TransGrid

Maintaining compliance with performance standards applicable to Darlington Point substation secondary systems

RIT-T – Project Assessment Conclusions Report

Region: South Western NSW

Date of issue: 12 July 2021

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

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining reliable secondary systems at Darlington Point substation. Publication of this Project Assessment Conclusions Report (PACR) represents the final step in the RIT-T process.

Darlington Point substation will continue to play a central role in the safe and reliable operation of the power system throughout and after the transition to a low-carbon electricity future. Located in the Riverina agricultural irrigation area inclusive of Leeton, the centre of the rice growing district in NSW, it forms part of the Southern New South Wales network which has been identified as an area of interest for new renewable connections[1].

Darlington Point substation is a customer connection point supplying the Essential Energy 132 kV network in the Riverina region and is the starting point for the 220 kV network supplying Far West NSW and interconnects to Victoria at Red Cliffs.

TransGrid has identified that the secondary systems at Darlington Point substation have reached a condition that reflects the end of serviceable life. As it is superseded by new technology at the manufacturer level and the existing technology becomes obsolete, spare parts become scarce and the ability of any primary asset connected to the substation to reliably operate will be at risk.

Identified need: meet the service level required under the National Electricity Rules for protection schemes

Secondary systems are used to control, monitor, protect and secure communication to facilitate safe and reliable network operation.[2] They are necessary to operate the transmission network and prevent damage to primary assets when adverse events occur.

Provision of redundant protection schemes to ensure the transmission system is adequately protected is a Network Performance Requirement under Schedule 5.1 of the National Electricity Rules (NER), therefore the condition issues affecting the secondary systems at Darlington Point substation must be addressed.

The Network Performance Requirements, set out in Schedule 5.1 of the NER, place an obligation on Transmission Network Service Providers (TNSPs) to provide redundant protection schemes to ensure the transmission system is adequately protected. Schedule 5.1.9(c) of the NER requires a TNSP to provide sufficient primary and back-up protection systems, including any communications facilities and breaker fail protection systems, to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.

Additionally, TNSPs are required to disconnect the unprotected primary systems where secondary systems fault lasts for more than eight hours (for planned maintenance) or 24 hours (for unplanned outages). TNSPs must also ensure that all protection systems for lines at a voltage above 66 kV are well-maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of protection systems is being carried out.[3] In the event of an unplanned outage, AEMO's Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours.[4]

Furthermore, as per clause 4.11.1 of the NER, remote monitoring and control systems are required to be maintained in accordance with the standards and protocols determined and advised by AEMO.

---

1 Darlington Point substation is located within the South-West Energy Zone, one of three Renewable Energy Zones (REZ) prioritised by the NSW Government

2 As per Schedule 5.1 of the NER.

3 As per S5.1.2.1(d) of the NER.

4 Australian Energy Market Operator. *"Power System Security Guidelines, 7 April 2021."* Melbourne: Australian Energy Market Operator, 2021.35. Accessed 22 June 2021. https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en

A failure of the secondary systems would involve replacement of the failed component or taking the affected primary assets, such as lines and transformers, out of service.

Though replacement of failed secondary systems component is a possible interim measure, the approach is not sustainable as the stock of spare components will deplete due to the technology no longer being manufactured or supported. Once all spares are used, replacement will cease to be a viable option to meet performance standards stipulated in clause 4.6.1 of the NER.

If the failure to provide functional secondary systems due to technology obsolescence, on the 220/330kV secondary systems components, is not addressed by a technically and commercially feasible credible option in sufficient time (by 2022/23), the likelihood of not recovering from secondary systems faults and not maintaining compliance with NER performance requirements will increase. TransGrid has assessed that the 132kV secondary system assets do not warrant replacement within the same timeframe under this proposed project, and although benefits would be further derived from modernisation of monitoring and control systems it is considered non-prudent expenditure before 2022/23.

The proposed investment will enable TransGrid to continue to meet the standards for secondary systems availability set out in the NER, and to avoid the impacts of taking primary assets out of service. Consequently, it is considered 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 received in response to the Project Specification Consultation Report

TransGrid published a Project Specification Consultation Report (PSCR) on 22 September 2020 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

Since the time the PSCR was published, the cost estimate factors for Option 2 have been adjusted to reflect the latest estimated resourcing requirements to implement the preferred option. This resulted in an increase to the total cost estimate from $6.8m to $7.8m. TransGrid recalculated the NPV analysis for this PACR using the updated estimate for capital expenditure for Option 2 and the outcome had no impact on the ranking of the options.

No additional credible options were identified during the consultation period following publication of the PSCR.

No other changes have occurred since the PSCR which have made an impact on the preferred option.

Option 2 remains the preferred option at this stage of the RIT-T process.

Complete in-situ replacement remains the most prudent and economically efficient option to meet regulatory obligations

In the PSCR TransGrid put forward for consideration three technically and commercially feasible options:

> **Option 1** – Strategic asset replacement
> **Option 2** – Complete in-situ replacement

> **Option 3** – IEC-61850 replacement[5]

Option 2 remains the most prudent and economically efficient option to address the identified need. Implementation of Option 2 will enable TransGrid to continue meeting its regulatory obligations set out in clauses 4.11.1, 4.6.1(b),[6] and Schedule 5.1 of the NER. Consequently, it will ensure the performance standards applicable to Darlington Point substation secondary systems are met and is therefore the preferred option for this RIT-T.

TransGrid expects coronavirus (COVID-19) to impact suppliers and disrupt their supply chains, although at this time the extent of the current or future impact is unknown. Consequently, some of the costs associated with the works outlined in this document may be affected.

All costs presented in this PACR are in 2020/21 dollars. The options are summarised in the table below.

Table E-1 Options considered

Option	Description	Capital cost ($m 2020/21)	Operating costs ($ per year)	Remarks
Option 1	Strategic asset replacement	~ 4.3 (+/- 25%) between 2020/21 and 2033/34	~6,000	Technically and commercially feasible but does not address technological obsolescence beyond 2023 and is therefore not practicable.
Option 2	**Complete in-situ replacement**	**~6.3 (+/- 25%) by 2022/23 for the 220/330kV assets and ~1.5 (+/- 25%) for the 132kV assets between 2023/24 and 2033/34**	**~5,000**	**Preferred option, would maintain regulatory obligations and provide highest net economic benefits**
Option 3	IEC-61850 replacement[7]	~ 8.3 (+/- 25%)	~10,000	Would maintain regulatory obligations but provide less benefits

[5] International Electrotechnical Commission (IEC), "IEC 61850 standard for Power Utility Automation," accessed 14 May 2020. http://www.iec.ch/smartgrid/standards/

[6] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

[7] International Electrotechnical Commission (IEC), "IEC 61850 standard for Power Utility Automation," accessed 14 May 2020. http://www.iec.ch/smartgrid/standards/

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

In the PSCR, TransGrid noted that non-network options are not considered to be commercially and technically feasible to assist with meeting the identified need for this RIT-T. This is because non-network options will not enable TransGrid to continue meeting its NER obligation to provide redundant secondary systems and ensure that the transmission system is adequately protected.

Conclusion: complete in-situ replacement of protection and control systems is optimal

The optimal commercially and technically feasible option presented in the PSCR – Option 2 (complete in-situ replacement of protection and control systems) – remains the preferred option to meet the identified need. Option 2 can be implemented in sufficient time to meet the identified need by 2022/23, and is therefore the preferred option presented in this PACR.

Moving forward with this option is the most prudent and economically efficient solution to enable TransGrid to continue meeting its regulatory obligations set out in clauses 4.11.1, 4.6.1(b),[8] and Schedule 5.1 of the NER. Consequently, it will ensure the performance standards applicable to Darlington Point substation secondary systems are met.

