Ensuring reliable supply for the Sydney Airport network area

FINAL PROJECT ASSESSMENT REPORT

6 MARCH 2020

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Ensuring reliable supply for the Sydney Airport network area

Final project assessment report – March 2020

Contents

Glossary of Terms

Term	Description
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
DNSP	Distribution Network Service Provider
DPAR	Draft Project Assessment Report
FPAR	Final Project Assessment Report
IPART	Independent Pricing and Regulatory Tribunal
LTC	Load Transfer Capability
NPV	Net Present Value
NER	National Electricity Rules
POE	Probability of Exceedance
RIT-D	Regulatory Investment Test for Distribution
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
USE	Unserved Energy
VCR	Value of Customer Reliability

Executive Summary

This report investigates the most economic option for continuing efficient supply to the Sydney Airport network area

In accordance with the Regulatory Investment Test for Distribution (RIT-D) framework and application guidelines, this Final Project Assessment Report (FPAR) has been prepared by Ausgrid and represents the final step in the application of the RIT-D to options for ensuring reliable electricity supply for the Sydney Airport network area.

This RIT-D focusses on asset condition issues identified with the 33kV switchgear installed at Sydney Airport zone substation (ZS), which if left unaddressed will increase the likelihood of equipment failure and could lead to loss of supply to Sydney Airport as well as industrial and commercial load located at the airport, including several airlines, hotels and catering facilities.

Ausgrid considers that reliability correction action is required at Sydney Airport ZS to address the identified issue.

One network option has been identified as credible to address reliability concerns

Ausgrid has identified the construction of a new building, installation of new equipment and retirement of the existing 33kV switchgear as the only credible network option to address reliability risks. Ausgrid considered the refurbishment of the 33kV switchgear with new equipment in situ (i.e. 'brownfield replacement') under a staged approach. However, brownfield replacement imposes materially greater safety and schedule risk, arising from work being carried out next to energised equipment.

Condition issues identified in the switchroom buildings have led to the decision to construct a new 33kV switchroom building at the customer's cost to house the new equipment.

Demolition of the existing building and site remediation will also occur as a result of the project. The new switchroom design will also support improved fire segregation, contributing to improved safety and reliability.

Ausgrid also considered other options such as the retirement of the 33kV switchgear or the construction of a new 132/11kV zone substation, but these options were not progressed since they were found technically or commercially not credible. In the case of simple retirement, the reliability of supply would be significantly reduced and future developments in Sydney Airport would be limited. In the case of the new substation, the cost would be materially higher than replacing the switchgear, without providing a commensurate increase in benefits.

Replacement of the 33kV switchgear in a new switchroom is identified as Option 1. It provides positive gross benefits across all scenarios largely from avoiding the involuntary load shedding that would otherwise be incurred under the base case.

Non-network options are not considered viable for this RIT-D

A demand management assessment into addressing the issues at Sydney Airport ZS showed that non-network alternatives cannot address the identified need, compared to the network option outlined above. it is not considered possible that sufficient demand management measures could be implemented to achieve the required demand reduction to make project deferral technically and economically viable. Further details are provided in a separate notice on screening for non-network options released in accordance with clause 5.17.4(d) of the NER.

Option 1 is therefore the preferred option

Option 1 involves replacing the 33kV switchgear by installing new equipment in a new, customer funded switchroom and reconnecting it to the existing network. In particular, the scope of works Option 1 consists of:

- Decommissioning and removal of reactors on feeders 356 and 359;
- Construction of a new 33kV switchroom on the site previously occupied by feeder 356 and 359 reactors;
- installation of a new 33kV switchboard, comprising two sections of single bus switchgear and ten circuit breakers;
- transfer of existing 33kV feeders 331, 345, 352 and 338 to the new 33kV switchgear; and
- decommissioning of the existing 33kV switchgear, which will be removed from site.

The work will be undertaken within the vicinity of the existing substation site. This area is Commonwealth land, leased on a long-term basis to Sydney Airport.

The estimated capital costs are expected to be $6.6 million, with operating costs expected to be around $33,000 per year. Sydney Airport will fund the construction of the new 33kV switchroom, control room and associated civil works to Ausgrid specifications. Ausgrid will fund the procurement and installation of the new 33kV switchgear equipment, the transfer of the existing 33kV feeders to the new switchgear and the decommissioning of the existing 33kV switchgear equipment. Specific tariff arrangements have been established to recover the cost of the assets required to supply Sydney Airport over a long-term period.

Ausgrid considers that this FPAR, and the accompanying detailed analysis, identify Option 1 as the preferred option and that this satisfies RIT-D requirements. Ausgrid is the proponent for Option 1.

How to make a submission and next steps

Construction is anticipated to commence by end of 2019/20, with planned commissioning in 2021/22 and finalisation of site works to be completed by 2022/23.

Any queries relating to this Final Project Assessment Report should be addressed to:

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email to: assetinvestment@ausgrid.com.au

1 Introduction

This Final Project Assessment Report (FPAR) has been prepared by Ausgrid and represents the final step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply to the Sydney Airport network area going forward.

Sydney Airport ZS supplies the Sydney Airport domestic terminal as well as some of the airport's commercial load through a network owned by the Sydney Airport Corporation Ltd (SACL) and provides back-up supply to the International Terminal via the 33kV switchboard. This zone substation was commissioned in 1969 and much of the original equipment is still in service. The 33/11kV transformers and 11kV switchgear are owned by SACL whilst the 33kV switchgear is owned by Ausgrid. The 33kV and 11kV switchgear is housed in separate rooms in a common switchroom building owned by SACL. Both the 11kV and 33kV switchgear at Sydney Airport ZS is in poor condition and requires replacement. SACL has initiated 11kV switchgear replacement works at their cost.

The 33kV switchgear equipment is compound insulated with oil-filled circuit breakers. Compound insulated switchgear has exhibited failures ranging from single equipment failures to multiple equipment failures impacting the operation of an entire substation. Furthermore, the 33kV oil circuit breakers at Sydney Airport ZS were originally commissioned in 1955 and are now an orphan technology with very limited spare parts availability. Ausgrid has conducted a condition and risk assessment of the equipment. In the event of failure, the risk of expected unserved energy from involuntary load shedding is such that it justifies the corrective actions outlined in this report.

Capital expenditure for replacement projects are subject to the Regulatory Investment Test for Distribution (RIT-D). No exemptions listed in the NER clause 5.17.3(a) apply and therefore Ausgrid is required to apply the RIT-D to this project. Accordingly, Ausgrid has initiated this RIT-D to replace the 33kV switchgear at Sydney Airport ZS, to identify a preferred option to address an identified need.

1.1 Role of this final report

Ausgrid has prepared this FPAR in accordance with the requirements of the National Electricity Rules (NER) under clause 5.17.4.

The purpose of the FPAR is to:

- describes the identified need which Ausgrid is seeking to address, together with the assumptions used in identifying this need;
- provides a description of each credible option assessed;
- quantifies costs and market benefits for each credible option;
- provides detailed description of the methodologies used in quantifying each class of cost and market benefit;
- explains why Ausgrid has determined that classes of market benefits or costs do not apply to a credible option;
- presents the results of a net present value analysis of each credible option and accompanying explanation of the results; and
- identifies and details information for the proposed preferred option.

This FPAR follows the Notice of Non-Network Options released earlier in February 2020. The FPAR represents the final stage of the formal consultation process set out in the NER in relation to the application of the RIT-D as outlined in Appendix B. The entire RIT-D process is detailed in Appendix B.

