Addressing reliability requirements in the Mascot load area

DRAFT PROJECT ASSESSMENT REPORT

18 August 2023

Ausgrid

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Addressing reliability requirements in the Mascot load area

Draft Project Assessment Report – August 2023

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Executive Summary

This report represents the application of the RIT-D to options for ensuring reliable supply to the Mascot load area

The Mascot 33/11kV Zone Substation (ZS) is located in the Eastern Suburbs network area and was commissioned in 1946. The substation serves over 7,000 residential and industrial customers, including the Qantas Corporate Precinct and the Equinix Data Centre.

Mascot ZS comprises three groups of 11kV compound insulated switchgear and two groups of 11kV air insulated switchgear configured in a double bus arrangement. Mascot ZS is supplied by six 33kV cables from Bunnerong North Subtransmission Station (STS).

There are increasing reliability and safety risks associated with the aging compound insulated 11kV switchgear at Mascot ZS. The three groups of compound-insulated switchgear consist of Bulk Oil Circuit Breakers (OCBs), which have been in service for over 75 years and are approaching the end of their serviceable lives.

If no corrective action is taken, our planning studies (based on predictive failure modelling) indicate an increasing amount of expected unserved energy (EUE) at Mascot 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. Substantial market benefits are expected to arise from taking action to avoid this EUE. Further, we expect that reliability performance standards would be put at risk if action is not taken, based on the amount of EUE calculated at Mascot ZS.

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.

This Draft Project Assessment Report (DPAR) represents the second step in the application of the RIT-D to options for ensuring reliable electricity supply to the Mascot load area and follows publication of the Options Screening Notice.

The 'identified need' for this RIT-D is to maintain the required level of reliability for customers connected to the Mascot ZS

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)*. Under the license, 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).

These two reliability measures capture two key sources of inconvenience to electricity customers from supply disruptions, i.e., how long their electricity supply is off for as well as how often their electricity supply is off. 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.

While a proportion of load can be transferred to adjacent ZS in the event of a failure, the remaining load would need to be supplied using mobile substations, with an associated interruption to supply. Despite these load transfer and back-up capabilities, our analysis shows that if action is not taken to address the deteriorating condition of the 11kV compound insulated switchgear at Mascot ZS, then the modelled EUE will lead to a breach of these standards going forward. Each of the options assessed in this DPAR provide substantial net market benefits from avoiding this EUE.

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

Three credible network options have been assessed

We have identified and assessed three credible options at part of this DPAR.

Table E.1 – Credible network options assessed, $2023/24

Option	Capital cost (inc. decommissioning)	Expected commissioning
Option 1 – Establish a new Mascot East ZS	$45.3 million	2027/28
Option 2 – Replace compound insulated switchgear with modern equivalent technology	$12.3 million (near-term) $20.1 million (future replacement)	2025/26 2044/45
Option 3 – Retire compound insulated switchgear at Mascot ZS	$11.4 million (near-term) $19.5 million (future replacement)	2025/26 2044/45

The 'near term' costs for Option 2 and Option 3 cover the compound insulated switchgear works, which are the subject of this RIT-D.

The later 'future replacement' costs cover replacing the air insulated switchgear and the 33kV sub-transmission cables (both of which do not currently need replacing) in future under Options 2 and 3. These later costs have been included in the costs for these two options in order to enable a 'like-for-like' comparison with Option 1, which effectively replaces all assets upfront.

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

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

Based on the current load forecasts, and predictive failure modelling at Mascot ZS, Ausgrid has determined that demand management and other non-network options (NNOs), as well as stand-alone power systems (SAPS), are unable to assist in meeting the identified need for this RIT-D. This is due to the relatively low near-term cost of the preferred network option (and hence the reduced value of deferring this investment), as well as the significant amount of EUE that needs to be avoided, compared to the base case.[3]

Ausgrid has therefore separately published a screening notice outlining the reasons why NNOs and SAPS are unable to assist in meeting the identified need for this RIT-D.

Three different scenarios have been modelled to deal with uncertainty

Ausgrid has assessed three alternative future scenarios for this RIT-D, namely:

- Scenario 1: central scenario – the central scenario consists of load assumptions that reflect Ausgrid's central demand forecast (based on the 2022 ISP Step Change scenario) and central risk cost estimates. In Ausgrid's opinion, this provides the most likely scenario;
- Scenario 2: low scenario – Ausgrid has adopted a scenario which reflects lower demand forecasts and lower risk costs, to represent a conservative future state of the world with respect to potential market benefits that could be realised under the credible option; and
- Scenario 3: high scenario – this scenario reflects higher than anticipated demand load at Mascot ZS, and higher risk costs, which investigates a state of the world which would have higher market benefits.

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

[3] We note that this differs from the assessment undertaken earlier as part of the 2019 RIT-D for Mascot ZS, when demand conditions were different, which is discussed in section 1.1.

Table E.2 – Summary of the three scenarios investigated

Variable	Scenario 1 – central scenario	Scenario 2 – low scenario	Scenario 3 – high scenario
Demand	POE50 2022 Step Change	POE90 2022 Step Change	POE10 2022 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	$63.37/kWh across all scenarios		
Discount Rate	3.44% across all scenarios		

While we note that AEMO has recently released its final 2023 IASR for the 2024 ISP, which contains updated scenarios and assumptions, the three demand forecasts used in this DPAR draw on the scenarios developed and consulted on for the 2022 ISP given the timing of the 2023 IASR release (28 July 2023). The NPV assessment undertaken in this DPAR shows that the preferred option is not sensitive to the three different demand forecasts used. We intend to review the scenarios in the final 2023 IASR further and consider whether to update the analysis in the forthcoming FPAR to draw directly on them.

Option 2 is the preferred option at this draft stage

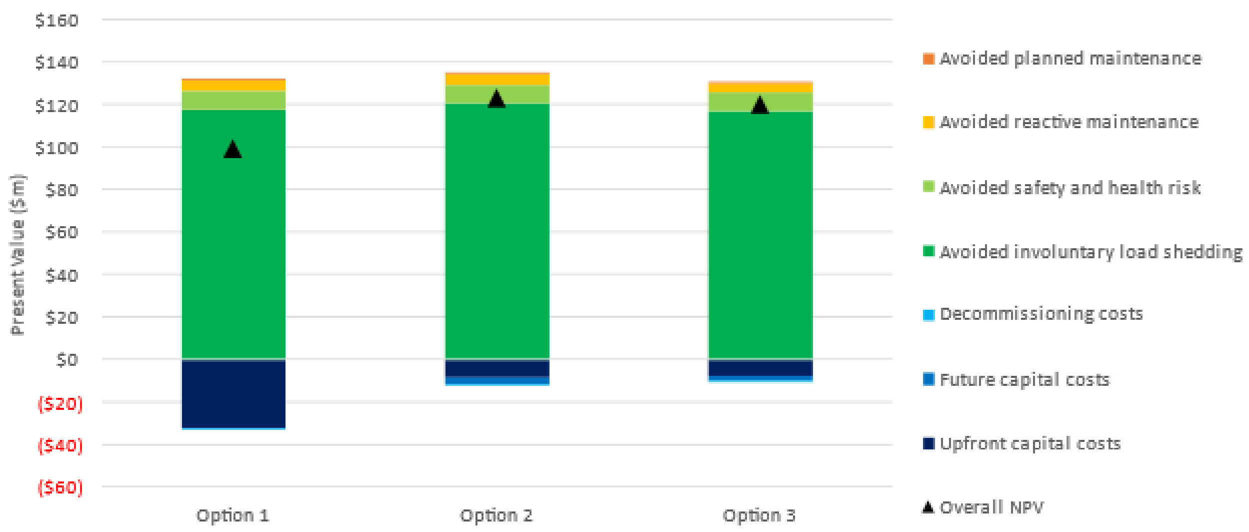
Ausgrid has identified Option 2 as the preferred option at this draft stage since it results in the greatest estimated net market benefits of the three options and satisfies the RIT-D requirements. Ausgrid is the proponent for Option 2.

Table E.3 – Summary of NPV assessment on a weighted basis across the scenarios ($m)

Option	NPV	Rank
Option 1	98.7	3
Option 2	**122.4**	**1**
Option 3	119.6	2

Figure E.1 below shows the present value of cost and benefit components (as well as headline NPVs), weighted across the three scenarios. Most of the expected benefits arise from a reduction in EUE compared to the base case.

Figure E.1 – Present value of costs and benefits weighted across the three scenarios ($m)



The replacement of switchgear under Option 2 will result in substantial market benefits from avoided EUE that would otherwise arise if no action were taken, with secondary benefits including reduced planned and unplanned maintenance costs, and reduced safety risk costs.

While Option 2 and Option 3 have a similar estimated net market benefit, Option 3 does not provide the same capacity for future expansion, if required, due to retiring the three groups of 11kV compound-insulated switchgear. This benefit of Option 2 over Option 3 has not been quantified in the analysis but serves to further support the conclusion that Option 2 is the preferred option.