Option 2 involves replacement of all secondary systems assets at Darlington Point substation. This option will modernise the automation philosophy to current design standards and practices. This option also includes replacement of Direct Current (DC) supplies to account for an increase in secondary systems power requirements and remediation of the 415V Alternating Current (AC) distribution in the building and the switchyard. There are also additional operational benefits available due to improved remote monitoring, control and interrogation, efficiency gains in responding to faults, and phasing out of obsolete and legacy systems and protocols.

The estimated capital cost of this option is approximately $7.8 million ($6.3 million of this by 2022/23 for the 330kV and 220kV assets). Routine and operating maintenance costs are approximately $5,000 per year.

The works on the 330kV and 220kV assets will be undertaken between 2020/21 and 2022/23. Planning and design (including completion of the RIT-T) commenced in 2019/20 and is due to conclude in 2020/21. The procurement and delivery of the identified assets is planned to occur in 2021/22. Works will be completed by 2022/23. The 132kV asset works are planned between 2023/24 and 2033/34.

Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

The analysis undertaken and the identification of Option 2 as the preferred option satisfies the RIT-T. Option 2 is the preferred option in accordance with NER clause 5.16.1(b) because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. This preferred option, Option 2, was found to have the highest net economic benefit while also maintaining compliance with regulatory and safety obligations. TransGrid also conducted sensitivity analysis on the net economic benefit to investigate the robustness of the conclusion to key assumptions. TransGrid finds that under all sensitivities, Option 2 delivers the most net benefit.

Next steps

This PACR represents the third and final step of the consultation process in relation to the application of the Regulatory Investment Test for Transmission (RIT-T) process undertaken by TransGrid. It follows a Project

[8] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

Specification Consultation Report (PSCR) released in September 2020. No submissions were received in response to the PSCR.

The second step, 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[9] due to:

- the estimated capital cost of the proposed preferred option being less than $43 million;
- the PSCR stating:
  - the proposed preferred option (including reasons for the proposed preferred option)
  - the RIT-T is exempt from producing a PADR
  - the proposed preferred option and any other credible option will not have material market benefits[10] except for voluntary load curtailment and involuntary load shedding
- the RIT-T proponent considers that there were 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.

Parties wishing to raise a dispute notice with the AER may do so prior to 10 August 2021 (30 days after publication of this PACR). 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 RIT-TConsultations@transgrid.com.au. In the subject field, please reference 'Darlington Point Secondary Systems PACR'.

[9] In accordance with NER clause 5.16.4(z1)(4), the exemption from producing a PADR will no longer apply if TransGrid considers that an additional credible option that could deliver a material market benefit is identified during the consultation period. No additional credible options were identified.

[10] As per clause 5.16.1(c)(6)

Contents

List of Tables

List of Figures

1. Introduction

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for maintaining a reliable secondary systems at Darlington Point substation. TransGrid has commenced this RIT-T to examine and consult on options to address the need - mitigate and alleviate the deterioration of the secondary systems at Darlington Point substation and the risk from technology obsolescence. As investment is intended to maintain compliance with NER requirement, TransGrid considers this a reliability corrective action RIT-T.

1.1 Purpose of this report

The purpose of this PACR[11] is to:

- describe the identified need
- describe and assess credible options to meet the identified need
- describe the assessment approach used
- provide details of the proposed preferred option to meet the identified need

1.2 Exemption from preparing a Project Assessment Draft Report (PADR)

Publication of a Project Assessment Draft Report (PADR) is not required for this RIT-T as TransGrid considers its investment in relation to the preferred option to be exempt from that part of the process under NER clause 5.16.4(z1). Production of a PADR is not required due to:

- the estimated capital cost of the proposed preferred option being less than $43 million[12];
- the PSCR stating:
  - the proposed preferred option (including reasons for the proposed preferred option)
  - that the RIT-T is exempt from producing a PADR
  - that the proposed preferred option and any other credible option will not have material market benefits[13] except for voluntary load curtailment and involuntary load shedding
- the RIT-T proponent considers that there were 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.

1.3 Next steps

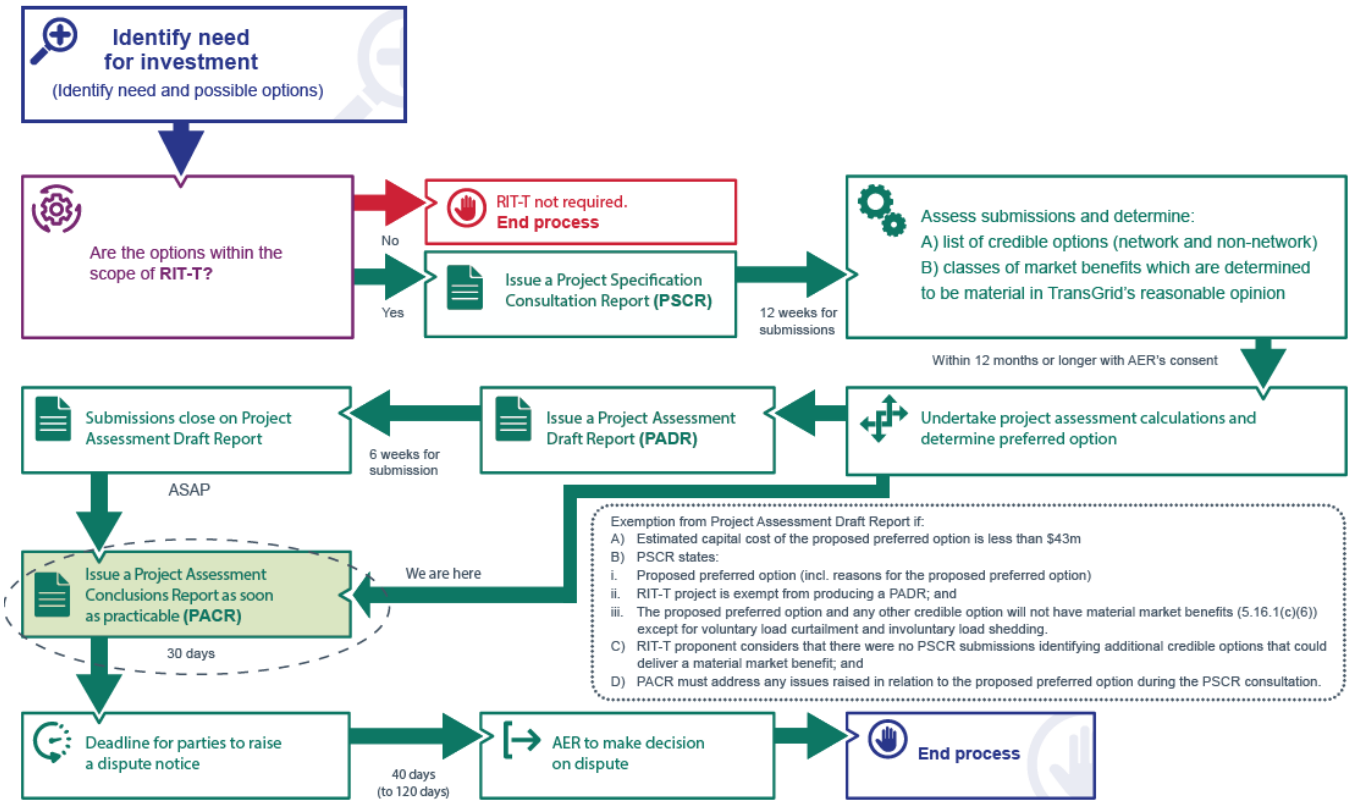
This PACR represents the third and final step of the consultation process in relation to the application of the Regulatory Investment Test for Transmission (RIT-T) process undertaken by TransGrid. It follows a Project Specification Consultation Report (PSCR) released in September 2020. No submissions were received in response to the PSCR.

