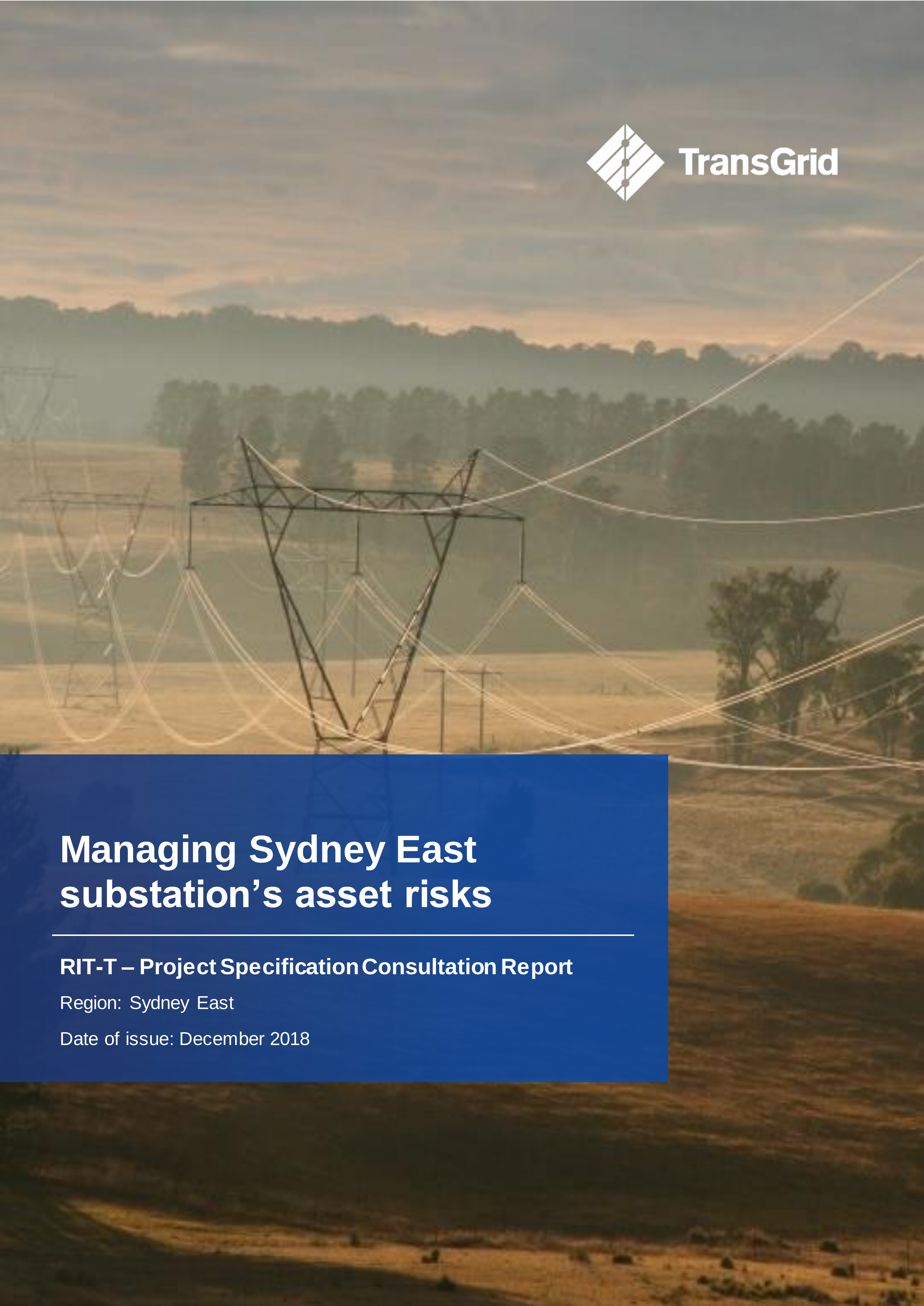

Managing Sydney East substation's asset risks

RIT-T – Project Specification Consultation Report

Region: Sydney East

Date of issue: December 2018

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Executive summary

This RIT-T is initiated to address the deteriorating condition of TransGrid's Sydney East transformers

This Project Specification Report (PSCR) represents the first step in the application of the Regulatory Investment Test for Transmission (RIT-T) to options for addressing the poor condition of ageing transformers at TransGrid's Sydney East substation. TransGrid's Sydney East 330/132 kV substation serves the areas north of Sydney Harbour including North Sydney, Ryde, Macquarie Park, Chatswood, and the suburbs along the Northern Beaches. It has a peak demand of about 700 MW.

There are three transformers at Sydney East that were installed in 1974 and a fourth transformer (Transformer 4), with a capacity of 375 MVA, was installed in 2013 to accommodate growing demand in the region. The older transformers are showing signs of deterioration attributable to ageing such as carbon particle contamination, paper insulation embrittlement, paper insulation moisture, dissolved gasses in main transformer tank, loss of oil due to deteriorating bushings, and large transformer losses due to mechanical failure of tapchangers switches. These issues, if not actioned, will result to electrical breakdown and transformer failures.

Further deterioration of the transformers' condition will increase the likelihood of equipment failure which will cause prolonged and frequent involuntary load shedding at a key transmission node supplying Sydney, and damage to TransGrid's transmission assets.

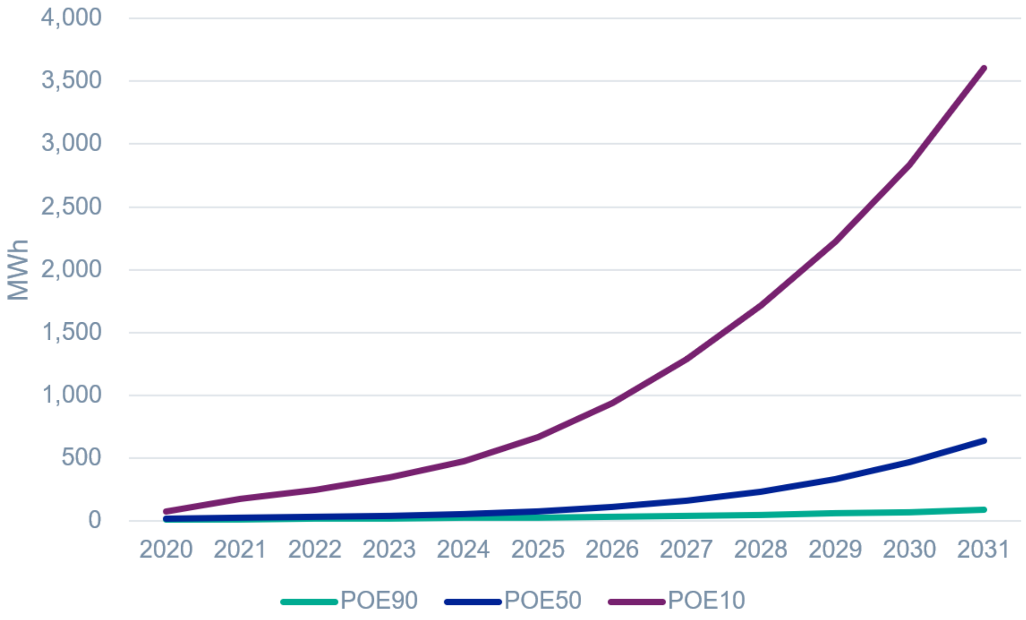
TransGrid's risk mitigation strategy, involving a principled methodology of quantifying risks of asset failures, has identified options that would lessen the potential consequences and lower the risk.

The 'identified need' is to avoid prolonged and frequent involuntary load shedding in Sydney

The transformers at Sydney East play a central role in providing reliable supply of electricity to the region. However, along with age, the deteriorating condition of the original three transformers worsens the assets' performance going forward.

Without remedial action, the deterioration will progress further and faster, resulting in an increased likelihood of failure. As the transformers are vital to supplying the forecast high demand at Sydney East substation, a failure of the transformers creates significant risk of prolonged and frequent involuntary load shedding if action is not taken.

Figure E-1 – Expected unserved energy



TransGrid has investigated five credible network options

TransGrid considers that there are five credible network options from a technological and project delivery perspectives that address the identified need, as summarised below.