The total capital cost associated with this option is $32.3 million[4], comprising:

- approximately $12.3 million upfront to replace the aging compound insulated switchgear by 2025/26 (which includes $0.7 million in decommissioning costs); and
- approximately $20.1 million in future capital costs associated with the replacement of air insulated switchgear and 4x33kV sub-transmission cables in 20 years' time (commissioned in 2044/45).

The effective capital cost in the short-term is the $12.3 million upfront to replace the aging compound insulated switchgear. The later works to replace the air insulated switchgear and 4x33kV sub-transmission cables in approximately 20 years' time is expected to have a separate RIT-D applied to it, closer to the time, in order to confirm that it remains the preferred option.

Routine operating costs are expected to average approximately $81,000 per year over the assessment period (approximately 0.3 per cent of capital expenditure per year).

Ausgrid intends to issue statutory notifications to the Bayside City Council within the next three months, once civil design works are progressed to a point where a detailed program of work can be finalised. Given that the majority or works will be contained within existing buildings at the substation site, the impact to the community is expected to be minimal.

How to make a submission and next steps

This DPAR represents the second step in the application of the RIT-D to options for ensuring reliable electricity supply to the Mascot load area and follows the publication of the Options Screening Notice. Ausgrid welcomes written submissions on this DPAR. Submissions are due on 29 September 2023 and should be addressed to:

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

Or

email to: assetinvestment@ausgrid.com.au

Submissions will be published on the Ausgrid website. If you do not want your submission to be publicly available, please clearly stipulate this at the time of lodgement.

The next step of this RIT-D involves publication of a Final Project Assessment Report (FPAR). The FPAR will update the assessment of the net benefit associated with different investment options, in light of any submissions received on this DPAR. Ausgrid intends to publish the FPAR as soon as practicable after submissions are received on this DPAR.

[4] Numbers do not add precisely due to rounding.

1 Introduction

This Draft Project Assessment Report (DPAR) has been prepared by Ausgrid and represents the second step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply to the Mascot network area. It follows publication of the Options Screening Notice for this RIT-D.

The Mascot Zone Substation (ZS) is located in the Eastern Suburbs network area and was commissioned in 1946. The substation serves over 7,000 residential and industrial customers, including the Qantas Corporate Precinct and the Equinix Data Centre. Mascot ZS is a 33/11kV substation, comprising three groups of 11kV compound insulated switchgear and two groups of 11kV air insulated switchgear configured in a double bus arrangement.

There are increasing reliability and safety risks associated with the aging compound insulated 11kV switchgear at Mascot ZS. The three groups of compound-insulated switchgear consist of Bulk Oil Circuit Breakers (OCBs) that have been in service for over 75 years and are approaching the end of their serviceable lives.

The switchgear remains original (i.e., commissioned in 1946) and failure rates for switchgear are expected to increase with age. If no corrective action is taken, our planning studies (based on predictive failure modelling) indicate the potential for substantial expected unserved energy (EUE) in the future, as well as increasing safety risks and reactive maintenance costs associated with having to repair and restore service in the event of equipment failure. Further, we expect that reliability performance standards would be put at risk if action is not taken.

Ausgrid is therefore undertaking a RIT-D to assess options for addressing the risk that the existing ageing 11kV switchgear poses and to ensure we continue to satisfy our reliability and performance standards and deliver benefits for customers. Each of the options assessed in this DPAR provide substantial net market benefits from avoiding EUE if action is not taken.

Ausgrid has determined that non-network and 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 The Mascot ZS was subject to an earlier 2019 RIT-D, which was not progressed

In September 2019, Ausgrid commenced a RIT-D through publishing a non-network options report (NNOR) to investigate the potential for demand management solutions to alleviate constraints associated with aging switchgear condition issues at Mascot ZS. Ausgrid received several inquiries from interested parties, however, due to a change to the preferred network option to one that was much lower in capital cost shortly following receiving the NNOR submissions the business case for non-network options became no longer viable.

At the time, Ausgrid was able to reduce the load at Mascot ZS by transferring loads to the nearby Green Square ZS. As a result, the peak load at Mascot was reduced from 52MVA in summer 2018/19 to 35MVA in summer 2020/21. Whilst these works were conceived as a risk mitigation measure capable to defer the construction of a new zone substation, which was the preferred network solution at the time, it was realised that such load transfers could become permanent due to lower demand forecasts, bringing an opportunity to consider other network solutions. Therefore, the RIT-D that commenced in 2019 did not progress further.

1.2 Non-network and SAPS options are not expected to assist with the identified need

Based on the current load forecasts and predictive failure modelling at Mascot ZS, Ausgrid has determined that demand management and other non-network options (NNOs), as well as stand-alone power systems (SAPS), are unable to assist in meeting the identified need for this RIT-D. This is due to the relatively low near-term cost of the preferred network option (and hence the reduced value of deferring this investment), as well as the significant amount of EUE that needs to be avoided, compared to the base case.

Ausgrid notes that the preferred option has changed since the earlier 2019 NNOR, and has a much lower cost, as it now reflects the replacement of the compound insulated switchgear only, rather than a greenfield development of a new ZS.

Ausgrid has separately published a screening notice outlining the reasons why NNOs and SAPS are unable to assist in meeting the identified need for this RIT-D.

1.3 Role of this draft report

Ausgrid has prepared this DPAR in accordance with the requirements of the NER under clause 5.17.4. It is the second stage of the RIT-D process set out in the NER.

The purpose of the DPAR 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 at this draft stage.

The next (and final) stage of this RIT-D involves publication of a Final Project Assessment Report (FPAR). The FPAR will update the quantitative assessment of the net benefit associated with the investment options, in light of any submissions received on this DPAR. The entire RIT-D process is detailed in Appendix B.

1.4 Submissions and quieries

Ausgrid welcomes written submissions on this DPAR. Submissions are due on 29 September 2023 and should be addressed to:

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

Or

email to: assetinvestment@ausgrid.com.au

Submissions will be published on the Ausgrid website. If you do not want your submission to be publicly available, please clearly stipulate this at the time of lodgement.

2 Description of the identified need

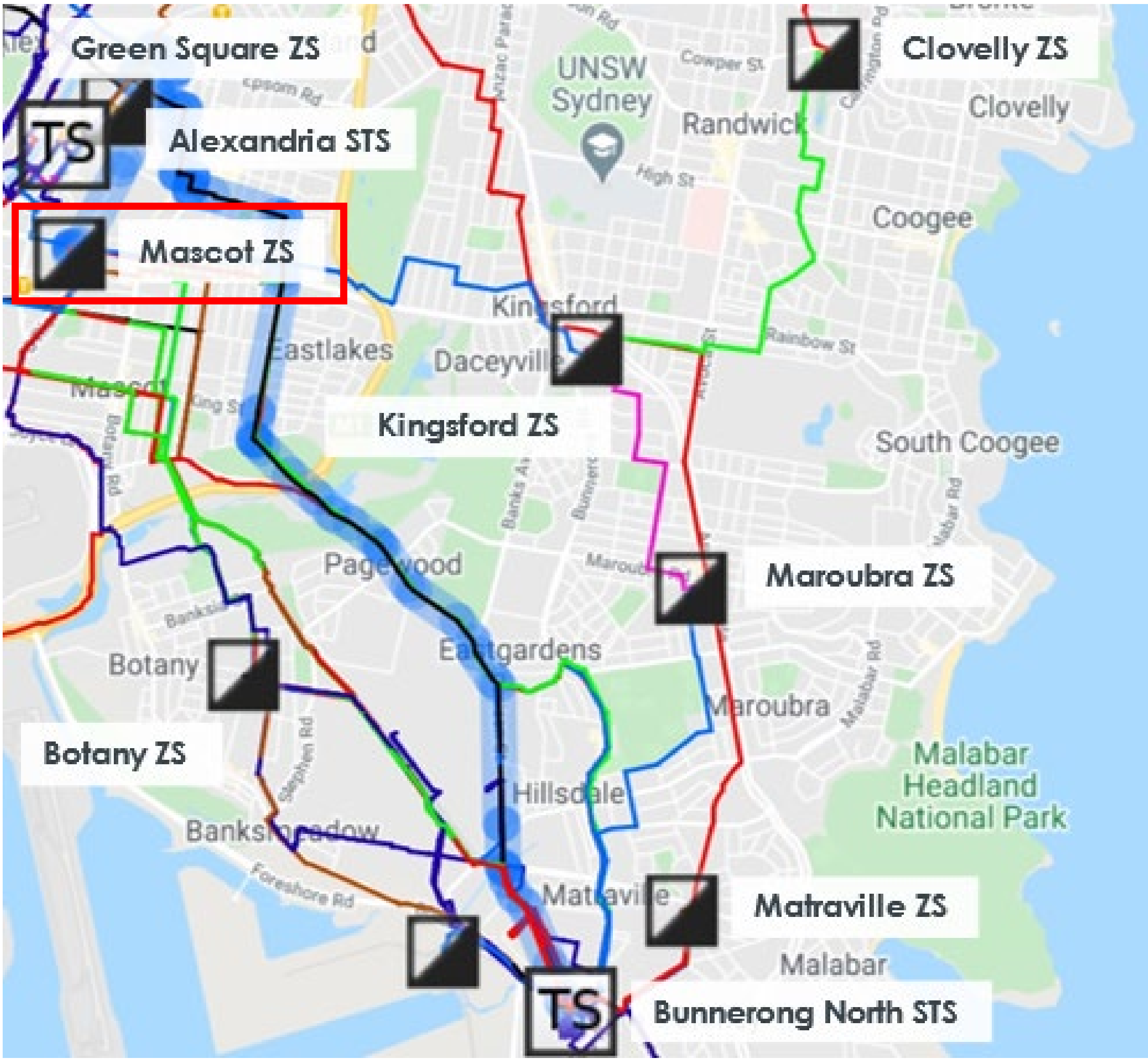
This section provides a description of the network area and the 'identified need' for this RIT-D, before presenting a number of key assumptions underlying the identified need.