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

[12] Varied from $35m to $43m based on the AER Final Determination: Cost threshold review November 2018.14. Accessed 20 May 2020 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/cost-thresholds-review-for-the-regulatory-investment-tests-2018

[13] As per clause 5.16.1(c)(6)

Figure 1-1 This PACR is the third stage of the RIT-T process[14]



Parties wishing to raise a dispute notice with the AER may do so prior to 10 August 2021(30 days after publication of this PACR). 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 RIT-TConsultations@transgrid.com.au. In the subject field, please reference 'Darlington Point Secondary Systems PACR'.

[14] Australian Energy Market Commission. "*Replacement expenditure planning arrangements, Rule determination*". Sydney: AEMC, 18 July 2017.65. Accessed 19 November 2019. https://www.aemc.gov.au/sites/default/files/content/89fbf559-2275-4672-b6ef-c2574eb7ce05/Final-rule-determination.pdf

2. The identified need

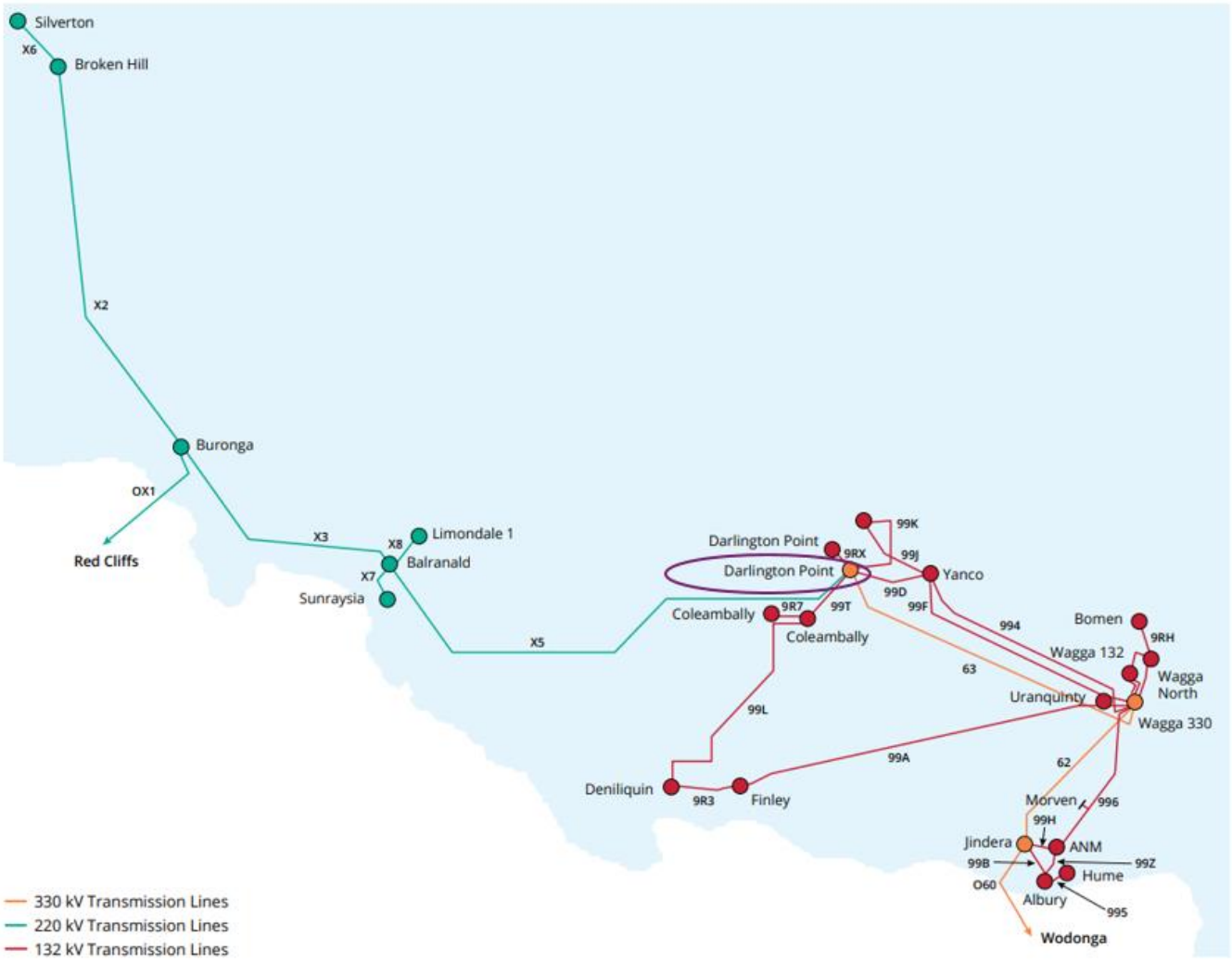
This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it. It first sets out background information related to South Western NSW network and existing electricity supply arrangements.

2.1 Background to the identified need

Darlington Point substation was commissioned in 1988 and forms part of TransGrid's network that serves South Western NSW.

The location of Darlington Point substation on the South Western NSW transmission network is provided in Figure 2-1 below, indicated by an orange dot and highlighted by a purple ellipse[15].

Figure 2-1 Location of Darlington Point substation on the South Western NSW transmission network



[15] The red dot just above Darlington Point substation and the additional 'Darlington Point' label indicate the location of Darlington Point Solar Farm which is not part of this RIT-T.

Darlington Point substation is situated within the Murrumbidgee Local Government Area in the Riverina agricultural irrigation area inclusive of Leeton. The centre of the rice growing district in NSW, Leeton is home to the headquarters of the Ricegrowers' Association of Australia (RGA), along with processing and marketing company SunRice[16].

The substation is a customer connection point supplying the Essential Energy 132 kV network in the Riverina region and is the starting point for the 220 kV network supplying Far West NSW and interconnects to Victoria at Red Cliffs.

The substation is supplied by Wagga substation and Balranald substation via two transmission lines (Line 63 at 330 kV and Line X5 at 220 kV, respectively) owned by TransGrid. A further six feeders at 132 kV, owned by TransGrid, Essential Energy, and Edify Energy[17] also connect at Darlington Point substation.

Darlington Point substation will continue to play a central role in the safe and reliable operation of the power system throughout and after the transition to a low-carbon electricity future. Darlington Point substation is located within the NSW-VIC interconnector which currently connects more than 1,700 MW[18] of generation in the North Western VIC, Wagga, Darlington Point and Broken Hill regions. It forms part of TransGrid's South Western NSW Network and is located within the South-West Energy Zone[19], one of three Renewable Energy Zones (REZ) prioritised by the NSW Government[20].

The secondary systems components at Darlington Point were installed between 1988 and 2010 to support the safe and reliable operation of the substation. This arrangement is necessary to ensure that all electricity users on TransGrid's South Western NSW network, whether they be large industrial customers directly connected to TransGrid's network or residential consumers connected via Essential Energy's distribution network, are able to receive the level of support they require. The load for Darlington Point substation is predominantly agricultural[21] and is forecast at 24 MW for the summer of 2022/23[22].

2.2 Description of the identified need

Secondary systems are used to control, monitor, protect and secure communication to facilitate safe and reliable network operation.[23] They are necessary to operate the transmission network and prevent damage to primary assets when adverse events occur.

The Network Performance Requirements, set out in Schedule 5.1 of the NER, place an obligation on TNSPs to provide redundant protection schemes to ensure the transmission system is adequately protected. Schedule 5.1.9(c) of the NER requires a TNSP to provide sufficient primary and back-up protection systems, including any communications facilities and breaker fail protection systems, to ensure that a fault of any type anywhere on its transmission system is automatically disconnected.