1.2 Contact details for queries in relation to this RIT-D

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email to: assetinvestment@ausgrid.com.au

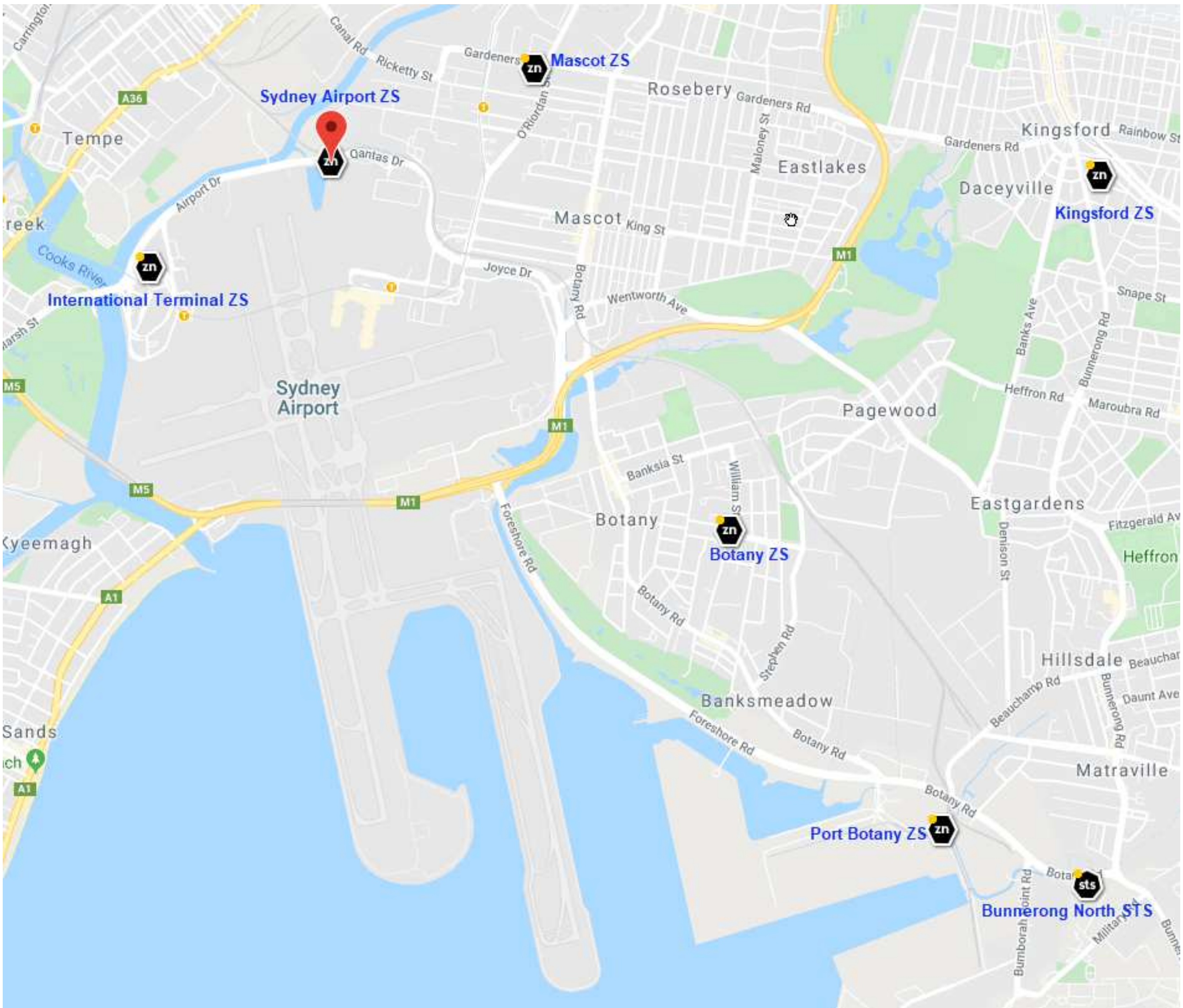
2 Description of the identifed need

This section provides a description of the network area and the 'identified need' for this RIT-D, before presenting key assumptions underlying the identified need.

2.1 Overview

Sydney Airport ZS is a 33/11kV zone substation. It was commissioned in 1969 and is supplied from Bunnerong North STS via multiple 33kV cables. The zone substation supplies Sydney Airport domestic terminal as well related commercial load (comprising over a hundred retail and commercial customers, including Qantas and Virgin Australia operations) through an 11kV network owned by the SACL. Sydney Airport's international terminal is supplied by the International Terminal ZS, which also relies on the 33kV switchboard at Sydney Airport ZS for backup supply. Figure 2.1 shows the location of Sydney Airport ZS relative to Bunnerong North STS and International Terminal ZS.

Figure 2.1 – Location of Sydney Airport zone substation

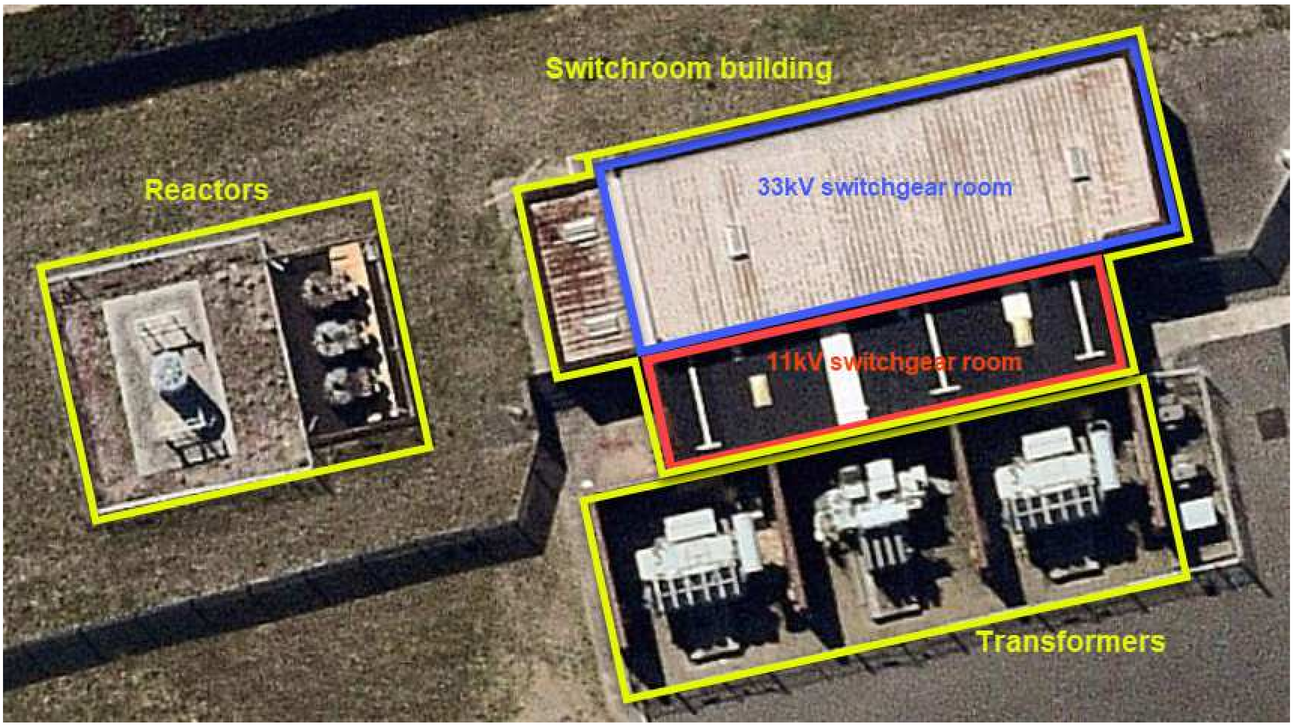


Sydney Airport is the largest airport in Australia, accounting for around 40% of international passenger movements and 47% of air freight. Peak loads at the Sydney Airport and International Terminal zone substations occur in summer and currently are 24.8MVA and 18.2MVA respectively.

