Addressing reliability requirements in the Concord load area

DRAFT PROJECT ASSESSMENT REPORT

22 OCTOBER 2020

Ausgrid

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Addressing reliability requirements in the Concord load area

Draft project assessment report – October 2020

Contents

Executive Summary

This report investigates the most economic option for continuing efficient supply to the Concord zone substation load area

This Draft Project Assessment Report (DPAR) has been prepared by Ausgrid and represents the first step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply for the Concord zone substation load area, located in the northern part of Sydney's Inner West.

In particular, the main issue for the Concord zone substation relates to asset condition, performance and safety concerns stemming from obsolete compound filled switchgear, which is beyond its design life and has approached the point at which the switchgear replacement maximises the net benefit for the community.

Ausgrid has prepared this report in accordance with the National Electricity Rules

Ausgrid has initiated this RIT-D for the Concord zone substation project in order to identify a preferred option that would ensure Ausgrid is able to satisfy its reliability and performance standards in supplying this network area.

Two credible network options have been assessed to address reliability concerns

Two network options were considered credible to address the reliability and asset condition issues at Concord zone substation. They both involve replacing the 11kV switchgear within the existing site at Concord zone substation but with differing approaches. The two credible options investigated are:

- Option 1: Replace the 11kV switchgear in-situ and
- Option 2: Replace the 11kV switchgear with a new switchroom.

Option 2 is the preferred option because it has a higher Net Present Value (NPV) as a result of a lower construction and network risks.

Other options were also considered in this assessment, such as retiring Concord zone substation by transferring the 11kV load to adjacent substations and the replacement of Concord zone substation with either a new 33/11kV or 132/11kV zone substation. However, these other options have significantly higher cost more than Option 2 but do not provide material additional benefits, therefore these options were not considered economically feasible.

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

Ausgrid has also considered the ability of any non-network solutions to assist in meeting the identified need. A demand management assessment into reducing the risk of unserved energy showed that non-network alternatives cannot cost-effectively address the risk, compared to the network option outlined above. Therefore, a notice on screening for non-network options has been released in accordance with clause 5.17.4(d) of the NER.

If a cost-effective non-network solution emerges during the course of this RIT-D process, then it will be assessed alongside the credible network option identified.

Three different 'scenarios' have been modelled to deal with uncertainty

Ausgrid has elected to assess three alternative future scenarios – namely:

- Low benefit scenario – Ausgrid has adopted several assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world with respect to potential market benefits that could be realised under each credible option;
- Baseline scenario – the baseline scenario consists of assumptions that reflect Ausgrid's central set of variable estimates, which, in Ausgrid's opinion, provides the most likely scenario; and
- High benefit scenario – this scenario reflects a set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential market benefits.

A summary of each scenario and the sets of variable values adopted is presented in Table E.1 below.

Table E.1 – Summary of the three scenarios investigated

Variable	Baseline scenario	Low benefits scenario	High benefits scenario
Capital cost	100 per cent of capital cost estimate	125 per cent of capital cost estimate	90 per cent of capital cost estimate
Unplanned corrective maintenance cost	100 per cent of baseline corrective maintenance cost estimates	70 per cent of baseline corrective maintenance cost estimates	130 per cent of baseline corrective maintenance cost estimates
Demand	baseline forecast	10 per cent below baseline forecast	15 per cent above baseline forecast
Value of Customer Reliability	$42/kWh	$29/kWh	$55/kWh

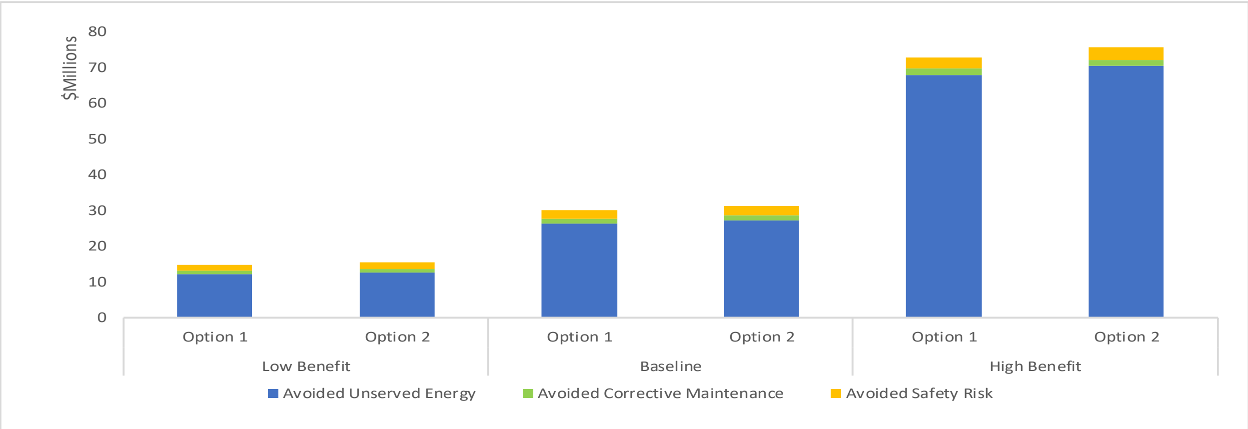
The results of Ausgrid's analysis shows that the proposed project will provide positive net benefit under all scenarios, primarily arising from the reduction of involuntary load shedding. These results are presented in more detail below.

