Addressing reliability requirements in the Milperra load area

FINAL PROJECT ASSESSMENT REPORT

01 May 2023

Ausgrid

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Final Project Assessment Report – May 2023

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Executive Summary

This Final Project Assessment Report (FPAR) is the final stage in a RIT-D investigating the most economic option for ensuring reliable electricity supply to the Milperra load area

The Milperra Zone Substation (**ZS**) is located in the Canterbury Bankstown network area and was commissioned in 1966. The substation serves approximately 9,500 customers including Bankstown-Lidcombe hospital, Western Sydney region TAFE, and Sydney Water Corporation. It is supplied by two underground 132kV feeders from Sydney South Bulk Supply Point (**BSP**) via Revesby ZS and comprises two 132/11kV 50MVA transformers, one compound insulated 11kV switchboard, and one air insulated 11kV switchboard in a double bus arrangement.

The main issue for the Milperra ZS relates to asset condition, reliability and safety concerns stemming from the compound insulated switchboard, which is beyond its design life. If no corrective action is taken, planning studies indicate the potential for substantial expected unserved energy (EUE) at Milperra ZS, as well as increasing safety risks and reactive maintenance costs associated with repairs in the event of equipment failure. Substantial market benefits are expected to arise from taking action to avoid this EUE. Further, we expect that our electricity distribution license reliability and performance standards would be breached based on the amount of EUE calculated at Milperra ZS if action is not taken.

Ausgrid is therefore undertaking a Regulatory Investment Test for Distribution (RIT-D) to assess options for addressing the risk that the existing ageing 11kV compound insulated switchgear poses, and to ensure we continue to satisfy our reliability and performance standards.

A draft report was released in March 2023 and received no submissions

A Draft Project Assessment Report (**DPAR**) for this RIT-D was published on 03 March 2023. The DPAR presented one credible option for addressing asset condition concerns in the Milperra load area, assessed in accordance with the RIT-D framework and concluded that the preferred option was to replace the existing 11kV compound insulated switchgear at Milperra ZS with modern equivalent equipment, using an extension of the existing switchroom.

The DPAR also summarised Ausgrid's assessment of the ability of non-network or stand-alone power system (SAPS) solutions to assist in meeting the identified need, reporting that such solutions were not viable for this particular RIT-D. The DPAR was accompanied by a separate notice that provided further detail on this assessment, in accordance with clause 5.17.4(d) of the NER.

The DPAR called for submissions from parties by 14 April 2023. No submissions were received on either the DPAR of the separate screening notice.

This report therefore re-presents the assessment of the draft report and maintains the conclusion that there is one credible network option

Considering no submissions made to either the DPAR or the separate non-network screening notice, as well as there being no significant exogenous changes to factors affecting this RIT-D assessment since the DPAR was released, this FPAR re-presents the assessment undertaken in the DPAR.

Ausgrid has identified one network option. The credible option is summarised below.

Table E.1 – Credible network option assessed, $2022/23

Option	Capital cost	Expected commissioning
Option 1 – Replace the 11kV switchgear in an extended switchroom	$13.2 million	2025/26

Ausgrid also considered other network options, but they were found to be technically or economically unfeasible.

Option 1 has been found to be the preferred option, which satisfies the RIT-D. This option involves:

- extension of the current switchroom building to accommodate the replacement 11 kV switchgear;
- installation of a new 11 kV switchboard including four sections of single bus switchgear and 21x11 kV circuit breakers;
- installation of 11 kV connections to transfer the load from the existing 11 kV feeders to the new switchboard;
- secondary system upgrades; and
- decommissioning of the 11 kV compound insulated switchboard from the site.

The estimated capital cost of this option is $13.2 million, including $700,000 in decommissioning costs to remove redundant equipment after the new 11kV switchgear is commissioned in 2025/26. Operating costs at Milperra ZS are expected decrease by approximately $10,000 following commissioning of the new switchgear in 2025/26, as a result of a reduction in planned maintenance costs.

Ausgrid issued statutory notifications to the Canterbury-Bankstown City Council in November 2022. Given this is an industrial area and construction works will be contained within the substation site, the community consultation will be focused on the neighbouring properties. This will take place once architectural perspective drawings are finalised.

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

Next Steps

Ausgrid intends to award the construction contract and have environmental approvals finalised in the second half of 2023, with a view to commence construction by end of 2023.

Under the NER, parties have 30 days from the date of this report to dispute the application of the RIT-D. Disputes are only able to be made on the grounds that Ausgrid has not applied the RIT-D in accordance with the NER, or that Ausgrid preformed a manifest calculation error in applying the RIT-D. Disputing parties cannot dispute issues in this FPAR that the RIT-D treats as externalities, or relate to an individual's personal detriment or property rights. Clause 5.17.5 of the NER sets out the full process and requirements regarding a dispute of how the RIT-D has been applied.

Any queries in relation to this RIT-D should be addressed to:

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Head of Asset Investment
Ausgrid
GPO Box 4009
Sydney 2001

Or

email to: assetinvestment@ausgrid.com.au

1 Introduction

This Final Project Assessment Report (**FPAR**) has been prepared by Ausgrid and is the final step in the application of the Regulatory Investment Test for Distribution (**RIT-D**) to options for ensuring reliable supply to the Milperra load area.

The Milperra Zone Substation (**ZS**) is located in the Canterbury-Bankstown network area and was commissioned in 1966. It serves approximately 9,500 customers and comprises two 132/11kV 50MVA transformers, one compound insulated 11kV switchboard, and one air insulated 11kV switchboard in a double bus arrangement.

The compound insulated 11kV switchboard is experiencing increasing condition, reliability, and safety issues. It remains original and failure rates for switchgear are expected to increase with age. If no corrective action is taken, planning studies indicate a significant increase in expected unserved energy (**EUE**), together with increasing safety risks and repair costs. Further, we expect that our electricity distribution license reliability and performance standards will be breached. Ausgrid is therefore undertaking a RIT-D to assess options for addressing the risk that the existing ageing 11 kV switchgear poses and to ensure we continue to satisfy our reliability and performance standards.

Ausgrid has determined that non-network or stand-alone power system (**SAPS**) solutions are unlikely to form a standalone credible option, or form a significant part of a credible option, for this RIT-D, as set out in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the National Electricity Rules (NER).

1.1 Role of this draft report

Ausgrid has prepared this FPAR in accordance with requirements of the NER under clause 5.17.4 and its purpose is to:

- describe the identified need Ausgrid is seeking to address, including the assumptions used in identifying this need;
- provide a description of each credible option assessed;
- quantify relevant costs and market benefits for each credible option;
- describe the methodologies used in quantifying each class of cost and market benefit;
- explain why Ausgrid has determined that classes of market benefits or costs do not apply to the options considered;
- present the results of a net present value (**NPV**) analysis of each credible option and explain these results; and
- identify the preferred option.

This FPAR follows the Draft Project Assessment Report (**DPAR**) released in March 2023 and is the final stage of the formal consultation process set out in the NER for the application of the RIT-D. The RIT-D process is detailed in Appendix B.

1.2 No submissions were received on the DPAR

The DPAR presented one credible option for addressing reliability concerns in the Milperra load area, assessed in accordance with the RIT-D framework and concluded that the preferred option was to replace the existing 11kV compound insulated switchgear at Milperra ZS with modern equivalent equipment, using an extension of the existing switchroom.