The 33/11kV transformers and 11kV switchgear at Sydney Airport ZS are owned by SACL whilst the 33kV switchgear is owned by Ausgrid. Critical components at Sydney Airport ZS which are in poor condition include the 11kV and 33kV switchgear used to control, protect and isolate electrical equipment. SACL has initiated replacement works for the 11kV switchgear at their cost.

The 11kV and 33kV switchgear are each housed in separate rooms in a common switchroom building owned by SACL, as shown in Figure 2.2. SACL has identified significant condition issues with the existing switchroom building and is also proposing to demolish the existing building and remediate the site.

Figure 2.2 – Location of switchroom building at Sydney Airport zone substation



In the case of the 33kV switchgear at Sydney Airport ZS, the 33kV oil circuit breakers are some of the oldest still in use on the Ausgrid network and are of a unique type with very limited spare parts availability. The 33kV switchgear is a compound switchboard initially installed and commissioned at the old Alexandria 33/5kV ZS in 1955 and then relocated to Sydney Airport ZS in 1969. It includes oil circuit breakers and bituminous compound insulation busbars (switchboard) which can act as a fuel source, increasing the risk of fire and safety issues in the event of equipment failure. Advances in circuit breaker technology since the 1970s have addressed these risks. Continued use of the existing 33kV switchgear at the Sydney Airport ZS exposes Ausgrid and the general public to unacceptable reliability and safety risks, given the alternative technologies that are now available.

Insulation testing of the switchboard and circuit breakers was conducted in 2016 on one busbar section. Partial discharge tests were above acceptable levels. Airport operations have prevented testing of other sections, but they are highly likely to exhibit similar results given their common make, age and operating environment. Unlike 11kV switchgear, there are no vacuum circuit breakers available to substitute for the 33kV oil circuit breakers.

Quantitative risk analysis undertaken by Ausgrid that benefits of reducing of unserved energy due to the risk of switchboard failure are such that the replacement investment outlined in this report is justified.

It follows that there is an identified need to undertake reliability corrective action to address the 33kV switchgear condition at Sydney Airport ZS.

2.2 Key assumptions underpinning the identified need

The need to undertake action is predicated on the deteriorating condition of 33kV switchgear at Sydney Airport ZS and the characteristics of any resultant outages, as well as the fact that maintaining the current technology presents heightened maintenance and asset failure risks.

This section summarises the key assumptions underpinning the identified need for this RIT-D. Appendix C provides additional detail on assumptions used, and methodologies applied, to estimate the costs and market benefits as part of this RIT-D.

2.2.1 Ageing assets at the Sydney Airport zone substation have an increasing likelihood of failure that leads to unserved energy

The 33kV switchgear at Sydney Airport ZS is a compound switchboard (ex-Alexandria 33/5kV ZS) and was originally commissioned in 1955. The 33kV oil circuit breakers are some of the oldest still in use on the Ausgrid network and are of a unique type with very limited spare parts availability.

The switchgear has bituminous compound insulation busbars (switchboard) and oil-filled circuit breakers which can act as a fuel source and may result in significant consequential damage in the event of failure. The switchgear itself is considered to be beyond its design life.

In the past oil-filled switchgear failures have resulted in a range of adverse consequences ranging from single equipment failures to multiple equipment failures impacting the operation of the entire substation. Consequently, Ausgrid has assessed that the ageing assets (i.e. compound insulated 33kV switchgear) at Sydney Airport ZS have an unacceptable risk of failure resulting in a corresponding risk of involuntary load shedding and to the safety of operational staff.

2.2.2 Limited recovery strategy in the event of failure

In the event of failure of the 33kV switchgear and subsequent loss of supply to Sydney Airport ZS, the recovery strategy would include supply from on-site generation plus supply via two 11kV feeders from International Terminal ZS. The 11kV transfer capability between the zone substations is estimated to be limited to 5MVA. Qantas has on-site generation at Sydney Airport but its impact has already been incorporated in the load forecast. Supply to the balance of the load at Sydney Airport ZS would be subject to completion of repair/replacement of damaged 33kV switchgear and associated equipment for restoration of supply.

3 Options considered to address the identified need

This section provides details of the only credible option that Ausgrid has identified in the network planning process. Several options were considered and assessed in consultation with the customer. A number of options were considered non-credible as they do not meet the customer's reliability needs and/or operational requirements of the customer. Some options could technically address the identified need but are likely to cost significantly more than the credible option without any significant increase in benefits. On this basis, Ausgrid has therefore identified one credible option which is technically and economically feasible. More details of the other options are set out in section 3.2.

Ausgrid has also considered whether there are non-network options that could address the identified need. In this case, it is not considered possible that sufficient demand management measures could be implemented to achieve the required demand reduction to defer the network option and make project deferral technically and economically viable. Ausgrid has therefore published a separate notice on screening for non-network options setting out that non-network options are unlikely to exist. However, Ausgrid would welcome submissions from non-network solution providers if credible non-network solutions exist.

The credible option identified by Ausgrid involves replacement of the 33kV switchgear in a new switchroom, which will improve reliability, reduce unserved energy levels and reduce operating expenditure over time. Additionally, this option will also avoid construction and network risks and will provide the opportunity to incorporate greater fire segregation between 33kV busbar sections. SACL has identified significant condition issues with the existing switchroom building and is proposing to demolish the existing building and remediate the site. Therefore, replacing the 33kV switchgear in a new switchroom is the only credible option. As agreed between Ausgrid and SACL, SACL will construct and provide a new 33kV switchroom building to house Ausgrid's new 33kV switchgear.

Table 3.1 below provides a summary of the credible option considered. All costs in this section are in $2019/20, unless otherwise stated.

Table 3.1 – Summary of the option considered

Option details	Option 1
Option description	Replace the 33kV switchgear in a new switchroom
Capital costs	$6.6 million
Construction period	2019/20
Commissioning date	2021/22

3.1 Options 1 -- Replacement of 33kV switchgear in a new switchroom

Option 1 involves the following components:

1. decommission and removal of reactors on feeders 356 and 359;
2. bypass reactors of feeders 345 and 352 at Bunnerong North STS and feeder 331 at Mascot ZS;
3. construction of a new 33kV switchroom on the site previously occupied by the feeder reactors
4. installation of new 33kV switchgear in the new switchroom;
5. transfer of the 33kV feeders from old to new switchgear; and
6. decommission of 33kV switchgear in the old switchroom.

These works will provide a reduction in the unserved energy and operating expenditure. This will also facilitate the customer's requirement to demolish the existing building and implement better safety measures for the 33kV busbar.

Option 1 is expected to cost $6.6 million. Ausgrid anticipated a two-year construction period, commencing in 2019/20 and with expected commissioning in 2021/22 and finalisation of site works in 2022/23. Once the new installation is complete, operating costs are expected to be around $33,000 per annum (approximately 0.5% of capital expenditure).

3.2 Options considered but not progressed

Ausgrid also considered several other options that have not been progressed. In general, these options have not progressed because they were found to be economically infeasible or technically infeasible.

The table below summarises Ausgrid's consideration and position on each of these potential options.