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

The Mascot ZS is located in the Eastern Suburbs network area and was commissioned in 1946. The substation serves over 7,000 residential and industrial customers, including the Qantas Corporate Precinct and the Equinix Data Centre.

Figure 2.1 below illustrates where the Mascot ZS sits in the wider Eastern Suburbs network area.

Figure 2.1 – Mascot network area



Mascot is a summer peaking substation. Peak load reached 52 MVA in 2018/19. Peak load has subsequently reduced to 35 MVA following the load transfer to the nearby Green Square ZS as a risk mitigation measure in 2020/21.

Figure 2.2 below provides an overview of the Mascot ZS site. The substation is situated within a predominantly industrial area.

Figure 2.2 – Overview of Mascot ZS site

Mascot ZS comprises three groups of 11kV compound insulated switchgear and two groups of 11kV air insulated switchgear configured in a double bus arrangement. Mascot ZS is supplied by six 33kV cables from Bunnerong North Subtransmission Station (STS), which can be seen in Figure 2.1 on page 9.

There are increasing reliability and safety risks associated with the aging compound insulated 11kV switchgear at Mascot ZS. The three groups of compound-insulated switchgear consist of Bulk Oil Circuit Breakers (OCBs), which have been in service for over 75 years and are approaching the end of their serviceable lives.

The OCBs at Mascot ZS are the last remaining group of 11kV OCBs that remain in operation in Ausgrid's network. Ausgrid has implemented a strategy to replace all OCBs with Vacuum Circuit Breakers (VCBs) to extend the service life of compound insulated switchgear. However, due to the site configuration at Mascot ZS, this solution is not technically feasible at Mascot ZS without extensive design work.

If no corrective action is taken, our planning studies (based on predictive failure modelling) indicate an increasing amount of EUE at Mascot 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. Further, the failure rates for this type of switchgear are expected to increase with age.

In the event of failure, a proportion of load can be transferred to adjacent zone substations, but the remaining load would need to be supplied using mobile substations with an associated interruption to supply. 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.

In addition to the increasing EUE at Mascot ZS, there are increasing safety risks associated with the bituminous compound of the busbars and OCBs, which can act as a fuel source in the event of failure, as well as increasing unplanned maintenance costs in the event of equipment failure.

2.2 Summary of the 'identified need'

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)*. Under the license, reliability and performance standards are expressed in two measures:

- SAIDI[5] – 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[6] – 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).

These two reliability measures capture two key sources of inconvenience to electricity customers from supply disruptions, i.e., how long their electricity supply is off for as well as how often their electricity supply is off. 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.

The main concern relates to increasing customer supply risks derived from the condition of the 11kV compound insulated switchgear at Mascot ZS. If action is not taken to address the deteriorating condition of this equipment, then the analysis shows that the unserved energy modelled will put performance standards at risk.

By addressing reliability concerns from the aging compound insulated switchgear, the investment will deliver material net market benefits for customers from a reduction in EUE.

2.3 Key assumptions underpinning the identified need

This section summarises the key assumptions 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

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.

[5] System Average Interruption Duration Index.
[6] System Average Interruption Frequency Index.

Ausgrid's probabilistic model anticipates increasing deterioration of the asset condition and significant levels of involuntary load shedding. As the compound insulated switchboard has been in service for longer than 75 years, it is at the higher end of the predicted failure rate projections.

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.

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 the 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 Mascot ZS by switching to adjacent zone substations such as Green Square, Botany and St Peters. However, 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.

In 2020, Ausgrid transferred approximately 20MVA of load from Mascot ZS to Green Square ZS to reduce the amount of load supplied by the compound insulated 11kV switchgear as a risk mitigation measure. However, other loads in the area are now connected to Green Square ZS and therefore further permanent load transfers are no longer viable, under the current network configuration.

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.

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 insulated switchboards.

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 4 per cent of the present value of the expected benefits under the central scenario in this DPAR).

3 Three credible options have been assessed

This section provides details of the credible options that Ausgrid has identified as part of its network planning activities. All costs and benefits presented in this DPAR are in $2023/24, unless otherwise stated.

3.1 Option 1 – Establish a new Mascot East Zone Substation

Option 1 involves establishing a new Mascot East ZS at an alternative location and decommissioning the current Mascot ZS. The technical scope of this option includes:

- establishment of a new 132/11kV zone substation to be named Mascot East;
- load transfers from Mascot ZS to Mascot East ZS; and
- decommissioning of Mascot 33/11kV ZS and 33kV paper insulated lead covered feeders.

Although this option would address condition issues associated with all equipment at Mascot ZS, the compound-insulated switchgear is the only asset requiring corrective action at this time. Ausgrid estimates that the air insulated switchgear and 33kV sub-transmission cables at the existing Mascot ZS will need to be replaced in approximately 20 years. These replacement works have been evaluated as part of the NPV assessment, i.e., as a future cost to be incurred under Options 2 and 3 which is not required under Option 1.

Option 1 resolves essentially all EUE risk associated with switchgear at Mascot ZS. By comparison, under Option 2 and Option 3, a small level of residual network risk remains following the commissioning of the option, due to the risk associated with the existing air-insulated switchgear at Mascot ZS and double banking of some of the feeders in 11kV panels.

It is assumed that the cost of property acquisition for the new site and remediation of the existing site is equivalent to the proceeds from the sale of the existing site (i.e., the NPV of property is zero).

Commissioning of Mascot East ZS under this option is anticipated by 2027/28, with a consequent reduction in EUE, safety risk and unplanned maintenance from this point forward.

The capital cost of this option is approximately $45.3 million, including $1.4 million in decommissioning costs (incurred between 2026/27 and 2027/28) to decommission Mascot ZS. Routine operating costs under Option 1 are expected to be around $41,000 per year (approximately 0.1 per cent of capital expenditure).

3.2 Option 2 – Replace compound insulated switchgear with modern equivalent technology

Option 2 involves replacing the compound-insulated switchgear with a modern equivalent technology, utilising an empty area at Mascot ZS for the new switchgear equipment. The technical scope of this option (in the near-term) includes:

- civil works within the existing switchroom building to support switchgear installation;
- installation of 11kV switchgear using modern equivalent technology, comprising two section of single bus switchgear and 13 switchgear panels;
- transfer of loads from the existing 11kV compound-insulated switchgear and 11kV connections to existing air insulated switchboards;
- secondary system upgrades; and
- decommissioning and removal of redundant 11kV compound-insulated switchboards, control panels and transformers from the site.

As noted above, a small level of residual network EUE risk remains under Option 2 until the replacement of the air-insulated feeders (and the 33kV sub-transmission cables) in 2044/45. Residual EUE risk has been modelled as part of the NPV assessment.

Ausgrid has incorporated the future capital costs associated with the replacement of air-insulated switchgear (and the 33kV sub-transmission cables[7]) in approximately 20 years' time as part of the NPV assessment. The inclusion of the costs for future works ensures that the RIT-D accounts for all costs incurred under Option 2 and enables a 'like-for-like' comparison with Option 1 (since condition issues are entirely resolved with the substation replacement under Option 1).

[7] Under Option 2, the ZS will be reduced to a 4-transformer arrangement. In the future, we will have to replace the 33kV subtransmission cables connected to these transformers (i.e., 4x33kV feeders).

Commissioning for the near-term works in Option 2 is expected by 2025/26 with decommissioning of the existing OCB switchboards also occurring in 2025/26.

The near-term capital cost associated with this option is $12.3 million, comprising:

- approximately $11.6 million in the near-term to replace the aging compound-insulated switchgear; and
- $0.7 million in decommissioning costs associated with decommissioning the existing compound-insulated switchgear in 2025/26.

There is also approximately $20.1 million in future capital costs under Option 2 associated with the replacement of air insulated switchgear and the 33kV sub-transmission cables in 20 years' time (commissioned in 2044/45).