The DPAR also summarised Ausgrid's assessment of the ability of non-network or stand-alone power system (SAPS) solutions to assist in meeting the identified need, reporting that such solutions were not viable for this particular RIT-D. The DPAR was accompanied by a separate notice that provided further detail on this assessment, in accordance with clause 5.17.4(d) of the NER. The DPAR called for submissions from parties by 14 April 2023. No submissions were received on either the DPAR of the separate screening notice.

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

Any queries in relation to this RIT-D should be addressed to:

Matthew Webb
Head of Asset Investment
Ausgrid
GPO Box 4009
Sydney 2001

Or

email to: assetinvestment@ausgrid.com.au

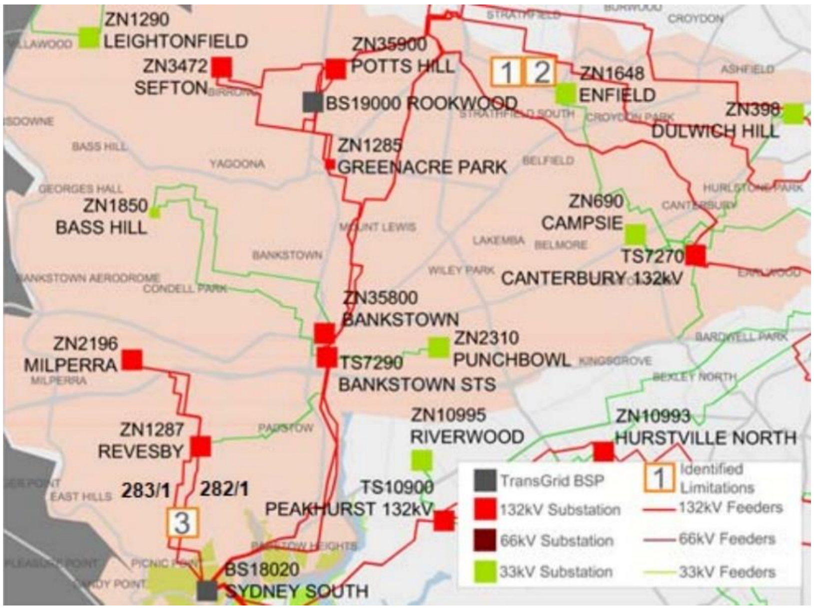
2 Description of the identified need

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

2.1 Overview of the Milperra ZS and existing supply arrangements for the load area

The Milperra ZS is located in the Canterbury Bankstown area and was commissioned in 1966. The substation serves approximately 9,500 customers including Bankstown-Lidcombe hospital, Western Sydney region TAFE, and Sydney Water Corporation. It is supplied by two underground 132 kV feeders from Sydney South BSP via Revesby ZS and comprises two 132/11 kV 50 MVA transformers and two groups of 11kV switchgear in a double bus arrangement. The first group is a compound insulated 11kV switchboard installed in 1966, and the second one is an air-insulated 11kV switchboard installed in 1983. Figure 2.1 illustrates where the Milperra ZS sits in the wider Canterbury Bankstown network area.

Figure 2.1 – Canterbury Bankstown network area



Milperra ZS is a summer peaking substation with a peak load of 42.0 MVA in summer 2020/21. Peak load is not forecast to exceed the substation's firm capacity of 61.2 MVA over the next 20 years.

Figure 2.2 provides an overview of the Milperra ZS site and its service area. The substation is placed within a predominantly industrial area.

Figure 2.2 – Location of Milperra ZS

The original 1966 compound insulated switchboards are deteriorating due to their age – resulting in increased condition, reliability and safety concerns. Physical tests conducted in June 2021 indicated that insulation resistance in the compound-insulated switchgear is lower than the standard requirement. Further, the failure rates for this type of switchgear are expected to increase with age.

If no corrective action is taken, our planning studies (based on predictive failure modelling) indicate an increasing amount of EUE at Milperra ZS, as well as increasing safety risks and reactive maintenance costs associated with having to repair and restore service in the event of equipment failure.

In the event of a significant failure at Milperra ZS, up to 48 per cent of load can be transferred away through manual switching to adjacent zone substations (the majority transferred to Revesby ZS) after a time delay. The remaining load would have to be supplied using mobile substations and power generation sets with a non-firm supply until repairs are completed.

Despite these load transfer and back-up capabilities, we expect that our electricity distribution license reliability and performance standards will be breached if action is not taken.

2.2 Summary of the 'identified need'

The main concern relates to increasing customer supply risks derived from the condition of the 11kV compound insulated switchgear at Milperra ZS. If action is not taken to address the deteriorating condition of this equipment, then the analysis shows that the unserved energy modelled will lead to a breach of reliability and performance standards going forward.

Ausgrid's planning studies indicate the potential for substantial expected unserved energy (EUE) at Milperra ZS, as well as increasing safety risks and reactive maintenance costs associated with repairs in the event of equipment failure. Substantial market benefits are expected to arise from taking action to avoid this EUE.

Further, we expect that our electricity distribution license reliability and performance standards would be breached based on the amount of EUE calculated at Milperra ZS if action is not taken. Ausgrid is obliged to comply with reliability and performance standards as part of its distribution license granted by the Minister for Industry, Resources and Energy under the *Electricity Supply Act 1995 (NSW)*. Reliability and performance standards are expressed in two measures:

- SAIDI[1] – which means the average derived from the sum of the durations of each sustained customer interruption (measured in minutes), divided by the total number of customers (averaged over the financial year); and
- SAIFI[2] – which means the average derived from the total number of sustained customer interruptions divided by the total number of customers (averaged over the financial year).

Customers experience less inconvenience (i.e., a better level of supply reliability), the lower each of these measures are. Reliability standards applied to distribution networks typically set maximums in relation to each of these two measures.

2.3 Key assumptions underpinning the identified need

Ausgrid installed compound insulated switchgear from the late 1930s until the early 1970s. This type of switchgear is characterised by bituminous compound in the busbar chamber. This bituminous compound electrically insulates the 11kV busbar during normal operation but can also act as a fuel source in the event of a fire.

Much of this type of equipment has already been retired from Ausgrid's network, and the remaining equipment is approaching end of life, with continued service resulting in further deterioration and an increasing number of failures.

The ability to support this switchgear technology into the future is also becoming more costly. Manufacturers no longer produce this type of equipment, Ausgrid's inventory of spares is limited and the expertise to perform required repairs is specialised and increasingly rare. Repair for failures requires bespoke engineering solutions specific to an individual switchboard installation. Repair is also heavily dependent on the nature and extent of damage to both the switchgear and the switch room, with the realistic outcome in some cases being that it cannot be repaired but only replaced.

Tests on the 11kV compound insulated switchgear conducted at Milperra ZS in June 2021 indicated a lower insulation resistance than the standard requirement, consistent with the age of the switchgear. As the compound switchboard approaches 60 years of service, Ausgrid's probabilistic model anticipates increasing deterioration of the asset condition and significant levels of involuntary load shedding.

[1] System Average Interruption Duration Index.
[2] System Average Interruption Frequency Index.

The need to undertake action is predicated on the deteriorating condition of the existing 11kV switchgear at the Milperra ZS and the consequences of any resultant outages.

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

2.3.1 Ageing 11 kV switchgear is expected to increase the risk of involuntary load shedding

A critical assumption underpinning the identified need is that retaining the existing 11kV switchgear is expected to increase the risk of involuntary load shedding. The major factor contributing to the risk of involuntary load shedding is that the switchgear is reaching the end of its technical life and is expected to fail at an increasing rate going forward if action is not taken. The technology used by the switchgear is also obsolete and requires specialist skills to repair and maintain and so, consequently, outage times can be lengthy and spares are not readily available since manufacturers no longer produce the switchgear.