Table 3.2 – Options considered but not progressed

Option not progressed	Description	Reason why option was not progressed
Brownfield development: replace the switchgear in-situ	Replacing the Sydney Airport ZS 33kV switchgear with new equipment in the existing switchroom building.	Sydney Airport has identified condition issues with the existing switchroom building and is proposing to demolish the existing building and remediate the site. In situ redevelopment would also pose significant operational risks to the airport during construction
Retirement of Sydney Airport ZS via 11kV load transfer	Retiring the Sydney Airport ZS and transfer of load to surrounding zones via 11kV load transfer. Both 11kV and 33kV network would need to be rearranged significantly. This option is expected to cost significantly more than the preferred option.	This option is deemed as not feasible as it costs significantly more and will impose construction issues and capacity constraints to the remaining network. The surrounding zones do not have spare capacity to absorb the airport load. The option is not feasible from both Ausgrid's perspective and the customer's point of view.
Establish a new 132/11kV zone substation	This option involves retirement of the 33/11kV Sydney Airport ZS and replace it with a new 132kV ZS. Both 33kV and 132kV network would need to be rearranged significantly. This option is expected to cost significantly more than the preferred option.	This option is considered as not economically feasible as it would cost several times more than the combined replacement of both 33kV and 11kV switchgear, without providing a commensurate increase in benefits and bringing forward replacement investments in subtransmission feeders by at least 7 years.
Rearrange 33kV supply by connecting the 33kV cables directly to the 33/11kV transformers	Rearranging supply and retiring the 33kV busbar and the 33kV switchgear. Under this option, the 33kV cables would be directly connected to the 33/11kV transformers.	This option was rejected by the customer, claiming that it would reduce reliability of supply and operational flexibility, as well as limiting future growth. In addition, this option has significant construction risks.

4 How the option has been assessed

This section outlines the methodology that Ausgrid has applied in assessing market benefits and costs associated with the credible option considered in this RIT-D. Appendix C presents additional detail on the assumptions and methodologies employed to assess the option.

4.1 General overview of the assessment framework

All costs and benefits for each credible option have been measured against a 'business as usual' base case.

The RIT-D analysis has been undertaken over a 10-year period, from 2019/20 to 2029/30. Ausgrid considers that a 10-year period takes into account the size, complexity and expected life of the relevant credible option to provide a reasonable indication of the market benefits and costs of the option. While the capital components of the credible option have asset lives greater than 10 years, Ausgrid has taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of long-lived options is appropriately captured in the 10-year assessment period.

Given that no non-network options have been found to be viable, the appropriate discount rate is considered to be the regulated cost of capital. As a result, Ausgrid has adopted a real, pre-tax discount rate of 3.22 per cent, equal to the latest AER final decision for a DNSP's regulatory proposal at the time of preparing this FPAR[1].

4.2 Ausgrid's approach to estimating project costs

Ausgrid has estimated capital costs by considering the scope of works necessary under credible option together with costing experience from previous projects of a similar nature. Where possible, Ausgrid has also estimated capital costs using supplier quotes or other pricing information.

4.3 Benefits are expected from reduced involuntary load shedding

Ausgrid considers that the only relevant category of market benefits prescribed under the NER for this RIT-D relate to changes in involuntary load shedding. Appendix D outlines the categories of market benefit that Ausgrid considers are not material for this particular RIT-D.

Involuntary load shedding occurs when a customer's load is interrupted from the network without their agreement or prior warning. These limitations relate to the availability of network connectivity and design configuration at the substation. It also arises from the unavailability of network elements and the resulting reduction in network capacity to supply the load

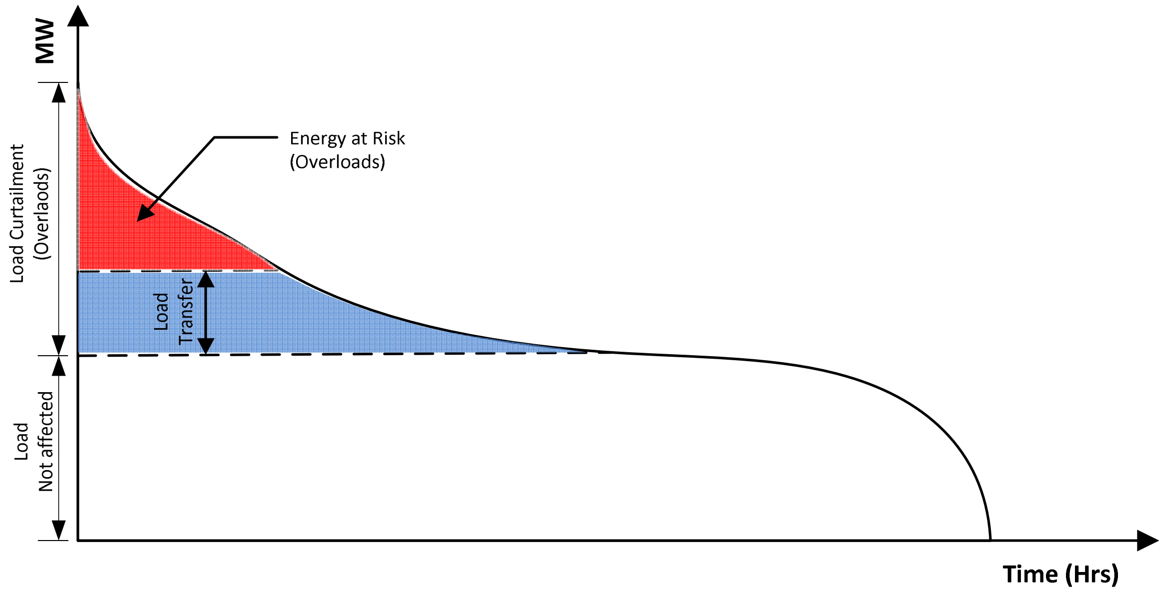
The Expected Unserved Energy (EUE) is the probability weighted average amount of load that customers request to utilise but would need to be involuntarily curtailed due to a network capacity limitation. Ausgrid has forecast load over the assessment period and has quantified the EUE by comparing forecast load to network capabilities under system normal and network outage conditions. A reduction in involuntary load shedding expected from an option, relative to the base case, results in a positive contribution to market benefits of the credible option being assessed.

The load duration curve at a substation is used to determine the energy at risk and/or the amount of load curtailment required at certain loading levels. The amount of load curtailment can be determined by using a discrete number of load points and the capacity adequacy at the substation following various credible contingencies and/or outages (i.e. single or multiple transformers out of service).

The following diagram illustrates the load curtailment due to overloads and the treatment of load transfer capability. During an overload condition, initially the necessary amount of load is shed, and then partial load is restored via available load transfer opportunities to surrounding zone substations. Energy at risk due is illustrated in the diagram below.

[1] See AER Final Decision – Ausgrid distribution determination 2019-24 - Overview, section 2.2, available at https://www.aer.gov.au/system/files/AER%20-%20Final%20decision%20-%20Ausgrid%20distribution%20determination%202019-24%20-%20Overview%20-%20April%202019.pdf

Figure 4-1 – Illustration of Load Curtailment



The market benefit that results from reducing the involuntary load shedding with a network solution is estimated by multiplying the quantity of EUE in MWh by the Value of Customer Reliability (VCR). The VCR is measured in dollars per MWh and is used as proxy to evaluate the economic impact of unserved energy on customers under the RIT-D.

Ausgrid has applied a central VCR estimate of $41/kWh, which has been derived from the 2014 AEMO VCR estimates[2]. Ausgrid has escalated the AEMO estimate to dollars of the day and weighted the AEMO estimates according to the make-up of the specific load considered.

