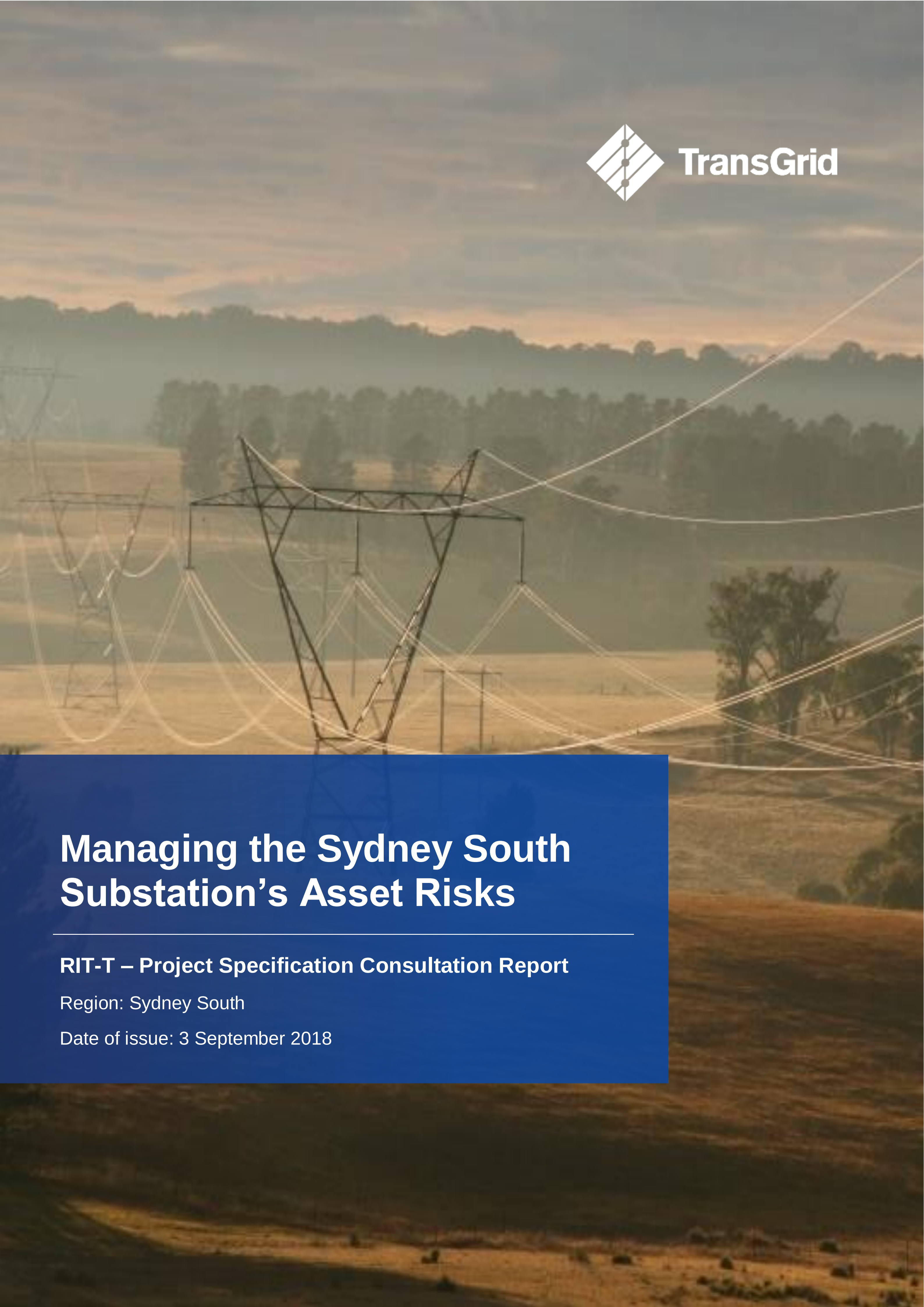

TransGrid

Managing the Sydney South Substation's Asset Risks

RIT-T – Project Specification Consultation Report

Region: Sydney South

Date of issue: 3 September 2018

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Executive summary

This RIT-T has been initiated to address corrosion issues on key assets at TransGrid's Sydney South substation

This report represents the first step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating the risk TransGrid, and its ultimate downstream consumers, face in terms of corroding gantries at the Sydney South 330 kV substation. Substation gantries are essential for the safe and reliable operation of the whole substation.

In particular, the gantries in Sydney South substation display evidence of corrosion, which, if unaddressed, may result in the failure of the steelwork, connection bolts, holding down bolts, or baseplates. The failure of the gantries may in-turn result in a loss of supply to end consumers, injury to staff and damage to equipment. These events may also affect more than one system element at the same time, which would require significant time to rectify.

TransGrid routinely assesses the condition of, and timing of ultimate replacement for its assets as part of its ongoing asset management processes. Asset condition assessments in the last few years have identified these corrosion related issues at the Sydney South substation and a plan has been developed to renew the affected steelwork. An allowance has been made for this work in TransGrid's 2018-23 Revenue Proposal to the Australian Energy Regulator.

Rule changes to the National Electricity Rules (NER) in July 2017 extended the application of regulatory investment tests to replacement capital expenditure from 18 September 2017. The application of the RIT-T to repex commenced on 18 September 2017, however, all repex projects that were 'committed' by 30 January 2018 are exempt.[1]

While the planning process for renewing the identified components of the gantries at Sydney South substation are well-advanced, the project was not 'committed' by 30 January 2018. Accordingly, TransGrid has initiated this RIT-T to consult on its proposed expenditure related to renewing these assets.

The 'identified need' for this RIT-T plans to avoid potentially significant unserved energy

TransGrid considers the proposed investment to be a 'market benefits' driven RIT-T as the proposed investment is for the purpose of maintaining network security at a critical transmission substation, which is estimated to deliver significant benefits in terms of avoided involuntary load shedding (ie, compared to if nothing is done and corrosion worsens). The investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from a failure in substation gantries.[2]

While the purpose of the proposed investment has similarities to those made under a reliability corrective action identified need (ie, to avoid involuntary load shedding), the scope of the current reliability standards applicable to TransGrid do not extend to multiple failures of transmission network elements that would be expected to result from a failure of substation gantries (eg, damage to and failure of multiple busbar sections

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1 See paragraph 18 of the AER's RIT-T for the definition of a 'committed project'.

2 TransGrid manages and mitigates safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with TransGrid's obligations under the New South Wales *Electricity Supply (Safety and Network Management) Regulation 2014* and TransGrid's Electricity Network Safety Management System (ENSMS).[2] In particular, risks for TransGrid and its consumers are mitigated unless it is possible to demonstrate that the cost involved in further reducing the risk would be grossly disproportionate to the benefit gained.

at the same substation). It follows that the proposed investment is driven by a 'market benefits' identified need given the lack of externally imposed obligations relating to multiple failures of transmission network elements.

TransGrid considers that refurbishing the assets is the only credible network option

TransGrid considers that there is only one feasible option from a technological and project delivery perspective, ie, replacing or refurbishing the identified corroded components in a single project. This involves in-situ renewal of the steelwork by removing corrosion, painting and replacement of components, where required.

It is expected that the remediation works will be undertaken in various stages between 2018/19 and 2020/21. The two broad stages to replacing all corroded elements are:

> Stage 1 (2018/19 and 2019/20) – Planning and procurement (including completion of the RIT-T); and

> Stage 2 (2020/21) – Project delivery and construction.

The estimated capital cost is between $18 million and $24 million depending on the extent of work required to address corrosion and the final selected remediation methods across the site. Where corrosion is pervasive, more extensive and costly remediation works will be necessary. It is expected that more accurate cost estimates will be provided in the Project Assessment Conclusion Report (PACR) as detailed scoping is progressed.

Planned operating costs are not expected to materially differ from the base case once remediation of corroded members and bolts have been completed. There are expected to be significantly lower unplanned maintenance costs associated with this option though, as the work is designed to eliminate gantry failures due to corrosion.

Planned outages and staging will be taken as necessary in order to complete the construction works.

TransGrid does not consider there is a role for network support solutions in this RIT-T

TransGrid does not consider that non-network solutions can assist with meeting the identified need for this RIT-T. This is driven by the fundamental role that the identified gantries play in the transmission of electricity at a substation, the enduring need for the Sydney South substation as well as how low the cost of refurbishing the gantries is (ie, $18 million to $24 million in capital cost).

Notwithstanding, this report sets out the required technical characteristics for non-network options, consistent with the requirements of the RIT-T.

Net benefits have been estimated across three different 'scenarios'

TransGrid has constructed three alternative scenarios for this Project Specification Consultation Report (PSCR) assessment – namely:

> a 'low benefit' scenario, involving a number of assumptions that give rise to a lower bound Net Present Value (NPV) estimate for the refurbishment option, in order to represent a conservative future state of the world with respect to potential benefits that could be realised;

> a 'central' scenario, which consists of assumptions that reflect TransGrid's central set of variable estimates which, in TransGrid's opinion, provides the most likely scenario; and

> a 'high benefit' scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected net benefits.