Routine operating costs associated with this option are expected to average approximately $81,000 per year over the assessment period (approximately 0.3 per cent of capital expenditure per year).[8]

3.3 Option 3 – Retire compound insulated switchgear at Mascot ZS

Option 3 involves retiring the three groups of compound-insulated switchgear at Mascot ZS, transferring load to the nearby Green Square ZS, and retaining the air-insulated switchgear in their current configuration (as under Option 2). This option also involves installing 11kV feeders to transfer 11kV loads to Green Square ZS.

Specifically, the technical scope of this option in the short-term includes:

- Installation of approximately 1,800m of new ductlines along Gardeners, Botany, Doody and O'Riordan roads, including cable installation and joints;
- Transfer of loads from 11kV compound-insulated switchboards to Green Square ZS;
- minor works at Mascot ZS to connect the remaining two groups of air-insulated 11kV switchgear, including an additional circuit breaker and bus-tie cable installations; and
- decommissioning and removal of three groups of redundant 11kV compound-insulated switchboards, control panels and associated transformers from the site

While this option is similar in cost to Option 2, a marginally higher amount of EUE risk remains since the load transfers remove the number of 11kV feeder panels in this part of the network. In addition, as with Option 2, a small level of residual network EUE risk also remains under Option 3 until the replacement of air-insulated feeders (and the 33kV sub-transmission cables) in 2044/45. All residual EUE risk has been modelled as part of the NPV assessment.

As with Option 2, Ausgrid has incorporated the future capital costs associated with the replacement of air-insulated switchgear (and 33kV sub-transmission cables[9]) in approximately 20 years' time as part of the NPV assessment. The inclusion of the costs for future works ensures that the RIT-D accounts for all costs incurred under Option 3 and enables a 'like-for-like' comparison with Option 1 (since condition issues are entirely resolved with the substation replacement under Option 1).

Commissioning for the near-term works in Option 3 is expected by 2025/26, with decommissioning of the existing OCB switchboards also occurring in 2025/26.

The near-term capital cost associated with this option is $11.4 million, comprising:

- approximately $10.7 million to retire the existing compound insulated switchgear at Mascot ZS and implement load transfers to adjacent zone substations; and
- approximately $0.7 million in decommissioning costs associated with the existing switchboards incurred in 2025/26.

There is also approximately $19.5 million in future capital costs for Option 3 associated with the replacement of air insulated switchgear and the 33kV sub-transmission cables in 20 years' time (commissioned in 2044/45).[10]

Routine operating costs associated with this option are expected to average approximately $81,000 per year over the assessment period (approximately 0.3 per cent of capital expenditure per year).

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[8] Operating costs have been estimated for all options as a percentage of total capital costs.

[9] Under Option 3 three transformers would be retired from ZS, reducing the site to a 3-transformer arrangement. In the future, we will have to replace the 33kV subtransmission cables connected to these remaining transformers (i.e., 3x33kV feeders).

[10] Ausgrid notes this cost differs slightly (approximately 3 per cent) from the cost of future works estimated for Option 2 owing to a different network configuration associated with future replacement works of transformers and feeders (as outlined in earlier footnotes).

3.4 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 options.

Table 3.1 – Options considered but not progressed

Option	Description	Reason why option was not progressed
Replace all OCBs with Vacuum Circuit Breakers (VCBs)	Replace OCBs with VCBs to extend the service life of compound insulated switchgear (as has been done elsewhere in the network)	Due to the site configuration at Mascot ZS, this solution requires extensive design work to accommodate VCBs in the existing arrangement. The additional cost of the design work is expected to be substantive and will not remove a significant component of the network risk, as the compound-insulated busbars will remain in service. This option could defer the replacement considered under Option 2 by approximately 5-10 years, but significant costs will be incurred while the EUE risk is not materially removed. Therefore, this option is considered not economically feasible.
Replace the air-insulated switchboard in the scope of Option 2 and Option 3	Replace the air-insulated 11kV switchboard at Mascot ZS at the same time as the upfront compound-insulated switchboard replacement works	The air-insulated switchboard at Mascot ZS is in better condition than the compound-insulated switchboards and is not expected to require replacement for another 20 years. Potential cost savings/efficiencies from doing both works at once cannot be compensated with a corresponding increase in benefits. Therefore, this is considered a suboptimal option.
Retirement of Mascot ZS	Transfer of all 11kV load from Mascot ZS to adjacent zone substations	The existing 11kV loads cannot be fully accommodated in adjacent zone substations such as Green Square, Botany, St Peters and/or Zetland, as there is no adequate spare capacity available. If implemented, the cost would be significant, as it would require network augmentations at some of these adjacent substations. Therefore, this option is considered not economically feasible.
Brownfield replacement of Mascot ZS	Replace all 11kV switchgear equipment on the existing site and replace existing 33kV feeders originated from Bunnerong North STS with new 33kV feeders from nearby Alexandria STS.	This project requires staging to replace sections of the 11kV switchgear, and therefore will take considerably longer than a greenfield replacement (i.e., New Mascot East under Option 1) to be completed. In addition, the brownfield replacement is expected to be more expensive than the greenfield replacement, requiring significant design/development work due to the complexity of working near energised electrical equipment. The combination of greater capital costs requirements and a longer delivery timeframe will provide a suboptimal solution when compared to a greenfield replacement, as the benefits would be the same but likely to take at least two years longer to be realised.

Option	Description	Reason why option was not progressed
Non-network options	Using non-network solutions either in combination with, or in-place of, a network option.	Ausgrid has considered how demand management could defer the timing of the preferred network solution and whether the EUE 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 EUE that the identified network option allows to be avoided, compared to the 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 options have been assessed

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

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 11kV switchgear in service (i.e., no change). This involves escalating regular and reactive maintenance activities 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 25-year period, from 2023-24 to 2047-48. Ausgrid considers that a 25-year period takes into account the size, complexity and expected life of the relevant credible options to provide a reasonable indication of the market benefits and costs of the options. The 25-year assessment period is five years longer than the typical assessment period Ausgrid applies for these types of investments and has been selected to capture the future costs under Options 2 and 3 associated with replacing the air insulated switchgear (and 33kV sub-transmission cables) at Mascot ZS in 20 years' time (which are avoided under Option 1).

Where the capital components of the credible options have asset lives greater than 25 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 25-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.

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.[11] This is approximately 32% lower than the central discount rate assumption. For the upper bound discount rate sensitivity, a value of 7.0% is adopted to align with the central estimate prepared and consulted on by AEMO as part of preparing the 2023 Inputs, Assumptions and Scenarios Report.[12]

4.2 Ausgrid's approach to estimating project costs

Ausgrid has estimated capital costs by considering the scope of works necessary under the credible options 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 2023-24, 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 options 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 options reduce the incidence of asset failures relative to the base case, and hence the expected operating and maintenance costs associated with restoring supply.

[11] 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).

[12] AEMO, *2023 Inputs, Assumptions and Scenarios Report*, Final report, July 2023, p 123.

To ensure a like-for-like comparison between Option 1 (all ZS condition issues are resolved upfront) and Options 2 and 3 (only compound insulated switchgear condition issues are resolved upfront), Ausgrid has included the cost of future works at Mascot in the assessment of Option 2 and Option 3. Specifically, the cost of future capital works to replace the air insulated switchgear (and 33kV sub-transmission cables) at Mascot ZS has been incorporated into the assessment undertaken as part of this RIT-D.

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.

While the three options also treat the future replacement of air insulated switchgear and the 33kV sub-transmission cables differently, these replacement works have been included on the cost-side for Option 2 and Option 3 to enable a 'like-for-like' comparison with Option 1 (as opposed to as a separate market benefit for each option).

The approach Ausgrid has adopted to estimating reductions in EUE are 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 options, relative to the base case, results in a positive contribution to market benefits of the credible options 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 $63.37/kWh, reflecting a load weighted value for the affected load at Mascot ZS calculated using the NSW VCR estimates (for residential, commercial and industrial load) derived by the AER in its VCR Final Report.[13] 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.[14]

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 2022 ISP Step Change scenario;
- the low forecast reflects POE90 demand from AEMO's 2022 ISP Step Change scenario; and
- the high forecast reflects POE10 demand from AEMO's 2022 ISP Step Change scenario.

While we note that AEMO has recently released its final 2023 IASR for the 2024 ISP, which contains updated scenarios and assumptions, the three demand forecasts used in this DPAR draw on the scenarios developed and consulted on for the 2022 ISP given the timing of the 2023 IASR release (28 July 2023). The NPV assessment undertaken in this DPAR shows that the preferred option is not sensitive to the three different demand forecasts used. We intend to review the scenarios in the final 2023 IASR further and consider whether to update the analysis in the forthcoming FPAR to draw directly on them.

