TransGrid

Summary: Managing asset risks at Sydney South substation

RIT-T – Project Assessment Draft Report

Region: Greater Sydney

Date of issue: 3 December 2019

Summary

TransGrid is applying the Regulatory Investment Test for Transmission (RIT-T) to options for mitigating asset risks caused by corroding gantries at Sydney South substation. Publication of this Project Assessment Draft Report (PADR) represents the second step in the RIT-T process.

Sydney South substation:

- supplies most of the load in Sydney CBD, Eastern suburbs and South Sydney
- is the largest bulk supply point for Ausgrid's distribution network with growing summer maximum demand at approximately 1,177 MW in 2019/20[1]
- must meet redundancy category 3 reliability standards with only 0.6 minutes of expected unserved energy (EUE) allowed each year across Inner Sydney.

At Sydney South substation, gantries support high voltage connections between switchbays and busbars. They are mainly used to support the power conductor in both directions between the transmission tower closest to the substation and the equipment within the substation. Gantries are connected to concrete footings by concrete plinths, holding down bolts and baseplates. They also support overhead earthwires that protect the substation equipment from direct lightning strikes and are essential for the safe and reliable operation of the substation.

Corrosion has been found on a large portion of gantries at Sydney South substation. The corrosion of holding down bolts and structural components, or 'members', ranges from initial development through to loss of steel thickness (cross-sectional area).

TransGrid's analysis indicates that the holding down bolts and several of the gantry members will reach the end of serviceable life by 2021. After this time, the loss of physical cross-sectional area from corrosion will decrease their capacity to provide structural support. This reduces structural integrity and significantly increases their probability of structural failure, especially during high wind events. Deterioration of holding down bolts has occurred across the site and action is required on the majority of structure footings. If unaddressed, these issues may cause failure of steelwork, holding down bolts or baseplates leading to gantry collapse.

Table E-1 outlines the condition issues identified at Sydney South substation and the potential consequences if not remediated.

Table E-1 Consequences of condition issues

Issue	Consequences if not remediated
Corrosion of gantry steel members	Structural failure
Corrosion of holding down bolts and base plates	Structural failure
Corroded fasteners	Structural failure
Corrosion of earth wire attachment fittings	Conductor drop

[1] Summer maximum demand is estimated to increase to 1,317 MW by 2028/29. TransGrid. "*Transmission Annual Planning Report 2019*." Sydney: TransGrid, 2019. 81. Accessed 13 November, 2019. https://www.transgrid.com.au/what-we-do/Business-Planning/transmission-annual-planning/Documents/2019%20Transmission%20Annual%20Planning%20Report.pdf

Identified need: managing asset risks to avoid potentially significant unserved energy

The proposed investment to address the corroded gantries has significant 'market benefits' as the proposed investment will help to avoid involuntary load shedding. Options considered under this RIT-T have been assessed relative to a base case. Under the base case, no proactive capital investment is made and the condition of Sydney South substation will continue to deteriorate. The investment will also assist TransGrid to manage and mitigate safety risks that would otherwise arise from a failure in substation gantries.[2]

The purpose of the proposed investment has similarities to those made under a reliability corrective action identified need (ie, to avoid involuntary load shedding), however 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 at the same substation). It follows that the proposed investment is driven by a 'market benefits' due to the lack of externally imposed obligations relating to multiple failures of transmission network elements.

No submissions received in response to the Project Specification Consultation Report

TransGrid published a Project Specification Consultation report (PSCR) on 3 September 2018 and invited written submissions on the material presented within the document. In the PSCR TransGrid put forward for consideration one technically and commercially feasible option: replacing and refurbishing the identified corroded components in a single project. This option (Option 1) involves in-situ renewal of the steelwork by removing corrosion, painting and replacement of components, where required. No submissions were received in response to the PSCR.

Developments since publication of the PSCR

At the time the PSCR was published, TransGrid's cost estimate for refurbishing the Sydney South substation gantries was primarily based on a desktop assessment of the activity required to refurbish the gantries. TransGrid has since undertaken additional investigations and onsite trials, in particular testing different blasting techniques. The field trials demonstrated that:

- blasting in a live switchyard takes significantly longer than originally anticipated in primarily due to outage/system constraints
- blasting requires extensive outages of all nearby high voltage plant due to garnet overspray, these risks were not considered in PSCR
- there are safety risks and cost impacts of blasting steelwork with lead contaminated paint which were also not considered in the PSCR.