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

Table E.1 – Summary of the three scenarios investigated

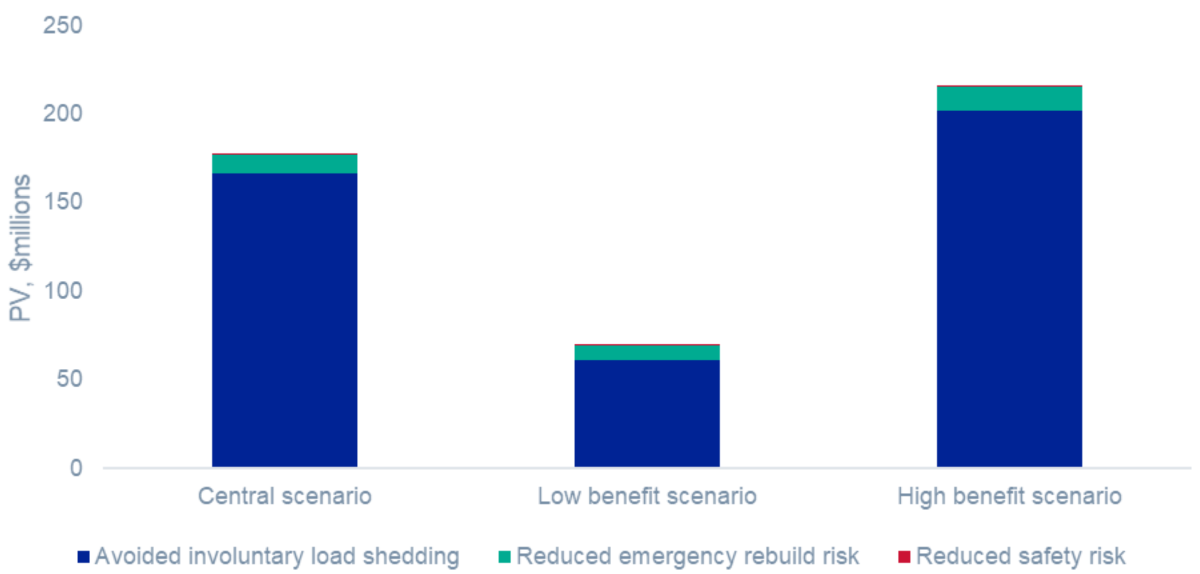
Variable / Scenario	Central	Low benefits	High benefits
Network capital costs	$21 million	$24 million	$18 million
Avoided emergency rebuild risks	Base estimate	Base estimate - 25%	Base estimate + 25%
VCR	$90/kWh	$40/kWh	$90/kWh
Demand forecast	POE 50	POE 90	POE 10
‘Commercial’ discount rate	7.04 per cent	9.48 per cent	4.60 per cent

We have applied a $90/kWh VCR in the central and ‘high benefits’ scenarios since the unserved energy the investment plans to avoid is in the Inner Sydney region. This is consistent with both the December 2016 Independent Pricing and Regulatory Tribunal (IPART) review of the New South Wales electricity transmission reliability standards as well as the recent Powering Sydney’s Future RIT-T. Noting that there is uncertainty in any estimate of the VCR, we have included a VCR of $40/kWh in the ‘low benefits’ scenario (ie, consistent with the 2014 AEMO estimates of VCR) and also tested the thresholds for what the VCR would need to be to change the outcome of the RIT-T.

The refurbishment works are found to deliver strongly positive net benefits

The figure below provides a breakdown of estimated benefits, showing almost all of the benefits are derived from avoided involuntary load shedding, while other avoided costs contribute relatively small amounts to overall gross benefits.

Figure E.1 – Breakdown of gross economic benefits Option 1 relative to the base case, PV $m



The table below summaries the net market benefit in NPV terms across the three scenarios, as well as on a weighted basis. The table shows that refurbishing the assets is found to have positive net market benefits for all scenarios investigated. On a weighted basis, this investment is expected to deliver approximately $159.7 million in net market benefits.

Table E.2 – Present value of net benefits relative to the base case, PV $m 2017/18

Option/Scenario	Central	Low benefit	High benefit	Weighted
Option 1	177.0	69.4	215.5	159.7

TransGrid has also conducted sensitivity analysis on the overall NPV of the net market benefit to investigate the consequences of 'getting it wrong' having committed to a certain investment decision. For all sensitivity tests, the estimated net market benefit of refurbishing the assets are found to be positive.

The results are found to be most sensitive to the assumed VCR. We have extended this sensitivity exercise and found that there would need to be a VCR for Inner Sydney of less than $3.33/kWh to result in no expected net market benefits (ie, a NPV of zero) under the central scenario, holding all else constant. While acknowledging there is uncertainty in any VCR estimate, TransGrid considers it extremely unlikely that the central estimate has been this overestimated.

Draft conclusion and exemption from preparing a PADR

Refurbishing the identified assets is the preferred option at this draft stage. In particular, this involves the remediation of substation gantries at Sydney South substation, including the treatment of corrosion of steelwork and replacement of components which have reached end of life due to corrosion. By undertaking the remediation works, the life of substation gantries at Sydney South substation are expected to be extended by approximately 20 years.

It is expected that this remediation works will be undertaken in various stages between 2018/19 and 2020/21. The two broad stages to renewing all corroded elements are:

> Stage 1 (2018/19 and 2019/20) – Planning and procurement (including completion of the RIT-T); and

> Stage 2 (2020/21) – Project delivery and construction.

While physical delivery and replacement of the identified assets is planned to occur over 2020/21, it will be delivered in a staged fashion over the course of the year with replacement targeted on asset condition. All work is expected to be completed by 2021/22.

The estimated capital cost of this option is estimated to be between $18 million and $24 million and will be refined in the PACR. Operating expenditure is not expected to be materially different from the base case.

The preferred option to refurbish the line reduces the risk of substation gantry failure and this risk reduction outweighs the capital expenditure.

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

> if the estimated capital cost of the preferred option is less than $41 million;

> if the TNSP identifies in its PSCR its proposed preferred option, together with its reasons for the preferred option and notes that the proposed investment has the benefit of the clause 5.16.4(z1) exemption; and

> if the TNSP considers that the proposed preferred option and any other credible options in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding.

TransGrid considers that Option 1 is exempt from producing a PADR under NER clause 5.16.4(z1).

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.

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

Should TransGrid consider that no additional credible options were identified during the consultation period, TransGrid intends to produce a PACR that addresses all submissions received including any issues in relation to the proposed preferred option raised during the consultation period.[3]

Submissions and next steps

TransGrid welcomes written submissions on material contained in this PSCR. Submissions are due on or before 4 December 2018.

Submissions should be emailed to TransGrid's Prescribed Revenue & Pricing team via RIT-TConsultations@transgrid.com.au. In the subject field, please reference "Sydney South substation steelworks project".

Submissions will be published on the TransGrid website. If you do not want your submission to be made publicly available, please clearly specify this at the time of lodging your submission.

Subject to submissions received on this PSCR, a PACR, including full option analysis, is expected to be published by February 2019.

[3] In accordance with NER clause 5.16.4(z2).

Contents

List of Tables

List of Figures

1. Introduction

This Project Specification Consultation Report (PSCR) represents the first step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating risks faced by TransGrid and its ultimate downstream consumers in terms of corroding steelwork on gantry structural members located at TransGrid's Sydney South substation.

More specifically, the gantries at Sydney South substation display evidence of corrosion in recent inspections. The corrosion ranges from initial development to the commencement of loss of member thickness and, if unaddressed, may result in the failure of the steelwork, connection bolts, holding down bolts or baseplates.

The failure of the steelwork may in-turn result in a loss of supply to end consumers, injury to staff and damage to equipment. Events, and in particular high wind events, may affect more than one system element at the same time, which would require significant time to rectify.

TransGrid routinely assesses the condition of, and timing of ultimate replacement for its assets as part of its ongoing asset management processes. Asset condition assessments in the last few years have identified a number of corrosion related issues at the Sydney South substation and a plan has been developed to renew the affected steelwork. An allowance has been made for addressing substation gantry corrosion in TransGrid's 2018-23 Revenue Proposal to the Australian Energy Regulator.

Rule changes to the National Electricity Rules (NER) in July 2017 extended the application of regulatory investment tests to replacement capital expenditure from 18 September 2017. The application of the RIT-T to repex commenced on 18 September 2017, however, all repex projects that were 'committed' by 30 January 2018 are exempt.[4]

While the planning process for renewing the identified components of the gantries at Sydney South substation are well-advanced, the project was not 'committed' by 30 January 2018. Accordingly, TransGrid has initiated this RIT-T to consult on its proposed expenditure related to renewing these assets.

1.1 Purpose of this report

The purpose of this PSCR is to:

> Set out the reasons why TransGrid proposes that action be undertaken (that is, the 'identified need')
> Present the option that TransGrid currently considers address the identified need
> Outline the technical characteristics that non-network solutions would need to provide, whilst outlining how these solutions are unlikely to be able to contribute to meeting the identified need for this RIT-T
> Allow interested parties to make submissions and provide input to the RIT-T assessment.

The entire RIT-T process is detailed in Appendix B. The next steps for this particular RIT-T assessment are discussed further below.

[4] See paragraph 18 of the AER's RIT-T for the definition of a 'committed project'.

1.2 How to make a submission and next steps

TransGrid welcomes written submissions on material contained in this PSCR. Submissions are due on or before 4 December 2018.

Submissions should be emailed to TransGrid's Prescribed Revenue & Pricing team via RIT-TConsultations@transgrid.com.au. In the subject field, please reference "Sydney South substation steelworks project".

Submissions will be published on the TransGrid website. If you do not want your submission to be made publicly available, please clearly specify this at the time of lodging your submission.

Subject to submissions received on this PSCR, a Project Assessment Conclusions Report (PACR), including full option analysis, is expected to be published by February 2019.

TransGrid is bound by the *Privacy Act 1988 (Cth)*. In making a submission in response to our consultation process in relation to the Sydney South substation RIT-T submission, TransGrid will collect and hold your personal information (that is, information about you such as your name, email address, employer and phone number). TransGrid will collect this information for the purpose of receiving your submission and may use your contact details to follow up on your submission. Under the National Electricity Law there are circumstances where TransGrid may be compelled to provide information to the AER. We will advise you should this occur. At the conclusion of the submissions process, all submissions received will be published on the TransGrid website. If you do not wish for your submission to be made publicly available, then please clearly specify this at the time of lodging your submission. Our Privacy Policy sets out our approach to managing your personal information. In particular, it explains how you may seek to access and/or correct the personal information that we hold about you, as well as how to make a complaint about a breach of our obligations under the Privacy Act, and how we will deal with complaints. You can access our Privacy Policy here (https://www.transgrid.com.au/Pages/Privacy.aspx).