Option 2 is the preferred option at this draft stage

Ausgrid proposes Option 2 to be the preferred option as it has a higher NPV than Option 1 and it satisfies RIT-D requirements. Ausgrid is the proponent for Option 2.

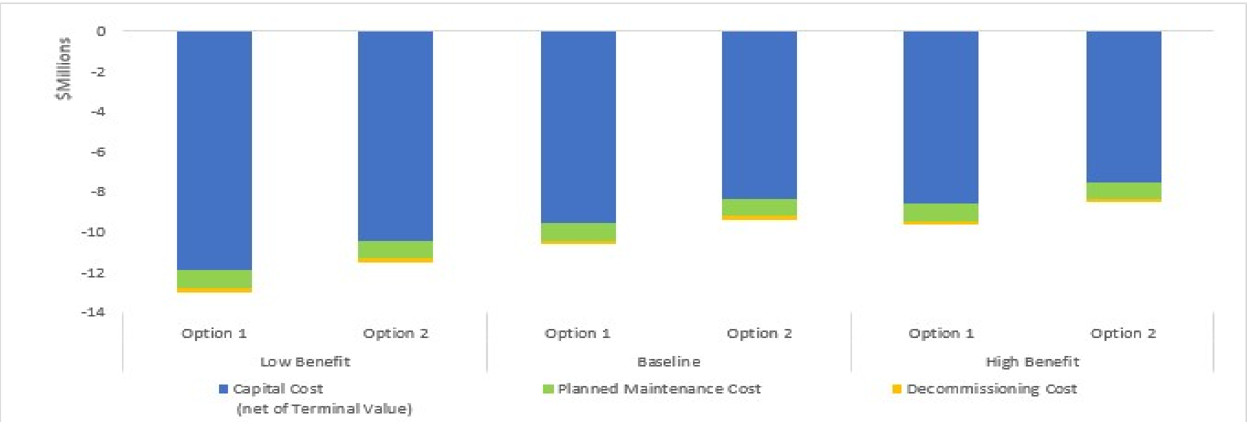
As illustrated in Figure E-1, both options provide benefits across all scenarios largely from avoiding unserved energy. There are also benefits from avoiding corrective maintenance and safety risk, however these benefits are relatively small.

Figure E-1 – Breakdown of gross benefits of both options relative to the base case, Present Values



Breakdown of cost involves capital, maintenance and decommissioning costs as illustrated in the figure below.

Figure E-2 – Breakdown of gross costs of both options relative to the base case, Present Values



Option 2 has lower gross costs than Option 1 across all scenarios, largely due to a lower capital cost.

When considering the present value of costs and benefits together, Option 2 has a higher NPV on a weighted basis. Table E.2 below provides a summary of the net market benefits for both options for comparison.

Table E.2 – Present value of expected net benefits relative to the base case, $m 2019/20

Option	PV of Capital Costs	PV of Operating Costs	Weighted PV of Gross Benefits	Weighted NPV of Benefits	Option Ranking
Option 1	-9.9	-1.1	36.9	25.9	2
Option 2	-8.7	-1.0	38.2	28.5	1

Option 2 involves the replacement of the 11kV compound switchgear with a new switchroom/control room at the existing site of Concord zone substation. The scope of works for this option involves:

- Install a new switchroom/control at the east of the existing substation, where there is available space
- Install new 11kV switchboard, comprising six sections of single bus switchgear and 35 circuit breakers
- Transfer the 11kV load to the new switchgear
- Decommission old 11kV compound switchgear

Option 2 is expected to cost $14.3 million (includes decommissioning cost) with a construction period of 4 years. Construction is scheduled to started in 2020/21 and is expected to be completed in 2023/24. Incremental operating costs (i.e. maintenance cost) for Option 2 are assumed to be approximately $70,000/year.

How to make a submission and next steps

Ausgrid welcomes written submissions on this DPAR. Submissions are due on or before 3 December 2020. Submissions and queries should be addressed to:

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

Or

email to: assetinvestment@ausgrid.com.au

The next 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 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.

1 Introduction

The suburb of Concord is located at the northern part of the Inner West area of Sydney. The suburb and surrounding area are served by the Concord 33/11kV zone substation, which was first commissioned in 1955. A critical component in the substation is the 11kV switchboard which is compound insulated, with 11kV bulk oil circuit breakers (OCBs). The compound insulated switchgear installed across Ausgrid network exhibit failures that have led to consequences ranging from simple equipment failures to fire events and structural damage. Although a range of measures have been implemented to mitigate these consequences, the 11kV switchgear is beyond its design life with continued service resulting in continuing condition deterioration, which increases the risk of supply outage and safety incidents. Consequently, Ausgrid has prioritised the retirement and replacement of compound insulated switchgear across the network.

According to the National Electricity Rules (NER) requirements, Ausgrid has initiated this RIT-D to replace the 11kV switchgear at Concord zone substation and consult on options to ensure Ausgrid is able to satisfy reliability and performance standards that it is obliged to meet.

No exemptions listed in the NER clause 5.17.3(a) apply and therefore Ausgrid is required to apply the RIT-D to this project.

1.1 Role of this draft report

Ausgrid has prepared this Draft Project Assessment Report (DPAR) in accordance with the requirements of the National Electricity Rules (NER) under clause 5.17.4. It is the first stage of the formal consultation process set out in the NER in relation to the application of the RIT-D for this proposed project. In particular, this DPAR:

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

It is unlikely that there will be credible non-network options given the size of the load served by the Concord zone substation. However, non-network options were considered in formulating the plan to address issues at the Concord zone substation. Further details can be found in the notice on screening for non-network options. .