Due to the issues described above, the cost estimate of refurbishing the existing gantries in the PSCR is not adequate to cover the scope of Option 1. The risk that the cost estimates could be too low was noted in the PSCR:

> *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*

[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). 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.

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 Conclusions Report (PACR) as detailed scoping is progressed.[3]

As the cost estimate of refurbishing the gantries outlined in the PSCR was much lower than the current estimates, more time has been spent developing better ways to address the need. In this PADR, TransGrid has updated the cost estimates and developed a new option to replace the gantries, which would result in a 45-year life extension.

Replacing gantries provides the most enduring benefits

TransGrid considers that there are two feasible options from a technical and project delivery perspective, which are replacing or refurbishing the gantries. Both options would involve removal of gantries that are not essential to the future operation of the substation resulting in fewer gantry structures being required at the site. Both options effectively address the risk of outages due to gantry failure, however the option to replace the gantries results in structures with a 45-year life but the option to refurbish the structures would result in the existing assets being extended only 20 years. Both options include refurbishment of the holding down bolts.

The difference in asset life is the key reason why option 2 to replace the gantries results in far greater benefits than option 1 to refurbish the existing assets and why option 2 is the preferred option. In other words, replacing the gantries will reduce the risk of outages due to asset failure for an additional 25 years when compared to the option to only refurbish the gantries, which significantly reduces the expected cost of unserved energy. Further, under option 1, refurbished assets will likely have a slightly higher expected failure rate and therefore a higher expected unserved energy for the initial 20 years.

It is expected that the remediation works will be undertaken in various stages. The two broad stages to replacing all corroded elements are:

> Stage 1 (2018/19 to 2020/21) – Planning and procurement (including completion of the RIT-T)

> Stage 2 (2020/21 to 2023/24) – Project delivery and construction.

The estimated capital cost is $42.5 million (-/+ 25%) in 2019/20 dollars. 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 has been completed. There are expected to be significantly lower unplanned maintenance costs associated with this option, though the work is designed to eliminate gantry failures due to corrosion.

Extensive planned outages and staging will be necessary in order to complete the construction works.

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

The PSCR 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 driven by the fundamental role that the identified gantries play in the transmission of electricity at a substation; the enduring need for Sydney South substation.

[3] TransGrid. *"Managing the Sydney South Substation's Asset Risks RIT-T – Project Specification Consultation Report."* Sydney: TransGrid, 2018.4. Accessed 13 November, 2019. https://www.transgrid.com.au/what-we-do/projects/regulatory-investment-tests/Documents/TransGrid%20PSCR%20-%20Managing%20the%20Sydney%20South%20Substation%27s%20Asset%20Risks.pdf

Net benefits have been estimated across three different 'scenarios'

TransGrid has considered three alternative scenarios in this PADR:

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. The scenarios include:

> A 'low benefit' scenario, involving a number of assumptions that give rise to a lower bound Net Present Value (NPV) estimate for the options, 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 TransGrid considers to be the most likely scenario.

> 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-2 Summary of the three scenarios investigated

Variable / Scenario	Central	Low benefit scenario	High benefit scenario
Scenario weighting	50%	25%	25%
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
Value of customer reliability (VCR)	$90/kWh	$40/kWh	$90/kWh
Demand forecast	POE 50	POE 90	POE 10
Discount rate	5.90%	8.95%	2.85%
Safety and Financial risk costs	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%, with the other two scenarios being weighted equally with 25% each.