---

16 The rice industry contributes significantly to the economic health of the Riverina region and supports a number of regional towns including Leeton, Griffith, Deniliquin, and Coleambally. It is estimated that every $1 of rice production equates to $4 in flow on economic activity. Rice Growers' Association of Australia, "Rice Regions", accessed 22 March, 2021. https://www.rga.org.au/Public/The_Rice_Industry/Rice_Regions/Public/Content/The_Rice_Industry/The_Rice_Regions.aspx?hkey=c103ced1-f22c-4e3b-97fb-089449ff2c80

17 Owner of Darlington Point Solar Farm

18 Total generation for Uranquinty Power Station, Griffith Solar Farm, Riverina Solar Farm, Darlington Point Solar Farm, Finley Solar Farm, Coleambally Solar Farm, Sunraysia Solar Farm, Limondale Solar Farm (Limondale 1 and Limondale 2) is approximately 1,756 MW.

19 TransGrid. "Transmission Annual Planning Report 2020." Sydney: TransGrid, 2020.20.Accessed 22 March 2021. https://www.transgrid.com.au/what-we-do/Business-Planning/transmission-annual-planning/Documents/2020%20Transmission%20Annual%20Planning%20Report.pdf

20 NSW Government. "*NSW Transmission Infrastructure Strategy*."Sydney: Department of Planning and Environment, NSW Government, 2018.10. Accessed 22 March 2021. https://energy.nsw.gov.au/media/1431/download

21 Australian Energy Market Operator, "AEMO Visualisations Map," accessed 22 March, 2021. https://www.aemo.com.au/aemo/apps/visualisations/map.html

22 Based on projections for Essential Energy's 132 kV bulk supply point for summer 2023/24. TransGrid. "Transmission Annual Planning Report 2020." Sydney: TransGrid, 2020.108. Accessed 22 March, 2021. https://www.transgrid.com.au/what-we-do/Business-Planning/transmission-annual-planning/Documents/2020%20Transmission%20Annual%20Planning%20Report.pdf

23 As per Schedule 5.1 of the NER.

Additionally, TNSPs are required to disconnect the unprotected primary systems where secondary systems fault lasts for more than eight hours (for planned maintenance) or 24 hours (for unplanned outages). TNSPs must also ensure that all protection systems for lines at a voltage above 66 kV are well-maintained so as to be available at all times other than for short periods (less than eight hours), while the maintenance of protection systems is being carried out.[24] In the event of an unplanned outage, AEMO's Power System Security Guidelines require that the primary network assets must be taken out of service within 24 hours.[25]

Furthermore, as per clause 4.11.1 of the NER, remote monitoring and control systems are required to be maintained in accordance with the standards and protocols determined and advised by AEMO.

A failure of the secondary systems would involve replacement of the failed component or taking the affected primary assets, such as lines and transformers, out of service.

Though replacement of failed secondary systems component is a possible interim measure, the approach is not sustainable as spare components will deplete due to the technology no longer being manufactured or supported. Once all spares are used, replacement will cease to be a viable option to meet performance standards applicable to Darlington Point substation secondary systems.

If the failure to provide functional secondary systems due to technology obsolescence is not addressed by a technically and commercially feasible credible option in sufficient time (by 2022/23), the likelihood of not recovering from secondary systems faults and not maintaining compliance with NER performance requirements will increase.

The proposed investment will enable TransGrid to continue to meet the standards for secondary systems availability set out in the NER, and to avoid the impacts of taking primary assets out of service. Consequently, it is considered 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

2.3.1 Depletion of available spares due to no manufacturer support for technologically obsolete components

Though like-for-like replacement of a failed secondary systems at Darlington Point substation is possible as an interim measure, the approach is not sustainable as spare components will deplete due to the technology no longer being manufactured or supported. Once all spares are used, repair will cease to be a viable option and will not enable performance standards applicable to Darlington Point substation secondary systems to be met.

2.3.2 Deterioration of control systems increases the risk of substation failure

Appendix B provides an overview of the Risk Assessment Methodology adopted by TransGrid. TransGrid has identified several critical issues with the secondary systems at Darlington Point substation. The issues are outlined in Table 2-1 are expected to escalate until the asset is fully inoperable.

[24] As per S5.1.2.1(d) of the NER.

[25] Australian Energy Market Operator. *"Power System Security Guidelines, 7 April 2021."* Melbourne: Australian Energy Market Operator, 2021.35. Accessed 22 June 2021. https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/power_system_ops/procedures/so_op_3715-power-system-security-guidelines.pdf?la=en

Table 2-1 Identified condition of Darlington Point substation secondary systems

Asset components	Issues	% of services at site
Energy Meters	> Component technology obsolescence resulting in a lack of spares and no manufacturer support	100% of all market meters on site
Protection Relays	> Increasing numbers of faults across a range of models	83% of all 330/220kV protection relays on site
Remote Monitoring and Control Equipment	> End of serviceable life > Manufacturer support withdrawn	100% of all 330/220kV remote monitoring and control on site

3. Potential credible options

This section describes the options explored by TransGrid to address the need, including the scope of each option and the associated costs. Refer to section 6.1 for benefits of each option.

TransGrid considered three technically and commercially feasible options in this PACR:

> **Option 1** – strategic asset replacement of protection, market metering and control systems;
> **Option 2** – complete in-situ replacement of protection, market metering and control systems; and
> **Option 3** – IEC-61850 replacement

No submissions were received in response to the PSCR and no additional credible options have been identified.

TransGrid expects coronavirus (COVID-19) to impact its suppliers and disrupt their supply chains. TransGrid has preliminary advice that this is already occurring, although at this time the extent of the current or future impact is unknown. Consequently, some of the costs associated with the works outlined in this document may be affected.

All costs presented in this PACR are in 2020/21 dollars.

3.1 Base case

The costs and benefits of each option in this PACR were compared against those of a base case[26]. Under this base case, no proactive capital investment is made to remediate the technological obsolescence, spares unavailability, discontinued manufacturer support, and components deterioration of the secondary systems. The asset will continue to operate and be maintained under the current regime. Annual maintenance costs are approximately $6,000 per year. Increases to the regular maintenance regime will not be able to mitigate the risk of failure of the secondary systems at Darlington Point substation due to technological obsolescence and reduced reliability.

The table below provides a breakdown of the operating expenditure under the base case.

Table 3-1 Operating expenditure breakdown under the base case ($ 2020/21)

Item	Operating expenditure ($)
Annualised protection maintenance activities	6,000
Total operating cost	**6,000 (+/-25%)**

The majority of protection relays, remote control and monitoring devices at this site have limited spares, no manufacturer support, and will reach end of serviceable life by 2022/23. Repairs will become more difficult due to limited spares and this will lead to periods of unavailability. This increases the asset's risk of failure, difficulty to repair any failures, likelihood of a hazardous event, and periods of unavailability.

TransGrid calculates the annual safety, environmental and operational risk costs associated with the Darlington Point substation secondary systems under the base case to be approximately $1.2 million.[27]

[26] As per the RIT-T Application Guidelines, the base case provides a clear reference point for comparing the performance of different credible options. Australian Energy Regulator. *"Application guidelines Regulatory Investment Test for Transmission - August 2020."* Melbourne: Australian Energy Regulator, 2020.21. Accessed 22 March 2021. https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

[27] This determination of yearly risk costs is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

3.2 Option 1 – Strategic asset replacement

Option 1 involves individual replacements of identified assets up to 2034. The option is based on a like-for-like approach whereby the asset is replaced by its modern equivalent. Additional system modifications or additional functionalities would not be deployed under this option. This option will lock TransGrid to a system architecture that cannot be expanded to match modern technology capabilities into the future.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network. Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

The estimated capital expenditure associated with this option is approximately $4.3 million. The table below provides a breakdown.