Table E-1 – Summary of the five credible options considered

Option	Capital cost ($m)	Transformer 1	Transformer 2	Transformer 3	Transformer 4
Option 1	19.3	Replace with new	Replace with new	Replaced with redeployed asset	Unchanged
Option 2	12.3	Decommission	Replace with new	Replaced with redeployed asset	Unchanged
Option 3	6.2	Refurbish onsite	Decommission	Replaced with redeployed asset	Unchanged
Option 4	2.9	Refurbish onsite	Decommission	Refurbish onsite	Unchanged
Option 5	5.3	Do nothing	Decommission	Replaced with redeployed asset	Unchanged

TransGrid's analysis reveals that there should at least be three transformers in service all the time to cater for unplanned transformer outages. Further reduction of the number of transformers will require large and expensive amounts of non-network support (as outlined in section 3.7).

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

TransGrid considers that it will not be commercially feasible for non-network options to assist with addressing the identified need for this RIT-T.

In addition, TransGrid does not consider that non-network options are able to cost-effectively defer the need for the additional (third) transformer component of the preferred option (Option 2). Specifically, to be considered equal to or cheaper than Option 2, non-network solutions coupled with Option 5 would need to cost below $4.50/kW for a minimum of 20-50 MW between 2024/25 to 2026/27. For non-network options to efficiently reduce the risk of unserved energy, non-network solutions would need to have higher economic net benefits than the incremental network option.

Notwithstanding the above, as part of the consultation process, TransGrid encourages interested parties to make submissions regarding non-network options that satisfy, or contribute to satisfying, the identified need detailed in this PSCR.

Net benefits have been estimated across three different 'scenarios'

TransGrid has constructed three 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 each credible 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. The weighting attached to these scenarios reflect TransGrid's view of their likelihood. Note that lower weightings are applied to the scenarios that use POE10 and POE90.

Table E-1 – Summary of the three scenarios investigated

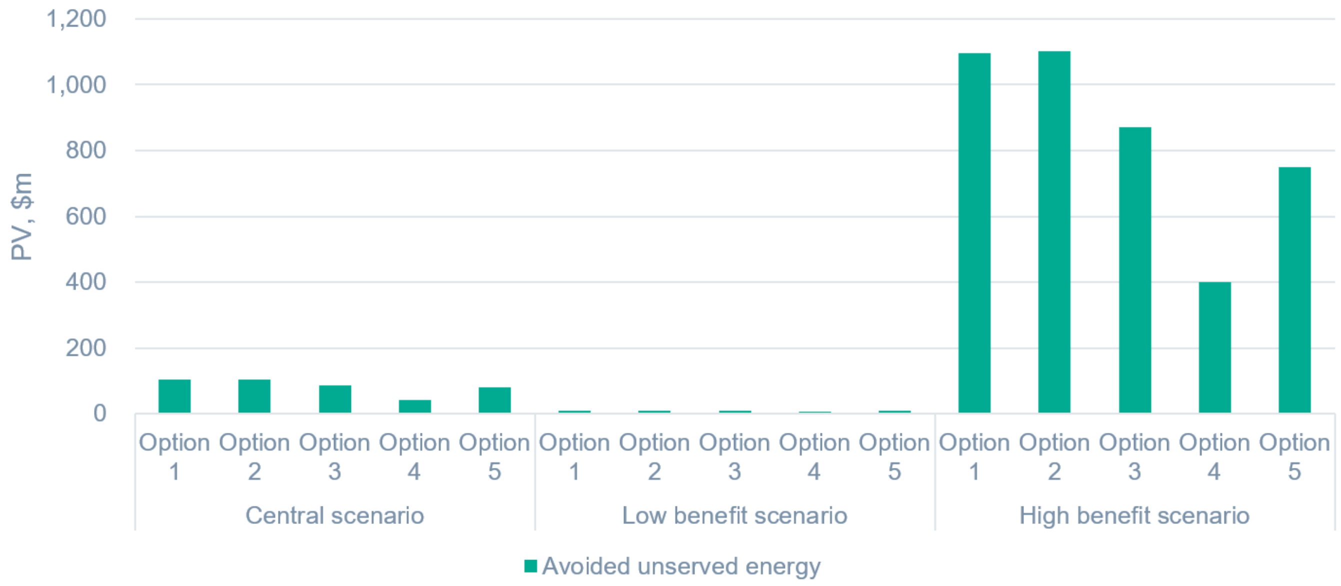
Variable / Scenario	Central	Low benefits	High benefits
Scenario weighting	50%	25%	25%
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
VCR	$40/kWh	$28/kWh	$52/kWh
Demand forecast	POE50	POE90	POE10
Discount rate	7.04 per cent	9.48 per cent	4.60 per cent

Each of the credible options is found to deliver strongly positive net benefits

The figure below illustrates the *gross* avoided involuntary load shedding benefits associated with each credible option, across each of the three scenarios considered.

As expected, higher levels of avoided involuntary load shedding benefits is estimated under the high benefit scenario. This is based on lower-weighted scenario using a peakier, POE10 forecast assumption.

Figure E-2 – Present value of gross economic benefits, PV $m



The table below summarises the *net* market benefits in NPV terms across the three scenarios, as well as on weighted basis for each credible option. These figures are the gross benefits shown in Figure E-1 less the estimated costs of the options. While the table shows that each credible option is expected to generate net market benefits, it also shows Option 2 to be the preferred option as it delivers the greatest net benefits. Specifically, Option 2 is expected to deliver approximately $320 million in net market benefits.

Table E-2 – Present value of net benefits relative to the base case, PV $m

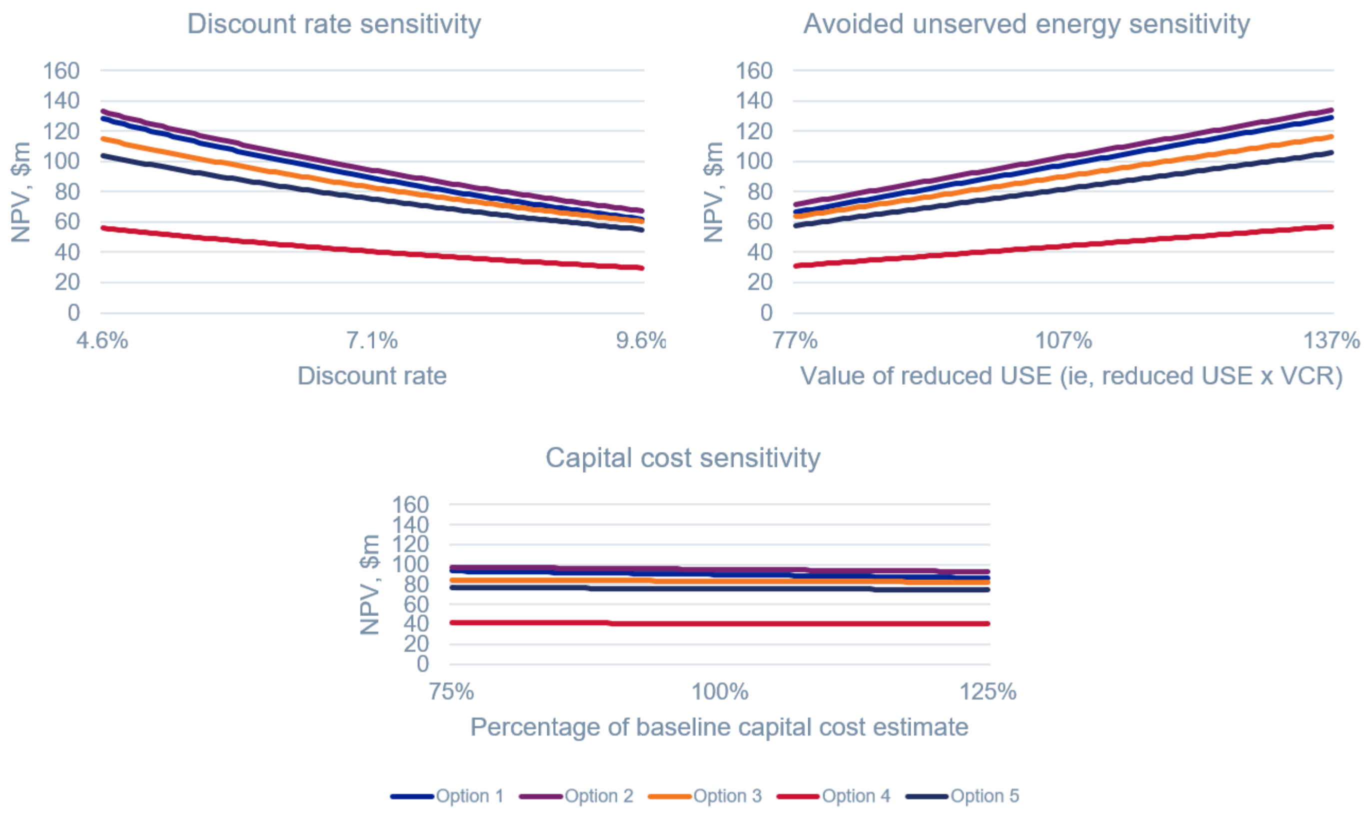
Option	Central	Low benefit	High benefit	Weighted	Rank
Scenario weighting	50%	25%	25%		
Option 1	90.3	-7.01	1084.13	314.43	2
Option 2	95.07	-1.88	1,095.34	320.90	1
Option 3	83.39	3.91	868.57	259.82	3
Option 4	40.81	2.46	398.60	120.67	5
Option 5	75.73	4.78	746.18	225.6	4

TransGrid estimates that the optimal timing for the commissioning of the preferred option is 2021/22.