2.3.2 Probability of assets failing increases with age

A range of models have been used to forecast the availability of equipment. These models utilise Ausgrid's historical outage records to determine the likelihood of failure and are combined with estimates for repair or supply restoration time to determine the availability of equipment.

Failures of 11kV 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 has been used to derive a probability distribution function for the asset's age at time of failure and the parameters of the function are derived by considering the following information:

- the age of Ausgrid's in service 11kV switchboards;
- the age of functional failure for Ausgrid's failed switchboards; and
- the age of retirement for Ausgrid's switchboards that were retired before the point of functional failure.

The model has been created to distinguish between 11kV switchboards that are of differing condition. This assessment was performed using a group of Ausgrid subject matter experts based upon their specialist knowledge of the asset(s) and a review of the available conditional information (i.e., test results).

Additional detail on the modelling approach and assumptions is provided in Appendix D.

2.3.3 The capacity to undertake load transfers is limited

As outlined in section 2.1, in the event of a significant failure, a proportion of the load can be transferred away from the Milperra ZS by switching to adjacent zone substations such as Revesby, but the remaining load would have to be supplied using mobile substations and power generation sets with a non-firm supply until repairs are completed.

The EUE presented in this DPAR takes account of the limited ability to transfer load, and ability to use back-up supply, when failures occur.

2.3.4 Reactive maintenance costs and safety risk

In addition to the expected unserved energy, the 11kV switchgear failure model also quantifies unplanned repairs and safety risks associated with the existing 11 kV switchgear. The safety risk arises primarily from the compound insulation in the existing 11kV switchgear catching fire as its condition deteriorates going forward.

It should be noted that all 11kV bulk Oil Circuit Breakers (OCBs) installed in the compound insulated and the air insulated switch groups at Milperra ZS were replaced with vacuum circuit breakers (VCBs) in 2011 (approximately 12 years ago). The compound insulated switchboards can have high fire risks (due to them being a fuel source), which may compromise the safety and reliability of supply. Advances in technology since the 1970s have provided superior (safer) alternatives to compound switchboards.

Whilst the removal of OCBs significantly mitigates fire risks, it does not eliminate the risk as the key parts of the original switchboard remain in service. The only practical way to fully eliminate the risk is to retire and replace the aged compound insulated switchboard with modern equivalent equipment.

The benefits of avoiding these costs and risks are minor relative to the avoided EUE benefits (together, making up approximately 13 per cent of the present value of the expected benefits under the central scenario in this DPAR).

3 One credible option has been assessed

This section provides details of the credible option that Ausgrid identified as part of its network planning activities to date. All costs and benefits presented in this FPAR are in $2022/23, unless otherwise stated.

3.1 Option 1 – Replace the 11 kV switchgear at Milperra ZS

Option 1 involves replacement of the 11kV compound insulated switchboard using an extension of the existing switchroom.

Specifically, the scope of this option includes:

- extension of the current switchroom building to accommodate the replacement 11 kV switchgear;
- installation of a new 11 kV switchboard including four sections of single bus switchgear and 21x11 kV circuit breakers;
- installation of 11 kV connections to transfer the load from the existing 11 kV feeders to the new switchboard;
- secondary system upgrades; and
- decommissioning of the 11 kV compound insulated switchboard from the site.

Commissioning of the new switchboard is expected by September 2025 with the decommissioning of the existing 11 kV switchboard targeted for June 2026.

The estimated capital cost of this option is $13.2 million, including approximately $700,000 in decommissioning costs incurred in 2026 to decommission the redundant switchgear equipment. Operating costs at the Milperra ZS are expected to decrease by approximately $10,000 per annum from 2025/26, following the commissioning of the new switchgear, as a consequence of a reduction in planned maintenance, including the need for fewer site visits.

3.2 Options considered but not progressed

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

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

Table 3.1 – Options considered but not progressed

Option	Description	Reason why option was not progressed
Establish a new substation and retire Milperra ZS	Establish a new substation in the load area and retire Milperra ZS	Costs are substantially higher than the credible option with no corresponding increase in benefits. The option also requires a longer timeframe due to the need to construct a new ZS on a suitable site. This option is therefore not considered to be economically feasible.
Transfer the 11 kV load to adjacent zone substations	Transfer load to adjacent zone substations, mainly Revesby ZS, and decommission the compound insulated switchgear at Milperra ZS.	Costs are substantially higher than the credible option with no corresponding increase in benefits. This option is therefore not considered to be economically feasible.
Replace the 11 kV switchgear by utilising a mobile equipment room (MER)	Installation of a MER arrangement capable of accommodating an arrangement of 21x11kV circuit breakers within the site and decommission the compound insulated switchgear at Milperra ZS.	A MER is typically designed to accommodate 11 circuit breakers, while this option would need to accommodate 21 circuit breakers. This option would therefore require two MERs or a re-design that, along with the additional time required for design work, means that this option is expected to be significantly more expensive than Option 1 without providing any additional benefits. This option is therefore not considered to be economically feasible.

Option	Description	Reason why option was not progressed
Including the air insulated switchboard in the scope of the option	Replacing the air insulated 11 kV switchboard at Milperra ZS at the same time	The air insulated switchboard at Milperra ZS is in better condition than the compound insulated switchboards and is not expected to require replacement for another 15-20 years. There are also not expected to be any material operational cost savings/efficiencies from doing both works at once as they are largely discrete tasks. This work is not required to meet the identified need and so this option is considered not economically feasible.
Non-network options	Using non-network solutions either in combination with, or in-place of, a network option.	Ausgrid has considered the ability of non-network solutions to assist in meeting the identified need. Specifically, an analysis of non-network options considered how demand management could defer the timing of the preferred network solution and whether the estimated unserved energy at risk could be cost effectively reduced. An assessment of demand management options has shown that non-network alternatives would not be cost effective due to the magnitude of the load reduction required. This result is driven primarily by the significant amount of unserved energy that the identified network option allows to be avoided, compared to base case, and the cost of demand management solutions. This is detailed further in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.
SAPS options	Transferring and/or connecting customers to SAPS	Ausgrid has considered the feasibility of SAPS, informed by its trial of SAPS with selected customers living in fringe-of-grid areas of Ausgrid's network. Based on Ausgrid's trial, the cost of SAPS would limit the number of customers available to reduce demand given the deferral funds available and consequently, the reduction in demand would not be sufficient to defer or postpone the network solution. This is detailed further in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.

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 D 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. Under this base case, Ausgrid will continue to maintain the existing 11 kV switchgear in service (i.e., no change). This involves escalating regular and reactive maintenance activates as the probability of failure and outages increases over time in the absence of an asset replacement program, as well as consequent escalating EUE and safety risks.

The RIT-D analysis has been undertaken over a 20-year period, from 2022/23 to 2041/42. Ausgrid considers that a 20-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.

Where the capital components of the credible option have asset lives greater than 20 years, Ausgrid has taken a terminal value approach to incorporate capital costs in the assessment, which ensures that the capital cost is appropriately captured in the 20-year assessment period. This ensures that costs and benefits are assessed over a consistent period. The terminal value has been calculated as the undepreciated value of capital costs at the end of the analysis period and can be interpreted as a conservative estimate for benefits (net of operating costs) arising after the analysis period.

Ausgrid has adopted a real, pre-tax discount rate of 3.44% for the NPV analysis. This represents Ausgrid's opportunity cost for its capital investments, based on the guidelines provided in the AER rate of return instrument. As no non-network options have been found to be viable, Ausgrid considers that appropriate discount rate is the regulated cost of capital.