Table 3-2 Capital expenditure breakdown under Option 1 ($m 2020/21)

Item	Capital expenditure ($m)
FY21	1.2
FY22	1.1
FY24	0.4
FY26	0.3
FY31	0.8
FY34	0.5
Total capital cost	**4.3 (+/- 25%)**

Routine operating and maintenance costs are approximately $6,000 per year. The table below provides a breakdown.

Table 3-3 Operating expenditure breakdown under Option 1 ($ 2020/21)

Item	Operating expenditure ($)
Annualised protection maintenance activities	6,000
Total operating cost	**6,000 (+/- 25%)**

TransGrid calculates the annual safety, environmental and operational risk costs associated with the Darlington Point substation secondary systems under Option 1 to be approximately $1.1 million.[28]

3.3 Option 2 – Complete in-situ replacement of protection and control systems

Option 2 involves replacement of all secondary systems assets at Darlington Point substation. This option will modernise the automation philosophy to current design standards and practices. This option also includes

[28] This determination of yearly risk costs is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

replacement of Direct Current (DC) supplies to account for an increase in secondary systems power requirements and remediation of the 415V Alternating Current (AC) distribution in the building and the switchyard.

The condition of various categories of automation assets such as protection relays, control systems, AC distribution, DC supply systems, and market meters creates a need for modernisation. This will deliver benefits such as reduced preventative maintenance requirements, improved operational efficiencies, better utilisation of our high speed communications network, improved visibility of all assets using modern technologies and reduced reliance on routine maintenance and testing[29].

There are also additional operational benefits available due to improved remote monitoring, control and interrogation, efficiency gains in responding to faults, and phasing out of obsolete and legacy systems and protocols.

The work on the 330 kV and 220 kV assets will be undertaken over the three-year period with all works expected to be completed by 2022/23. Work on the 132 kV assets will have to be addressed by 2033/34.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network. Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

The estimated capital expenditure associated with the 330kV and 220 kV assets in this option is approximately $6.3 million +/- 25 per cent in 2020/21 to 2022/23 and the estimated capital expenditure associated with the 132kV assets in this option is approximately $1.5 million +/- 25 per cent in 2023/24 to 2033/34. The table below provides a breakdown.

Table 3-4 Capital expenditure breakdown under Option 2 ($m 2020/21)

Item	Capital expenditure ($m)
FY21	0.8
FY22	1.9
FY23	3.6
FY24	0.4
FY31	0.8
FY34	0.2
Total capital cost	**7.8 (+/- 25%)**

Routine operating and maintenance costs are approximately $5,000 per year. The table below provides a breakdown.

Table 3-5 Operating expenditure breakdown under Option 2 ($ 2020/21)

Item	Operating expenditure ($)

[29] International Electrotechnical Commission (IEC), "IEC 61850 standard for Power Utility Automation," accessed 14 May, 2020. http://www.iec.ch/smartgrid/standards/

Annualised protection maintenance activities	5,000 (+/- 25%)
Total operating cost	**5,000 (+/- 25%)**

TransGrid calculates the annual safety, environmental and operational risk costs associated with the Darlington Point substation secondary systems under Option 2 to be approximately $60,000[30]. TransGrid expects an additional site operational benefit of $25,000 per annum in remote interrogation, investigation and response capability improvements by undertaking the full site renewal under Option 2.

3.4 Option 3 – IEC-61850 replacement

Option 3 involves a complete replacement of the secondary systems at Darlington Point substation with new IEC-61850 based secondary systems technology. This option will modernise the automation philosophy. It will implement the IEC-61850 protocol for unmanned substation site involving automation systems. By implementing this option TransGrid will be able to achieve savings through the reduction in the number of traditional copper-core cables by installing optical fibre cables between substation switchyards and relay rooms.

The condition of various categories of automation assets such as protection relays, control systems, AC distribution, DC supply systems, and market meters creates a need for modernisation. This will deliver benefits such as reduced preventative maintenance requirements, improved operational efficiencies, better utilisation of our high speed communications network, improved visibility of all assets using modern technologies and reduced reliance on routine maintenance and testing[31].

The work will be undertaken over the three-year period with all works expected to be completed by 2022/23.

All works under all options will be completed in accordance with the relevant standards and components shall be replaced to have minimal modification to the wider transmission network. Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

The estimated total capital costs for the option is approximately $8.3 million +/-25 per cent. The table below provides a breakdown.

Table 3-6 Capital expenditure breakdown under Option 3 ($m 2020/21)

Item	Capital expenditure ($m)
FY21	0.5
FY22	6.5
FY23	1.3
Total capital cost	**8.3 (+/- 25%)**

Routine operating and maintenance costs are approximately $10,000 per year. This maintenance reflects the higher probability of secondary system component failure due to increase likelihood of inadvertent exposure to the weather with the secondary systems being located in outdoor enclosures. It was based on the installed cost to annually replace one out of approximately 126 secondary system components. The table below provides a breakdown.

[30] This determination of yearly risk costs is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

[31] International Electrotechnical Commission (IEC), "IEC 61850 standard for Power Utility Automation," accessed 14 May, 2020. http://www.iec.ch/smartgrid/standards/

Table 3-7 Operating expenditure breakdown under Option 3 ($ 2020/21)

Item	Operating expenditure ($)
Annualised protection maintenance activities	10,000
Total operating cost	**10,000**

TransGrid calculates the annual safety, environmental and operational risk costs associated with the Darlington Point substation secondary systems under Option 3 to be approximately $350,000[32]. TransGrid expects an additional site operational benefit of $425,000 per annum initially through new technology design efficiencies, ramping down to $25,000 by 2025/26 by undertaking the full site renewal under Option 3.

3.5 Options considered but not progressed

At this stage of the RIT-T process, TransGrid determines that there is no other commercially and technically feasible option to meet the identified need.

3.6 No material inter-network impact is expected

TransGrid has considered whether the credible options listed above is expected to have material inter-regional impact.[33] 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:[34]

- a decrease in power transfer capability between transmission networks or in another TNSP's network of no more than the minimum of 3 per cent 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 per cent 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
- the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

TransGrid notes 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.

3.1 Non-network options

In the PSCR, TransGrid noted that non-network solutions will not enable TransGrid to continue meeting its Rules obligation under Schedule 5.1 and clause 4.11 of the NER to provide redundant secondary systems and ensure that the transmission system is adequately protected. Notwithstanding, as part of this consultation process, interested parties were able to make submissions regarding non-network options that satisfy, or

[32] This determination of yearly risk costs is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure/exposure, various types of consequence costs and corresponding likelihood of occurrence.

[33] As per clause 5.16.4(b)(6)(ii) of the NER.

[34] Inter-Regional Planning Committee. *"Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations."* Melbourne: Australian Energy Market Operator, 2004. Appendix 2 and 3. Accessed 23 June 2021. https://aemo.com.au/-/media/files/electricity/nem/network_connections/transmission-and-distribution/170-0035-pdf.pdf

contribute to satisfying, the identified need. TransGrid did not receive any responses from proponents of non-network options to the PSCR.

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.[35]

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.[36]

TransGrid determines that 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. TransGrid therefore considers 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
- competition benefits
- Renewable Energy Target (RET) penalties.

4.2 No other classes of market benefits are material

In addition to the classes of market benefits listed above, NER clause 5.16.1(c)(4) requires TransGrid to consider the following classes of market benefits, listed in Table 4-1, arising from each credible option. TransGrid considers that none of the classes of market benefits listed are material for this RIT-T assessment for the reasons in Table 4-1.