TransGrid has also conducted sensitivity analysis on the overall NPV of the net market benefit to investigate the consequences of 'getting it wrong' and having committed to a certain investment decision.

The figure below illustrates that the estimated net market benefits for each option, varying the three separate key assumptions in the central scenario individually. Importantly, for all sensitivity tests shown below, Option 2 remains the preferred option and the estimated net market benefits of each credible option are found to be positive.

Figure E-1 – Sensitivities of net present value of net market benefits of each option



Draft conclusion and exemption from preparing a PADR

Option 2 is the preferred option at this draft stage. It will involve:

> decommissioning of Transformer 1;
> replacement of Transformer 2 with a new asset; and
> replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

The estimated capital cost of Option 2 is $12.3 million. Routine and operating maintenance costs are expected to be approximately less than 1 per cent once the replacement works have been completed.

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 2 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.[1]

Submissions and next steps

TransGrid welcomes written submissions on material contained in this PSCR. Submissions are due on or before 15th of March 2019.

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

Subject to submissions received on this PSCR, a Project Assessment Conclusions Report (PACR), including full option analysis, is expected to be published by 15th of April 2019.

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

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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 addressing the poor condition of ageing transformers at TransGrid's Sydney East substation. The three transformers at Sydney East substation that were installed in 1974 are showing contamination, embrittlement, loss of oil, and mechanical failures. These issues attributable to ageing, if not actioned, will result to electrical breakdown and transformer failures.

Further deterioration of the transformers will increase the likelihood of equipment failure which will result to prolonged and frequent involuntary load shedding at a key transmission node supplying Sydney and damage to TransGrid's transmission assets.

TransGrid's risk mitigation strategy, involving a principled methodology of quantifying risks of asset failures, has identified options that would lessen the potential consequences of the assets' failures.

Rule changes to the National Electricity Rules (NER) in July 2017 extended the application of regulatory investment tests to replacement capital expenditure ('repex') 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.[2]

While the planning process for renewing the identified components at Sydney East 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 options 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; and
> 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.

1.2 Making submissions and next steps

TransGrid welcomes written submissions on material contained in this PSCR. Submissions are due on or before 15th of March 2019.

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

Subject to submissions received on this PSCR, a Project Assessment Conclusions Report (PACR), including full option analysis, is expected to be published by 15th of April 2019.

TransGrid is bound by the *Privacy Act 1988 (Cth)*. In making submissions in response to the Sydney East substation transformer project consultation process, TransGrid will collect and hold your personal information

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

such as your name, email address, employer and phone number for the purpose of receiving and following up on your submissions.

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

At the conclusion of the consultation process, all submissions received will be published on the TransGrid's website. If you do not wish for your submission to be made public, please clearly specify this at the time of lodgement.

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

2. The identified need

This section outlines the identified need for this RIT-T, as well as the assumptions and data underpinning it. It first sets out useful background on the Sydney East substation and its deteriorating transformers.

2.1 Background to the identified need

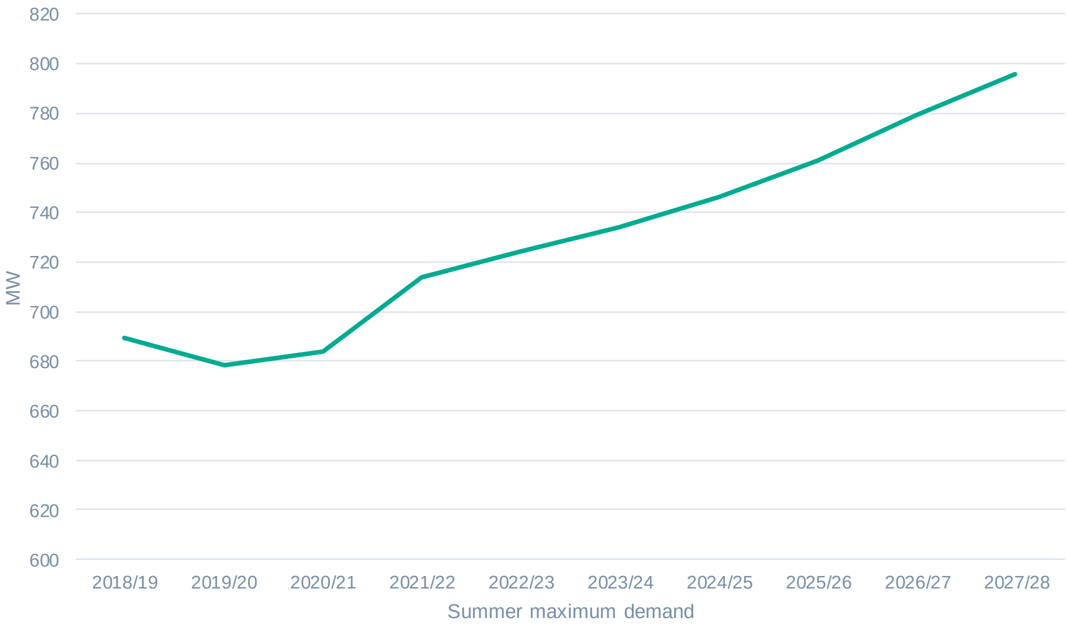
TransGrid's Sydney East 330/132 kV substation was established in 1974 and is located north of the Sydney Central Business District. It plays a critical role in stepping down voltage level to supply the areas north of Sydney Harbour including North Sydney, Ryde, Macquarie Park, Chatswood, and the suburbs along the Northern Beaches.

Figure 2-1 depicts the location of Sydney East in TransGrid's wider Sydney network.

Figure 2-1 – TransGrid's wider Sydney network

When the Sydney East substation was first commissioned, it comprised three 400 MVA transformers (Transformer 1, Transformer 2 and Transformer 3) which still remain in operation. A fourth transformer (Transformer 4), with a capacity of 375 MVA, was installed in 2013 to accommodate growing demand in the region. Further growth in demand is anticipated in the region over the next ten years, as shown in Figure 2-2.

Figure 2-2 – Sydney East – Summer peak demand



Source: TransGrid, 2018 Transmission Annual Planning Report.

TransGrid's routine maintenance activities have identified that the three initial transformers are already exhibiting worsening conditions, including:

> carbon particle contamination;
> deterioration in the paper insulation system;
> tapchanger gas leakage into the main transformer tank;
> increasing dielectric dissipation factor trends from bushings; and
> tapchanger and diverter switch issues.

2.2 Description of identified need

The transformers at Sydney East substation play a central role in supplying electricity to a key transmission node in TransGrid's wider Sydney network. However, the ageing nature of the original three transformers is leading to carbon particle contamination, paper insulation embrittlement, paper insulation moisture, dissolved gasses in main transformer tank, loss of oil due to deteriorating bushings, and large transformer losses due to mechanical failure of tapchangers switches, consequently, risking performance issues and failures.

Without remedial action, the condition and performance of the transformers will deteriorate further and faster, hence increasing the likelihood of prolonged and frequent failure. As the Sydney East transformers are crucial to supplying the high demand in Sydney region, failure of the transformers creates a significant risk of prolonged and frequent involuntary load shedding if action is not taken.

TransGrid considers that the preferred option determined in this PSCR will sufficiently alleviate the risk of prolonged and frequent unserved energy. Accordingly, TransGrid views the investment to rectify the condition of the transformers as a 'market benefit' driven RIT-T.

In addition to the market benefit of avoided prolonged and frequent involuntary load shedding, TransGrid notes that rectifying the worsening condition of the transformers will also reduce safety risks, as well as lower planned and unplanned corrective maintenance costs. However, these costs are of small magnitude compared to the cost of prolonged and frequent involuntary load shedding and do not affect the preference amongst the options. As such, TransGrid has not quantified these avoided safety risk costs as part of this assessment.

2.3 Assumptions underpinning the identified need

2.3.1 Worsening transformer condition is increasing the risk of unserved energy

TransGrid's assessment of the three transformers at Sydney East has revealed signs of deterioration attributable to accelerated ageing. These worsening asset conditions, summarised in Table 2-1, render the transformers more challenging and more costly to service and repair.