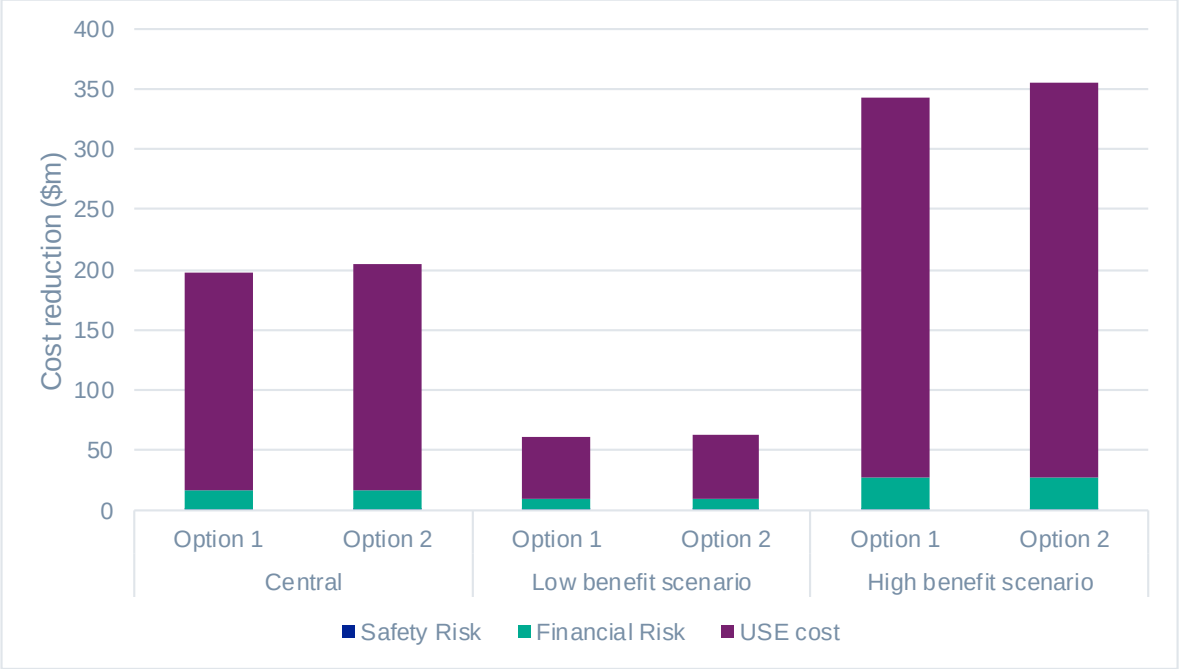
A $90/kWh VCR has been applied in the central and 'high benefits' scenarios since the unserved energy the investment is intended to avoid is in the Inner Sydney region. This is consistent with both the December 2016 Independent Pricing and Regulatory Tribunal's (IPART) Electricity Transmission Reliability Standards review 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 (consistent with the 2014 AEMO estimates of VCR[4]) and also tested the thresholds for what the VCR would need to be to change the outcome of the RIT-T.

[4] $38.35/kWh adjusted for inflation. Australian Energy Market Operator. "Value of Customer Reliability Review- Final Report." Melbourne: Australian Energy Market Operator, 2014.30. Accessed 14 November 2019. https://www.aemo.com.au/-/media/Files/PDF/VCR-final-report--PDF-update-27-Nov-14.pdf

The proposed investment proposed significant 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 Gross benefits for all credible options relative to the base case, present value ($m 2019/20)



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 the proposed investment is found to have positive net market benefits for all scenarios investigated. On a weighted basis, this investment is expected to deliver approximately $180.3 million in net economic benefits over the life of the investment.

Table E-3 Present value of net benefits relative to the base case ($m 2019/20)

Option/Scenario	Central	Low benefit scenario	High benefit scenario	Weighted
Option 1 Refurbish gantries	168.5	24.7	321.7	170.8
Option 2 Replace gantries	177.8	27.2	338.4	180.3

TransGrid has also conducted sensitivity analysis on the present value 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 replacing and refurbishing the assets is found to be positive.

The results are found to be most sensitive to the assumed VCR. TransGrid has extended this sensitivity exercise and found that there would need to be a VCR for Inner Sydney of less than $4.91/kWh (assuming no other variables change) to result in no expected net market benefits (NPV of zero) under the central scenario. While acknowledging there is uncertainty in any VCR estimate, TransGrid considers it unlikely that the central estimate has been overestimated to this extent.

Given the life extension offered by Option 2 is a key driver behind this option producing greater benefits than Option 1, TransGrid also modelled the benefits that are likely to be derived if the replacement assets remain in service for only 35 years instead of 45 years. In all scenarios the replacement option (Option 2) results in positive benefits and those benefits are greater than the benefits under Option 1.

Draft Assessment – the preferred option

The preferred option, Option 2, involves the renewal of holding down bolts and replacing the gantries at Sydney South substation. In particular, this involves the remediation of substation gantries at Sydney South substation, in a staged manner:

> treating corroded holding down bolts

> removing and replacing existing corroded gantry structures with new gantries

The resulting structures are expected to have a life of 45 years.

It is expected that the remediation works will be undertaken in various stages. The two broad stages to replacing all corroded elements are:

> Stage 1 (2018/19 to 2020/21) – Planning and procurement (including completion of the RIT-T)

> Stage 2 (2020/21 to 2023/24) – Project delivery and construction.