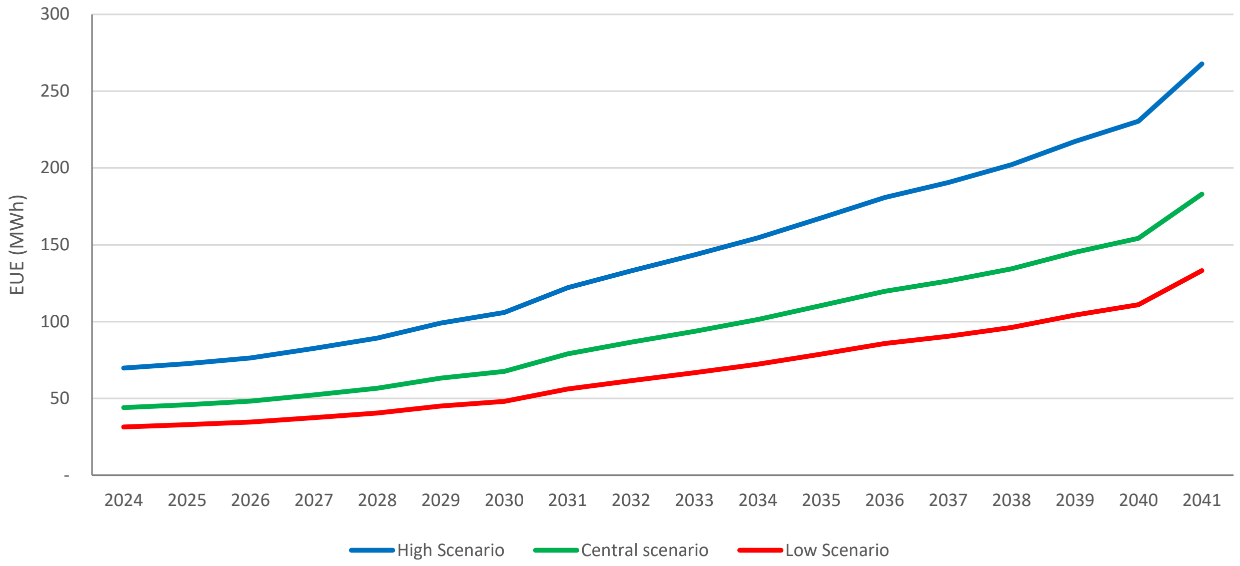
The figure below shows the assumed levels of EUE, under each of the three underlying demand forecasts investigated over the next 25 years. For clarity, this figure illustrates the MWh of unserved energy prior to any replacement of the 11 kV

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

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

switchgear, taking into consideration the underlying demand forecasts and the assumed failure rates associated with keeping the existing network assets in service.

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



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:

- central scenario – the central scenario consists of load assumptions that reflect Ausgrid's central set of demand estimates, 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 2022 ISP Step Change scenario.
- 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 options. The low demand load forecast comprises POE90 demand conditions from AEMO's 2022 ISP Step Change scenario; and
- high scenario – this scenario reflects higher than anticipated demand load at Mascot 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 2022 ISP 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 (i.e., the discount rate and capital costs) have been investigated in the sensitivity analysis.

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 2022 Step Change	POE90 2022 Step Change	POE10 2022 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	$63.37/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.

For the weighted case, Ausgrid has weighted the scenarios equally since the scenarios reflect three equally probable 'future states of the world'. Ausgrid notes that the NPV outcome is positive across all three scenarios and the ranking of the preferred option is invariant to the weighting applied, i.e., the preferred option ranks highest across all three scenarios modelled.

5 Assessment of the credible options

This section provides the outcome of the NPV assessment of the credible network options. The options are compared against the base case 'do nothing' option.

5.1 Gross market benefits estimated for the credible options

The table below summarises the gross market benefit of the credible options relative to the base case in present value terms. The gross market benefit for the options compared to the 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 options relative to the base case, $m 2023/24

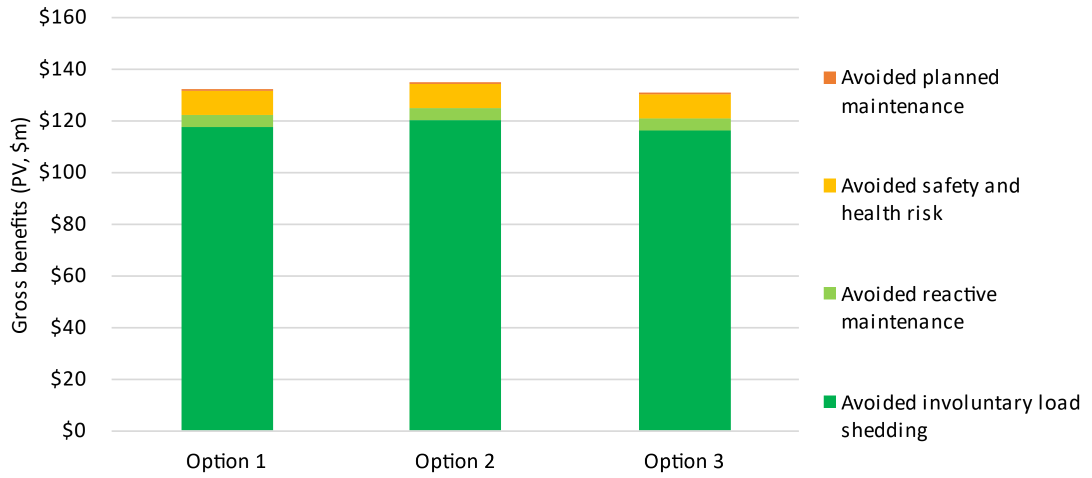
Option	Central scenario	Low scenario	High scenario	Weighted benefits
Scenario weighting	1/3	1/3	1/3	
Option 1	123.8	89.0	182.9	131.9
Option 2	125.5	89.2	187.8	134.2
Option 3	121.6	85.5	183.7	130.3

The primary benefit is avoided EUE, comprising approximately 89 per cent of total benefits on average, 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 11 per cent, combined, of gross benefits on a present value basis).

Option 2 demonstrates the greatest estimated gross benefits across all scenarios, and on a weighted basis owing to its earlier commissioning date (compared to Option 1) and higher avoided EUE (compared to Option 3).

Figure 5.1 – Breakdown of gross benefits of the credible options relative to the base case weighted across scenarios, $m 2023/24



5.2 Estimated costs for the credible options

The costs for each option include the capital costs (including future replacement works of other substation components, where appropriate) and decommissioning costs. Avoided planned maintenance costs are reflected as a benefit (in section 5.1) since operating costs are reduced under the option case in comparison to the base case.

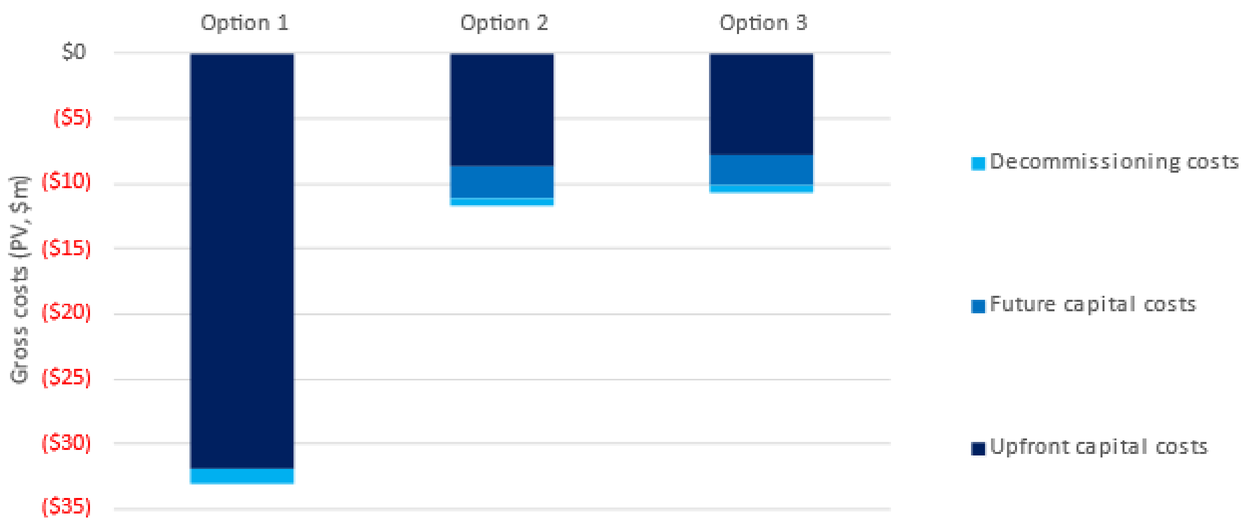
The table below summarises the capital cost of the credible options across the three scenarios and on a weighted basis, in present value terms. The capital cost for each option does not vary across the three scenarios, or on a weighted basis. Variations in the capital costs have been tested as a sensitivity.