Transformer 3 is already out of service and without action on Transformer 1 and Transformer 2, their failure rates are expected to be 2.1 per cent and 4 per cent in 2020/21, respectively. No remedial action would further mean that their failure rates will escalate in the future, and the likelihood of simultaneous transformer outage will continue to rise. Failing to correct the conditions of the transformers creates a significant risk of prolonged and frequent unserved energy.

Table 2-1 – Transformer condition issues at Sydney East and their consequences

Issue	Consequences if not remediated
Carbon particle contamination	Carbon is a conductor and there can be a tendency for the individual particles to accumulate in areas of strong high electric fields. This could lead to electrical breakdown and failure of the transformer.
Paper insulation system	The transformer insulation system is based on special papers impregnated with insulating oil. The papers provided insulation and also support the structure of the transformer winding. Over time and with load and the presence of moisture, the paper becomes embrittled. This may progress to the point where a mechanical shock caused by a through fault can result in electrical failure.
Moisture in paper	Moisture acts to increase the rate of degradation of the paper insulating system. At high levels, it may compromise the insulation.
Dissolved gas	Measurement of hydrocarbon gasses in oil is used as a diagnostic tool to identify fault conditions in a transformer. In the case of the Sydney East transformers, there are leakages from the tapchanger switch compartments into the main tank of the transformers. High levels of hydrocarbon gasses are generated during tapchanger operation and the gasses pass into the main transformer tank and render the diagnostic tool ineffective.
Bushings	Bushings are used to bring the high voltage connections through the steel transformer tank into the transformer. They are oil paper insulated and are specially designed to manage the high levels of electrical stress. However, in the case of an electrical fault, total loss of the transformer with loss of all oil and a major fire is almost certain. The bushings fitted to the Sydney East transformers are the original units and electrical tests show that they are deteriorating.
Tap changer and diverter switch	The tapchanger switches the voltage ratio on the transformer while it is under load. It is a mechanical device and in the case of failure, large amounts of energy are expected to be released and transformer loss is likely.

2.3.2 Unserved energy will increase in the absence of remedial action

Due to the increase in failure rates as a result of the worsening asset condition, the forecasts for involuntary load shedding for different levels of transformer outages will increase in the absence of any remedial action. These unserved energy forecasts under different unplanned transformer outage configuration are weighted by the probabilities of those outages to estimate an expected unserved energy (EUE) figure.

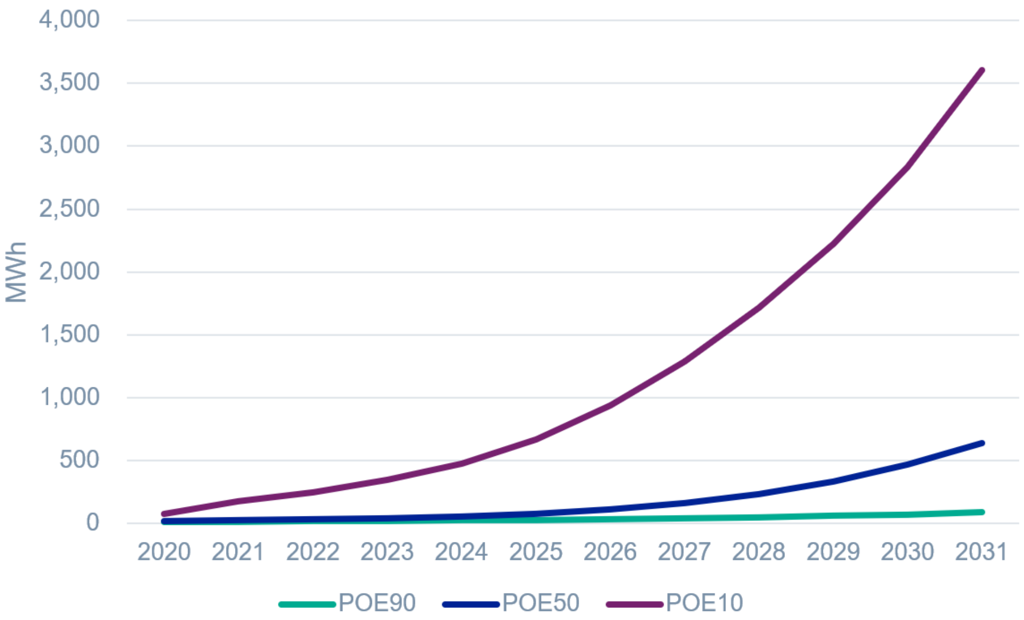
Figure 2-3 shows the expected unserved energy projections using three different Sydney East load forecasts, namely;

> a central forecast of 50 per cent probability of exceedance (POE50);
> a low forecast using POE90; and
> a high forecast using the POE10 forecasts.

In all forecast assumptions, TransGrid found that unserved energy will occur if there are only two operational transformers. Therefore, to cater for unplanned transformer outages, there should at least be three transformers in service all the time.

As expected, higher levels of avoided involuntary load shedding benefits is estimated based on the lower-weighted high scenario that uses a peakier, POE10 forecast assumption.

Figure 2-3 – Expected unserved energy



While TransGrid has forecast unserved energy for a 25-year period, the estimates have been capped after tenth year to negate large volumes in the future distorting the economic assessment.

TransGrid values the EUE forecasts under each option at the Value of Consumer Reliability (VCR). Measured in dollars per MWh, the VCR is a proxy to economic impact of involuntary customer load shedding under the RIT-T.

TransGrid has applied a central VCR estimate of $40/kWh using the figures from the 2014 AEMO VCR estimates.[3]

TransGrid has also investigated the impact of assuming lower and higher underlying VCRs. A lower sensitivity of $28/kWh[4] has been assumed and reflects a 30 per cent reduction in the AEMO central estimate. This is

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[3] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.
[4] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.

consistent with the AEMO-stated level of confidence in its estimates. The higher sensitivity involves applying a VCR of $52/kWh, which represents a 30 per cent increase from the AEMO-derived estimates.

3. Options that meet the identified need

TransGrid considers five credible options that would meet the identified need from a technological, commercial, and project delivery perspective.[5] These options are summarised in Table 3-1.

Table 3-1 – Summary of the credible options

Option	Capital cost ($m)	Transformer 1	Transformer 2	Transformer 3	Transformer 4
Option 1	19.3	Replace with new	Replace with new	Replaced with redeployed asset	Unchanged
Option 2	12.3	Decommission	Replace with new	Replaced with redeployed asset	Unchanged
Option 3	6.2	Refurbish onsite	Decommission	Replaced with redeployed asset	Unchanged
Option 4	2.9	Refurbish onsite	Decommission	Refurbish onsite	Unchanged
Option 5	5.3	Do nothing	Decommission	Replaced with redeployed asset	Unchanged

TransGrid's analysis reveals that there should at least be three transformers in service all the time to cater for unplanned transformer outages. Further reduction of the number of transformers will require large amounts of non-network support as outlined in section below.

In addition, all works under each option are assumed to be completed in accordance with the relevant standards and components shall be replaced 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 each option to a base case 'do nothing' option.

Under this base case, the existing condition issues at Sydney East substation will not be remediated and the transformers will continue to operate as they are. The base case considers no investment in the transformer assets other than continuing the maintenance regime. In this case, the risk of prolonged and frequent involuntary load shedding and risks on safety will continue to increase.

The regular maintenance regime will not be able to address the identified need to undertake action, and as a consequence, will not address the increasing probability of transformer failure. It is expected that this will expose end-customers to prolonged and frequent unserved energy.

3.2 Option 1 – Replace Transformer 1 and 2 with new assets, and replace Transformer 3 with redeployed asset

Option 1 involves:

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

> replacement of Transformer 1 and 2 with new assets; and
> replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

The estimated capital cost of Option 1 is $19.3 million. In this option, risks posed by all three ageing transformers are greatly reduced with the installation of new and redeployed transformers. Planned operating costs for Option 1 are expected to approximately $3,500 per year.

3.3 Option 2 – Decommission Transformer 1, replace Transformer 2 with new asset, and replace Transformer 3 with redeployed asset

Option 2 involves:

> decommissioning of Transformer 1;
> replacement of Transformer 2 with a new asset; and
> replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

The estimated capital cost of Option 2 is $12.3 million. Planned operating costs for Option 2 are expected to approximately $3,500 per year.