To test the results against variations in the discount rate, a value of 2.34% has been adopted for the lower bound discount rate sensitivity, to reflect the average of the latest AER Final Decision for a DNSP's regulated weighted average cost of capital (**WACC**) at the time of preparing this DPAR.[3] This is approximately 32% lower than the central discount rate assumption. For the upper bound discount rate sensitivity, the value of 5.50% is adopted to consider the scenario prepared by AEMO for the 2022 Integrated System Plan (**ISP**).

4.2 Ausgrid's approach to estimating project costs

Ausgrid has estimated capital costs by considering the scope of works necessary under the 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. Where costs for design work have been incurred prior to 2022/23, we have adjusted these costs to reflect the opportunity cost of this expenditure using Ausgrid's regulated cost of capital.

Operating and maintenance costs have been determined by comparing the operating and maintenance costs with the option in place to the operating and maintenance costs without the option in place. These costs are included for each year in the planning period. If operating and maintenance costs are reduced with the option in place, the cost savings are effectively treated as a benefit in the assessment.

Operating costs have been estimated for the credible option and the base case by taking into account:

- the probability and expected level of network asset faults, which translates to the level of corrective maintenance costs; and
- the level of regular maintenance required to maintain network assets in good working order, including planned refurbishment costs.

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

Ausgrid has also identified an opportunity to concurrently replace the voltage regulation scheme and DC boards at the Milperra ZS, for approximately $0.2 million. This is considered an opportunity to replace the equipment more efficiently than if the replacements were conducted on a standalone basis, given the required duplication in mobilisation costs. This additional expenditure represents approximately 1.6 per cent of total capital costs.

[3] Specifically, we take a straight average of the real, pre-tax WACCs for the Victorian DNSPs (since they represent the latest Final Decision(s) by the AER).

4.3 Market 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 EUE. The approach adopted to estimating reductions in EUE is outlined in section 4.3.1 below. Further details on the assumptions and methodology considered are presented in Appendix D. In addition, Appendix C summarises the market benefit categories that Ausgrid considers are not material for this RIT-D.

4.3.1 Reduced involuntary load shedding

Involuntary load shedding occurs when a customer's load is interrupted from the network without their agreement or prior warning. This relates 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 EUE is the probability weighted average amount of load that customers request to utilise but would need to be involuntarily curtailed due to loss of network connectivity or 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 EUE from the option, relative to the base case, results in a positive contribution to market benefits of the credible option being assessed.

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 $57.80/kWh, reflecting a load weighted value for the affected load at Milperra ZS calculated using the NSW VCR estimates (for residential, commercial and industrial load) derived by the AER in its VCR Final Report.[4] A breakdown of how the central load weighted VCR has been calculated is provided in Appendix D.

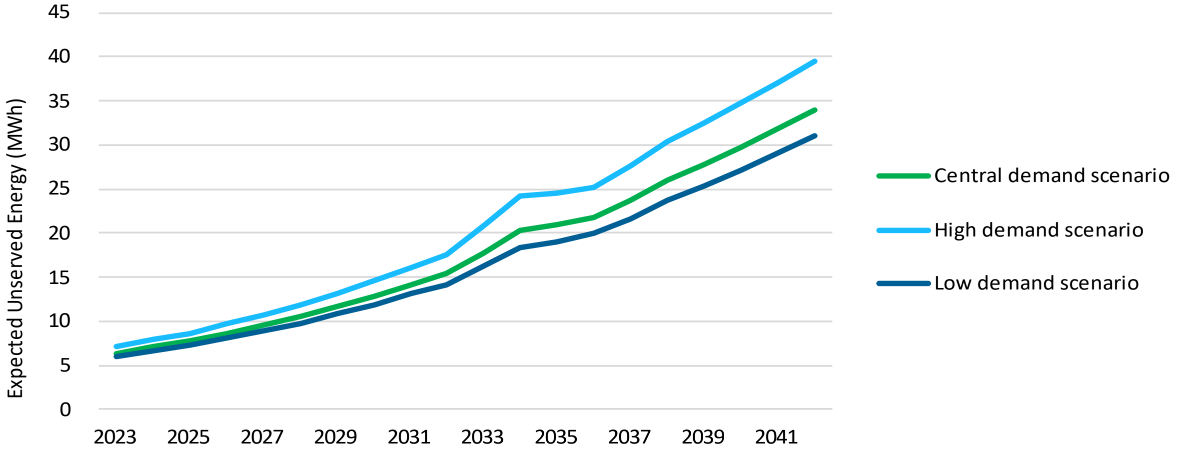
We have also tested the VCR as a sensitivity with values that are 30 per cent lower and 30 per cent higher than the central rate, consistent with the AER's specified +/- 30 per cent confidence interval.[5]

Ausgrid has investigated how assuming different load forecasts going forward changes expected market benefits under each option. In particular, three future load forecasts for the area in question have been investigated – namely:

- the central forecast uses 50 percent probability of exceedance ('POE50') under AEMO's ISP Step Change scenario;
- the low demand forecast reflects the minimum demand forecast across AEMO's ISP Slow Change, Progressive Change, Step Change and Strong Electrification scenarios for each year; and
- the high forecast reflects POE10 demand from AEMO's ISP Step Change scenario.

The figure below shows the assumed levels of EUE, for each of the three demand forecasts investigated over the next 20 years. For clarity, this figure illustrates the EUE in MWh prior to any replacement of the 11kV switchgear, taking into consideration the underlying demand forecasts and the failure rates associated with keeping the existing assets in service.

Figure 4.1 – Forecast EUE under each of the three demand forecasts



[4] AER, 2022 VCR Annual Adjustment, December 2022.

[5] AER, *Values of Customer Reliability – Final Report on VCR values*, December 2019, p. 84.

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

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 alternative future scenarios– namely:

- low scenario – Ausgrid has adopted a scenario that reflects a lower demand forecast and 30 per cent lower assumed safety risk costs and reactive maintenance costs, to represent a conservative future state of the world with respect to potential market benefits that could be realised under the credible option. Our low demand growth forecasts reflect the minimum demand forecast across AEMO's Slow Change, Progressive Change, Step Change and Strong Electrification scenarios for each year.
- central scenario – the central scenario consists of load assumptions that reflect Ausgrid's central set of variable estimates which, in Ausgrid's opinion, provides the most likely scenario, together with our central estimate of safety risk costs and reactive maintenance costs. The central demand forecasts reflect the 50 percent probability of exceedance ('POE50') forecast under AEMO's Step Change scenario; and
- high scenario – this scenario reflects higher than anticipated demand load at Milperra ZS, and 30 per cent higher assumed safety risk costs and reactive maintenance costs, to investigate the higher end of reasonably expected market benefits. The high demand load forecast comprises POE10 demand conditions from AEMO's Step Change scenario.

The scenarios only differ by the demand forecasts and the assumed levels of risk costs and reactive maintenance costs, given these are key parameters that may affect the ranking of the credible options. How the results are affected by changes to other variables (e.g., the discount rate and capital costs) have been investigated in the sensitivity analysis. This represents a change in approach to earlier Ausgrid RIT-Ds and reflects additional guidance provided by the AER in November 2022 in the context of the RIT-T (that we consider is also relevant for the RIT-D).[6]

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

Table 4.1 – Summary of the three scenarios investigated

Variable	Scenario 1 – central scenario	Scenario 2 – low scenario	Scenario 3 – high scenario
Demand	POE50 Step Change	Minimum POE50 demand across AEMO ISP scenarios	POE10 Step Change
Safety and health risk costs	Central estimate	70 per cent of central estimate	130 per cent of central estimate
Avoided reactive maintenance costs	Central estimate	70 per cent of central estimate	130 per cent of central estimate
VCR	$57.8/kWh across all scenarios		
Discount Rate	3.44% across all scenarios		

Note: The demand forecasts align with those used by AEMO in the 2022 ISP.