1.2 Making a submission and next steps

Ausgrid welcomes written submissions on this DPAR. Submissions are due on or before 3 December 2020.

Submissions and queries should be addressed to:

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Head of Asset Investment
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2 Description of the identifed need

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

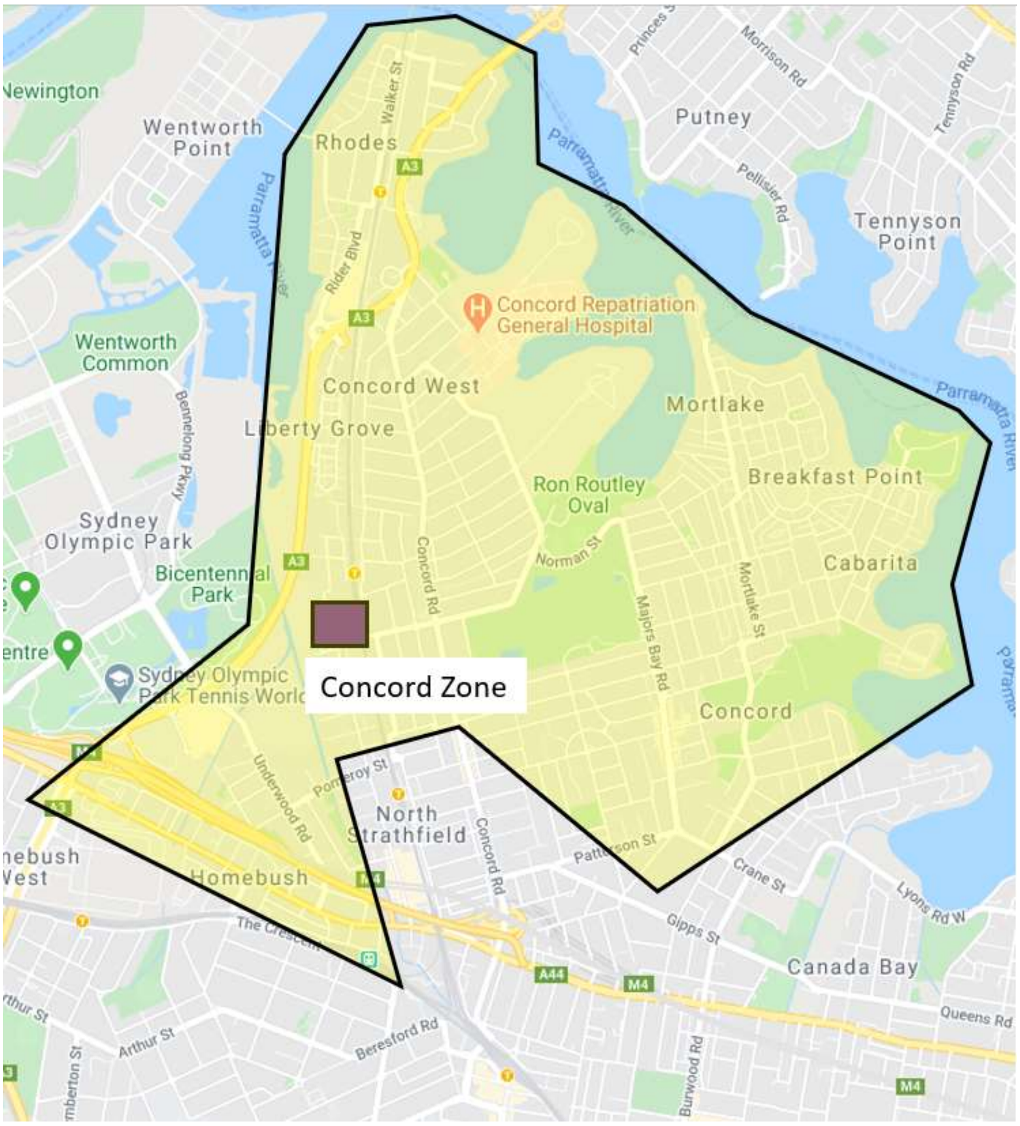
2.1 Overview of the Inner West network area and the Concord zone substation

Concord 33/11kV zone substation is located in the northern part of the Inner West network area of Sydney. The Inner West network area in Sydney extends from Homebush Bay in the north, south-west to Rozelle and Leichhardt and west as far as Auburn. The network area is divided by parts of Sydney Harbour and the Parramatta River. Parramatta Road runs through the southern part of the area.

Concord zone substation is surrounded by existing 132/11kV zone substations including Olympic Park, Burwood, Croydon and Flemington. The catchment area for Concord zone substation extends from the Parramatta river in the north, south-west to Homebush and south-east to Concord. Concord zone substation supplies approximately 12,000 residential and industrial/commercial customers including Thomas Walker Hospital, Medical Educational Centre, Concord Hospital and businesses on the Rhodes peninsula. Measures will be in placed to ensure continuous supply to medical centres and hospitals during the proposed work.