Table 5.2 – Present value of costs of the credible options relative to the base case, NPV $m 2023/24

Option	Central scenario	Low scenario	High scenario	Weighted costs
Scenario weighting	1/3	1/3	1/3	
Option 1	33.1	33.1	33.1	33.1
Option 2	11.8	11.8	11.8	11.8
Option 3	10.7	10.7	10.7	10.7

Figure 5.2 below presents the costs for each option in present value terms and demonstrates that most of the costs relate to capital expenditure to commission the proposed options in the near term.

Figure 5.2 - Breakdown of gross costs of the credible options relative to the base case, $m 2023/24



5.3 Net present value assessment outcomes

The table below summarises the net market benefit in NPV terms for the credible options under each scenario. The net market benefit is the gross 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.

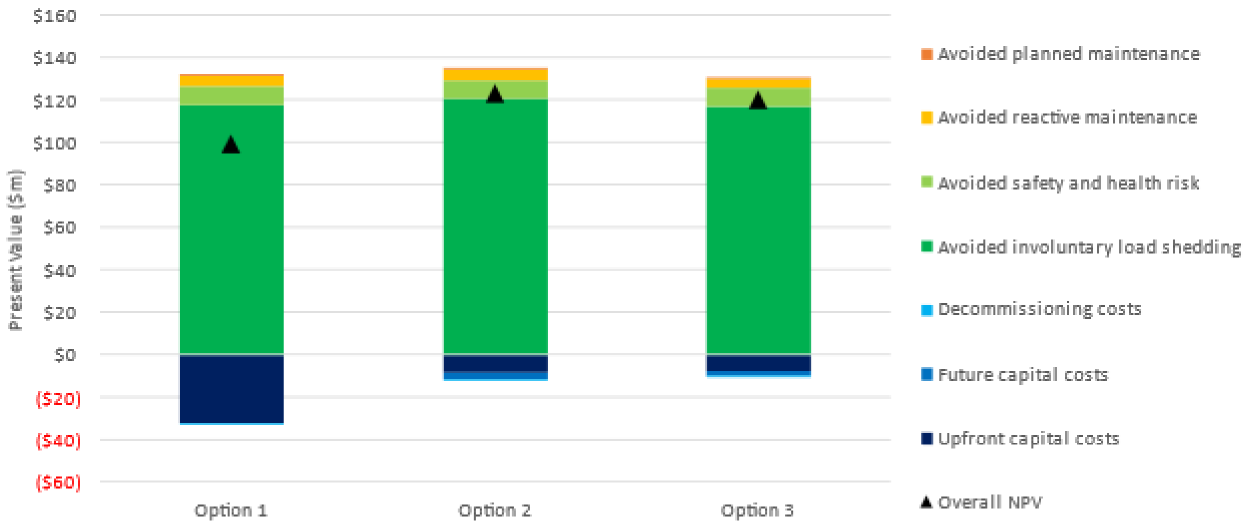
The net market benefit is positive across the three scenarios, and on a weighted basis, and ranges from approximately $98.7 million to $122.4 million across the options on a weighted basis. Option 2 has the greatest estimated net market benefits of all options across each of the scenarios investigated.

Table 5.3 – Present value of benefits relative to the base case by scenario and weighted, $m 2023/24

Option	Central scenario	Low scenario	High scenario	Weighted	Rank
Scenario weighting	1/3	1/3	1/3		
Option 1	90.7	55.8	149.7	98.7	3
Option 2	**113.7**	**77.4**	**176.1**	**122.4**	**1**
Option 3	110.9	74.8	173.0	119.6	2

Figure 5.3 presents a breakdown of net present costs and benefits across the three scenarios, and on a weighted basis.

Figure 2.3 - Present value of benefits and costs by scenario, $m 2023/24



5.4 Sensitivity analysis results

Ausgrid has undertaken a 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 options

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.[15] This process was undertaken for both the central set of assumptions (i.e., 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 each option is found to be invariant to the assumptions of:

- a 25 per cent increase/decrease in the assumed network capital costs (including the capital costs of future works);
- a 25 per cent increase/decrease in the assumed operating costs;
- a lower ($82.4/kWh) and higher ($44.4/kWh) VCR;
- lower and higher assumed risks costs, i.e., avoided reactive maintenance and safety risk (+/- 30 per cent); and
- a higher (7.0 per cent) and lower (2.34 per cent) discount rate.

The optimal commissioning date occurs in the first year possible for each option modelled. This indicates that each project's optimal timing is robust to a range of conditions. Under the central scenario, the optimal timing for Option 2 occurs in 2025/26.

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

Figure 5.4 – Option 1's distribution of optimal project commissioning years under each sensitivity

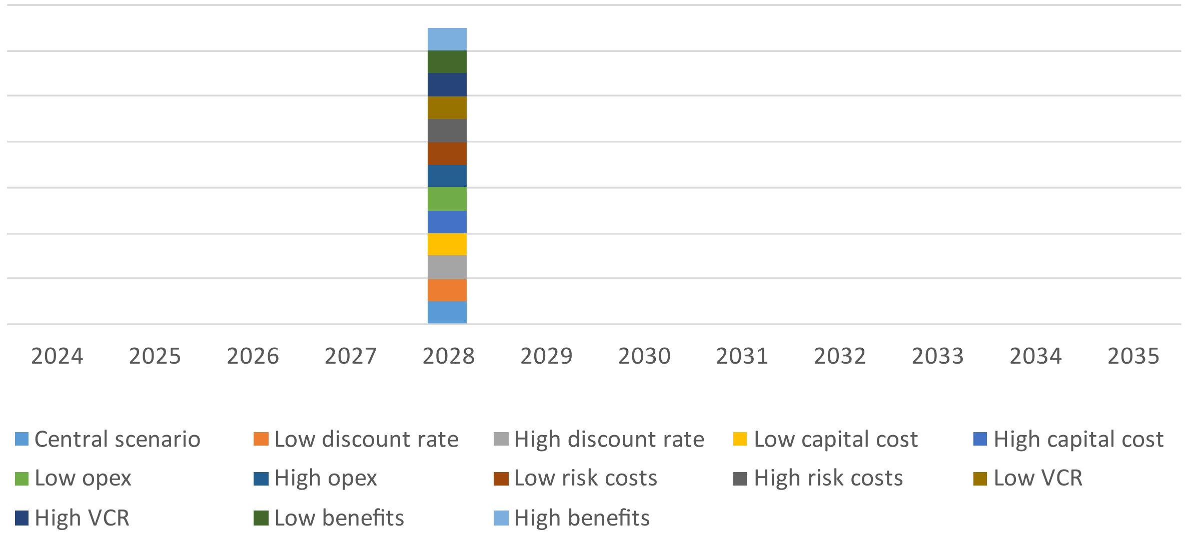


Figure 5.5 – Option 2's distribution of optimal project commissioning years under each sensitivity

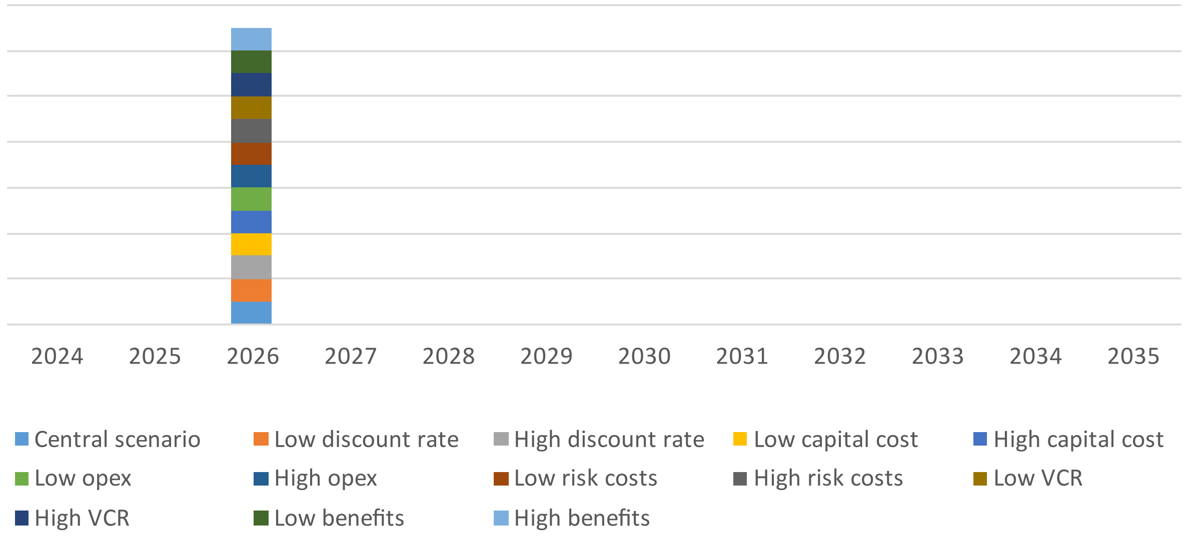
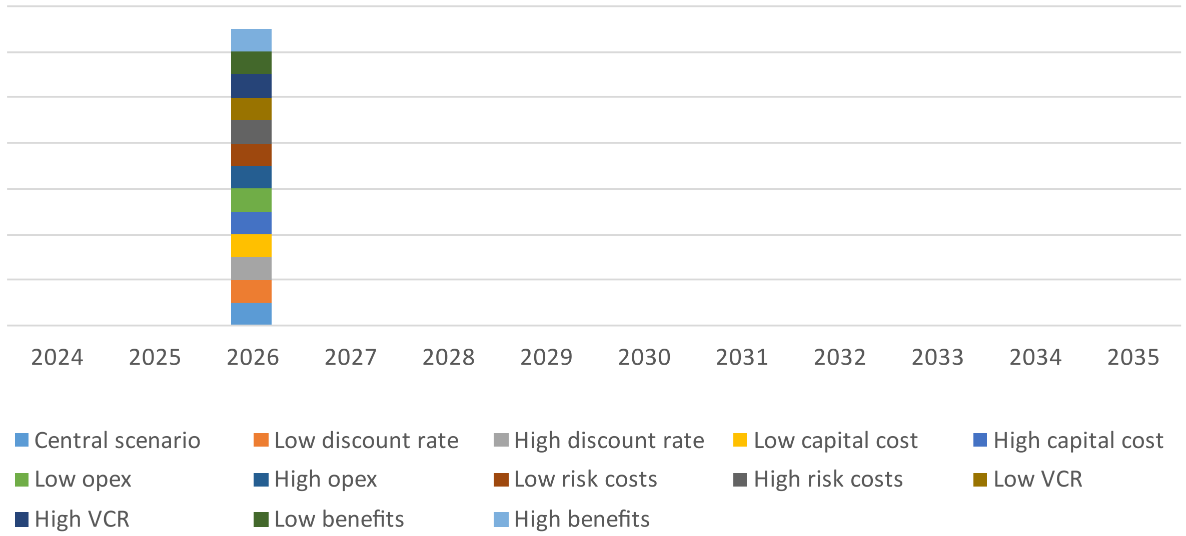