Ausgrid considers that the central scenario is the most likely, since it is based primarily on a set of expected/central assumptions. Ausgrid has therefore assigned this scenario a weighting of 80 per cent, with the other two scenarios being weighted equally with 10 per cent each. However, we note that the NPV outcome is positive across all scenarios, therefore the weightings do not influence the outcome that Option 1 is preferred to the 'do nothing' base case.

[6] Specifically, the guidance provided in the AER's determination on the North West Slopes and Bathurst, Orange and Parkes RIT-T disputes, which we consider is also relevant for the RIT-D.

5 Assessment of the credible option

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

5.1 Gross market benefits estimated for the credible option

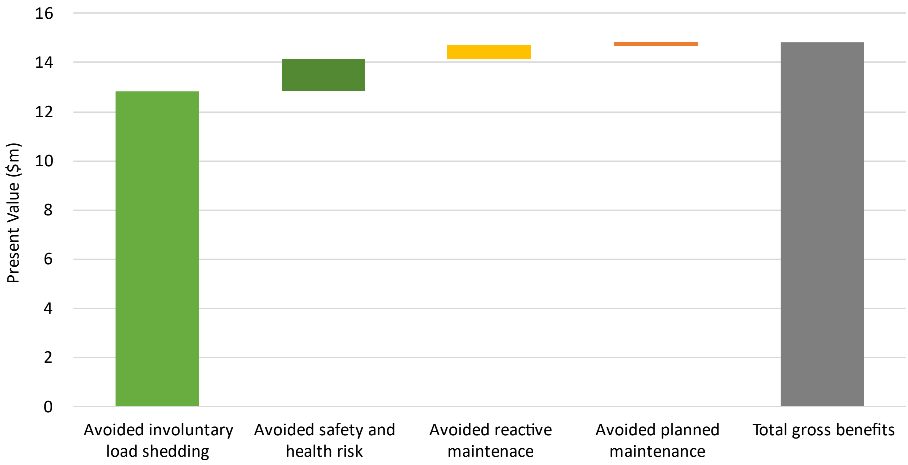
The table below summarises the gross market benefit of the credible option relative to the base case in present value terms. The gross market benefit for the option compared to the credible base case has been calculated for each of the three scenarios outlined in the section above and is also provided on a weighted basis.

Table 5.1 – Present value of gross benefits of credible option relative to the base case, $m 2022/23

Option	Central scenario	Low scenario	High scenario	Weighted benefits
Scenario weighting	80%	10%	10%	
Option 1	14.7	13.1	17.3	14.8

The primary benefit is avoided EUE, on account of the increasing likelihood of failure of the switchgear in question, which is nearing the end of its technical life. Secondary benefits such as avoided planned and unplanned maintenance (corrective maintenance) and avoided safety and health risk costs reflect only a small proportion of the benefits for each proposed option (approximately 13 per cent of gross benefits on a present value basis).

Figure 5.1 – Breakdown of gross benefits of the credible option relative to the base case weighted across scenarios, $m 2022/23



5.2 Estimated costs for the credible option

The table below summarises the capital cost of the credible option, in present value terms.

As noted earlier, operating costs at the Milperra ZS are expected to decrease by approximately $10,000 per annum compared with the base case, from 2025/26, following the commissioning of the new switchgear. This is a consequence of a reduction in planned maintenance, including the need for fewer site visits. We have reflected this reduction in operating costs as an avoided planned maintenance benefit at Milperra ZS in this RIT-D (see Figure 5.1).

The capital cost of the option does not vary across the three scenarios. Variations in the capital costs have been tested as a sensitivity.

Table 5.2 – Present value of costs of the credible option relative to the base case, NPV $m 2022/23

Option	Central scenario	Low scenario	High scenario	Weighted costs
Scenario weighting	80%	10%	10%	
Option 1	-8.3	-8.3	-8.3	-8.3

5.3 Net present value assessment outcomes

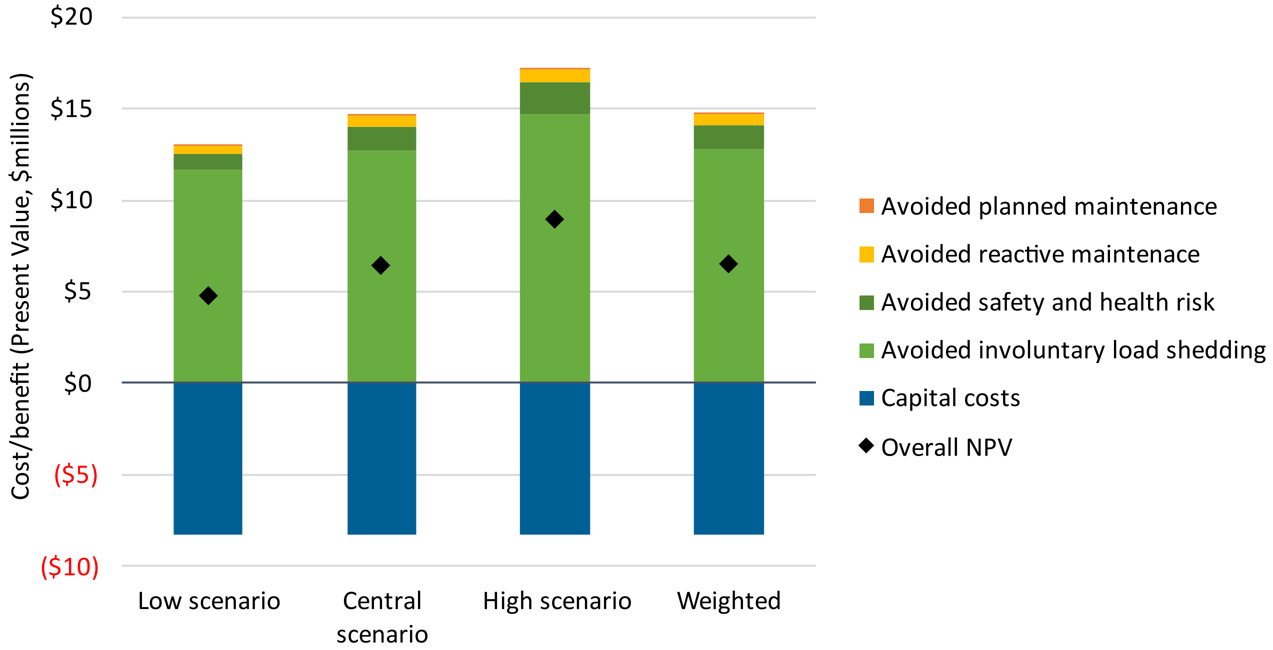
The table below summarises the net market benefit in NPV terms for the credible option under each scenario. The net market benefit is the gross market benefit (as set out in Table 5-1) minus the cost of the option (as set out in Table 5-2), all in present value terms.

The net market benefit is positive across the three scenarios, and on a weighted basis, and ranges from approximately $4.8 million to $9.0 million across the three scenarios. Figure 5.2 presents a breakdown of net present costs and benefits across the three scenarios, and on a weighted basis.

