex to address an identified need is supported by risk monetised benefit streams, to allow the costs of the project or program to be assessed against the value of the avoided risks

30 Industry practice application note - Asset replacement planning, AER January 2019

and costs. The major quantified risks we apply for repex justifications include asset failures that materialise as:

- safety risk;
- bushfire risk;
- environmental risk;
- reliability risk; and
- financial risk.

The risk categories relevant to this RIT-T are explained in Section 2.3.

Further details are available in our Network Risk Assessment Methodology.

Appendix C Asset health and probability of failure

The first step in calculating the PoF of an asset is determining the asset health and associated effective age,[31] which considers that:

- an asset consists of different components, each with a particular function, criticality, underlying reliability, life expectancy and remaining life - the overall health of an asset is a compound function of all of these attributes;
- key asset condition measures and failure data provides vital information on the current health of an asset, where the 'current effective age' is derived from asset information and condition data;
- the future health of an asset (health forecasting) is a function of its current health and any factors causing accelerated (or decelerated) degradation or 'age shifting' of one or more of its components – such moderating factors can represent the cumulative effects arising from continual or discrete exposure to unusual internal, external stresses, overloads and faults; and
- 'future effective age' is derived by moderating 'current effective age' based on factors such as, external environment/influence, expected stress events and operating/loading condition.

The PoF is the likelihood that an asset will fail during a given period resulting in a particular adverse event, eg, equipment failure, pole failure, broken overhead conductor.

The outputs of the PoF calculation are one or more probability of failure time series which provide a mapping between the effective age, discussed above, and the yearly probability of failure value for a given asset class. This analysis is performed by generating statistical failure curves, normally using Weibull analysis, to determine a PoF time series set for each asset that gives a probability of failure for each further year of asset life. This establishes how likely it is that the asset will fail over time.

The Weibull parameters which represent the probability of failure curve for key transmission line components are summarised in Table C-1 below.

Further details are available in our Network Asset Health Methodology.

[31] Apparent age of an asset based on its condition.

Table C-1 Weibull parameters for asset components

Asset component	Weibull parameters	
	η	β
Structure – Steel Tower - C2	3900	1.319
Structure – Steel Tower - C3	270.9	2.17
Structure – Steel Tower - C4	141.21	2.71
Conductor – C1 and C2	109.8	2.289
Conductor – C3	68.46	7.272
Conductor – C4	63.3	25.19
Insulators - Non-Ceramic Insulators	26.55	3.232
Insulators - Porcelain and Glass Disc - Low corrosion	261.7	4.581
Insulators - Porcelain and Glass Disc - High corrosion	173.7	4.763
Conductor Fittings - C1/C2	127.4	4.376
Conductor Fittings - C3/C4	64.24	10.13
Earthwire Fittings - C1/C2	116.5	5.198
Earthwire Fittings - C3/C4	66.61	10.98

Note: C1 (Very Low), C2 (Low), C3 (Medium) and C4 (High) relate to atmospheric corrosion zones based on Australian Standard AS 4312-2008.