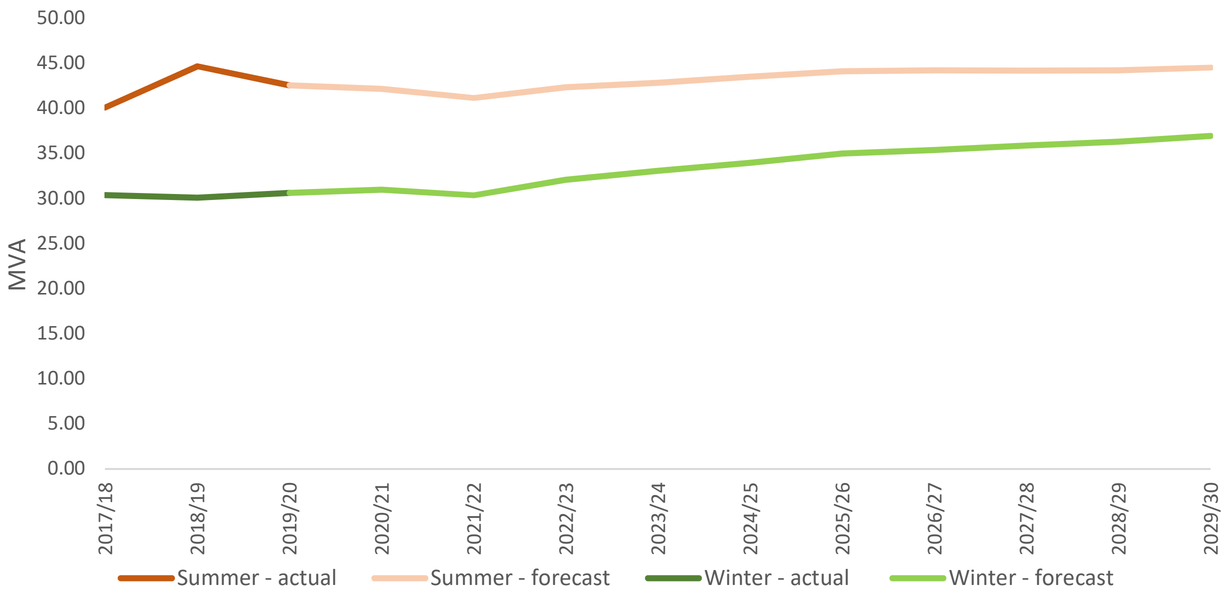
Concord zone substation was commissioned in 1955 and is supplied from Homebush 132/33kV Subtransmission Substation (STS). It has three 19MVA transformers and one 15MVA transformer, as well as three double bus sections of 11kV switchgear, with a firm capacity of 48.5MVA in summer and 54.4MVA in winter. The 11kV load transfer capability from Concord zone substation to surrounding zone substations is limited due to geographic constraints.

Figure 2-1 – Location and catchment area of the Concord zone substation



Concord zone substation is a summer peaking substation with a current peak load of 43 MVA and a long term 25 years forecast load of about 48MVA. Figure 2-2 shows winter and summer forecast for the next 10 years, where the load is expected to grow modestly to 45MVA by 2029/30.

Figure 2-2 – Concord zone substation load



Critical components at the Concord zone substation are showing signs of deterioration, especially the switchgear that is used to control, protect and isolate electrical equipment. The 11kV switchgear used at the Concord zone substation is compound insulated, and approximately half of the 11kV circuit breakers are OCBs (Oil Circuit Breakers). The compound insulated switchboards with OCBs have high fire risks, which compromises safety and reliability of supply.

Advances in circuit breaker technology since the 1970s have provided superior alternatives to oil / compound switchboards.

The quantitative risk analysis indicates that benefits of reducing of unserved energy due to the risk of switchboard failure exceed the annualised cost of removing this asset.

2.2 Key assumption underpinning the identified need

The need to undertake action is predicated on the deteriorating condition of assets at the Concord zone substation, and the characteristics of any resultant outages.

The key assumption underpinning this RIT-D project is that the failure of the 11kV switchgear at Concord zone substation can compromise its function, leading to unserved energy. The existing 11kV double bus switchgear is compound insulated and consist of Email and South Wales manufactured types, which were mainly commissioned in 1955. 15 of the 26 11kV bulk oil circuit breakers (OCBs) at the substation have been replaced with Vacuum type circuit breakers. The remaining OCBs have not been replaced due to challenges in retrofitting/replacement.

The compound insulated switchgear at Concord zone substation have become increasingly problematic as they age. Compound insulated switchgear have bituminous compound insulation busbars (switchboard) and oil-filled circuit breakers, which can act as a fuel source and increase fire risk in the event of failure. A range of measures have been implemented to mitigate risks presented by compound insulated switchgear, however the 11kV switchgear itself is considered to be beyond its design life with continued service resulting in on-going condition deterioration.

In the past, there have been a considerable number of 11kV switchgear failures within Ausgrid's network, which have resulted in a range of adverse consequences from simple outages to fires and/or structural damage. Consequently, Ausgrid's modelling indicates that that aging assets (i.e. compound insulated switchgear) at the Concord zone substation have an increasing likelihood of failure and involuntary load shedding.

Appendix C provides additional detail on assumptions used and methodologies applied to estimate the costs and market benefits as part of this RIT-D.

3 Options considered

This section provides details of credible options that Ausgrid has identified as part of its network planning activities to date. Other options could technically address the identified need, however are likely to cost significantly more than the credible options identified without any material increase in benefits. Ausgrid has therefore identified two credible options as other options are deemed non-credible on the basis that they are not economically feasible. More details of the other options deemed non-credible are set out in section 3.3.