Table 5.3 – Present value of benefits relative to the base case by scenario and weighted, $m 2022/23

Option	Central scenario	Low scenario	High scenario	Weighted
Scenario weighting	80%	10%	10%	
Option 1	6.4	4.8	9.0	6.5

Figure 5.2: Present value of benefits and costs by scenario, $m 2022/23



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, if demand turns out to be lower 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

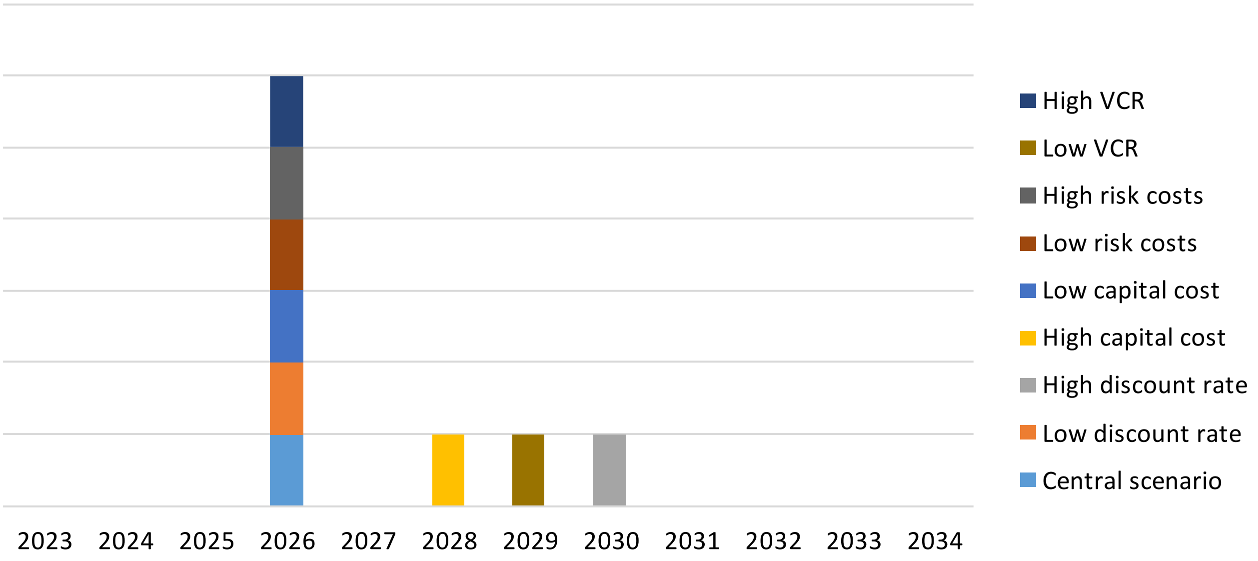
Ausgrid has estimated the optimal timing for each option according to when the expected annual benefit from the proposed option exceeds its annualised cost, consistent with the AER guidance on how to determine the economically prudent and efficient timing for asset retirement.[7] This process was undertaken for both the central set of assumptions (ie, the central scenario) as well as a range of alternative assumptions for key variables.

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

- a 25 per cent increase/decrease in the assumed network capital costs;
- a lower ($40.5/kWh) and higher ($75.1/kWh) VCR;
- lower and higher assumed risks costs, i.e., avoided reactive maintenance costs and safety risk costs (+/- 30 per cent); and
- a higher (5.5 per cent) and lower (2.34 per cent) discount rate.

Timing analysis indicates the optimal commissioning year depends on the sensitivity modelled. Generally, the optimal commissioning occurs in 2025/26. This indicates the project's optimal timing is robust to a range of conditions. Under the central scenario, the optimal timing for Option 1 occurs in 2025/26.

Figure 5.3 – Option 1's distribution of optimal project commissioning years under each sensitivity



5.4.2 Step 2 – Sensitivity of the overall net market benefit

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

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

- a 25 per cent increase/decrease in the assumed network capital costs;
- at 25 per cent increase/decrease in the assumed planned maintenance costs;
- a lower VCR ($40.5/kWh) and a higher VCR ($75.1/kWh);
- lower and higher assumed avoided unplanned corrective maintenance costs (+/- 30 per cent);
- lower and higher assumed safety risk costs (+/- 30 per cent); and
- a higher/lower discount rate.

[7] AER, *Industry practice application note – Asset replacement planning*, January 2019, p. 37.

The results of the sensitivity test are presented in the table below, showing that Option 1 has positive net market benefits, across all variables investigated.

Table 5.4 - Sensitivity tests parameters

Sensitivity	High sensitivity	Low sensitivity
Demand	Central scenario	
Planned maintenance costs	+25%	-25%
Capital costs	+25%	-25%
VCR	$75.1/kWh (+30%)	$40.5/kWh (-30%)
Discount rate	5.50%	2.34%
Safety risk costs	+30%	-30%
Unplanned corrective maintenance	+30%	-30%

Table 5.5 presents the outcomes from the sensitivity tests on a weighted basis across the three scenarios. On a weighted basis, the overall NPV result remains positive across the broad range of sensitivities tested.

Table 5.5 – Net present value outcome from sensitivity tests under the weighted scenario

Sensitivity	Weighted by scenario
Baseline weighted outcome across scenarios	**6.5**
High capital costs (+25%)	4.4
Low capital costs (-25%)	8.6
High planned maintenance costs (+25%)	6.5
Low planned maintenance costs (-25%)	6.5
High VCR ($75.1/kWh)	10.4
Low VCR ($40.5/kWh)	2.7
High discount rate (5.50%)	2.3
Low discount rate (2.34%)	9.4
High safety risk costs (+30%)	6.9
Low safety risk costs (-30%)	6.1
High unplanned corrective maintenance (30%)	6.7
Low unplanned corrective maintenance (-30%)	6.3

6 Proposed preferred option

Ausgrid considers that Option 1 is the preferred option that satisfies the RIT-D. It involves the replacement of the existing 11 kV double bus switchgear at Milperra ZS with modern equivalent switchgear in an extension to the existing switchroom.

The estimated capital cost of this option is $13.2 million plus decommissioning costs of approximately $0.7 million.

Ausgrid assumes that the necessary construction to replace the existing switchgear would commence as soon as practicable after this RIT-T and end in 2025/26. Once the new installation is complete, ongoing planned maintenance costs at Milperra ZS are expected decrease by approximately $10,000 per annum.