2. The identified need for this RIT-T

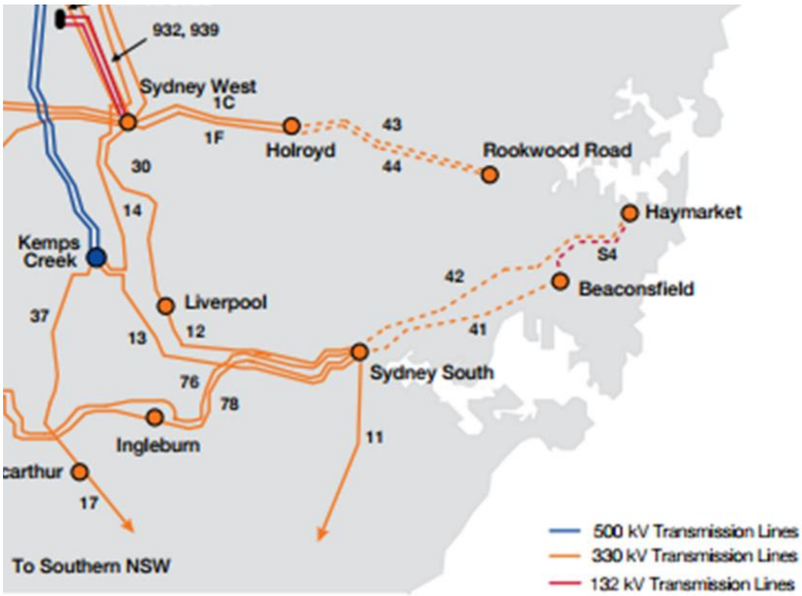
This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it. It first sets out useful background on the Sydney South substation and the assets affected by corrosion.

2.1 Background to the identified need

TransGrid's Sydney South substation was established in 1961 and connects to TransGrid's Haymarket and Beaconsfield substations via 330 kV underground cables. The aforementioned substations are in-turn, classified as AusGrid's bulk supply points (BSP), necessitating the 132 kV connections to Ausgrid's sub-transmission network. Haymarket BSP provides supplies to the Inner Sydney area which includes Sydney CBD loads, whereas Beaconsfield BSP provides supplies to Eastern Suburbs area.

Hence, TransGrid's Sydney South substation criticality and significance in ensuring a safe and reliable supply cannot be overstated.

Figure 2 – Sydney South substation and the TransGrid network



Given its critical role, the Sydney South substation is required to meet redundancy category 3 reliability standards with only 0.6 minutes of expected unserved energy (EUE) allowed each year across Inner Sydney. These standards are set by the Independent Pricing and Regulatory Tribunal (IPART) and were last revised in December 2016.

To meet these reliability standards, Sydney South substation comprises the following high voltage system assets:

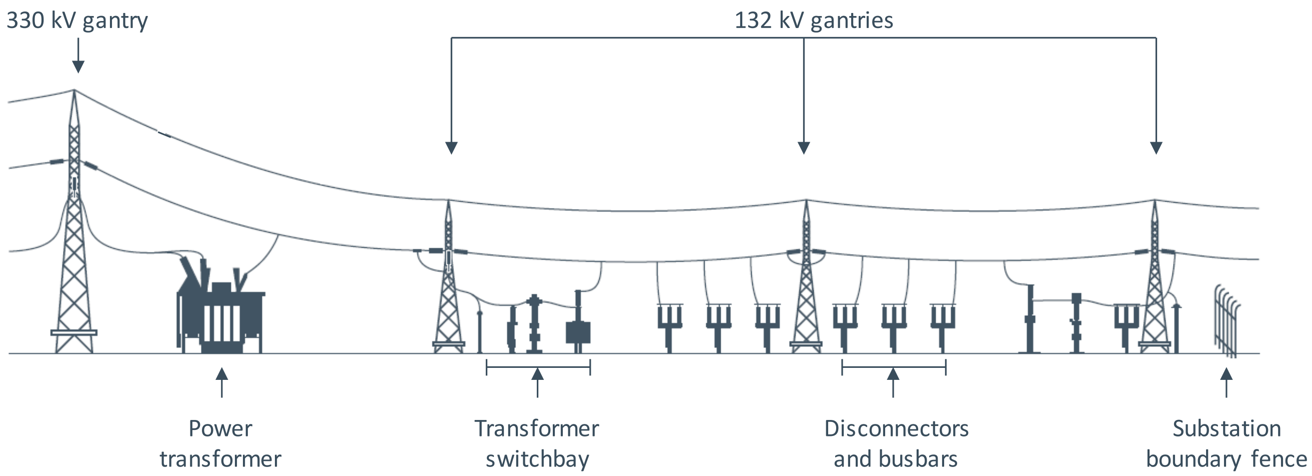
- 330 kV switchbays to support
  - Five 330kV overhead transmission lines;
  - Two 330 kV cables;
  - Five 330 kV reactors;
  - One 330 kV capacitor bank; and
  - Six 330/132 kV transformers.
- 132 kV switchbays to support

- Twelve Ausgrid 132 kV overhead transmission lines;
- Six 330/132 kV transformers; and
- Two 132 kV capacitor banks.

The transmission assets at Sydney South substation, together with Rookwood Road substation, supply most of load in the Sydney CBD, Eastern suburbs and south Sydney. Sydney South is the largest TransGrid bulk supply point supplying Ausgrid's distribution network with summer maximum demand at estimated to be approximately 1,190 MW in 2018-19, increasing to 1,336 MW by 2027-28.[5] It follows that there is an ensuring need for Sydney South substation as a critical part of TransGrid's transmission network supplying Sydney.

The Sydney South substation contains numerous gantry structures which are supporting infrastructure for the substation. These gantries suspend transmission line conductors entering and exiting the substation and support high voltage connections between transformers, switchbays and busbars within the substation, as shown in the simplied figure below.

Figure 3 - Simplified diagram of substation elements highlighting the role that gantries play



The gantries also support overhead earthwires which are required to protect the substation equipment from direct lightning strike. The gantries are connected to concrete footings by holding down bolts (the gantry and associated holding bolts are generally referred to within this document as 'substation gantries').

Overall, substation gantries are essential for the safe and reliable operation of the whole substation.

Substation gantries at Sydney South substation date back to 1961 when the substation was commissioned and are now 57 years old. A large proportion of the gantry structural members at Sydney South exhibit evidence of corrosion that ranges from initial development to loss of thickness in gantry steelwork, commonly refered to as members and bolts. The loss of thickness in members and bolts reduces the structual integrity of gantry structures, which over time leads to increasing risk of structural failure, particularly during high wind events.

Examples of corrosion on gantry structural members are shown in the figures below.

[5] TransGrid, *Transmission Annual Planning Report 2018*, Appendix 2, p 92.

Figure 4 – View of gantry steel members showing corrosion

TransGrid's analysis indicates that the gantry members (as shown in Figure 4) and holding down bolts will reach their end of life by 2021. After this period, the probability of failure starts to increase as the capacity of members to provide support the required loads decreases due to the loss of physcial cross-sectional area.

Figure 5 and Figure 6 below show examples of holding down bolts, base plates and member connection bolts displaying advanced stages of corrosion that TransGrid consider need to be addressed as a matter of urgency as some have already reached the end of their lives. It is also necessary to address the holding down bolts and base plates that have not yet displayed evidence of corrosion as it is expected that corrosion on these parts will commence in the near future.

Figure 5 – View of corrosion to holding down bolts and baseplates

Figure 6 – View of typical corrosion of member connection bolts

2.2 Description of Identified Need

TransGrid considers the proposed investment a 'market benefits' driven RIT-T as the proposed investment is for the purpose of maintaining network security at a critical transmission substation, which is estimated to deliver significant benefits in terms of avoided involuntary load shedding (ie, compared to if nothing is done and corrosion worsens). The investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from a failure in substation gantries.[6]

Investments made under a 'market benefits' identified need differs from those undertaken under a 'reliability corrective action' identified need in that market benefits driven investments are not made to meet externally imposed obligations on the network business and, consequently the preferred option must have positive net market benefits.[7]

While the purpose of the proposed investment has similarities to those made under a reliability corrective action identified need (ie, to avoid involuntary load shedding), the scope of the current reliability standards applicable to TransGrid do not extend to multiple failures of transmission network elements that would be expected to result from a failure of substation gantries (eg, damage to and failure of multiple busbars at the same substation). It follows that the proposed investment is driven by a 'market benefits' identified need given the lack of externally imposed obligations relating to multiple failures of transmission network elements.

Overall, TransGrid consider that the option proposed in this PSCR will enable TransGrid to appropriately manage the risk associated with substation gantries at Sydney South substation going forward, which is expected to realise strongly positive net market benefits. The approach to determining this, and the assessment itself, is presented in this PSCR.

2.3 Assumptions underpinning the identified need

Failure of column (the vertical structures of the gantry) and beam (the horizontal structures connected to the top of the columns) members on substation gantries or on gantry structure holding down bolts, may lead to their failure, particularly during high wind events. This in turn causes loss of supply and further potential damage to other substation assets due to the contact of high voltage conductors with the ground within the substation. Such a failure would likely lead to loss of supply to Ausgrid's downstream zone substations which in turn will trigger involuntary load shedding for end customers. In addition, the failure poses significant safety hazards for TransGrid field crews in attending and rectifying the site.