3.4 Option 3 – Refurbish Transformer 1, decommission Transformer 2, and replace Transformer 3 with redeployed asset

Option 3 involves:

> onsite refurbishment of Transformer 1, which includes oil treatment and degassing to remove moisture and gases, replace high voltage and low voltage bushings, fixing oil leaks, and minor painting;
> decommissioning of Transformer 2; and
> replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

There is marginal improvement on the Transformer 1's failure rates after onsite refurbishment.

The estimated capital cost of Option 3 is $6.2 million. A near-new redeployed transformer will greatly reduce the risk of failure for Transformer 3. Decommissioning of Transformer 2 will not only remove its failure risk from the network but also provide asset component cover for Transformer 1. Routine operating costs for Option 3 are expected to approximately $6,000 per year.

3.5 Option 4 – Decommission Transformer 2, and refurbish Transformer 1 and Transformer 3

Option 4 involves:

> the following for Transformer 1 and Transformer 3:
  – onsite treatment and degassing to remove moisture and gases;
  – replacement of high voltage and low voltage bushings; and
  – oil leak repair and minor painting; and
> decommissioning Transformer 2.

There are marginal improvements on Transformers 1 and 3's failure rates after refurbishment.

The estimated capital cost of Option 4 is $2.9 million. The main impact arising from refurbishment on these transformers will arise from the removal of high risk bushings. Routine operating costs for Option 4 are expected to approximately $6,600 per year.

3.6 Option 5 – Decommission Transformer 2 and replace Transformer 3 with redeployed asset

Option 5 involves:

- leaving Transformer 1 unchanged;
- decommissioning of Transformer 2;
- replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

The estimated capital cost of Option 5 is $5.3 million. A near-new redeployed transformer will greatly reduce the risk of failure for Transformer 3. Decommissioning of Transformer 2 will not only remove its failure risk from the network but also provide asset component cover for Transformer 1. Routine operating costs for Option 3 are expected to approximately $6,300 per year.

3.7 Options considered but not progressed

Table 3-2 summarises other credible options TransGrid has considered and outlines the reasons these options were not progressed any further.

Table 3-2 – Options considered but not progressed

Option	Reason(s) for not progressing
Refurbish three transformers at Sydney East	TransGrid does not consider refurbishment of three transformers will sufficiently achieve the required risk reduction as it is not feasible to replace the main paper insulation systems of the transformers through on site refurbishment. Hence, four reliable transformers cannot be maintained through this option. TransGrid also estimates that the cost is not commensurate to the benefits of maintaining all four transformers.
Having only two transformers at Sydney East (i.e., decommissioning two transformers)	TransGrid considers that a two-transformer option would result in unacceptable levels of expected unserved energy and likely non-compliance with the IPART reliability standards. This will also have implication on the required redundancies to cater for unplanned transformer outages. While this expected unserved energy could technically be mitigated through the use of non-network solutions, TransGrid does not consider this commercially feasible. TransGrid estimates that approximately 300 to 400 MW of non-network support would be required over assessment period in order to meet the IPART reliability standards if there are only two active transformers at Sydney East.

In addition, as set out in section 4 below, TransGrid does not consider that non-network solutions are commercially feasible to address, or help address, the identified need to undertake network investment. This is because of the relatively low cost of network options that address the deteriorations of transformers, and allow them to continue playing a crucial role in providing electricity supply to Sydney East substation, compared to the size of the load they serve.

Nevertheless, 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.

3.8 There is no expected material inter-network impact

TransGrid has considered whether the credible options listed above is expected to have a material inter-regional impact.[6] 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:[7]

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

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

7 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 considers that it will not be commercially-feasible for non-network solutions to assist with meeting the identified need for this RIT-T.

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

As part of this consultation process, TransGrid encourages interested parties to make submissions regarding non-network options that satisfy, or contribute to satisfying, the identified need detailed in this PSCR. Non-network proposals must include the information specified in section 4.4.

4.1 Required technical characteristics of non-network options

The technical characteristics described below refer to the non-network options required to address the expected unserved energy when only one transformer is replaced (Option 5). Non-network support up to 50 MW will be considered on a cost benefit basis against the reduction in unserved customer energy.

TransGrid considers that possible non-network options include:

> embedded generation;
> energy storage (including battery system) which inject power into the grid as required;
> voluntary curtailment of customer load; and
> permanent reduction of customer load (including energy efficiency).

4.1.1 Nature of any load reduction or additional supply required

Under Option 5, two new 375 MVA transformers and one older 400 MVA transformer are present at the substation. 750 MVA can be firmly supplied throughout the year, however, the older 400 MVA transformer has a higher probability of failure and associated risk costs. The non-network solution would need to provide non-network support for the duration of that outage when the load exceeds the firm transformer capacity. It is expected that the transformer is unavailable 5-6% of the year (or 526 hours per year) due to unplanned outages.

4.1.2 Indicative size and duration of non-network solutions

Table 4-1 – Maximum load at risk and indicative size of non-network, POE50[8]

Year	Load at risk: Option 5 (N-1)	Load at risk: Option 5 (N-2)	DM required
2021	-	337 MVA	-
2022	-	353 MVA	-
2023	-	368 MVA	-
2024	8MVA	383 MVA	-
2025	24 MVA	399 MVA	20 MW

[8] Based on nominal ratings of transformers, and Ausgrid bulk supply point winter maximum demand, Transmission Annual Planning Report 2018.

2026	43 MVA	418 MVA	30 MW

Figure 4-1illustrates the demand profile of Sydney East Substation over the 2016 calendar year. As the Sydney East region is predominantly winter-peaking, the risk of unserved energy is greatest during this period.

To address the risk of lack of supply to customers, non-network solutions would need to address exceedances above the 95% level of the 2016 load profile. Non-network support would need to be offered between 6pm and 8pm on winter peaking days, as shown in Figure 4-2. Non-network solutions would be called upon to provide non-network support for short periods on a handful of peak days (40-60 hours per year).

Figure 4-1 – Sydney East load profile, calendar year 2016

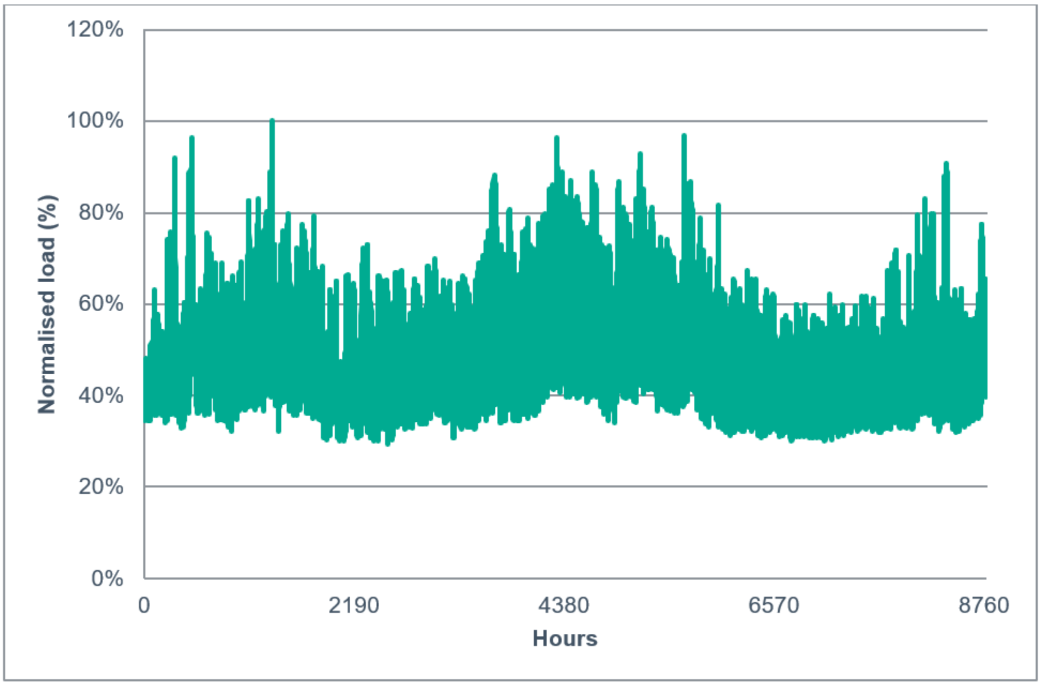
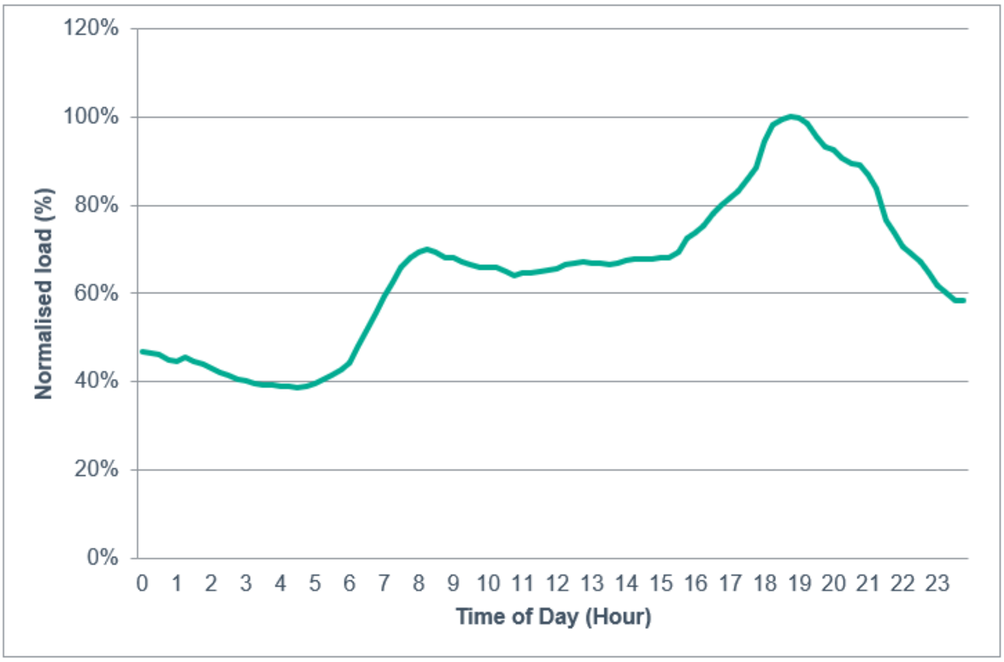