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

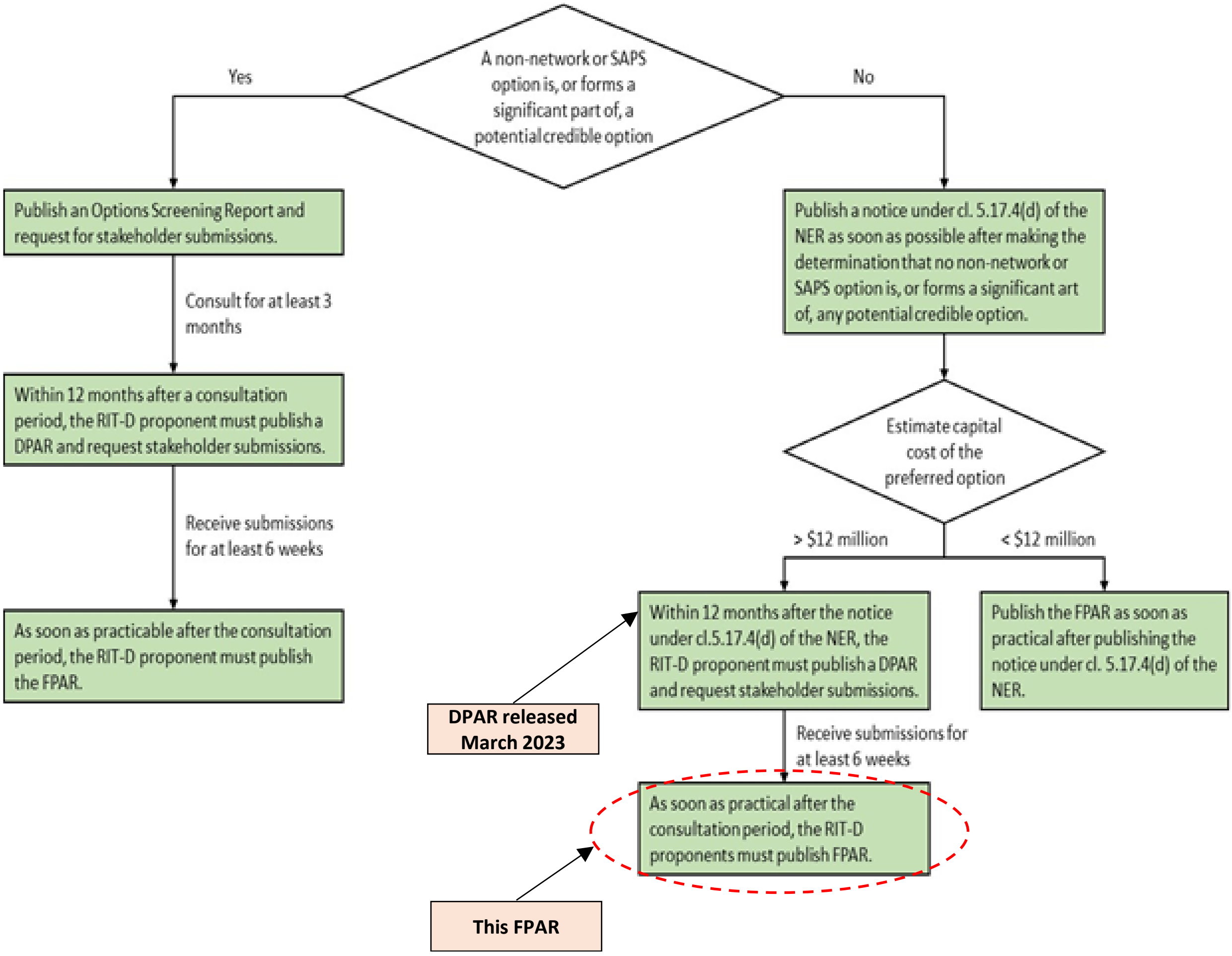
Appendix A – Checklist of compliance clauses

This section sets out a compliance checklist that demonstrates the compliance of this FPAR with the requirements of clause 5.17.4(r) of the National Electricity Rules version 196.

Clause	Summary of requirements	Section in the FPAR
5.17.4(r)	The matters specified as requirements for the draft project assessment report, as outlined below in clause 5.17.4(j).	See below
	A summary of any submissions received on the draft project assessment report and the RIT-D proponent's response to each such submission.	NA
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
	(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	5.2
	(7) a detailed description of the methodologies used in quantifying each class of cost and market benefit	4
	(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 C
	(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 draft 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 – Market benefit classes considered not relevent

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

- changes in the timing of unrelated expenditure;
- changes in voluntary load curtailment;
- changes in costs to other parties;
- changes in load transfer capability and capacity of embedded generators to take up load;
- option value; and
- changes in electrical energy losses.

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 C.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 expenditure	Ausgrid does not expect the project will have any effect on unrelated expenditures in other parts of the network. Accordingly, Ausgrid considers the market benefit from changes in timing of unrelated expenditure is not material.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the National Electricity Market (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	Load transfer capacity between substations is predominantly limited by the high voltage feeders that connect substations. The option under consideration does not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, the option is unlikely to enable embedded generators in Ausgrid's network to be able to take up load given the size and profile of the load serviced by network assets currently considered for replacement. Consequently, Ausgrid has not attempted to estimate any benefits from changes in load transfer capacity and embedded generators.
Option value	Option values 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 have sufficiently flexible to respond to that change. Ausgrid notes that the credible option assessed does not involve stages or any other flexibility and so we do not consider that option value is relevant.
Changes in electrical energy losses	Ausgrid does not expect that the credible option considered will lead to significant changes in network losses and so have not estimated this category of market benefits.

Appendix D – Additional detail on the assessment methodology and assumptions

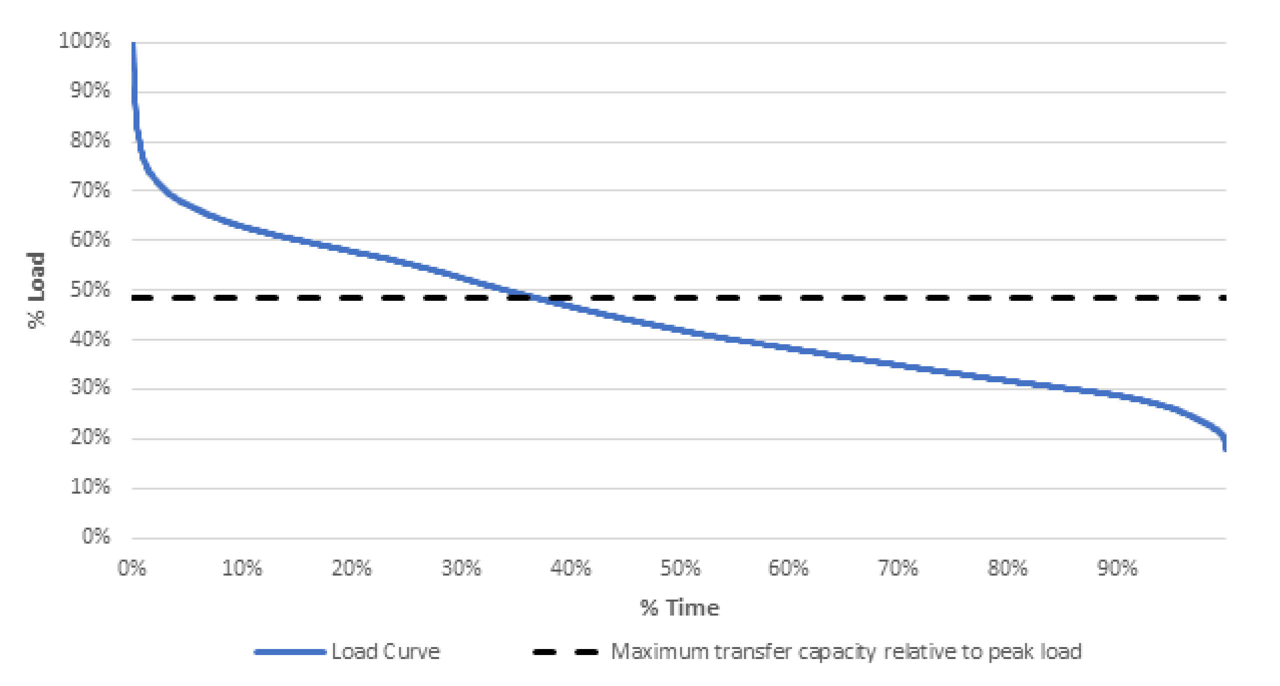
This appendix provides additional detail on key input assumptions that are used in the evaluation of the base case and the credible option.

D.1 Characteristic load duration curve

The load duration curve for Milperra ZS is presented in Figure D.1 below.