The need to undertake investment is predicated on the deteriorating condition of the identified assets affected by corrosion and the characteristics of any resultant physical asset failures.

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

> Uses externally verifiable parameters to calculate asset health and failure consequences

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6 TransGrid manages and mitigates safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with TransGrid's obligations under the New South Wales *Electricity Supply (Safety and Network Management) Regulation 2014* and TransGrid's Electricity Network Safety Management System (ENSMS).[6] In particular, risks for TransGrid and its consumers are mitigated unless it is possible to demonstrate that the cost involved in further reducing the risk would be grossly disproportionate to the benefit gained.

7 Reliability corrective action identified need can have negative net market benefits on account of having to meet an externally imposed obligation on the network business.

> Assesses and analyses asset condition to determine remaining life and probability of failure
> Applies a realistic worst-case asset failure consequence and significantly moderates this down to reflect the likely consequence in the particular circumstances
> Identifies safety and compliance obligations with a linkage to key enterprise risks

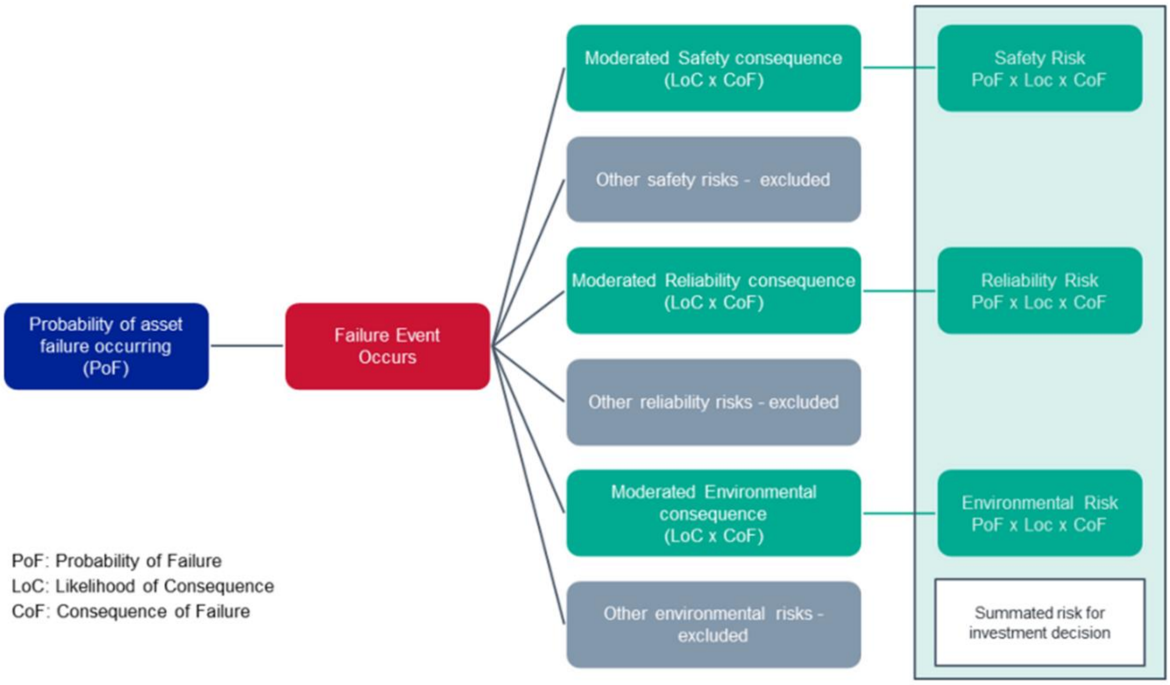
This section summarises the key assumptions and data from the risk assessment methodology modelling that underpin the identified need for this RIT-T and the assessment undertaken in preparing the Revenue Proposal.[8] Section 6 provides further detail on the general modelling approaches applied, including the commercial discounts rate used.

2.3.1 Overview of how the risks have been assessed

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

The figure below summarises the framework for calculating the 'risk cost', which has been applied across TransGrid's portfolio of assets considered to need replacing and/or refurbishing.

Figure 7 – Overview of TransGrid's 'risk cost' framework



The ultimate 'risk costs' for a project are calculated based on the Probability of a Failure (PoF), the Consequence of Failure (CoF) and the corresponding Likelihood of consequence (LoC) in the particular situation.

In calculating the PoF, each failure mode that could result in a consequential impact is considered. For replacement planning, only 'life ending' failures are ultimately used to calculate the risk cost. PoF is calculated for each failure mode considering the asset condition and relevant wind loadings in accordance with the Australian standard.

In calculating the CoF and LoC, TransGrid uses a moderated 'worst case' consequence to value risk. This is

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8 For additional information on the risk assessment methodology, please refer to pages 63-69 of our Revised Regulatory Proposal for the period 2018-23, available at: https://www.aer.gov.au/system/files/TransGrid%20-%20Revised%20Revenue%20Proposal%20-%201%20December%202017.pdf

an accepted approach in risk management with the benefit of ensuring that low probability but high consequence events are not dismissed or overlooked. It also excludes the risk costs of lower consequence but potentially more likely events (the resultant calculated risk is lower than it would be if these were included).

Recognising that this assessment approach has inherent uncertainty built into it, this RIT-T investigates a number of different scenarios and sensitivities that have been designed to see whether assuming alternate assumptions regarding risks and consequences (as well as other variables, such as the discount rate assumed) have an impact on the identification of the preferred option. These are outlined in more detail in sections 6.3 and 7.4 below and the results, in terms of the effects on net benefits are presented in section 7.

2.3.2 Substation gantry condition issues and their consequences

TransGrid's asset condition assessments in September 2016 identified a number of corrosion related issues with substation gantries, which can be grouped into:

- corrosion on member sections; and
- corrosion on bolts, base plates and member connection bolts.

Corrosion on a member section reduces its cross-sectional area (ie, thickness) and the capacity of the member section to support the required load. Measurements already confirm up to 8 per cent of the cross-sectional area being lost in 2016.

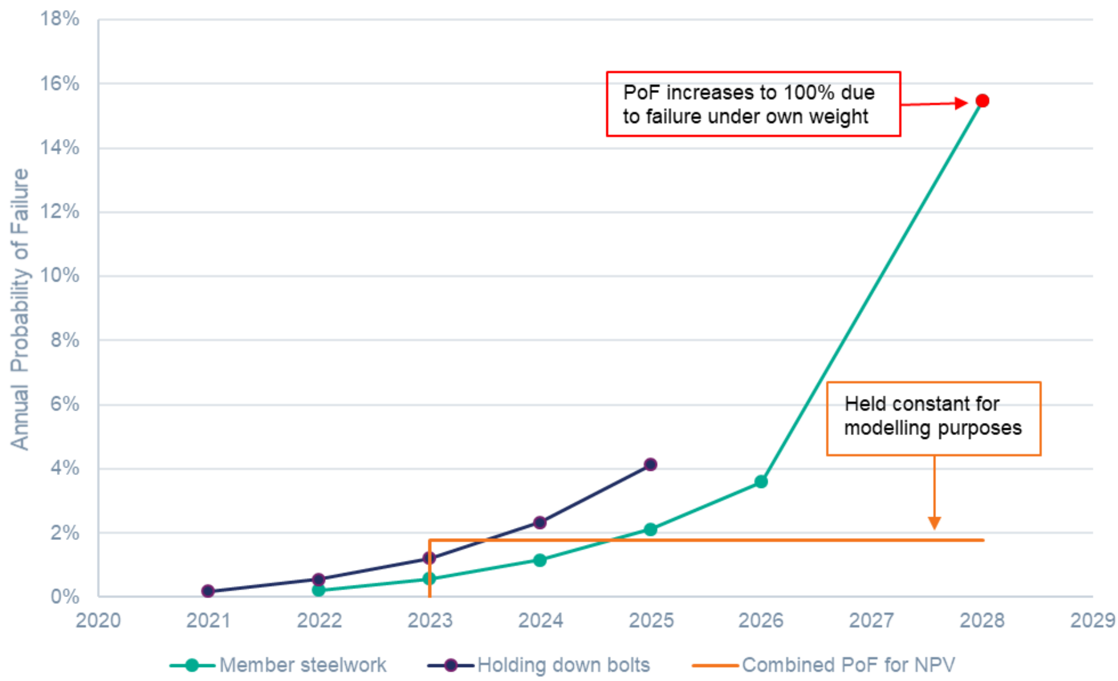
Based on the expected corrosion rates, TransGrid calculates that gantry members will on average reach end of life in 2020 without remediation to the protective coating prior to the member cross-sectional area reducing to 90 per cent of the original section area. After the end of life is reached, the probability of failure will start to increase markedly. The probability is determined by the governing wind events in accordance with Australian standards.

If allowed to continue, minor members will no longer be able to provide lateral restraint to the major members once they have lost 30 per cent of their cross-sectional area, at which point the probability of failure is assumed to be 100 per cent.

As noted above, corrosion on holding down bolts, base plates and member connection bolts displaying advanced stages of corrosion and would need to be addressed as a matter of urgency. The end of life for holding down bolts, base plates and member connection bolts is calculated to be 2021 on average.

The figure illustrates the average probability of failure for gantry members and holding down bolts at Sydney South substation between 2020 and 2028. In particular, it outlines the modelled average probability of failure for members and holding down bolts (in green and blue, respectively), as well as how we have assumed a constant expected combined probability of failure of 1.8 per cent/annum from 2023 onwards in the economic assessment presented in this PSCR. This is a conservatively low representation of the risk as the probability of failure will certainly increase due to ongoing deterioration but has been assumed to demonstrate the need to address the gantries before they reach their end of life.