We have also investigated the effect of assuming both a lower and higher underlying VCR estimate. The AEMO Value of Customer Reliability – Application Guide recommends using values of ± 30% of the base case VCR for the purposes of testing how sensitive investment decisions are to the VCR input. Thus, a lower VCR of $29/kWh and a higher VCR of $53/kWh have been chosen as reasonable for the low and high benefit scenarios.

In addition, while load forecasts are not a determinant of the identified need, Ausgrid has taken the view of considering the current Sydney Airport peak load of 24.8MVA as the reference, with an array of load transfer capabilities and additional embedded generation, to investigate how combined variations of load transfer capabilities and potential expansion of embedded generation change the expected net market benefits. Whilst the current load transfer capability (via 11kV interconnections) is limited to 5MVA, it is conceivable there may be additional embedded generation in the future. This is considered a conservative approach, since there are no committed investments or confirmed plans to increase 11kV interconnections between Sydney Airport ZS and International Terminal ZS and/or increase embedded generation capacity.

The figure below shows the assumed levels of unserved energy under different levels of transfer capabilities and embedded generation over the next ten years. For clarity, this figure illustrates the MWh of unserved energy if no credible option is commissioned, i.e. it reflects both the underlying demand forecast, the assumed mix of Load Transfer Capability (LTC) and Additional Embedded Generation (AEG), as well as the assumed failure rates associated with keeping assets in service.

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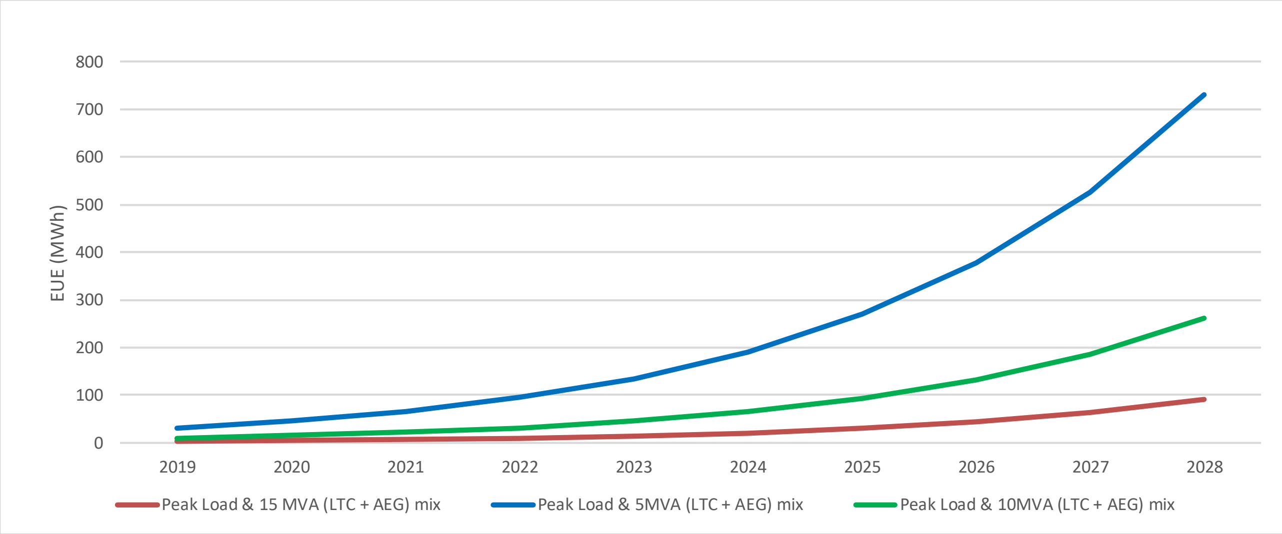
[2] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.

Figure 4.2 – Estimated level of Unserved Energy under each of the Load Transfer Capability + Additional Embedded Generation scenarios considered



Ausgrid has capped the EUE at the value in 2028. Since the base case reflects a 'do nothing' approach, it is considered that the level of EUE will be particularly uncertain after ten years. This also avoids a situation where an exponential increase in USE in later years[3] dwarfs other market benefits and skews the results,[4] and does not affect identification of the preferred option at all.

4.4 Three different 'scenarios' have been modelled to address uncertainity

RIT-D 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.

Ausgrid has elected to assess three future scenarios:

- Baseline scenario – the baseline scenario consists of assumptions that reflect Ausgrid's central set of variable estimates, which, in Ausgrid's opinion, provides the most likely scenario;
- Low benefit scenario – Ausgrid has adopted several 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 market benefits that could be realised under each credible option; and
- High benefit scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential market benefits.

[3] An exponential increase in USE results from assumptions that failure rates increase exponentially with asset age. 'Capping' the USE level recognises that in reality action would be taken before this occurred.

[4] Ausgrid notes that this approach was commented on and supported by Dr Darryl Biggar in his review of the modelling undertaken for the Powering Sydney's Future RIT-T. See: Biggar, D., *An Assessment of the Modelling Conducted by TransGrid and Ausgrid for the "Powering Sydney's Future" Program*, May 2017, available at: https://www.aer.gov.au/system/files/Biggar%2C%20Darryl%20-%20An%20assessment%20of%20the%20modelling%20conducted%20by%20TransGrid%20and%20Ausgrid%20for%20the%20%20Powering%20Sydney%20s%20Future%20%20program%20-%20May%202017.pdf

Table 4.1 – Summary of the three scenarios investigated

Variable	Baseline scenario	Low benefits scenario	High benefits scenario
Capital cost	100 per cent of capital cost estimate	125 per cent of capital cost estimate	75 per cent of capital cost estimate
Unplanned corrective maintenance cost	100 per cent of baseline corrective maintenance cost estimates	70 per cent of baseline corrective maintenance cost estimates	130 per cent of baseline corrective maintenance cost estimates
Demand	Current Peak Load and 10MVA LTC + AEG	Current Peak Load and 15MVA LTC + AEG	Current Peak Load and 5MVA LTC + AEG
VCR	$41/kWh	$29/kWh	$53/kWh
Discount rate	3.22 per cent	3.22 per cent	3.22 per cent

Ausgrid considers that the baseline scenario is the most likely, since it based primarily on a set of expected/central assumptions. Ausgrid 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, Ausgrid notes that the identification of the preferred option is the same across all three scenarios, i.e. the result is insensitive to the assumed scenario weights.

5 Assessment of the credible option

This section provides a description of the credible network option Ausgrid has identified as part of its network planning activities to date. The option is compared against a base case 'do nothing' option.