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

Market benefits	Reason
Changes in involuntary load shedding	A failure of secondary system element results in an extremely low chance of unserved energy.
Differences in the timing of expenditure	Options considered are 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 expenditure from any of the options considered.

[35] The NER requires that all classes of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific class (or classes) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.16.1(c)(6). See Appendix A for requirements applicable to this document.

[36] Australian Energy Regulator. *"Application guidelines Regulatory Investment Test for Transmission - August 2020."* Melbourne: Australian Energy Regulator, 2020.29-30. Accessed 22 March 2021. https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

Market benefits	Reason
	Options are being undertaken to mitigate, in isolation, the rising risk caused by the existing asset nearing its end of serviceable life.
Option value	TransGrid notes the AER's view 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.[37] TransGrid also notes the AER's view that appropriate identification of credible options and reasonable scenarios captures any option value, thereby meeting the NER requirement to consider option value as a class of market benefit under the RIT-T. TransGrid notes that no credible option is sufficiently flexible to respond to change or uncertainty. Additionally, a significant modelling assessment would be required to estimate the option value benefits but it would be disproportionate to potential additional benefits for this RIT-T. Therefore, TransGrid has not estimated additional option value benefit.

[37] Australian Energy Regulator. *"Application guidelines Regulatory Investment Test for Transmission - August 2020."* Melbourne: Australian Energy Regulator, 2020.53. Accessed 22 March 2021. https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

5. Overview of the assessment approach

This section outlines the approach that TransGrid has applied in assessing the net benefits associated with each of the credible options against the base case.

5.1 Description of the base case

The costs and benefits of each option in this document are compared against the base case. Under this base case, no investment is undertaken and TransGrid incurs regular and reactive maintenance costs, operational and safety related risks costs that are caused by the failure of secondary systems to operate when required.

TransGrid notes 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.[38]

5.2 Assessment period and discount rate

A 15 year assessment period from 2022/23 to 2036/37 was considered in this analysis. This period takes into account the expected asset life of the secondary systems.

TransGrid adopted a central real, pre-tax 'commercial' discount rate[39] of 5.90 per cent as the central assumption for the NPV analysis presented in this report. TransGrid considers that this is a reasonable contemporary approximation of a commercial discount rate and it is consistent with the commercial discount rate calculated in the RIT-T Economic Assessment Handbook (Version 2.0) published by Energy Networks Australia (ENA) in October 2020[40].

TransGrid also tested the sensitivity of the results to discount rate assumptions. A lower bound real, pre-tax discount rate of 2.23 per cent equal to the latest AER Final Decision for a TNSP's regulatory proposal at the time of preparing this document[41], and an upper bound discount rate of 9.57 per cent (a symmetrical adjustment upwards) were used.

5.3 Approach to estimating option costs

TransGrid has estimated the capital costs of the options based on the scope of works necessary together with costing experience from previous projects of a similar nature. TransGrid estimates that the actual cost is within +/- 25 per cent of the central capital cost.

Routine operating and maintenance costs are based on works of similar nature.

---

[38] As per the RIT-T Application Guidelines, 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 defines 'BAU activities' as ongoing, economically prudent activities that occur in the absence of a credible option being implemented. Australian Energy Regulator. *"Application guidelines Regulatory Investment Test for Transmission - August 2020."* Melbourne: Australian Energy Regulator, 2020.21. Accessed 22 March 2021. https://www.aer.gov.au/system/files/AER%20-%20Regulatory%20investment%20test%20for%20transmission%20application%20guidelines%20-%2025%20August%202020.pdf

[39] The use of a 'commercial' discount rate is consistent with the RIT-T and is distinct from the regulated cost of capital (or 'WACC') that applies to network businesses like TransGrid.

[40] Available at https://www.energynetworks.com.au/resources/fact-sheets/ena-rit-t-handbook-2020/ Note the lower bound discount rate of 2.23 per cent is based on the most recent final decision for a TNSP revenue determination which was Directlink in June 2020.

[41] See 2020-25 Directlink's Post-tax Revenue Model (PTRM) cashflow derived pre-tax real WACC available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/directlink-determination-2020-25/final-decision

5.4 Three different scenarios have been modelled to address uncertainty

The assessment was conducted under three net economic benefits scenarios. These are plausible scenarios which reflect different assumptions about the future market development and other factors that are expected to affect the relative market benefits of the options being considered. All scenarios (low, central and high) involve a number of assumptions that result in the lower bound, the expected, and the upper bound estimates for present value of net economic benefits respectively.

A summary of the key variables in each scenario is provided in the table below.

Table 5-1 Summary of scenarios

Variable / Scenario	Central	Low benefit scenario	High benefit scenario
Scenario weighting	*50%*	*25%*	*25%*
Discount rate	5.90%	9.57%	2.23%
Costs			
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Operating and maintenance costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Benefits (negative benefits)			
Reduction in safety and environmental risk costs	Base estimate	Base estimate - 25%	Base estimate + 25%
Reduction in operational risks	Base estimate	Base estimate - 25%	Base estimate + 25%

TransGrid considered that the central scenario was most likely since it was based primarily on a set of expected assumptions. TransGrid therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being weighted equally with 25 per cent each.

6. Assessment of credible options

This section outlines the assessment TransGrid has undertaken of the credible network options. The assessment compares the costs and benefits of each credible option to the base case. The benefits of each credible option are represented by reduction in costs or risks compared to the base case.

No changes have occurred since the PSCR which have made an impact on the preferred option.

All costs presented in this PACR are in 2020/21 dollars.

6.1 Estimated gross benefits

The table below summarises the present value of the gross benefit estimates for each credible option relative to the base case under the three scenarios.

The benefits included in this assessment are:

> reduction in safety and environmental risks (increases in Option 3 resulting in negative benefits)
> reduction in operational risks[42]

Table 6-1 Estimated gross benefits from credible options relative to the base case, present value ($m 2020/21)

Option/scenario	Central	Low benefit scenario	High benefit scenario	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	0.5	0.3	0.8	0.5
Option 2	10.7	6.2	17.9	11.4
Option 3	8.5	5.0	14.0	9.0

6.2 Estimated costs

The table below summarises the capital and operating and maintenance costs of the options, relative to the base case, in present value terms. The cost of each credible option has been calculated for each of the three reasonable scenarios outlined in section 5.4.

Table 6-2 Estimated costs of credible options relative to the base case, present value ($m 2020/21)

Option/Scenario	Central	Low benefit scenario	High benefit scenario	Weighted value
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	3.1	3.7	2.5	3.1
Option 2	6.5	7.6	5.2	6.4

[42] There are benefits associated with operational efficiencies through greater operational visibility, remote operational switching and remote diagnostic capability.

Option 3	7.8	9.4	6.1	7.8

6.3 Estimated net economic benefits

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

As shown in the table and figure below Option 2 has the highest net economic benefit while also maintaining compliance with regulatory and safety obligations. TransGrid finds that under all sensitivities, Option 2 delivers the most net benefit.

Table 6-3 Estimated net economic benefits relative to the base case, present value ($m 2020/21)

Option	Central	Low benefit scenario	High benefit scenario	Weighted value	Ranking
Scenario weighting	*50%*	*25%*	*25%*		
Option 1	-2.6	-3.4	-1.6	-2.6	3
Option 2	4.2	-1.4	12.7	4.9	1
Option 3	0.7	-4.4	7.9	1.2	2

Figure 6-1 Net economic benefits, present value ($m 2020/21)

6.4 Meeting relevant regulatory obligations

Implementation of Option 2 will enable TransGrid to meet regulatory obligations set out under Schedule 5.1 and clauses 4.11.1 and 4.6.1(b)[43] of the NER to provide redundant secondary systems and ensure that the transmission system is adequately protected. Consequently, it will also ensure the performance standards applicable to Darlington Point substation secondary systems are met.