Figure 8 – Sydney South's probability of failure



2.3.3 Avoiding unserved energy to consumers is the most substantial driver of this RIT-T

Failure of substation gantry steelwork or holding down bolts will lead to conductors contacting the ground within the substation and is also likely to damage critical substation assets that are in close proximity to substation gantries, such as feeder conductors, busbars, circuit breakers, and transformers. It is also likely to result in overhead earth wires contacting high voltage conductors which would also cause outages.

Damage to these transmission assets are likely to occur concurrently given their close proximity to substation gantries, which means the failure of a single substation gantry section is likely to cause extended supply outages and reduced network reliability that would require significant time to restore.

The prospect of extended supply outages and the subsequent involuntary load shedding exists, despite a meshed transmission network around Sydney due to:

- the high likelihood of damage to multiple transmission elements that could disable multiple feeders required to ensure reliable supply;
- limited capacity to provide reactive support that would be needed to reroute load to TransGrid's Beaconsfield substation (which would likely necessitate some degree of load shedding to ensure network security); and
- the fact that two Ausgrid substations are exclusively supplied from Sydney South substation.

Consequently, the risk associated with involuntary load shedding arises from downstream Ausgrid distribution zone substations that either rely solely on Sydney South substation or substations that would be required to shed load to maintain voltage stability across the network in the event of a substation gantry failure at Sydney South.

TransGrid has calculated expected risk costs of doing nothing to be over $18.9 million in 2022, which is predominantly from involuntary load shedding[9] and consists of $7.5 million attributed to failure of holding down bolts and $11.4 million attributed to the failure of gantry members. These risk costs if nothing is done are expected to increase over time as loads at Sydney South substation increases and as the assets deteriorate further.

TransGrid has adopted two conservative simplifying assumptions that are used to provide lower bound estimates of these risk costs – namely:

- a constant probability of failure equal to 1.8 per cent is applied each year (as shown in Figure 8 above), despite escalating probabilities in reality as asset conditions deteriorate; and
- gantry failures are only considered on the 132 kV transmission network, whereas Sydney South substation has gantries supporting both 132 kV and 330 kV transmission networks.[10]

TransGrid considers these conservative assumptions appropriate for this RIT-T. In particular, refining the assumptions to be more realistic are significant exercises and will not change the outcome of the RIT-T in terms of the identified preferred option (it will just *increase* the estimated net benefits).

The economic assessment shown in this PSCR demonstrates that there are strong net benefits from refurbishing gantries under these conservative assumptions, even under our 'low benefits' scenario (as set out in section 7 below). In fact, under these assumptions, the assessment in section 7 below shows that the estimated VCR would need to decrease to $3.33/MWh to result in no net benefits from refurbishing the gantries.

9 This determination of per year risk cost is based on TransGrid's Network Asset Risk Assessment Methodology and incorporates variables such as likelihood of failure, various types of consequence costs and corresponding likelihood of occurrence.

10 This assumption has been made to simplify the analysis (estimating the PoF, LoC and CoC for the 330 kV gantries is a significant exercise and one that TransGrid considers is not warranted since the investment is strongly justified when considering just the 132 kV gantries).

TransGrid therefore considers it extremely unlikely that the true underlying reliability risk costs would fall outside this sensitivity, particularly in light of the conservative assumption of a constant risk each year going forward.

Overall, the risk if nothing is done is expected to increase beyond levels that could be considered in the long-term interests of consumers. It follows that TransGrid considers the condition of gantry steelwork and bolt corrosion must be addressed to ensure risks to consumers from falling substation gantries is reasonably minimised.

3. Options that meet the identified need

TransGrid considers that there is only one feasible option from a technological and project delivery perspective, ie, replacing or refurbishing the identified corroded components in one stage.

This section provides more information on the scope and cost of this option. It also outlines options considered but not progressed and how it is not expected to have a material inter-network impact.

Option 1 below is considered to be both technically and commercially feasible and able to be implemented in sufficient time to meet the identified need.[11] In addition, all works under this option is assumed to be completed in accordance with the relevant standards and components shall be replaced or refurbished with the objective of minimal modification to the wider transmission assets.

3.1 Description of the 'base case'

Consistent with the RIT-T, the assessment undertaken in this PSCR compares the costs and benefits of the option to a base case 'do nothing' option.

Under this base case, the existing condition issues at Sydney South substation will not be remediated and it will continue to operate, with an increasing risk level. Specifically, the base case considers no investment in the network asset other than continuing the maintenance regime.

3.2 Option 1 - In situ gantry steelwork renewal and remediation

Option 1 involves in-situ renewal of the steelwork by removing corrosion, painting and replacement of components where required. The scope of works is summarised in Table 3.1.

Table 3.1 – Over of items addressed under Option 1

Issue	Remediation
Corrosion of gantry steel members	> Removal of rust via blasting of gantry columns, beams and earth wire peaks > Painting of blasted gantries with zinc based paint > Replacement of connection bolts and steel members (if required)
Corrosion of gantry holding down bolts and base plates	> Removal of grout and corrosion > Painting and repair of holding down bolts and base plates > Reinstatement of grout

It is expected that the remediation works will be undertaken in various stages between 2018/19 and 2020/21. The two broad stages to replacing all corroded elements are:

> Stage 1 (2018/19 and 2019/20) – Planning and procurement (including completion of the RIT-T); and

> Stage 2 (2020/21) – Project delivery and construction.

The estimated capital cost of Option 1 is estimated cost of between $18 million and $24 million depending on the extent of work required to address corrosion and the final selected remediation methods across the site.

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11 In accordance with the requirements of NER clause 5.15.2(a).

Where corrosion is pervasive, more extensive and costly remediation works will be necessary. It is expected that more accurate cost estimates will be provided in the PACR as detailed scoping is progressed.

Planned operating costs for Option 1 are not expected to materially differ from the base case once remediation of corroded members and bolts have been completed. There are expected to be significantly lower unplanned maintenance costs associated with Option 1 though as the work is designed to eliminate gantry failures due to corrosion.

Planned outages and staging will be taken as necessary in order to complete the construction works.

3.3 Options considered but not progressed

TransGrid has also considered whether there are other credible options that would meet the identified need. However, the identified need to address asset failure risk and safety risks associated with corroding components of substation gantries do not lend itself to other technological solutions other than those considered in preceding sections above.

The table below summarises two other options TransGrid has considered as part of this RIT-T, and its earlier asset condition and replacement planning. The table also outlines the reasons why these options were not progressed any further and have not been explicitly modelled alongside the options considered.

Table 3.2 – Options considered but not progressed

Option	Reason(s) for not progressing
Stage the delivery of Option 1 over multiple years	There are cost efficiencies associated with renewing all identified components in one stage, as opposed to spreading the work out over multiple years. In addition, delaying the replacement of any components comes with a greater expected risk value. The combination of greater costs and less expected benefits (in terms of avoided risk costs) has led TransGrid to consider this option commercially infeasible relative to Option 1 and so it has not been progressed.
Replacement of substation gantries or entire site rebuild	The option of replacing all substation gantries at Sydney South substation, as opposed to just the corroded components, is estimated to have a capital cost in the order of $100 million. This cost is significantly more than Option 1 (at least four times greater) and is not expected to provide any additional market benefits. The option of replacing the entire substation is similar to replacing gantries as replacement and rebuild would substantially require a rebuild of the substation. A full rebuild option is also estimated to have a capital cost in excess of that estimated for the replacing of all gantries, which is significantly more than Option 1 and is not expected to provide any additional market benefits. In addition, replacing gantries or rebuilding the substation is not technically feasible as it is not possible to keep planned outages (necessary to deliver these options) to an acceptable level.
Decommissioning of substation gantries	This option is not considered technically feasible due to requirement for the substation to fulfil the required functionality for the transmission network.

In addition, as set out in section 4 below, TransGrid does not consider that non-network solutions can feasibly address, or help address, the identified need to undertake network investment. This is driven by the fundamental role that the identified gantries play in the transmission of electricity at a substation, the enduring need for the Sydney South substation as well as how low the cost of refurbishing the gantries is (ie, $18 million to $24 million in capital cost).

TransGrid remains open to considering credible non-network options that address the identified need and are commercially and technically feasible. A more detailed discussion is provided in section 4.

While TransGrid has only investigated one type of credible option from a technological and project delivery perspective (ie, replacing or refurbishing the identified corroded components in one-go), we have investigated different assumed commissioning dates for this option in order to identify the optimal commissioning date. This assessment is presented in section 7.4.1 below.

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

TransGrid has considered whether Option 1 is expected to have a material inter-regional impact.[12]

A 'material inter-network impact' is defined in the NER as:

> *"A material impact on another Transmission Network Service Provider's network, which 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:[13]

> a decrease in power transfer capability between the 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 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; and

> the investment does not involve either a series capacitor or modification in the vicinity of an existing series capacitor.

TransGrid notes that Option 1 satisfies these conditions as it does not modify any aspect of electrical or transmission assets. As a consequence, by reference to AEMO' s screening criteria, there are no material inter-network impacts associated with Option 1.

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

13 The screening test is set out in Appendix 3 of the Inter-Regional Planning Committee's Final Determination: Criteria for Assessing Material Inter-Network Impact of Transmission Augmentations, Version 1.3, October 2004.

4. Non-network options

TransGrid does not consider that non-network solutions can assist with meeting the identified need for this RIT-T. This is driven by the fundamental role that the identified gantries play in the transmission of electricity at a substation, the enduring need for the Sydney South substation as well as how low the cost of refurbishing the gantries is (ie, $18 million to $24 million in capital cost).

Notwithstanding, this section sets out the required technical characteristics for a non-network options, consistent with the requirements of the RIT-T.