Figure 5.6 – Option 3's distribution of optimal project commissioning years under each sensitivity



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;
- a 25 per cent increase/decrease in the assumed planned maintenance costs;
- a lower VCR ($44.4kWh) and a higher VCR ($82.4/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.

Table 5.4 presents the outcomes from the sensitivity tests on a weighted basis across the three scenarios. On a weighted basis, the overall NPV result each option remains positive across the broad range of sensitivities tested. The sensitivity tests also demonstrate that the preferred option (Option 2) is robust to changes in all key parameters modelled.

Table 5.4 – Net present value outcome from sensitivity tests under the weighted scenario ($m)

Sensitivity	Option 1	Option 2	Option 3	Preferred Option
Baseline weighted outcome across scenarios	98.7	**122.4**	119.6	Option 2
High capital costs (+25%)	90.8	**119.6**	117.0	Option 2
Low capital costs (-25%)	106.7	**125.2**	122.1	Option 2
High planned maintenance costs (+25%)	98.9	**122.4**	119.6	Option 2
Low planned maintenance costs (-25%)	98.6	**122.4**	119.5	Option 2
High VCR ($82.4/kWh)	134.0	**158.5**	154.5	Option 2
Low VCR ($44.4/kWh)	63.5	**86.3**	84.6	Option 2
High discount rate (7.00%)	42.6	**71.3**	69.5	Option 2
Low discount rate (2.34%)	125.0	**146.1**	142.8	Option 2
High safety risk costs (+30%)	101.5	**125.1**	122.3	Option 2
Low safety risk costs (-30%)	96.0	**119.7**	116.8	Option 2
High unplanned corrective maintenance (30%)	100.1	**123.8**	121.0	Option 2
Low unplanned corrective maintenance (-30%)	97.3	**121.0**	118.1	Option 2

6 Proposed preferred option

Ausgrid considers that Option 2 is the preferred option that satisfies the RIT-D. It involves the replacement of the existing 11 kV compound-insulated switchgear at Mascot ZS with modern equivalent switchgear.

The replacement of switchgear under the preferred option will result in substantial market benefits from avoided EUE that would otherwise arise if no action were taken, with secondary benefits including reduced planned and unplanned maintenance costs, and reduced safety risk.

While Option 2 and Option 3 have a similar estimated net market benefit, Option 3 does not provide the same capacity for future expansion, if required, on account of retiring the three groups of 11kV compound-insulated switchgear. This benefit of Option 2 over Option 3 has not been quantified in the analysis but serves to further support the conclusion that Option 2 is the preferred option.

The total capital cost associated with this option is $32.3 million[16], comprising:

- approximately $12.3 million upfront to replace the aging compound insulated switchgear by 2025/26 (which includes $0.7 million in decommissioning costs); and
- approximately $20.1 million in future capital costs associated with the replacement of air insulated switchgear and 4x33kV sub-transmission cables in 20 years' time (commissioned in 2044/45).

However, the effective capital cost in the short-term is the $12.3 million upfront to replace the aging compound-insulated switchgear. The later works to replace the air insulated switchgear and 4x33kV sub-transmission cables in approximately 20 years' time is expected to have a separate RIT-D applied to it, closer to the time, in order to confirm that it remains the preferred option.

An overview of the proposed works is presented in the figure below.

Figure 6.1 – Overview of Mascot ZS with proposed works highlighted

[16] Numbers do not add precisely due to rounding.

Routine operating costs are expected to average approximately $81,000 per year over the assessment period (approximately 0.3 per cent of capital expenditure per year).

Ausgrid assumes that the necessary construction to replace the existing switchgear would commence as soon as practicable after this RIT-D and end in 2025/26.

Ausgrid intends to issue statutory notifications to the Bayside City Council within the next three months, once civil design works are progressed to a point where a detailed program of work can be finalised. Given that the majority or works will be contained within existing buildings at the substation site, the impact to the community is expected to be minimal.

Ausgrid considers that this DPAR, and the accompanying detailed analysis, identify Option 2 as the preferred option and that this satisfies the RIT-D. Ausgrid is the proponent for Option 2.

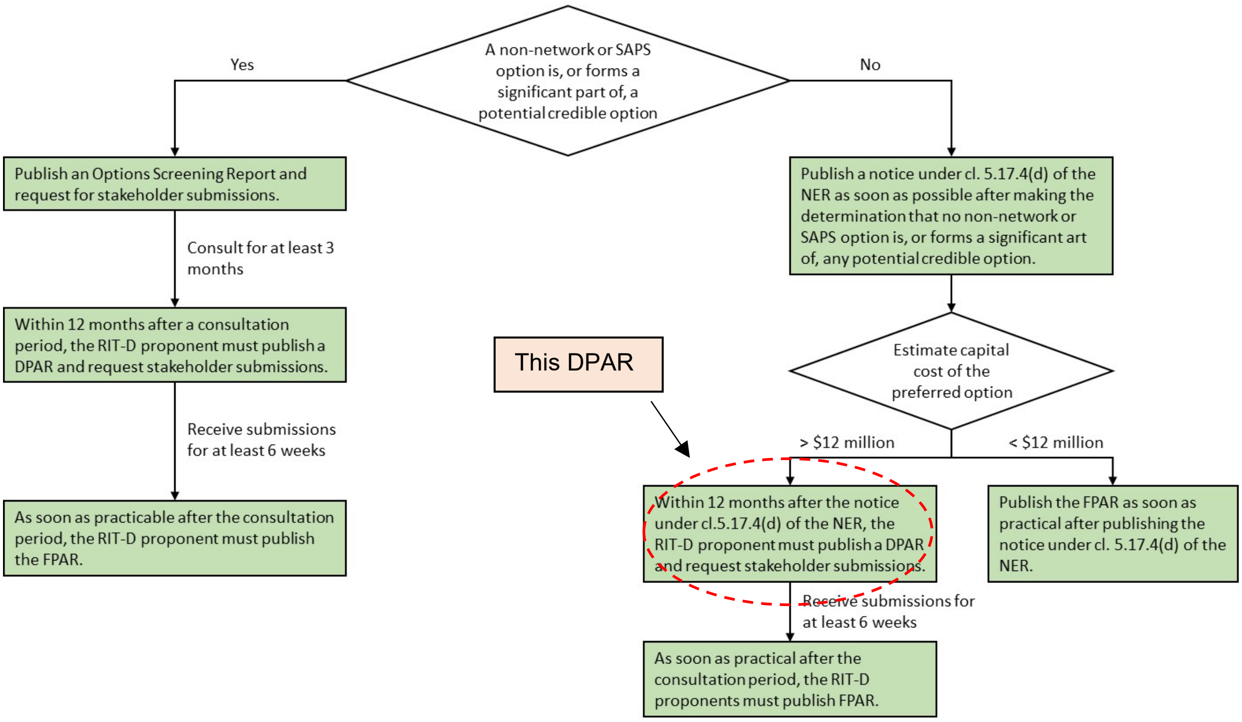
Appendix A – Checklist of compliance clauses

This section sets out a compliance checklist that demonstrates the compliance of this DPAR with the requirements of clause 5.17.4(r) of the National Electricity Rules version 200.