Ausgrid has also considered whether there are non-network options that could address the identified need. However, non-network options are unlikely to address the identified need given the size of the load at Concord zone substation and the level of involuntary load shedding that would be incurred in the event of an equipment failure. Ausgrid has therefore published a notice on screening for non-network options, consistent with clause 5.17.4(d) of the NER's, setting out that a non-network options are unlikely to exist. However, Ausgrid would welcome submissions from non-network solution providers if credible non-network solutions exist.

Table 3.1 provides a summary of the two credible options that are considered for Concord zone substation. All costs in this section are in $2019/20 real dollars, unless otherwise stated.

Table 3.1 – Summary of the credible option considered

Option details	Option 1	Option 2
Option description	Replacement of 11kV switchgear in-situ	Replacement of 11kV switchgear with a new switchroom
Capital cost	$16.5 million	$14.1 million
Decommissioning Cost	$0.2 million	$0.2 million
Construction period	FY21-25	FY21-24
Commissioning date	FY24	FY23

3.1 Option 1 – Replacement of 11kV switchgear in-situ

Option 1 involves staged decommissioning of the 11kV compound switchgear and the installation of the new switchgear in the same room. The scope of works for this option involves:

- Transfer 11kV load away to neighbouring zone substations
- Decommission existing 11kV compound switchgear
- Build an extension to the existing 11kV switchroom to accommodate the new switchgear
- Install new 11kV switchboards, comprising six sections of single bus switchgear and 35 circuit breakers
- Transfer the 11kV load to the new switchgear from neighbouring zone substations

Option 1 is expected to cost $16.7 million (includes decommissioning cost) with a construction period of 5 years.

Operating costs is assumed to be approximately $80,000/year, equivalent 0.5% of the capital costs.

3.2 Option 2 – Replacement of 11kV switchgear with a new switchroom

Option 2 involves the replacement of the 11kV compound switchgear with a new switchroom/control room at the existing site of Concord zone substation. The scope of works for this option involves:

- Install a new switchroom/control at the east of the existing substation, where there is available space
- Install new 11kV switchboards, comprising six sections of single bus switchgear and 35 circuit breakers
- Transfer the 11kV load to the new switchgear
- Decommission old 11kV compound switchgear

Option 2 is expected to cost $14.3 million (includes decommissioning cost) with a construction period of 4 years.

Operating costs is assumed to be approximately $70,000/year, equivalent 0.5% of the capital costs.

3.3 Options considered but not progressed

Ausgrid also considered several other options that have not been progressed. In general, these options have not progressed because they were found to be economically infeasible without providing significant additional benefits. The table below summarises Ausgrid's consideration and position on each of these potential options.

Table 3.2 – Options considered but not progressed

Option not progressed	Description	Reason why option was not progressed
Construction of a new substation to replace the existing Concord zone substation	This option involves retiring Concord zone substation and establishing a brand new 33/11kV zone substation within the area. To allow for the retirement, all of Concord load will need to be transferred to the new zone substation.	The construction of a new substation is deemed to be economically infeasible, as it is nearly double the cost of the replacement of 11kV switchgear in a new switchroom and provides no significant additional benefits.
Retirement of Concord zone substation via 11kV load transfers to Olympic Park zone substation	This option involves retiring Concord zone substation and transferring all of Concord load to Olympic Park zone substation by installing new 11kV feeders between Olympic Park and Concord zone substations. To provide the required capacity, the existing Olympic Park zone substation will need to be expanded with an additional 3rd transformer and associated 11kV switchgear.	Due to geographical constraints (i.e. area surrounded by waterways and congested roads with subtransmission and distribution assets), this option involves significantly higher costs as well as lower reliability due to longer than existing 11kV connections.

4 How the option has been assessed

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

4.1 General overview of the assessment framework

All costs and benefits for each credible option have been measured against a ‘business as usual’ base case. Under this base case, Ausgrid is assumed to undertake escalating regular and reactive maintenance activities as the probability of failure and outages increases over time in the absence of an asset replacement program.

The RIT-D analysis has been undertaken over a 20-year period, from 2020 to 2039. 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. While the capital components of the credible option have asset lives greater than 20 years, Ausgrid has taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of long-lived options is appropriately captured in the 20-year assessment period.

Given that no non-network options have been found to be viable, the appropriate discount rate is considered to be the regulated cost of capital. As a result, Ausgrid has adopted a real, pre-tax discount rate of 3.25 per cent, equal to the latest Australian Energy Regulator (AER) Final Decision for Ausgrid’s regulatory proposal[1]. The adopted discount rate is adjusted annually, according to guidelines provided in the AER Final Decision Report.

4.2 Ausgrid’s approach to estimating project costs

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

Operating and maintenance costs have been determined for each option 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 an option in place, the cost savings are effectively treated as a benefit in the assessment.

Operating costs have been estimated for each 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.

All options reduce the incidence of asset failures earlier than the base case, and hence the expected operating and maintenance costs associated with restoring supply.

Ausgrid has also included the financial costs associated with corrective maintenance and safety outcomes that are assumed to be avoided under each of the options, relative to the base case. These costs have been estimated using internal Ausgrid estimates and are found to be minor relative to the involuntary load shedding in the analysis, both in terms of absolute values as well as being the same across the options, as illustrated in section 5.1. Details of the assumptions and methodologies adopted to estimate these avoided costs are presented in Appendix C.