4.1 Required technical characteristics of non-network options

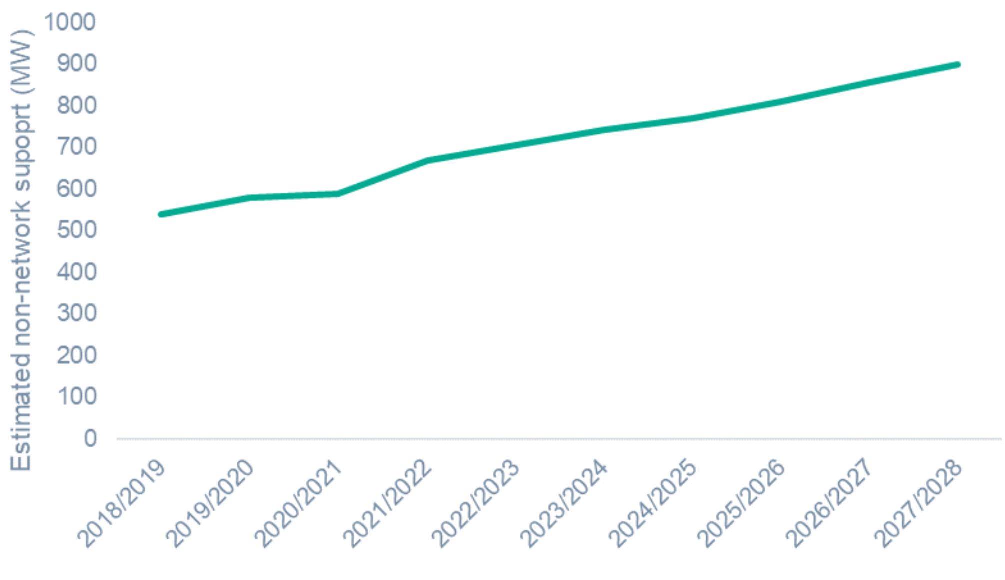
As outlined in section 2, the identified gantries are essential for the operation of the Sydney South substation.

A network support option that avoids the replacement work identified in Option 1 would therefore need to replicate the functionality, capacity and reliability of the substation on an enduring basis at a cost that is lower than the network option currently under consideration (ie, $18 million to $24 million in capital cost).

TransGrid considers that the extent of the load in question make this commercially and technically infeasible for non-network solutions.

The figure below illustrates the estimated maximum load required from a non-network option during an assumed one-week outage of the Sydney South substation (eg, following a high wind event) over the next ten years. While this is a theoretical maximum, assuming the repair occurs during the peak demand period of the year, it provides an indication of the amount of support that would be required in Inner Sydney.

Figure 9 – Indicative non-network support required during an outage



In addition, TransGrid notes that there are a number of downstream Ausgrid zone substations whose sole supply is from Sydney South.

TransGrid considers that a non-network option would be required to meet these loads on a continuous basis, potentially 24 hours a day over the period of any outage.

While non-network options may be technically possible, TransGrid considers that such solutions at the scale required is unlikely to be commercially feasible.

5. Materiality of market benefits

The section outlines the categories of market benefits prescribed in the NER and whether they are considered material for this RIT-T.[14]

5.1 Changes in in involuntary load curtailment are the only material category

Changes in in involuntary load curtailment are the only material category of market benefit for this RIT-T. In particular, Option 1 resolves the asset condition issues identified that, if unaddressed (ie, under the base case), are forecast to result in significant amounts of unserved energy for end consumers.

As outlined in section 2.3.3, the unserved energy under the base case arises from downstream Ausgrid distribution zone substations that rely solely on Sydney South substation and substations that would need to shed load to maintain voltage stability across the network if the gantries fail.

5.2 Market benefits relating to the wholesale market are not material

The AER has recognised that if the credible options considered will not have an impact on the wholesale 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.[15]

Option 1 outlined above does 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 for TransGrid (since there will be no deferral of generation investment);
> changes in ancillary services costs;
> competition benefits; and
> Renewable Energy Target (RET) penalties.

5.3 All other categories of market benefits are also not 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 in relation to each credible option: differences in the timing of transmission investment; option value; and changes in network losses.

TransGrid considers that none of the classes of market benefits listed above are material for this RIT-T assessment for the reasons set out below.

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[14] The NER requires that all categories of market benefit identified in relation to the RIT-T are included in the RIT-T assessment, unless the TNSP can demonstrate that a specific category (or categories) is unlikely to be material in relation to the RIT-T assessment for a specific option – NER clause 5.16.1(c)(6). Under NER clause 5.16.4(b)(6)(iii), the PSCR should set out the classes of market benefit that the NSP considers are not likely to be material for a particular RIT-T assessment.

[15] AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, 18 September 2017, pp. 13-14.

Table 5.1 – Reasons why non-wholesale market benefit categories are considered immaterial

Market benefits	Reason
Differences in the timing of expenditure	Option 1 is not expected to affect the timing of scope of any unrelated transmission investment.
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 in the future is likely to change and the credible options considered by the TNSP are sufficiently flexible to respond to that change.[16] 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 changes in future demand levels are not relevant for this RIT-T, since the need for and timing of the required investment is being driven by asset condition rather than future demand growth. As a result, it is not relevant to consider different future demand scenarios in undertaking the RIT-T analysis. The estimation of any option value benefit would require a significant modelling assessment, which would be disproportionate to any additional option value benefit that may be identified for this specific RIT-T assessment. Therefore, TransGrid has not estimated any additional option value market benefit for this RIT-T assessment.
Changes in network losses	As there is no change to the transmission lines or the destination of the line under any of the options considered, there will not be any material market benefits associated with changes to network losses.

[16] AER, *Final Regulatory Investment Test for Transmission Application Guidelines*, 18 September 2017, pp. 37 & 74.

6. Overview of the assessment approach

This section outlines the approach that TransGrid has applied in assessing the net benefits associated with remediating steelwork on substation gantries at Sydney South substation.

6.1 General overview of the assessment framework

As outlined in section 3.1, all costs and benefits considered have been measured against a base case where the existing condition issues at Sydney South substation are assumed to not be remediated and the gantries will continue to operate, with an increasing risk level.

The RIT-T analysis has been undertaken over a 20-year period, from 2018/19 to 2038/39. TransGrid considers that a 20-year period takes into account the size, complexity and expected life of the refurbishment option to provide a reasonable indication of the benefits and costs this option. While the capital components of the new components under Option 1 have asset lives greater than 20 years, TransGrid has taken a terminal value approach to incorporate capital costs in the assessment, which ensures that the capital cost of long-lived assets is appropriately captured in the 20-year assessment period.

TransGrid has adopted a central real, pre-tax 'commercial'[17] discount rate of 7.04 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, consistent with the RIT-T.

TransGrid has also tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound real, pre-tax discount rate of 4.60 per cent (equal to the latest AER Final Decision for a TNSP's regulatory proposal at the time of preparing this PSCR[18]), and an upper bound discount rate of 9.48 per cent (ie, a symmetrical adjustment upwards).

6.2 Approach to estimating project costs

TransGrid has estimated the capital costs of the refurbishment option by considering the scope of works necessary together with costing experience from previous projects of a similar nature. TransGrid considers the central capital costs to be estimated to within +/- 25 per cent of the actual cost.

Routine operating and maintenance cost are not expected to be material under either Option 1 or the base case as these costs relate to planned routine checks of the line by TransGrid field staff.

Reactive maintenance costs under the base cost have been estimated by considering both the:

> level of reactive maintenance required to restore assets to working order following a physical failure; and

> probability and expected level of network asset faults, which translates to the level of corrective maintenance costs.

Option 1 reduces the incidence of asset failures relative to the base case, and hence the expected operating and maintenance costs associated with restoring supply.

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17 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.

18 See TransGrid's PTRM for the 2018-23 period, available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/transgrid-determination-2018-23

6.3 Three different 'scenarios' have been modelled to address uncertainty

RIT-T assessments are required to be based on cost-benefit analysis that includes an assessment of 'reasonable scenarios', which are designed to test alternate sets of key assumptions and whether they affect identification of the preferred option.

TransGrid has constructed three alternative scenarios for this PSCR assessment – namely:

> a 'low benefit' scenario, involving a number of assumptions that give rise to a lower bound NPV estimate for the refurbishment option, in order to represent a conservative future state of the world with respect to potential benefits that could be realised;
> a 'central' scenario, which consists of assumptions that reflect TransGrid's central set of variable estimates which, in TransGrid's opinion, provides the most likely scenario; and
> a 'high benefit' scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected net benefits.

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

Table 6.1 – Summary of the three scenarios investigated

Variable / Scenario	Central	Low benefits	High benefits
Network capital costs	$21 million	$24 million	$18 million
Avoided emergency rebuild risks	Base estimate	Base estimate - 25%	Base estimate + 25%
VCR	$90/kWh	$40/kWh	$90/kWh
Demand forecast	POE 50	POE 90	POE 10
Discount rate	7.04 per cent	9.48 per cent	4.60 per cent

We have applied a $90/kWh VCR in the central and 'high benefits' scenarios since the unserved energy Option 1 plans to avoid is in the Inner Sydney region. This is consistent with both the December 2016 Independent Pricing and Regulatory Tribunal (IPART) review of the New South Wales electricity transmission reliability standards as well as the recent Powering Sydney's Future RIT-T. Noting that there is uncertainty in any estimate of the VCR, we have included a VCR of $40/kWh in the 'low benefits' scenario (ie, consistent with the 2014 AEMO estimates of VCR) and also tested the thresholds for what the VCR would need to be to change the outcome of the RIT-T (which is presented in section 7.4 below).