Clause	Summary of requirements	Section in the DPAR
5.17.4(r)	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
	(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.	1.4

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.0.12 – 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	While the three options also treat the future replacement of air insulated switchgear and the 33kV sub-transmission cables differently, these replacement works have been included on the cost-side for Option 2 and Option 3 to enable a ‘like-for-like’ comparison with Option 1 (as opposed to as a separate market benefit). These differences in costs are not expected to be material to the outcome of the RIT-D and Ausgrid considers the approach taken to be proportionate under the RIT-D.
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 options are 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 options. Ausgrid notes that the options 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 options under consideration do not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, the options are 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. Other loads in the area are now connected to Green Square ZS and therefore further load transfers are no longer viable under the current network configuration.
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 options assessed do 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 options 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

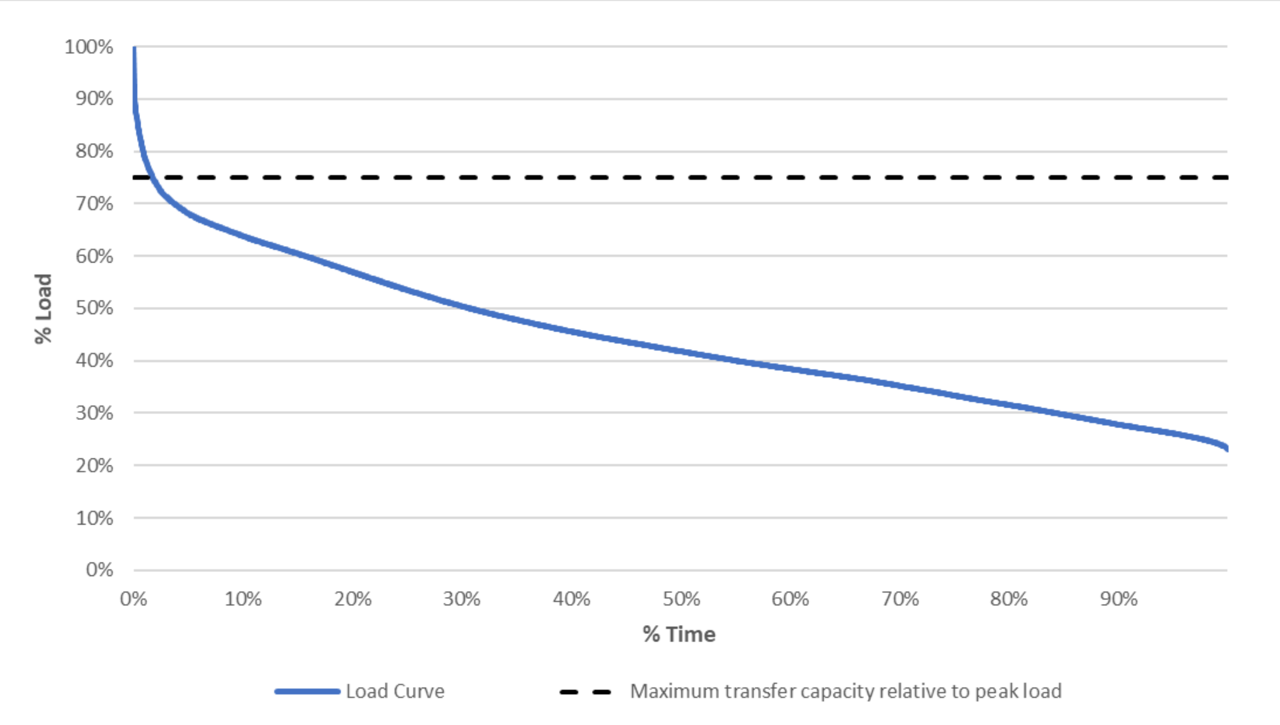
This appendix provides additional detail on key input assumptions that are used in the evaluation of the base case and the credible options.

D.1 Characteristic load duration curve

The load duration curve for Mascot 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 Mascot.

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



D.2 Load transfer capacity and supply restoration

Mascot zone substation load area is classified as urban and has 11kV interconnections with the Green Square ZS, Zetland ZS, St Peters ZS and Botany ZS. In the event of a total loss of supply to Mascot zone substation, approximately 75 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 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 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 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). This review assigned switchboards into three specific condition bands: 'Good', 'Average' and 'Poor'. The Mascot zone substation compound and air 11kV switchboards are assigned a condition band of Poor and Average respectively.

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 11kV switchboard	Poor	6.06	90.3
Air-insulated 11kV switchboard	Average	3.60	203.5

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:

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

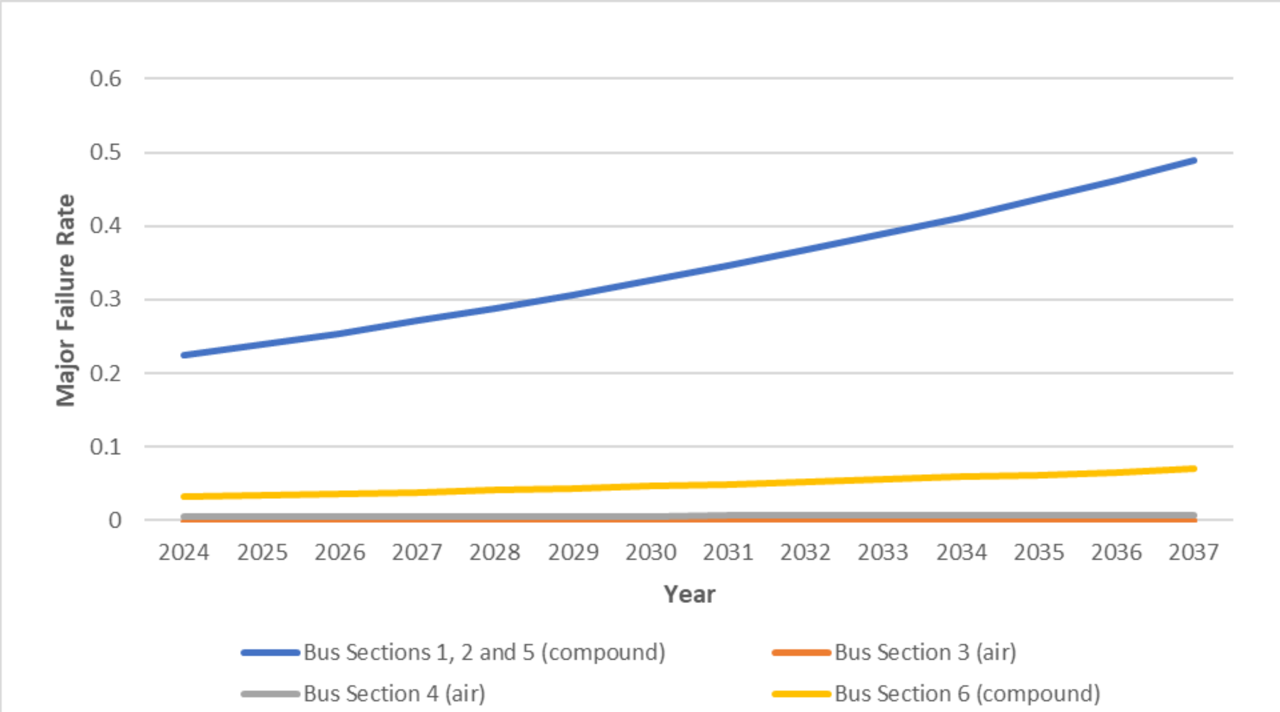
Unavailability is calculated by using a restore time, so the unavailability represents the percentage of time that a particular busbar is not available to supply load. The unavailability (U) of a switchboard is calculated for each year by applying Equation 2:

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

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 Mascot 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 are in 2019/20 real dollars and have been escalated to 2023/24 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 11 kV feeder connections, protection and earthing designs, delivery costs and labour rates.

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 Mascot ZS

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

	Unit	Residential	Small non-residential	Large non-residential (LV)	Large non-residential (HV)
Annual consumption	MWh	24,280	23,609	50,904	42,060
Per cent of annual consumption	%	16.8%	16.9%	37.0%	29.3%
AER VCR estimates (2022)	$/kWh	$32.57	$75.99	$66.37	$69.94
Load-weighted VCR for Mascot	**$/kWh**	**$63.37**			

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

- For residential loads, the VCR is determined by using the postcode of the area (i.e., Mascot, NSW, 2020), which is located under Climate Zone 5 CBD & Suburban NSW, as determined by the AER[17] and adjusted by CPI.
- Small non-residential loads are considered to be small businesses, for which the VCR determined by the AER[18] 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.

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

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