Figure 4-2 Sydney East typical winter day of maximum demand, 2016



4.1.3 Location of the required non-network support

Non-network options located in areas supplied by TransGrid's Sydney East Substation provide the most effective non-network support. The Ausgrid zones that are supplied from Sydney East Substation are listed below:

Table 4-3 – Ausgrid zones in the area of impact

Areas		
Balgowlah	Gore Hill	North head
Balgowlah North	Harbord	North Sydney
Beacon Hill	Killarney	Pymble
Belrose	Kuring-gai	RNS Hospital
Brookvale	Lindfield	St Ives
Careel Bay	Manly	Sydney East
Castle Cove	Mona Vale	Terrey Hills
Chatswood	Mosman	Turramurra
Crows Nest	Narabeen	Warringah
Dee Why West	Newport	Willoughby

4.2 Cost of non-network solutions

For non-network solutions to be feasible, they must efficiently defer the need for the additional (third) transformer component of the preferred option (Option 2). The value of the deferrable component – one new transformer replacement – is estimated to cost $7 million. The annualised cost of the additional transformer, based upon a discount rate of 7.04 per cent, is expected to be less than $492,000 per annum. This is low compared to the amount of expected unserved energy and risk (estimated at around $1 million in the next few years). That is, there is around $500,000 per annum of net benefit if a 2nd transformer is replaced.

For non-network options to efficiently reduce the risk of unserved energy, non-network solutions would need to have higher economic net benefits than the incremental network option. In other words, non-network solutions would need to cost below $4.50/kW, for a minimum of 20-50 MW between 2024/25 to 2026/27, to economically defer the additional transformer component of Option 2.

The total cost of the non-network solution will be evaluated against the reduction in the cost of expected unserved energy that it is able to address.

4.3 Information to be included in non-network solution proposals

The proposed solution must be large enough collectively, to reduce the loading on the transmission network when there are only two transformers in service. To manage a complex portfolio of demand management of sufficient scale, we require the proposed solutions to provide a minimum aggregated capacity of 5 MW.

TransGrid may choose to select a subset of non-network solutions it determines to be most economical and reliable.

Using proven technology, the proposed non-network solutions must be reliably and immediately dispatched in a post-contingent scenario over a sustained period. A longer day ahead notification period is likely.

The table below sets out the parameters that TransGrid request parties nominate in any proposal.

Table 4.4 Parameters Description

Parameter	Description
Block ID	Block Identifier (e.g. Block 1) of non-network solution
Block Capacity	Discrete amount of the non-network option (reduced load or additional supply) capacity in kW. Sum of block capacities must meet a minimum requirement of 5 MW. TransGrid may choose to select a subset of blocks it determines that is most economical and reliable to dispatch.
Location	For new generation solutions, details of the proposed sites for the new generators
Availability Period	Period for that block is available within the operating profile (months/days/hours)
Call Notice Period	Minimum period of time before the block can be dispatched
Establishment Fee	Setup payment that applies to a block
Availability Fee	A fee per month for a block to be made available to be dispatched
Indicative Dispatch Fee	Fee for a block to be dispatched per MWh
Timeframe for project delivery	When the block of DR will be available for dispatch
Communications	Proposed dispatch communications protocol with TransGrid's control room
Metering	Metering equipment installed or to be installed to measure and record the data to be verified

Proposals and queries relating to non-network options should be emailed to RIT-TConsultations@transgrid.com.au or by telephone to 02 9284 3354.

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.[9]

5.1 All credible options are expected to reduce prolonged and frequent involuntary load shedding

Involuntary load shedding is where a customer's load is interrupted from the network without their agreement or prior warning. TransGrid has employed Ausgrid's load forecasts over the assessment period to quantify the expected unserved energy by comparing forecast load to network capabilities based upon aggregate transmission line failure and mean time to repair.

A reduction in prolonged and frequent involuntary load shedding is expected under each option, relative to the base case, as outlined in section 2.3

5.2 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.[10]

The credible options outlined above do 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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[9] 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.

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

Table 5-1 – Reasons non-wholesale market benefit categories are considered immaterial

Market benefits	Reason
Differences in the timing of expenditure	Options considered will provide an alternative to meeting reliability requirements and are unlikely to affect decisions to undertake unrelated expenditure in the network. Consequently, material market benefits will neither be gained nor lost due to changes in the timing of expenditure from any of the options considered.
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.[11] TransGrid does not consider there to be any option value with the options considered in this RIT-T.
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 changed to network losses.

[11] 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 each credible option that maintains the reliable supply of energy in the Sydney East region.

6.1 General overview

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 East substation are assumed to not be remediated.

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 options and provide a reasonable indication of the benefits and costs over a long outlook period. Since the capital components have asset lives greater than 20 years, TransGrid has taken a terminal value approach to ensure 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'[12] 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. This involves 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[13]), and an upper bound discount rate of 9.48 per cent (a symmetrical adjustment upwards).

6.2 Approach to estimating project costs

TransGrid has estimated the capital costs of the refurbishment options by using scope from similar works. TransGrid considers the central capital costs to be estimated to within +/- 25 per cent of the actual cost.

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 each credible 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.

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12 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.

13 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

Table 6-1 – Summary of the three scenarios investigated

Variable / Scenario	Central	Low benefits	High benefits
Scenario weighting	50%	25%	25%
Network capital costs	Base estimate	Base estimate + 25%	Base estimate - 25%
VCR	$40/kWh	$28/kWh	$52/kWh
Demand forecast	POE 50	POE 90	POE 10
Discount rate	7.04 per cent	9.48 per cent	4.60 per cent

TransGrid considers that the central scenario is the most likely, since it is based primarily on a set of expected 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.

7. Assessment of credible options

This section outlines the assessment TransGrid has undertaken to compare the costs and benefits of each option to a ‘do nothing’ base case, where there existing condition issues at Sydney East substation will not be remediated and continue to operate, with an increasing risk level.

7.1 Estimated benefits

The table below summarises the present value of benefits estimated for each credible option, for each of the three reasonable scenarios outlined in the section above.

The only class of ‘market benefit’ described under the RIT-T guidelines is the avoided involuntary load shedding. The lower and upper bounds on the avoided involuntary load shedding benefits are reflected in the ‘low’ and ‘high’ scenarios.

As expected, higher levels of avoided involuntary load shedding benefits is estimated based on the lower-weighted high scenario that uses a peakier, POE10 forecast assumption.

Table 7-1 – Present value of economic benefits of credible options relative to the base case, PV $m

Option/scenario	Central	Low benefit	High benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	103.18	9.46	1093.10	327.23
Option 2	104.08	9.84	1,101.52	329.88
Option 3	87.9	9.77	871.66	264.31
Option 4	43.31	5.53	400.49	123.16
Option 5	79.76	10.07	748.93	229.63

7.2 Estimated costs

Table 7-2 summarises the present value of costs of the credible options for each of the three scenarios investigated.