TransGrid considers that the central scenario is the most likely, since it is based primarily on a set of expected/central assumptions. TransGrid has therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being weighted equally with 25 per cent each. However, TransGrid notes that, on account of there only being one credible option, the identification of the preferred option is the same across all three scenarios, ie, the result is insensitive to the assumed scenario weights.

7. Assessment of credible options

This section outlines the assessment TransGrid has undertaken of the credible network option.

The assessment compares the costs and benefits of the option to a base case 'do nothing' option, where the existing condition issues associated with substation gantries will not be remediated and will continue to operate with an increasing risk level.

7.1 Benefits estimated

The table below summarises the benefit estimated for Option 1 relative to the 'do nothing' base case in present value terms. The benefit has been calculated for each of the three reasonable scenarios outlined in the section above.

The only 'market benefit' under the RIT-T arises from the proposed investment avoiding involuntary load shedding, while other benefits relate to avoided costs from avoiding emergency reconstruction works and avoiding safety incidents. These avoided costs are *expected* costs in that the actual cost (if an event occurs) has been multiplied by the chance of it occurring.

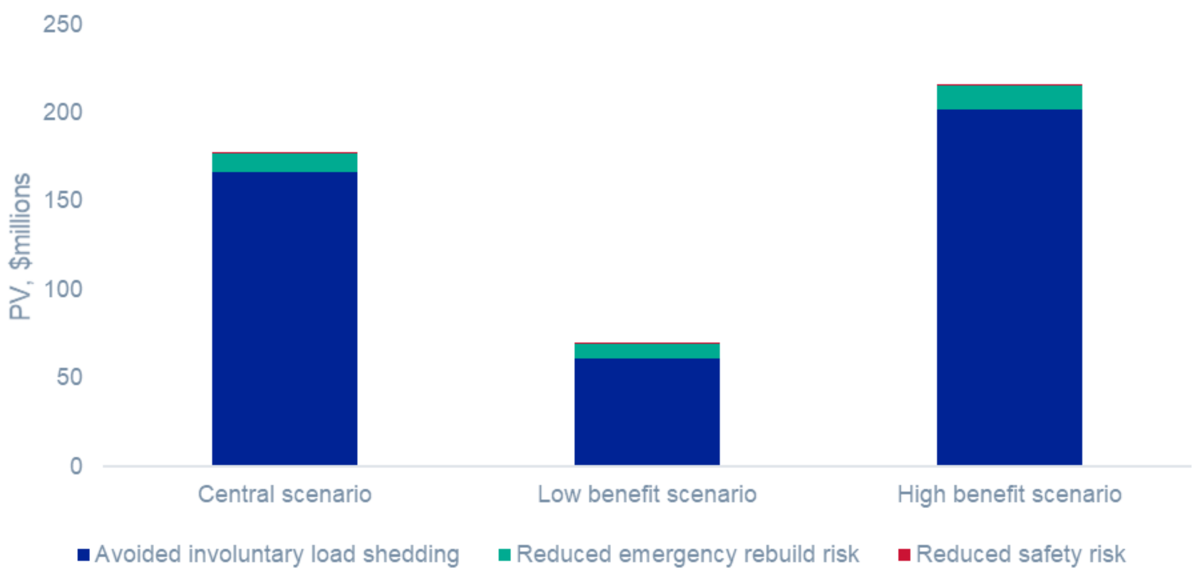
The 'low' and 'high' scenarios reflect lower and upper bounds on TransGrid's expectations regarding these market and avoided cost benefits.

Table 7.1 – Present value of economic benefits of Option 1 relative to the base case, PV $m

Option/scenario	Central	Low benefit	High benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	177.0	69.4	215.5	159.7

The figure below provides a breakdown of benefits estimated for Option 1, showing almost all of the benefits are derived from avoided involuntary load shedding, while other avoided costs contribute relatively small amounts to overall gross benefits.

Figure 10 – Breakdown of gross economic benefits Option 1 relative to the base case, PV $m



7.2 Estimated costs

The table below summarises the costs of Option 1, relative to the base case, in present value terms. The cost of Option 1 has been calculated for each of the three reasonable scenarios outlined above.

Table 7.2 – Present value of costs of Option 1 relative to the base case, PV $m

Option/Scenario	Central	Low benefit	High benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	16.9	19.3	14.5	16.9

7.3 Net market benefits

The table below summaries the net market benefit in NPV terms for Option 1 across the three scenarios, as well as on a weighted basis. The net market benefit is the benefits (as set out in section 6.1 above) minus the costs (as outlined in section 6.2 above), all in present value terms.

The table shows that Option 1 is found to have positive net market benefits for all scenarios investigated. On a weighted basis, Option 1 is expected to deliver approximately $142.9 million in net market benefits.

Table 7.3 – Present value of net benefits relative to the base case, PV $m 2017/18

Option/Scenario	Central	Low benefit	High benefit	Weighted
Option 1	160.2	50.1	201.0	142.9

Overall, TransGrid's analysis shows that the investment to remediate steelwork gantries at South Sydney substation is highly positive in NPV terms, even under the low benefit scenario where it is expected to generate $50.1 million in net economic benefits. The assumptions feeding into the low scenario include:

- high expected network capital costs;
- a VCR of $40/kWh;
- a low POE90 demand forecast;
- a commercial discount rate of 9.48 per cent; and
- low assumed avoided emergency rebuild risks under the base case.

Furthermore, underlying assumptions used to generate these results are considered conservative – namely:

- a constant probability of failure equal to 1.8 per cent is applied each year – despite escalating probabilities in reality as asset conditions deteriorate;
- only the impact of 132 kV transmission equipment (ie 132 kV busbars) has been considered in the development of the risk cost – there is an additional risk cost associated with the deterioration of the 330 kV gantries, which has not been included; and
- it would only take five days to recover in the event of gantry failure, limiting the amount of time involuntary load shedding would be incurred – this assumption reflects a highly optimistic view of the ability for TransGrid and its contractors to recover from gantry and transmission equipment failure.

More severe outcomes would be expected to occur in reality than reflected in the above conservatively low assumptions and this would result in a significant increase in the net economic benefits arising from the proposed investment. However, a conservative approach has been adopted for the purposes of this RIT-T given that refinement of these assumptions would involve extensive and time-consuming modelling that will not change the outcome of the RIT-T (ie, in terms of the identified preferred option).

7.4 Sensitivity testing

TransGrid has undertaken thorough sensitivity testing exercise 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 – namely:

> 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.

TransGrid has therefore undertaken sensitivity analysis to first determine the optimal timing of the project, to conclude that a particular year represents the ‘most likely’ date at which the project will be needed.

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 demand forecasts are not as high as expected, for example, what would be the impact on the net market benefit associated with the project continuing to go ahead on that date.

We outline how each of these two steps have been applied to test the sensitivity of the key findings below.

7.4.1 Step 1 – Sensitivity testing of the assumed optimal timing for the credible option

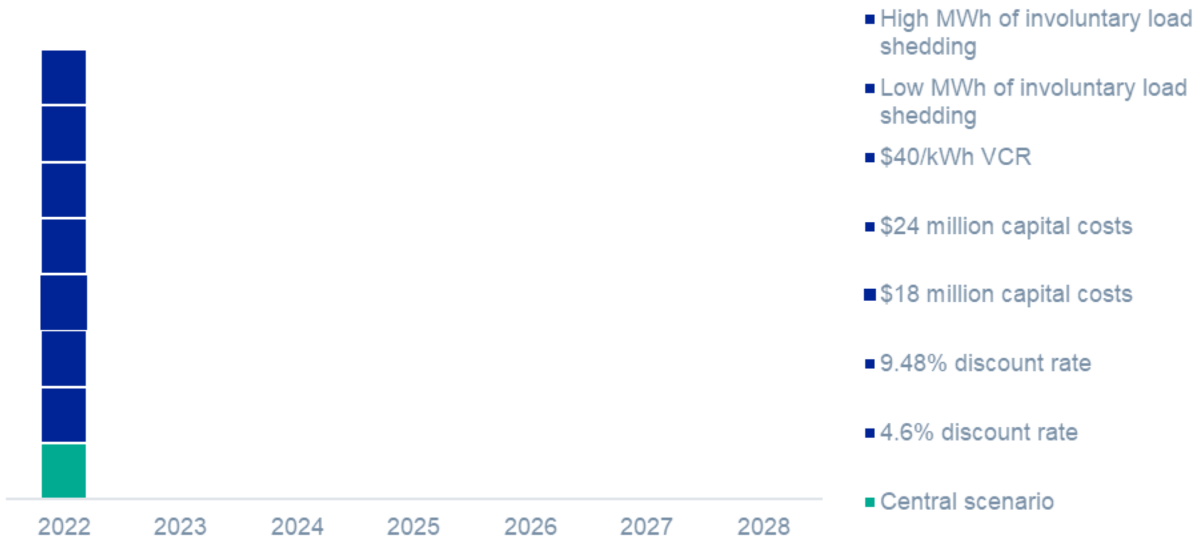
TransGrid has estimated the optimal timing for Option 1 based on the year in which the NPV is maximised. This process was undertaken for both the central set of assumptions and also a range of alternative assumptions for key variables.

This section outlines the sensitivity of the identification of the commissioning year to changes in the underlying assumptions. In particular, the optimal timing of the option is found to be invariant to the assumptions of:

> lower and higher capital costs of $18.0 million and $24.0 million, respectively;
> lower discount rate of 4.60 per cent as well as a higher rate of 9.48 per cent;
> lower VCR of $40/kWh; and
> lower and higher demand forecasts.

The figure below outlines the impact on the optimal commissioning year, under a range of alternative assumptions. It illustrates that for Option 1, the optimal commissioning date is found to be in 2021/22 for all of the sensitivities investigated.