4.3 Benefits are expected mostly from reduced involuntary load shedding

The approach Ausgrid has made to estimating reductions in involuntary load shedding are outlined in section 4.3.1 below. Further details on the assumptions and methodology considered are presented in Appendix C.

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

In addition, Appendix D outlines the market benefit categories that Ausgrid considers are not material for this RIT-D.

4.3.1 Reduced involuntary load shedding

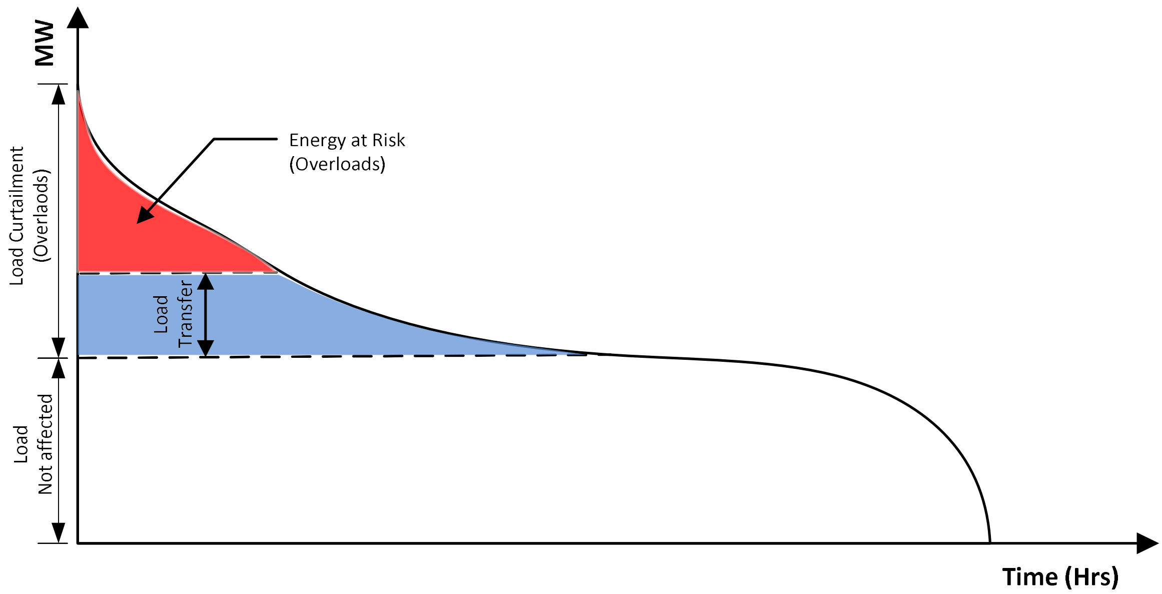
Involuntary load shedding is where a customer's load is interrupted from the network without their agreement or prior warning. These limitations relate to the availability of network connectivity and design configuration at the substation. It also arises from the unavailability of network elements and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

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

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

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

Figure 4-1: Illustration of Load Curtailment



A reduction in involuntary load shedding expected from an option, relative to the base case, results in a positive contribution to market benefits of the credible option being assessed.

The 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 $42.12/kWh, which is the load weighted value calculated for the NSW and ACT region by the AER in its VCR Final Report[2] (table 5.22 of the report). The report also recommends using values of ±30% of the base case VCR for the purposes of testing how sensitive investment decisions are to the VCR input (section

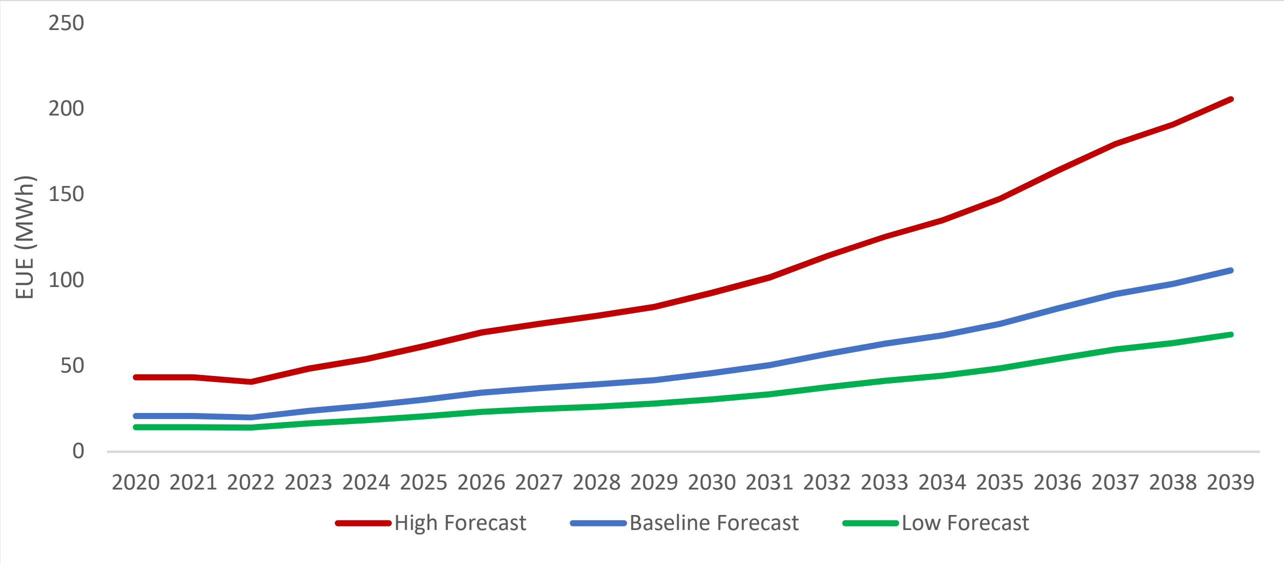
[2] AER, *Values of Customer Reliability Review* – Final Report on VCR values – December 2019. https://www.aer.gov.au/system/files/AER%20-%20Values%20of%20Customer%20Reliability%20Review%20-%20Final%20Report%20-%20December%202019.pdf

7.2 of the report). Thus, a lower VCR of $29/kWh and a higher VCR of $55/kWh have been chosen as reasonable for the low and high benefit scenarios.