Table 7-2 – Present value of costs of credible options relative to the base case, PV $m

Option/Scenario	Central	Low benefit	High benefit	Weighted
Scenario weighting	*50%*	*25%*	*25%*	
Option 1	12.88	16.47	8.97	12.8
Option 2	9.01	11.72	6.18	8.98
Option 3	4.50	5.86	3.09	4.49

Option 4	2.50	3.07	1.89	2.49
Option 5	4.04	5.29	2.76	4.03

7.3 Net market benefits

Table 7-3 summaries the present value of the net market benefit for each credible option across the three scenarios, the weighted net market benefit, and the ranking of options. These net market benefits are the benefits (as set out in section 7.1 above) minus the estimated costs (as outlined in section 7.2 above) in present value terms.

Option 2 is found to have the highest net market benefits for the central and high scenarios.

While the net market benefits are marginally negative under the low scenario, TransGrid notes that this scenario comprises an extreme combination of assumption, including low avoided unserved energy and high capital costs. The low scenario, along with the other two scenarios, also apply the conservative assumption outlined in section 2.3 that the expected avoided unserved energy is capped at the ten-year value for the assessment period.

On a weighted basis, Option 2 is expected to deliver approximately $320 million in net market benefits.

Table 7-3 – Present value of net benefits relative to the base case, PV $m

Option	Central	Low benefit	High benefit	Weighted	Rank
Option 1	90.3	-7.01	1084.13	314.43	2
Option 2	95.07	-1.88	1,095.34	320.90	1
Option 3	83.39	3.91	868.57	259.82	3
Option 4	40.81	2.46	398.60	120.67	5
Option 5	75.73	4.78	746.18	225.6	4

7.4 Sensitivity testing

TransGrid has undertaken thorough sensitivity tests 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, it investigates the impact on the net market benefit associated with the project continuing to go ahead on that date if demand forecasts are not as high as expected.

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 options

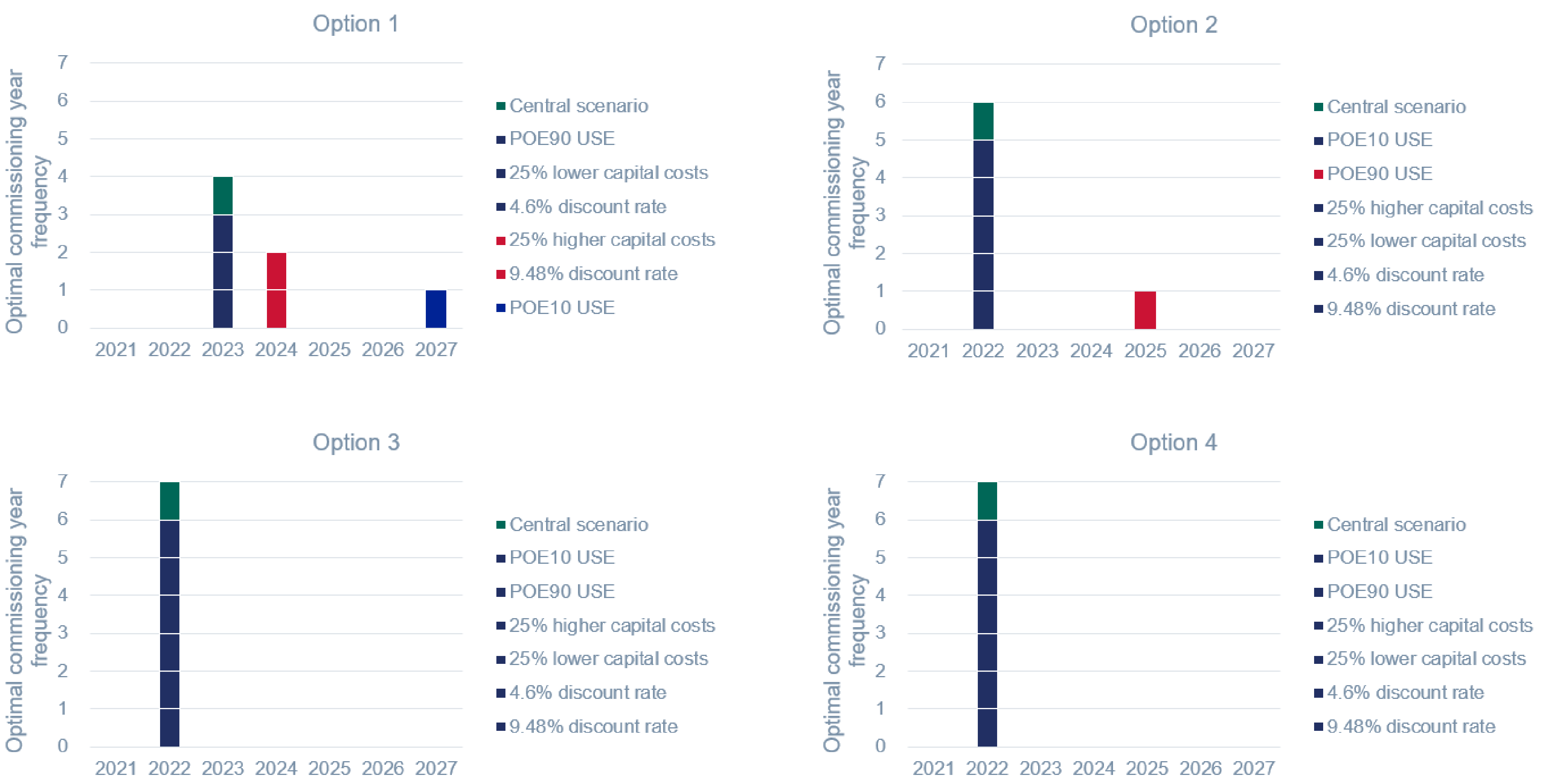
TransGrid has estimated the optimal timing for each of the credible options based on the year in which the NPV is maximised. This process was undertaken for both the central set of assumptions and also a range of alternative assumptions for key variables.

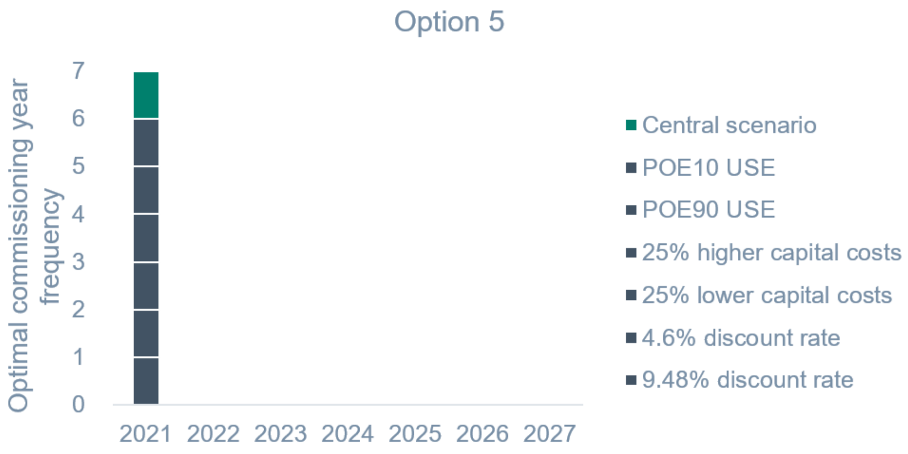
This section outlines the sensitivity of the identification of the commissioning year to changes in the underlying assumptions. In particular, the optimal timing of the options are found to be invariant to the assumptions on:

> a higher discount rate of 9.48 per cent per cent and a lower discount rate of 4.60 per cent;
> 25 per cent lower and higher capital costs;
> unserved energy using POE90 and POE10 demand forecasts.

Figure 7-1 overleaf illustrates the distribution of the optimal commissioning year for each of the options under each of the sensitivities set out above. For Option 2, the optimal commissioning year is 2021/22 for most sensitivities (with the exception of the POE90 unserved energy forecast). For Option 3, the optimal commissioning year is 2021/22 for all sensitivities. For Option 4, the optimal commissioning year is 2021/22 for all sensitivities. Finally, for Option 5, the optimal commissioning year is 2020/21 across all sensitivities.

Figure 7-1 – Distribution of optimal commissioning year for each option 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.