The estimated capital cost is $42.5 million (-/+ 25%) in 2019/20 dollars. It is expected that more accurate cost estimates will be provided in the Project Assessment Conclusion Report (PACR) as detailed scoping is progressed. Operating expenditure is not expected to be materially different from the base case.

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

Submissions and next steps

TransGrid welcomes written submissions on material contained in this PADR. Submissions are due on or before 21 January 2020.

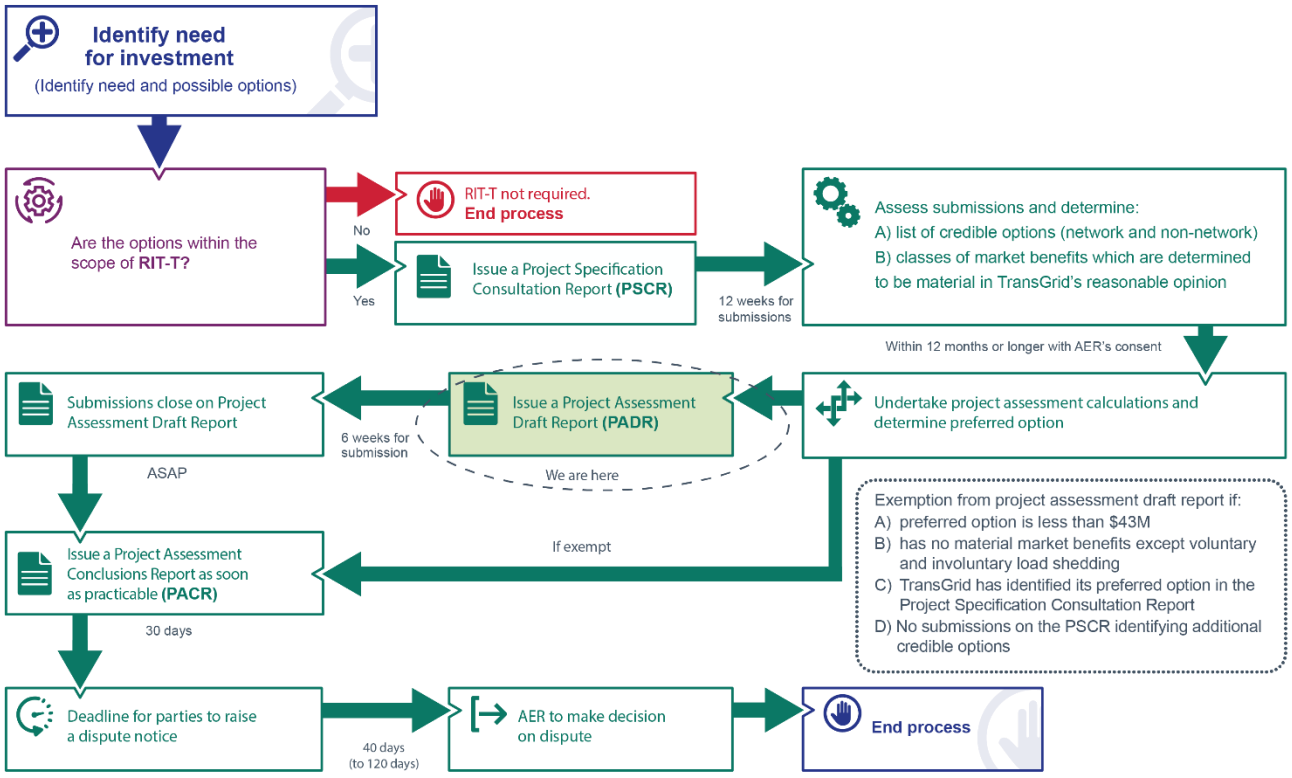
Submissions should be emailed to TransGrid's Regulation team via RIT-TConsultations@transgrid.com.au[5]. In the subject field, please reference 'PADR Sydney South substation steelworks project'.

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.

The next step in this RIT-T, following consideration of submissions received via the six-week consultation period and any further analysis required, will be publication of a Project Assessment Conclusion Report (PACR). TransGrid anticipates publication of a PACR by June 2020.

[5] 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. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement. See the Disclaimer section of this PADR for more details.

Figure E-2 This PADR is the second stage of the RIT-T process[6]



To read the full Project Assessment Draft Report visit the Regulatory Investments Test page on TransGrid's website.

[6] 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