5.1 Gross market benefits for each credible option

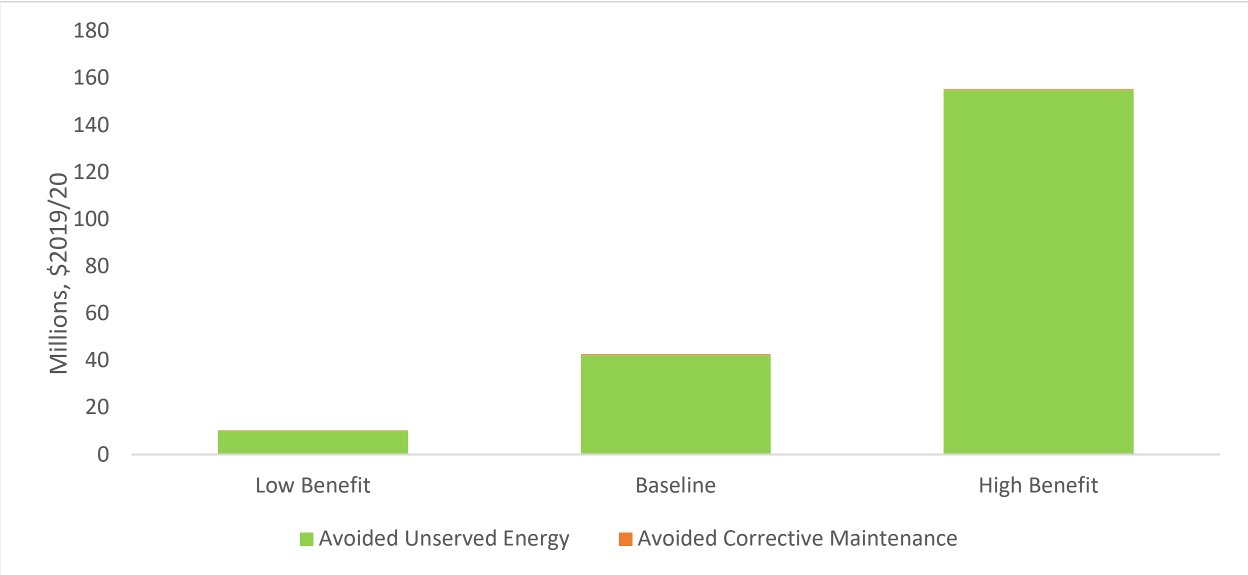
The table below summarises the gross benefit Option 1 relative to the 'do nothing' base case in present value terms. The gross market benefit for each option has been calculated for each of the two reasonable scenarios outlined in the section above.

Table 5.1 – Present value of gross benefits of Option 1 relative to the base case, $m 2019/20

Option	Low Benefit Scenario	Baseline Scenario	High Benefit Scenario	Weighted Benefits
Weighting	*25 per cent*	*50 per cent*	*25 per cent*	
Option 1	10.2	42.5	155.2	62.6

Figure 5.1 provides a breakdown of benefits relating to each credible option, showing almost all of the benefits from Option 1 are derived from avoided involuntary load shedding, with avoided corrective maintenance contributing relatively small amounts to gross benefits. This is driven by the age and condition of the assets in question and the fact that they are expected to fail, resulting in customer outages, more going forward if left in service (i.e. under the base case).

Figure 5.1 – Breakdown of present value gross economic benefits of Option 1 relative to the base case (NPV results in $m 2019/20)



5.2 Estimated costs for each credible option

The table below summarises the costs for Option 1 relative to the base case in present value terms. The costs consist mostly of capital costs, with a small portion of decommissioning costs and planned routine maintenance cost. The cost of each option has been calculated for each of the three reasonable scenarios, in accordance with the approaches set out in Section 4.

Table 5.2 – Present value of costs of Option 1 relative to the base case, $m 2019/20

Option	Low Benefit Scenario	Baseline Scenario	High Benefit Scenario	Weighted Costs
Weighting	*25 per cent*	*50 per cent*	*25 per cent*	
Option 1	-5.0	-4.1	-3.2	-4.1

5.3 Net present value assessment outcomes

Table 5.3 summaries the net market benefit in NPV terms for each credible option on a weighted basis across the three scenarios. The net market benefit is the gross market benefit (as set out in Table 5.1) minus the cost of each option (as outlined in Table 5.2), all in present value terms.

The table shows that Option 1 provides net economic benefits on a weighted scenario basis, with most of the benefits arising from avoided unserved energy.

Table 5.3 – Present value of weighted net benefits relative to the base case, $m 2019/20

Option	PV of Capital Costs	PV of Operating Costs	Weighted PV of Gross Benefits	Weighted NPV of Benefits
Option 1	-3.2	-0.9	62.6	58.5

5.4 Sensitivity analysis results

Ausgrid has undertaken a thorough sensitivity testing exercise to understand the robustness of the RIT-D assessment to underlying assumptions about key variables.

In particular, we have undertaken two tranches of sensitivity testing – 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.

That is, Ausgrid has 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, Ausgrid has also looked at the consequences of 'getting it wrong' under Step 2 of the sensitivity testing. That is, load transfer capability turns out to be higher than 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 has been applied to test the sensitivity of the key findings.

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

Ausgrid has estimated the optimal timing for Option 1 based on the year in which the NPV of Option 1 is maximised. This process was undertaken for both the baseline set of assumptions and also a range of alternate assumptions for key variables (i.e. a single assumption is changed, keeping the remaining parameters of the baseline unaltered).

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

- a 25 per cent increase/decrease in the assumed network capital costs; and
- a lower VCR ($29/kWh) and a higher VCR ($53/kWh)

The figures below outline the impact on the optimal commissioning year for Option 1, under a range of alternate assumptions. It illustrates that the optimal commissioning date for all to be 2022/23.

Figure 5.2 – Distribution of optimal project commissioning years under each sensitivity investigated for Option 1

This indicates that the central commissioning year of 2022/23 is likely to offer the highest NPVs under most circumstances. Ausgrid is therefore satisfied that a commissioning year of 2022/23 has been robustly determined and tested.

5.4.2 Step 2 – Sensitivity testing of the overall net market benefit

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

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

- a 25 per cent increase/decrease in the assumed network capital costs;
- a lower VCR ($29/kWh) and a higher VCR ($53/kWh); and

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

Table 5.4 presents the results of these sensitivity tests and, for each sensitivity. The analysis reaffirms the robustness that Option 1 has a positive net market benefit for all sensitivities investigated.

Table 5.4 - Sensitivity testing results, $m 2019/20

Sensitivity	Option 1
Baseline	38.4
25 per cent higher capital cost	37.6
25 per cent lower capital cost	39.3
VCR $53/kWh	51.1
VCR $29/kWh	25.8
LTC 5MVA	115.3
LTC 15MVA	10.5

6 Proposed preferred option

Ausgrid proposes Option 1 to be the preferred option, as the proposed preferred option satisfies the RIT-D. Ausgrid is the proponent for Option 1 and has presented this project to SACL.

Option 1 involves replacement of the 33kV switchgear in a new 33kV switchroom building to be constructed by SACL. The proposed scope of works for Option 1 consists of:

- Decommissioning and removal of reactors on feeders at Sydney Airport ZS;
- Bypass reactors of feeders at Bunnerong North STS and Mascot ZS;
- Construction of a new 33kV switchroom on the site previously occupied by feeder reactors at Sydney Airport ZS;
- Installation of a new 33kV switchboard, comprising two sections of single bus switchgear and 10 x 33kV circuit breakers;
- Transfer the existing 33kV feeders to the new 33kV switchgear; and
- Decommission the existing 33kV switchgear, including removal from site.

Sydney Airport will fund the construction of the new 33kV switchroom, control room and associated civil works to Ausgrid specifications. Ausgrid will fund the procurement and installation of the new 33kV switchgear equipment, the transfer of the existing 33kV feeders to the new switchgear and the decommissioning of the existing 33kV switchgear equipment. Ausgrid expects to incur a total of $6.6 million in capital costs. Operating costs are assumed to be approximately 0.5% of capital expenditure, equivalent to $33,000 per annum.

Specific tariff arrangements have been established to recover the cost of the assets required to supply Sydney Airport over a long-term period.

The work will be undertaken within the vicinity of the existing substation site. This area is Commonwealth land, leased on a long-term basis to Sydney Airport. Construction is anticipated to commence by end of 2019/20, with planned commissioning in 2021/22 and finalisation of site works in 2022/23.

Ausgrid considers that this FPAR, and the accompanying detailed analysis, identify Option 1 as the preferred option and that this satisfies RIT-D requirements.