Figure 11 – Distribution of optimal project commissioning year for Option 1 under each sensitivity



7.4.2 Step 2 – Sensitivity of the overall net market benefit

TransGrid has also conducted sensitivity analysis on the overall NPV of the net market benefit, based on the optimal option timing established in step 1.

Specifically, TransGrid has investigated the same sensitivities under this second step as in the first step, ie:

> lower and higher capital costs;
> lower discount rate of 4.60 per cent as well as a higher rate of 9.48 per cent; and
> lower VCR of $40/kWh.

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

The three figures below illustrate the estimated net market benefits for each option if we vary three separate key assumptions in the central scenario individually. Importantly, for all sensitivity tests shown below, the estimated net market benefit of Option 1 is found to be positive.

The results are found to be most sensitive to the assumed VCR. We have extended this sensitivity exercise and found that there would need a VCR for Inner Sydney of less than $3.33/kWh to result in no expected net market benefits (ie, a NPV of zero) under the central scenario, holding all else constant. While acknowledging there is uncertainty in any VCR estimate, TransGrid considers it extremely unlikely that the central estimate has been this overestimated.

Figure 12 – Sensitivity testing of Option 1

8. Draft conclusion and exemption from preparing a PADR

Option 1 is the preferred option at this draft stage and involves refurbishing the existing gantry steelwork by renewing the identified corroded components.

In particular, Option 1 involves the remediation of substation gantries at Sydney South substation, including the treatment of corrosion of steelwork and replacement of components which have reached end of life due to corrosion. By undertaking the remediation works, the life of substation gantries at Sydney South substation are expected to be extended by approximately 20 years.

It is expected that this remediation works will be undertaken in various stages between 2018/19 and 2020/21. The two broad stages to renewing all corroded elements are:

- Stage 1 (2018/19 and 2019/20) – Planning and procurement (including completion of the RIT-T); and
- Stage 2 (2020/21) – Project delivery and construction.

While physical delivery and replacement of the identified assets is planned to occur over 2020/21, it will be delivered in a staged fashion over the course of the year with replacement targeted on asset condition. All work is expected to be completed by 2021/22.

The estimated capital cost of this option is estimated to be between $18 million and $24 million and will be refined in the PACR. Operating expenditure is not expected to be materially different from the base case.

The preferred option to refurbish the line reduces the risk of substation gantry failure to acceptable levels and this risk reduction outweighs the capital expenditure.

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

- if the estimated capital cost of the preferred option is less than $41 million;
- if the TNSP identifies in its PSCR its proposed preferred option, together with its reasons for the preferred option and notes that the proposed investment has the benefit of the clause 5.16.4(z1) exemption; and
- if the TNSP considers that the proposed preferred option and any other credible options in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4), with the exception of market benefits arising from changes in voluntary and involuntary load shedding.

TransGrid considers that Option 1 is exempt from producing a PADR under NER clause 5.16.4(z1).

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.

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

Should TransGrid consider that no additional credible options were identified during the consultation period, TransGrid intends to produce a PACR that addresses all submissions received including any issues in relation to the proposed preferred option raised during the consultation period.[19]

[19] In accordance with NER clause 5.16.4(z2).

Appendix A – Compliance checklist

This appendix sets out a compliance checklist which demonstrates the compliance of this PSCR with the requirements of clause 5.16.4(b) of the Rules version 111.

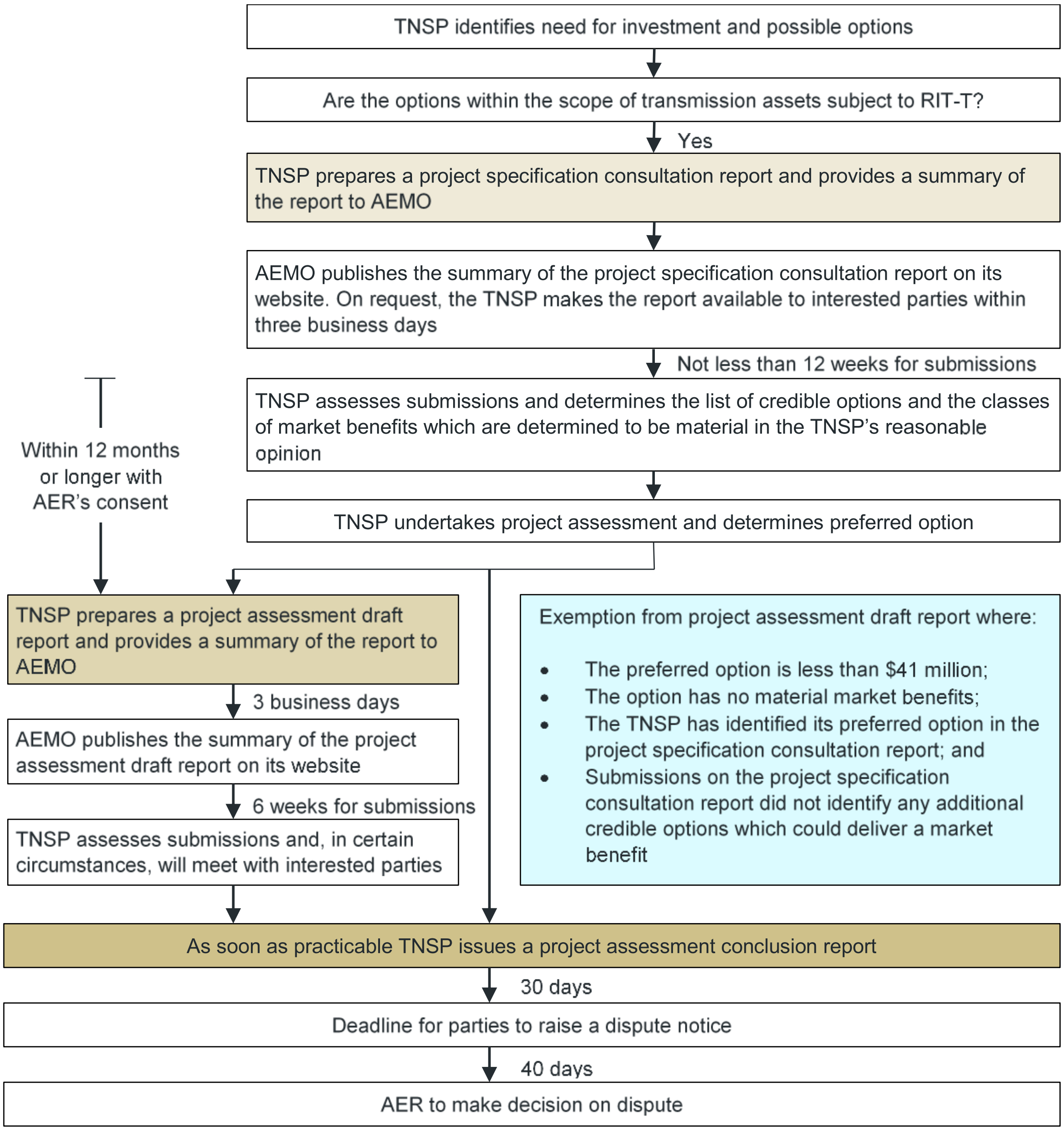
Rules clause	Summary of requirements	Relevant section(s) in PSCR
5.16.4 (b)	A RIT-T proponent must prepare a report (the project specification consultation report), which must include:	–
	(1) a description of the identified need;	2
	(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	2
	(3) the technical characteristics of the identified need that a non- network option would be required to deliver, such as: (i) the size of load reduction of additional supply; (ii) location; and (iii) operating profile;	4
	(4) if applicable, reference to any discussion on the description of the identified need or the credible options in respect of that identified need in the most recent National Transmission Network Development Plan;	NA
	(5) a description of all credible options of which the RIT-T proponent is aware that address the identified need, which may include, without limitation, alterative transmission options, interconnectors, generation, demand side management, market network services or other network options;	3
	(6) for each credible option identified in accordance with subparagraph (5), information about: (i) the technical characteristics of the credible option; (ii) whether the credible option is reasonably likely to have a material inter-network impact; (iii) the classes of market benefits that the RIT-T proponent considers are likely not to be material in accordance with clause 5.16.1(c)(6), together with reasons of why the RIT-T proponent considers that these classes of market benefit are not likely to be material; (iv) the estimated construction timetable and commissioning date; and (v) to the extent practicable, the total indicative capital and operating and maintenance costs.	3 & 5

5.16.4(z1)	A RIT-T proponent is exempt from paragraphs (j) to (s) if: 1. the estimated capital cost of the proposed preferred option is less than $35 million (as varied in accordance with a cost threshold determination); 2. the relevant Network Service Provider has identified in its project specification consultation report: (i) its proposed preferred option; (ii) its reasons for the proposed preferred option; and (iii) that its RIT-T project has the benefit of this exemption; 3. the RIT-T proponent considers, in accordance with clause 5.16.1(c)(6), that the proposed preferred option and any other credible option in respect of the identified need will not have a material market benefit for the classes of market benefit specified in clause 5.16.1(c)(4) except those classes specified in clauses 5.16.1(c)(4)(ii) and (iii), and has stated this in its project specification consultation report; and 4. the RIT-T proponent forms the view that no submissions were received on the project specification consultation report which identified additional credible options that could deliver a material market benefit.	8

Appendix B – RIT-T process overview

For the purposes of applying the RIT-T, the NER establishes a typically three stage process, ie: (1) the PSCR; (2) the PADR; and (3) the PACR. This process is summarised in the figure below (in gold), as well as the criteria for PADR exemption that this RIT-T is seeking to apply (in blue).

Figure 13 – The RIT-T assessment and consultation process



Source: AER, Final Regulatory investment test for transmission application guidelines, 18 September 2017, p. 42.