Implementation of Option 2 is the most efficient option to ensure reliability of the secondary systems at Darlington Point and mitigate its risks of prolonged failure.

6.5 Sensitivity testing

TransGrid undertakes sensitivity testing to understand the robustness of the RIT-T assessment to underlying assumptions about key variables. In particular, TransGrid undertakes two sets of sensitivity tests – namely:

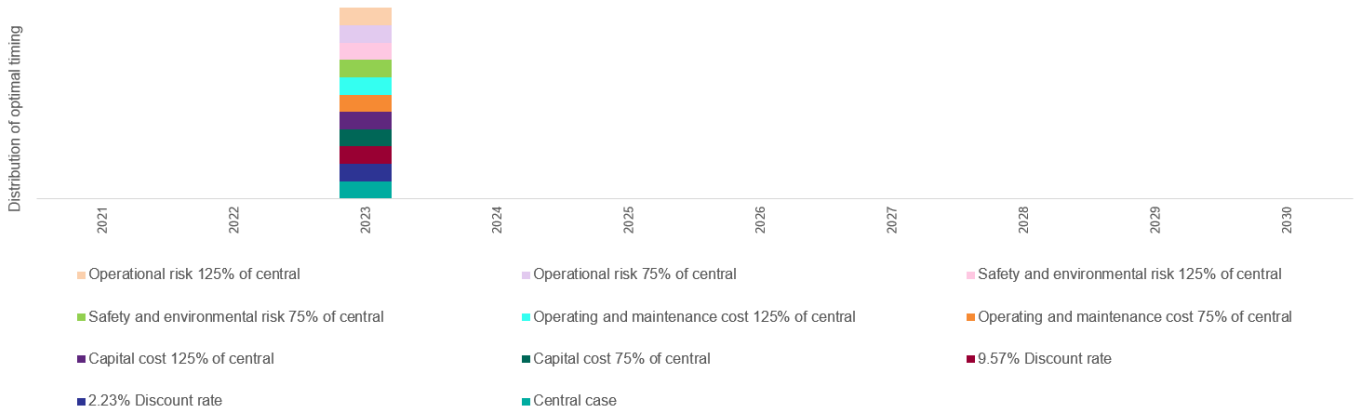
> Step 1 – testing the sensitivity of the optimal timing of the project ('trigger year') to different assumptions in relation to key variables

> 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.

6.5.1 Step 1 – Sensitivity of the optimal timing

TransGrid has undertaken Step 1 of the sensitivity analysis to determine the optimal timing of the project is 2022/23. If the failure to provide functional secondary systems due to technology obsolescence is not addressed by a technically and commercially feasible credible option in sufficient time (by 2022/23), the likelihood of not recovering from secondary systems faults and not maintaining compliance with NER performance requirements will increase. The proposed investment will enable TransGrid to continue to meet the standards for secondary systems availability set out in the NER, and to avoid the impacts of taking primary assets out of service.

Figure 6-2 Optimal timing under sensitivities for Option 2



Having assumed to have committed to the project by this date, TransGrid has also looked at the consequences of 'getting it wrong' under step 2 of the sensitivity testing. That is, if expected safety and environmental risks are not as high as expected, for example, the impact on the net economic benefit associated with the project continuing to go ahead on that date.

[43] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

The application of the second step to test the sensitivity of the key findings is outlined below.

6.5.2 Step 2 – Sensitivity of the overall net benefit

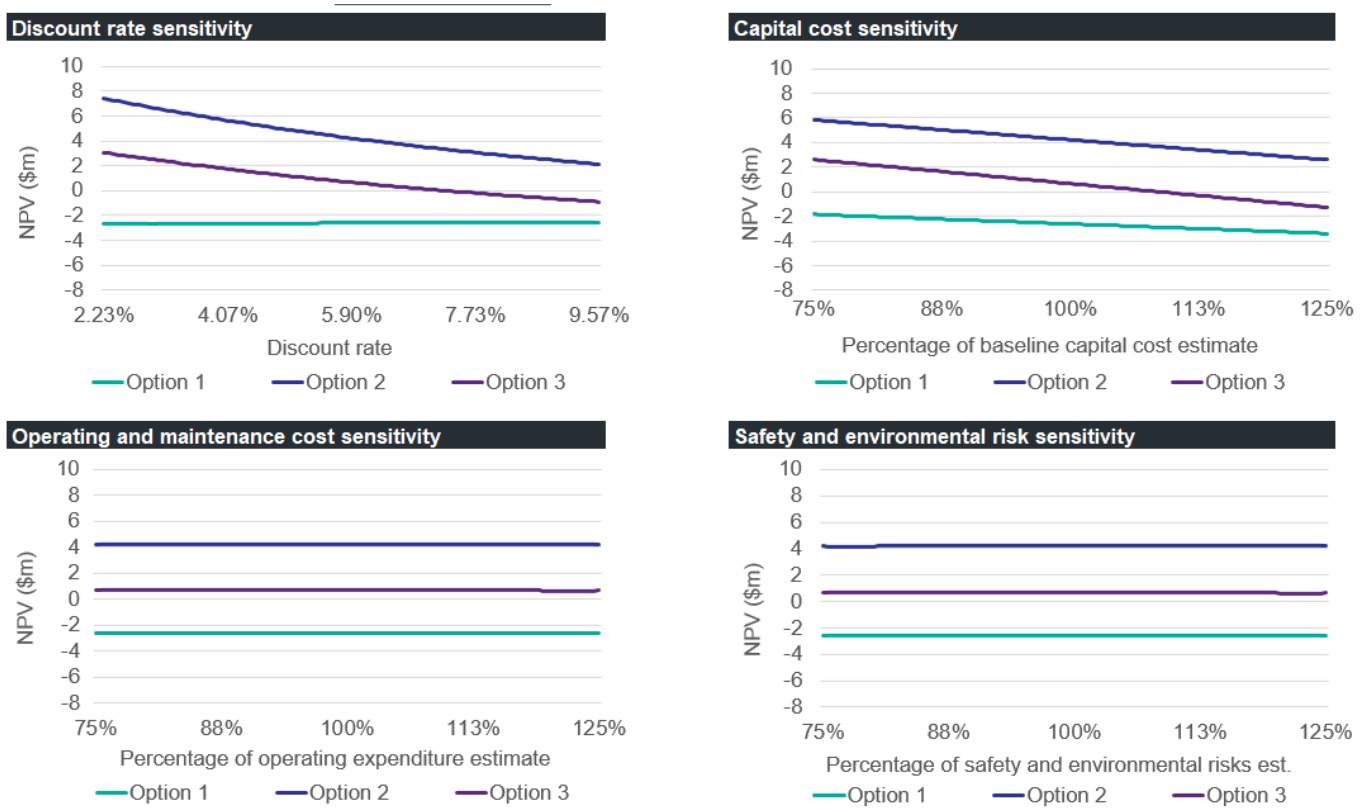
TransGrid has conducted sensitivity analysis on the present value of the net economic benefit, based on having to undertake the project by 2022/23. Specifically, TransGrid has investigated the following sensitivities:

- a 25 per cent increase/decrease in the assumed network capital costs
- lower discount rate of 2.23 per cent as well as a higher rate of 9.57 per cent
- lower (or higher) assumed operation and maintenance costs
- lower (or higher) assumed safety and environmental risks
- lower (or higher) assumed operational risk

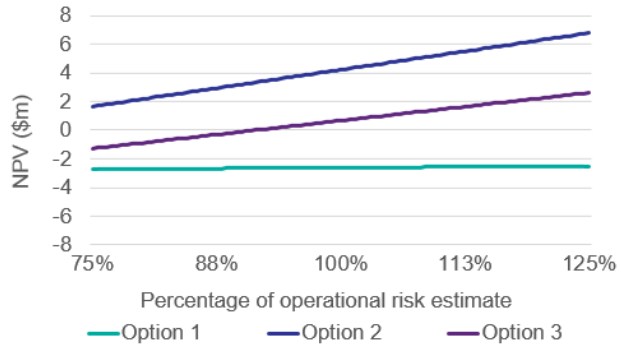
All these sensitivities investigate the consequences of 'getting it wrong' having committed to a certain investment decision.