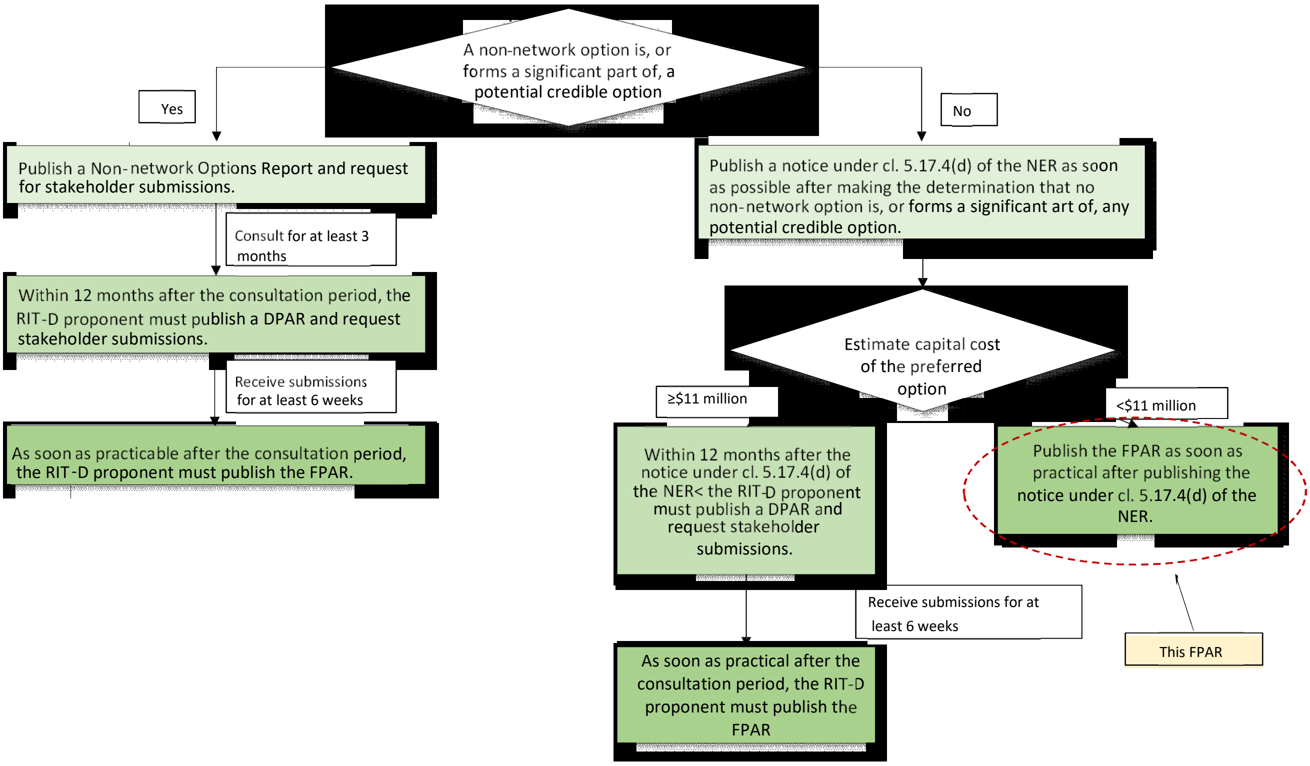
Appendix A – Checklist of compliance clauses

This section sets out a compliance checklist that demonstrates the compliance of this FPAR with the requirements of clause 5.17.4(j) of the National Electricity Rules version 107.

Rules clause	Summary of requirements	Relevant sections in the FPAR
5.17.4(r)	The matters detailed in that report as required under 5.17.4(j)	See rows below
	A summary of any submissions received on the DPAR and the RIT-D proponent's response to each such submission	Not required. Refer to Appendix B
5.17.4(j)	(1) a description of the identified need for the investment	2
	(2) the assumptions used in identifying the identified need	2.3, 4 & Appendix C
	(3) if applicable, a summary of, and commentary on, the submissions on the non-network options report	NA
	(4) a description of each credible option assessed	3
	(5) where a DNSP has quantified market benefits, a quantification of each applicable market benefit for each credible option;	5.1
	(6) a quantification of each applicable cost for each credible option, including a breakdown of operating and capital expenditure	3 & 5.2
	(7) a detailed description of the methodologies used in quantifying each class of cost and market benefit	2.3, 4 & Appendix C
	(8) where relevant, the reasons why the RIT-D proponent has determined that a class or classes of market benefits or costs do not apply to a credible option	Appendix D
	(9) The results of a net present value analysis of each of credible option and accompanying explanatory statements regarding the results	5
	(10) the identification of the proposed preferred option	6
	(11) for the proposed preferred option, the RIT-D proponent must provide: (i) details of technical characteristics; (ii) the estimated construction timetable and commissioning date (where relevant); (iii) the indicative capital and operating cost (where relevant); (iv) a statement and accompanying detailed analysis that the proposed preferred option satisfies the regulatory investment test for distribution; and (v) if the proposed preferred option is for reliability corrective action and that option has a proponent, the name of the proponent	6
	(12) Contact details for a suitably qualified staff member of the RIT-D proponent to whom queries on the final report may be directed.	1.3

Appendix B – Process for implementing the RIT-D

For the purposes of applying the RIT-D, the NER establishes a three-stage process: (1) the Non-Network Options Report (or notice circumventing this step); (2) the DPAR; and (3) the FPAR. This process is summarised in the figure below.



Appendix C – Additional detail on key assumptions

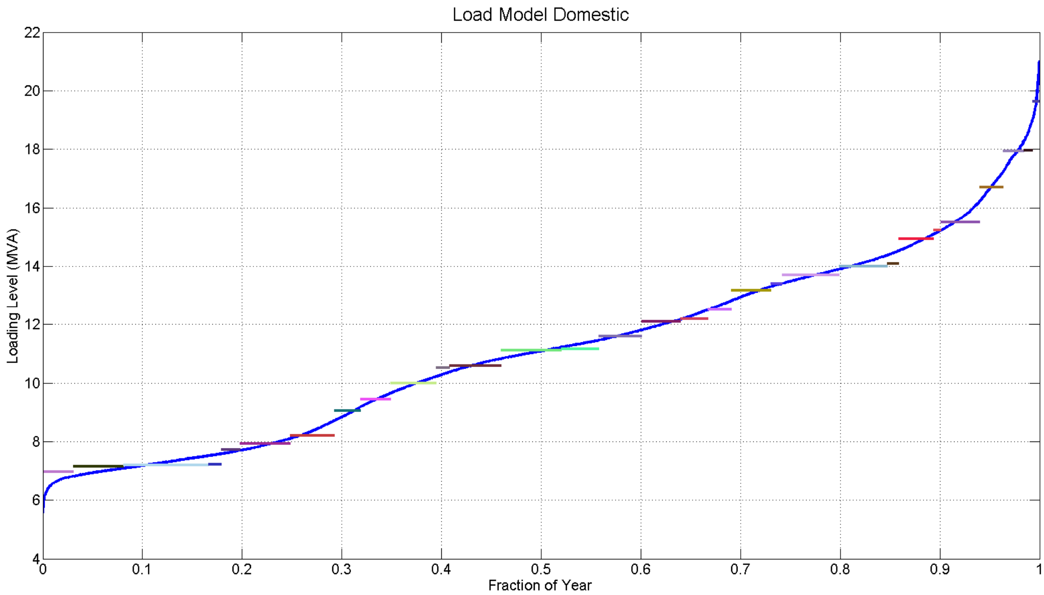
This appendix provides additional detail on key input assumptions that are used in the evaluation of the base case and the credible option.