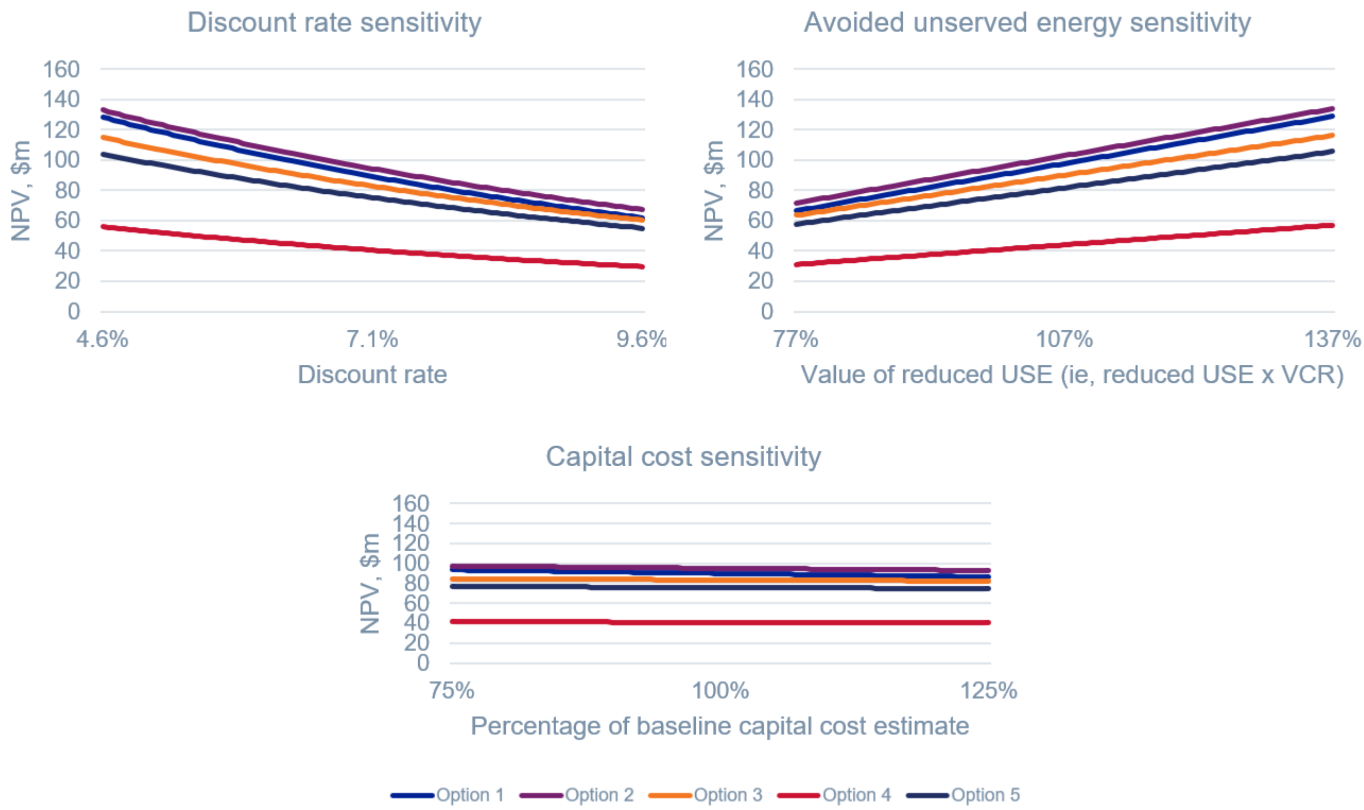
Specifically, TransGrid has investigated the same sensitivities under this second step as in the first step, i.e.:

- a higher discount rate of 9.48 per cent and a lower discount rate of 4.60 per cent;
- 25 per cent lower and higher capital costs;
- unserved energy using POE90 and POE10 demand forecasts.

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

The figure below illustrates the estimated net market benefits for each option varying the discount rate, capital cost and unserved energy risks. It shows that for all the sensitivity tests, and for all options, the estimated net market benefits are found to be positive, and the ranking is consistent across sensitivities.

Figure 7-2 –Sensitivities of net present value of net market benefits of each option



8. Draft conclusion and exemption from preparing a PADR

Option 2 is the preferred option at this draft stage and will involve:

> decommissioning of Transformer 1;
> replacement of Transformer 2 with a new asset; and
> replacement of Transformer 3 with a redeployed three phase 375 MVA transformer that is technically-suitable for Sydney East substation and in near-new condition.

The estimated capital cost of Option 2 is $12.3 million. Routine and operating maintenance costs are expected to be less than 1 per cent once the replacement works have been completed.

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 2 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.[14]

[14] 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.

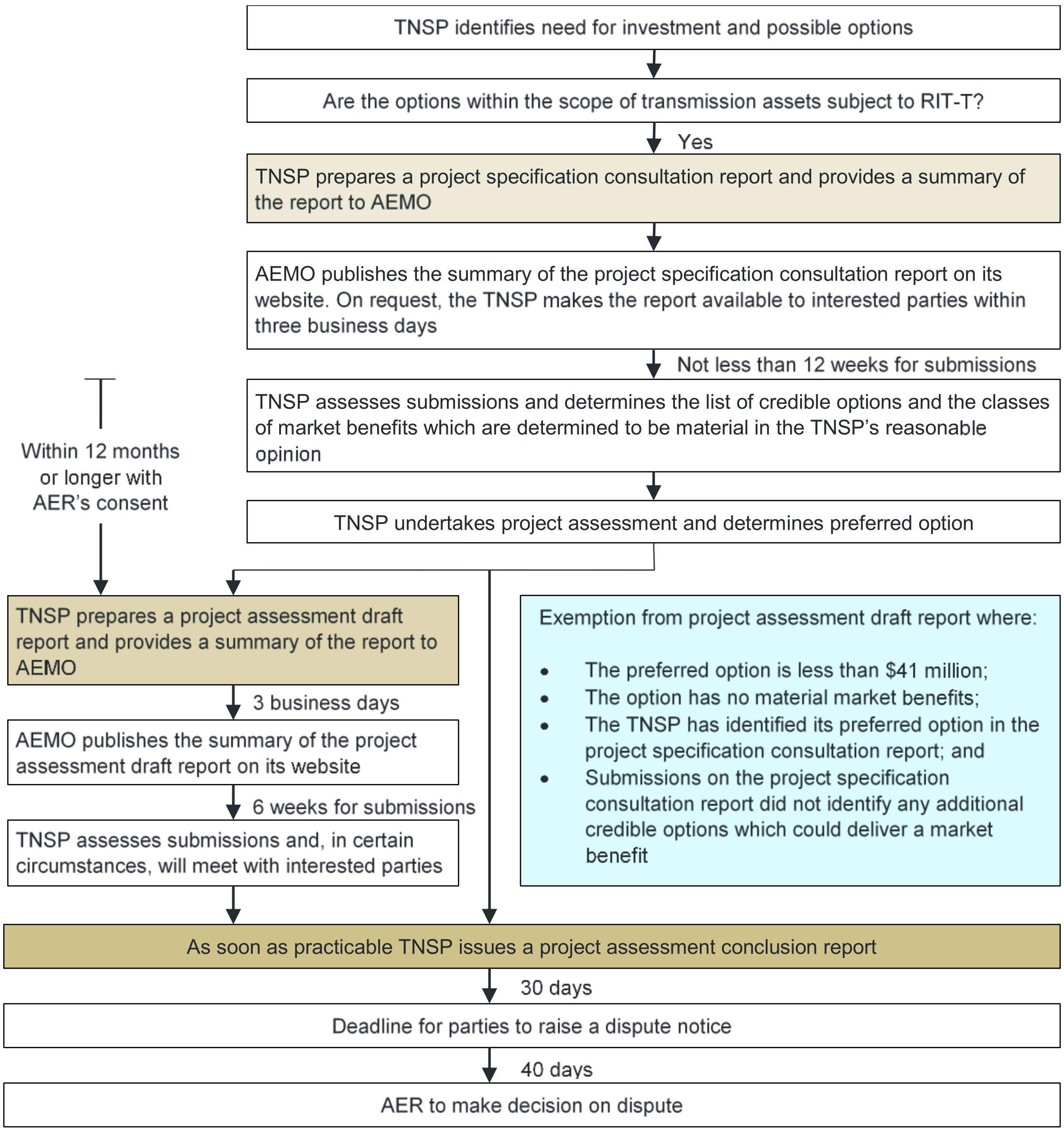
Rules clause	Summary of requirements	Relevant section(s) in PSCR
5.16.4 (b)	A RIT-T proponent must prepare a report (the project specification consultation report), which must include:	–
	(1) a description of the identified need;	2
	(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-T proponent considers reliability corrective action is necessary);	NA
	(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, i.e.: (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 A-1 – The RIT-T assessment and consultation process



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