It is assumed that the load types supplied by the substation will not change substantially into the future and therefore the load duration curve will maintain their characteristic shape regardless of the zone substation supplying the existing load at Milperra.

Figure D.1 – Load duration curve for Milperra Zone Substation



D.2 Load transfer capacity and supply restoration

Milperra zone substation load area is classified as urban and has 11kV interconnections with the Revesby ZS. In the event of a total loss of supply to Milperra zone substation, approximately 48 per cent of peak load can be recovered within days via the load transfer capacity of the existing 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 D.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**
	Total - MINOR FAILURE	**8.5**

D.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 outage 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.

D.3.1 Availability of 11 kV switchboards

For the purposes of this analysis, failures of 11 kV 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 11 kV switchboards;
- the age of functional failure for Ausgrid's failed switchboards; and
- the age of retirement for Ausgrid's switchboards that were retired before the point of functional failure.

The model has been created to distinguish between 11 kV switchboards that are of differing condition. This assessment was performed using a group of Ausgrid subject matter experts based upon their specialist knowledge of the asset(s) and a review of the available conditional information (i.e. test results). This review assigned switchboards into three specific condition bands: 'Good', 'Average' and Poor'. The Milperra zone substation compound 11 kV switchboard are assigned a condition band of Poor.

The resultant Weibull parameters are given in the table below.

Table D.2: Switchboard parameters for the Weibull analysis

Equipment	Condition	Shape	Scale
Compound insulated 11 kV switchboard	Poor	6.06	90.3

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

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

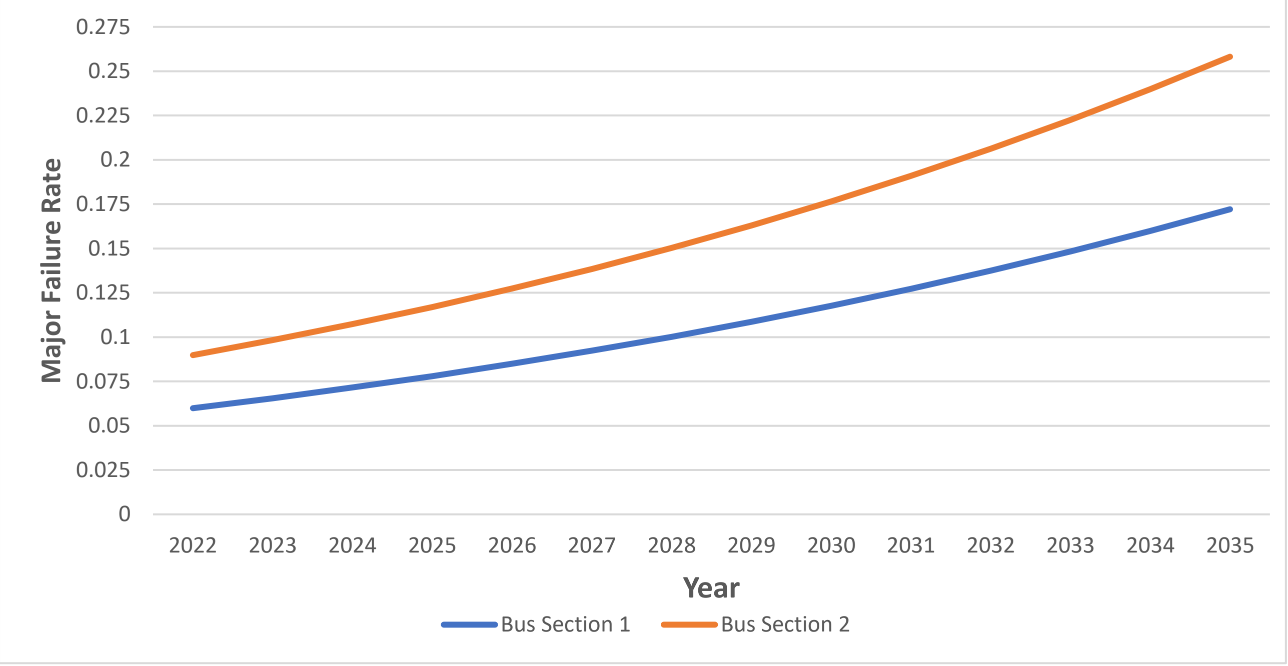
Unavailability is calculated by using a restore time, so the unavailability represents the percentage of time that a particular busbar is not available to supply load. The unavailability (U) of a switchboard is calculated for each year by applying Equation 2:

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

This model is based on the assumption that the condition of a switchboard is dependent upon its age. In order to explore the possibility that each board is in better or worse condition than the population average, lower and upper bounds for U are calculated by either adding or subtracting ten years from the age of each board.

Figure D.2 shows cumulative probability of failure for the 11 kV switchboards at Milperra ZS.

Figure D.2: Cumulative probability of failure – 11 kV switchboards



D.4 Direct costs of equipment failures

For the purposes of evaluating safety impacts, it is assumed that equipment outages have direct costs as per the table below. All costs have been escalated to 2022/23 real dollars for the purposes of this RIT-D.

For switchboard failures, these costs are based on the estimated cost of implementing the contingency plans described above. This cost includes 11kV feeder connections, protection and earthing designs, delivery costs and labour rates.

Transformer replacement costs are based on planning estimates for capital replacements. 33kV reactor, 132kV circuit switch and 132kV gas-insulated switchgear replacement costs are based on high level estimates.

Table D.3: Direct costs of equipment outages

Equipment outage		Direct cost ($)
Transformer/Feeder Panel	Time between failure and access	2,320
	Time to undertake causal analysis	8,000
	Time to engineer solution (T&D Engineering)	8,640
	Time to manufacturer/repair engineered solution	16,800
	Time to implement engineered solution	71,040
	Ancillary Work - testing etc.	70,000
	Return to Service (RTS)	5,120
	Total - MAJOR FAILURE	**181,920**
	Total - MINOR FAILURE	**90,960**

D.5 Calculation of central VCR estimate for Milperra ZS

Table D.4: Breakdown of the central VCR estimate for the Milperra ZS

	Unit	Residential	Small non-residential	Large non-residential (LV)	Large non-residential (HV)
Annual consumption	MWh	54,184	27,233	82,642	13,429
Per cent of annual consumption	%	30.5%	15.3%	46.6%	7.6%
2021 AER VCR estimate	$/kWh	$30.37	$70.84	$61.87	$66.16
2021/22 AER VCR estimate using CPI	$/kWh	$32.57	$75.99	$66.37	$69.94
2022 load-weighted VCR for Milperra	$/kWh	$57.80			

The underpinning assumptions for the calculation of the VCR for Milperra ZS are:

- For residential loads, the VCR is determined by using the postcode of the area (i.e. Revesby, NSW, 2212), which is located under Climate Zone 5 CBD & Suburban NSW, as determined by the AER[8] and adjusted by CPI.
- Small non-residential loads are considered to be small businesses, for which the VCR determined by the AER[9] for commercial small-medium businesses is applied, adjusted by CPI.
- Large non-residential loads (LV) are considered to be a mix of small industrial and large commercial loads. Therefore, an average VCR of those two categories is applied, adjusted by CPI.
- Large non-residential loads (HV) are predominantly large industrial businesses. For this reason, the VCR determined by the AER[12] for large industrial loads is applied, adjusted by CPI.

[8] See AER, Annual update – VCR review final decision – Appendix F – Residential VCR by postcode, December 2021.
[9] See AER, Annual update – VCR review final decision – Appendices A-E – Final decision – Adjusted values, December 2021.

Ausgrid