In addition, while load forecasts are not a determinant of the identified need, Ausgrid has 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 were investigated – namely a base forecast, as well as a low forecast (10% below the base forecast) and a high forecast(15% above the base forecast).

The figure below shows the assumed levels of EUE, under each of the three underlying demand forecasts investigated over the next twenty years. For clarity, this figure illustrates the MWh of unserved energy prior to feeder replacement minus the MWh of unserved energy post feeder replacement, taking into consideration the underlying demand forecasts and the assumed failure rates associated with keeping the network asset in service.

Figure 4-2 - Assumed expected unserved energy (EUE) under each of the three demand forecasts



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

RIT-D assessments are required to be based on cost-benefit analysis that includes an assessment of 'reasonable scenarios', which are designed to test alternate sets of key assumptions and whether they affect identification of the preferred option.

Ausgrid has elected to assess three alternative future scenarios:

- Baseline scenario – the baseline scenario consists of assumptions that reflect Ausgrid's central set of variable estimates, which, in Ausgrid's opinion, provides the most likely scenario;
- Low benefit scenario – Ausgrid has adopted a number of assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world with respect to potential market benefits that could be realised under each credible option; and
- High benefit scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential market benefits.

Ausgrid considers that the baseline scenario is the most likely, since it based primarily on a set of expected/central assumptions. Ausgrid has therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being weighted equally with 25 per cent each. However, Ausgrid notes that the identification of the preferred option is the same across all three scenarios, i.e. the result is insensitive to the assumed scenario weights.

Table 4.1 – Summary of the three scenarios investigated

Variable	Baseline scenario	Low benefits scenario	High benefits scenario
Capital cost	100 per cent of capital cost estimate	125 per cent of capital cost estimate	90 per cent of capital cost estimate
Unplanned corrective maintenance cost	100 per cent of baseline corrective maintenance cost estimates	70 per cent of baseline corrective maintenance cost estimates	130 per cent of baseline corrective maintenance cost estimates
Demand	Base forecast	10 per cent below base forecast	15 per cent above base forecast
VCR	$42/kWh	$29/kWh	$55/kWh

5 Assessment of the credible options

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

5.1 Gross market benefits for each credible option

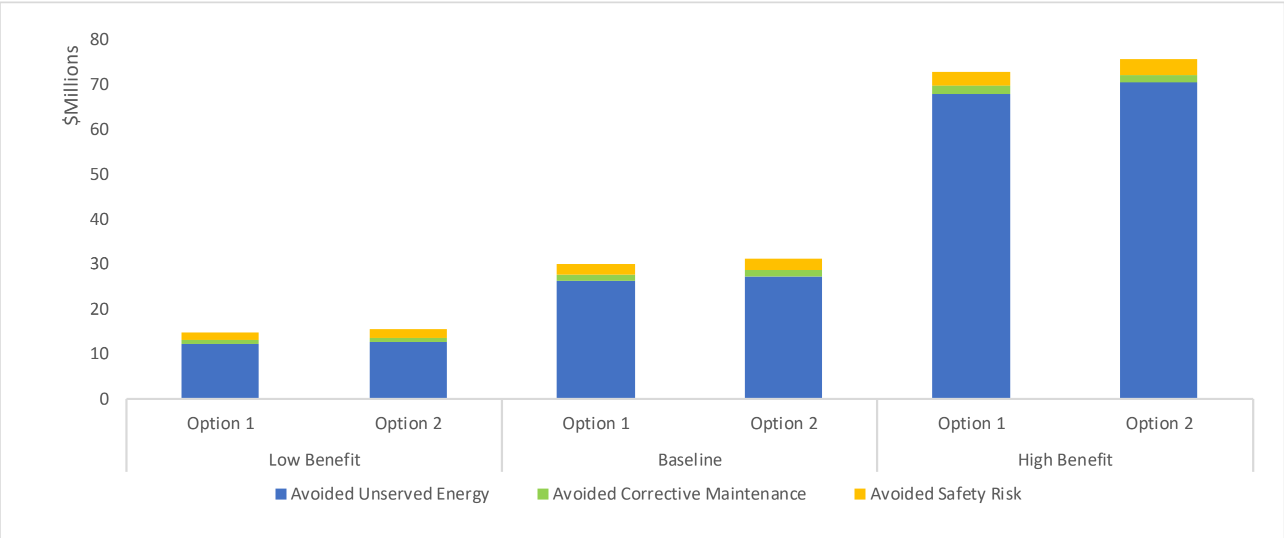
The table below summarises the gross benefit Option 1 relative to the 'do nothing' base case in present value terms. The gross market benefit for each option has been calculated for each of the three reasonable scenarios outlined in the section above.