C.1 Load duration curve

The load duration curve for Sydney Airport zone substation is presented in Figure C.1 below.

As Sydney Airport zone substation supplies a single customer, it is assumed that the load types supplied by this substation will not change substantially into the future and therefore the load duration curve will maintain its characteristic shape.

Figure C.1: Load duration curve for Sydney Airport



C.2 Load transfer capacity and supply restoration

Sydney Airport zone substation supplies a single customer but has some interconnection with International Terminal zone substation through the customer's 11kV network. In the event of a total loss of supply to Sydney Airport zone substation, it is estimated that approximately 5MVA of peak load can be recovered within days via the load transfer capacity of the existing customer network.

In the event of an equipment outage, the network may be returned to a normal configuration by one of the following actions:

- repairing the failed equipment
- initiating a contingency plan
- replacing the failed equipment with spares.

The assumed supply restoration actions and the time taken to implement the action are detailed in the table below. These actions are the most likely actions for the contingencies considered in this planning study.

Table C.1: Equipment outage assumptions

Equipment outage	Action	Outage duration (Days)
Transformer/Feeder Panel	Time between failure and access	1
	Time to undertake causal analysis	1
	Time to engineer solution (T&D Engineering)	1
	Time to manufacturer/repair engineered solution	6
	Time to implement engineered solution	6
	Ancillary Work - testing etc.	2
	Total - MAJOR FAILURE	**17**

C.3 Forecast availability of equipment

A range of models have been used to forecast the availability of equipment relevant to this RIT-D. These models utilise Ausgrid's historical failure records to determine the likelihood of failure. These models are combined with the estimates for repair or supply restoration time to determine the availability of equipment. The assumptions used to obtain the availability forecasts are provided in this section.

C.3.2 Availability of 33kV switchboards

For the purposes of this analysis, failures of 33kV switchboards are assumed to be non-repairable because typically the board is no longer functional following a failure (and hence is replaced or removed from service). Weibull analysis is used to derive a probability distribution function for the asset's age at time of failure. This function is denoted as f(t), where t is expressed in years. The parameters of the function are derived by considering the following information:

- the age of Ausgrid's in service 33kV switchboards;
- the age at failure for Ausgrid's failed switchboards; and
- the age at retirement for Ausgrid's switchboards that were retired before the point of functional failure.

The resultant Weibull parameters are given in the table below.

Table C.2: Switchboard parameters for the Weibull analysis

Equipment	Shape	Scale
33kV switchboard	13.1	63.98

The concept of conditional probability is used to evaluate the probability of failure (Pf) for each year in the planning period. The probability of a switchboard failure occurring each year, given that the board has survived to the current age (T) is calculated by applying the Equation 1:

$$P_f = \frac{\int_t^{t+1} f(t)dt}{\int_T^{\infty} f(t)dt} \qquad (1)$$

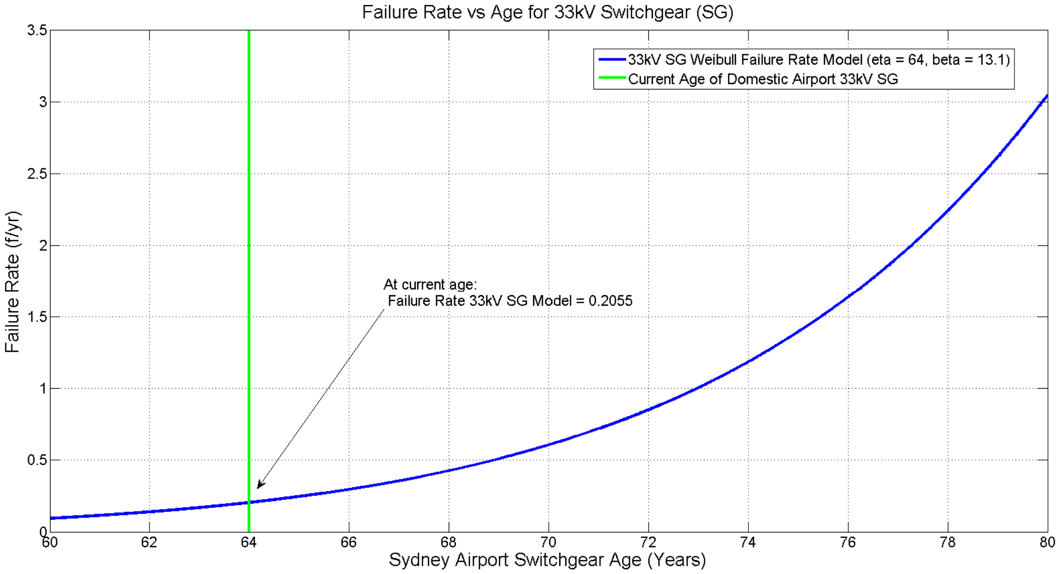
Unavailability is calculated by using a restore time, so the unavailability represents the percentage of time that a particular busbar is not available to supply load. The unavailability (U) of a switchboard is calculated for each year by applying Equation 2:

$$U = \frac{P_f \, . \, Outage\ Duration}{365} \qquad (2)$$

This model is based on the assumption that the condition of a switchboard is dependent upon its age.

Figure C.2 in the next page shows cumulative probability of failure for the 33kV switchboard at Sydney Airport zone substation.

Figure C.2: Cumulative probability of failure – 33kV switchboard



Appendix D – Market benefit classes considered not relevent

The market benefits that Ausgrid considers will not materially affect the outcome of this RIT-D assessment include:

- timing of unrelated network expenditure;
- changes in voluntary load curtailment;
- costs to other parties;
- changes in load transfer capacity and embedded generators;
- changes in electrical energy losses;
- option value; and
- deferring the need for unrelated network expenditure.

The reasons why Ausgrid considers that each of these categories of market benefit is not expected to be material for this RIT-D are outlined in the table below.

Table D.1 – Market benefit categories under the RIT-D not expected to be material

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated network expenditure	Ausgrid does not expect any changes in unrelated network expenditure in both size of expenditure or timing of expenditure as a consequence of implementing Option 1. Ausgrid has therefore excluded from timing of unrelated network expenditure benefits from this RIT-D.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the NEM is limited. Where the implementation of a credible option affects pool price outcomes, and in particular results in pool prices reaching higher levels on some occasions than in the base case, this may have an impact on the extent of voluntary load curtailment. Ausgrid notes that the option is not expected to affect the pool price and so there is not expected to be any changes in voluntary load curtailment.
Costs to other parties	This category of market benefit typically relates to impacts on generation investment from the option. Ausgrid notes that the option will not affect the wholesale market and so we have not estimated this category of market benefit.
Changes in load transfer capacity and embedded generators	The credible option does not impact the arrangement of 11kV connections between Sydney Airport ZS and International Terminal ZS and therefore is unlikely to change the load transfer capacity. Since the load forecast considered in the assessment is net of on-site generation, changes in embedded generation will not impact the benefits generated by the credible option. It should be noted that the embedded generation connected at Sydney Airport ZS is owned by Qantas and is used to support their aircraft operations.
Changes in electrical energy losses	Ausgrid does not expect that the credible option considered would lead to significant changes in network losses and so have not estimated this category of market benefits.
Option value	Option value arises where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the options considered are flexible to respond to that change. The credible option addresses a well-defined need and does not involve staging or any other flexibility and therefore option value is not considered relevant. Ausgrid considered an estimated option value as part of its assessment of non-network alternatives but its inclusion resulted in no change in the viability of non-network options to form part of the least cost solution.
Deferring the need for unrelated network expenditure	Option 1 does not affect the timing of any other network investment.

Ausgrid