The figures below illustrate the estimated net economic benefits for each option if separate key assumptions in the central scenario are varied individually. Option 2 delivers the most benefit under all scenarios.

Figure 6-3 Sensitivities



Operational risk sensitivity



7. Final conclusion on the preferred option

The optimal commercially and technically feasible option presented in the PSCR – Option 2 (complete in-situ replacement of protection and control systems) – remains the preferred option to meet the identified need. Option 2 can be implemented in sufficient time to meet the identified need by 2022/23, and is therefore the preferred option presented in this PACR.

Option 2 is the most prudent and economically efficient solution to enable TransGrid to continue meeting its regulatory obligations set out in clauses 4.11.1, 4.6.1(b),[44] and Schedule 5.1 of the NER. Consequently, it will ensure the performance standards applicable to Darlington Point substation secondary systems are met.

Option 2 involves an on-site upgrade and renewal (replacement) of the protection and control systems at Darlington Point substation to combined systems which eliminates the need for standalone remote monitoring and control units. Efficiencies will be leveraged by reusing the existing building, tunnel boards, and the cabling where practicable.

The works on the 330kV and 220kV assets will be undertaken between 2020/21 and 2022/23. Planning and design (including completion of the RIT-T) commenced in 2019/20 and is due to conclude in 2020/21. The procurement and delivery of the identified assets is planned to occur in 2021/22. Works will be completed by 2022/23. The 132kV asset works are planned between 2023/24 and 2033/34.

Necessary outages of relevant assets in service will be planned appropriately in order to complete the works with minimal impact on the network.

The estimated capital cost of this option is approximately $7.8 million ($6.3 million of this by 2022/23 for the 330kV and 220kV assets). Routine and operating maintenance costs are approximately $5,000 per year.

Option 2 is the preferred option in accordance with NER clause 5.16.1(b) because it is the credible option that maximises the net present value of the net economic benefit to all those who produce, consume and transport electricity in the market. This preferred option, Option 2, was found to have the highest net economic benefit while also maintaining compliance with regulatory and safety obligations. TransGrid also conducted sensitivity analysis on the net economic benefit to investigate the robustness of the conclusion to key assumptions. TransGrid finds that under all sensitivities, Option 2 delivers the most benefit. The analysis undertaken and the identification of Option 2 as the preferred option satisfies the RIT-T.

[44] As per clause 4.6.1(b) of the NER, AEMO must ensure that there are processes in place, which will allow the determination of fault levels for normal operation of the power system and in anticipation of all credible contingency events and protected events that AEMO considers may affect the configuration of the power system, so that AEMO can identify any busbar which could potentially be exposed to a fault level which exceeds the fault current ratings of the circuit breakers associated with that busbar.

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 167.

Rules clause	Summary of requirements	Relevant section
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, 4
	(4) a detailed description of the methodologies used in quantifying each class of material market benefit and cost;	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);	3, 4
	(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 the key assumptions and data from the risk assessment methodology that underpin the identified need for this RIT-T and the assessment undertaken for the Revenue Proposal[45].

As part of preparing its Revenue Proposal for the current regulatory control period, TransGrid developed the Network Asset Risk Assessment Methodology to quantify risk for replacement and refurbishment projects. The risk assessment methodology:

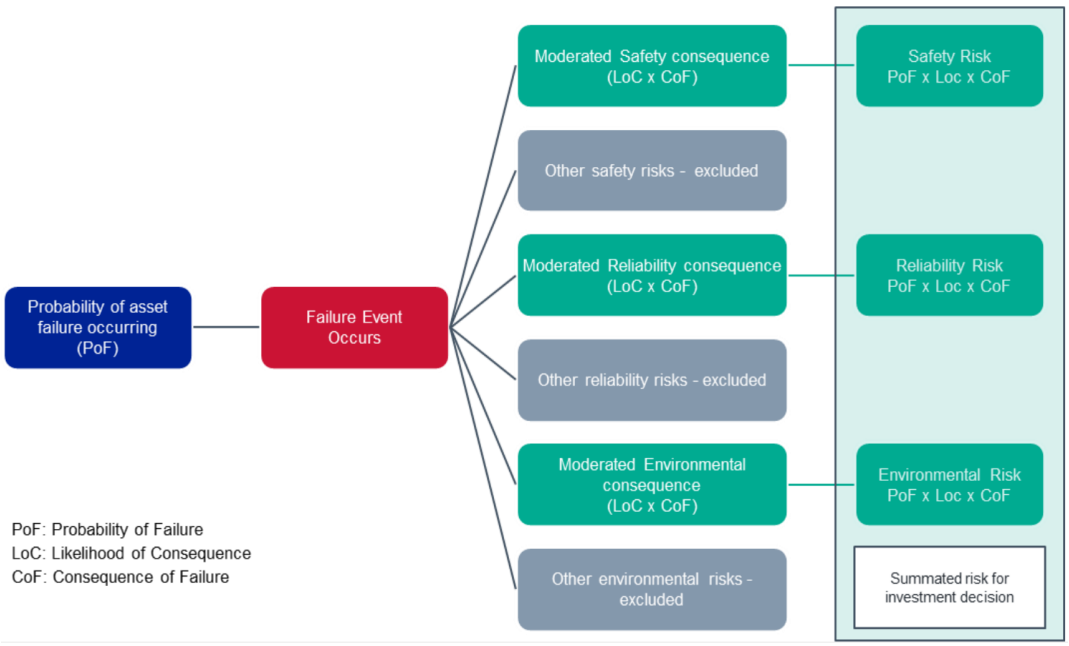
- uses externally verifiable parameters to calculate asset health and failure consequences
- assesses and analyses asset condition to determine remaining life and probability of failure
- applies a worst-case asset failure consequence and significantly moderates this down to reflect the likely consequence in a particular circumstance
- identifies safety and compliance obligations with a linkage to key enterprise risks.

B.1 Overview of the risk assessment methodology

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

The figure below summarises the framework for calculating the 'risk costs', which has been applied on TransGrid's asset portfolio considered to need replacement or refurbishment.

Figure B-1 Overview of TransGrid's 'risk cost' framework



The 'risk costs' are calculated based on the Probability of Failure (PoF), the Consequence of Failure (CoF), and the corresponding Likelihood of Consequence (LoC).

In calculating the PoF, each failure mode that could result in significant impact is considered. For replacement planning, only life-ending failures are used to calculate the risk costs. PoF is calculated for each failure mode base on 'conditional age' (health-adjusted chronological age), failure and defect history, and benchmarking

[45] TransGrid. *"Revised Regulatory Proposal 2018/19-2022/23."* Melbourne: Australian Energy Regulator, 2017. 63-69. Accessed 15 March 2019. https://www.aer.gov.au/system/files/TransGrid%20-%20Revised%20Revenue%20Proposal%20-%201%20December%202017.pdf

studies. For ‘wear out’ failures, a Weibull curve may be fitted; while for random failures, a static failure rate may be used.

In calculating the CoF, LoC and risks, TransGrid uses a moderated ‘worst case’ consequence. This is an accepted approach in risk management and ensures that high impact, low probability (HILP) events are not discounted. The approach excludes the risk costs of low impact, high probability (LIHP) which would results in lower calculated risk.