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

Option	Low Benefit Scenario	Baseline Scenario	High Benefit Scenario	Weighted Benefits
Weighting	*25 per cent*	*50 per cent*	*25 per cent*	
Option 1	14.7	30.0	72.8	36.9
Option 2	15.3	31.1	75.4	38.2

Figure 5-1 provides a breakdown of benefits relating to each credible option, showing almost all of the benefits are derived from avoided involuntary load shedding, while avoided corrective maintenance and avoided safety & environment risks contributing relatively small amounts to gross benefits. This is driven by the age and condition of the assets in question and the fact that they are expected to result in customer outages if left in service (i.e. under the base case).

Figure 5-1 – Breakdown of present value gross economic benefits relative to the base case



Gross benefits under the high benefit scenario is significantly higher than under the baseline and low benefit scenarios, reflecting a higher levels of avoided USE (i.e. involuntary load shedding) and a VCR of $55/kWh. Benefits from avoiding unserved energy dominate gross benefits under all scenarios, while avoided safety risks and corrective maintenance only contribute minimally to overall gross benefits.

5.2 Estimated costs for each credible option

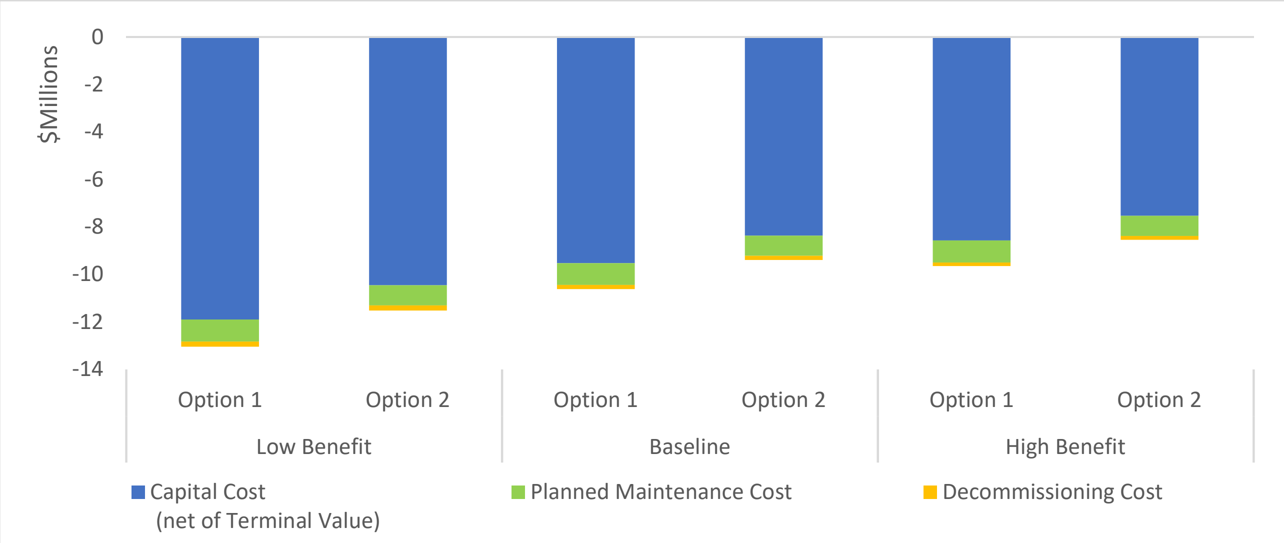
The table below summarises the gross costs relative to the base case in present value terms for each option. The gross cost of each option has been calculated for each of the three reasonable scenarios, in accordance with the approaches set out in Section 4.

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

Option	Low Benefit Scenario	Baseline Scenario	High Benefit Scenario	Weighted Costs
Weighting	*25 per cent*	*50 per cent*	*25 per cent*	
Option 1	-13.0	-10.6	-9.7	-11.0
Option 2	-11.5	-9.4	-8.5	-9.7

Figure 5.2 provides a breakdown of costs relating to each credible option, showing most of the costs are related to the capital costs (net of terminal value). Other costs include decommissioning cost and planned maintenance costs, although these only contribute minimal amounts to total cost

Figure 5.2 – Breakdown of present value gross cost relative to the base case



5.3 Net present value assessment outcomes

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

The table shows that Option 2 provides the highest net economic benefits on a weighted basis

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

Option	PV of Capital Costs	PV of Operating Costs	Weighted PV of Gross Benefits	Weighted NPV of Benefits	Option Ranking
Option 1	-9.9	-1.1	36.9	25.9	2
Option 2	**-8.7**	**-1.0**	**38.2**	**28.5**	**1**

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 based on the year in which the NPV is maximised. This process was undertaken for both the baseline set of assumptions and also a range of alternate assumptions for key variables.

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

- a 25 per cent increase and a 10 per cent decrease in the assumed network capital costs;
- alternate forecasts of maximum demand growth, including a low forecast (10% below base case forecast) and a high forecast (15% above base case forecast); and
- a lower VCR ($29/kWh) and a higher VCR ($55/kWh).

The figures below outline the impact on the optimal commissioning year for each option, under a range of alternative assumptions. It illustrates that the optimal commissioning year for Option 1 is 2023/24 and for Option 2 is 2022/23

Figure 5-3 – Distribution of optimal project commissioning years under each sensitivity investigated for Option 1

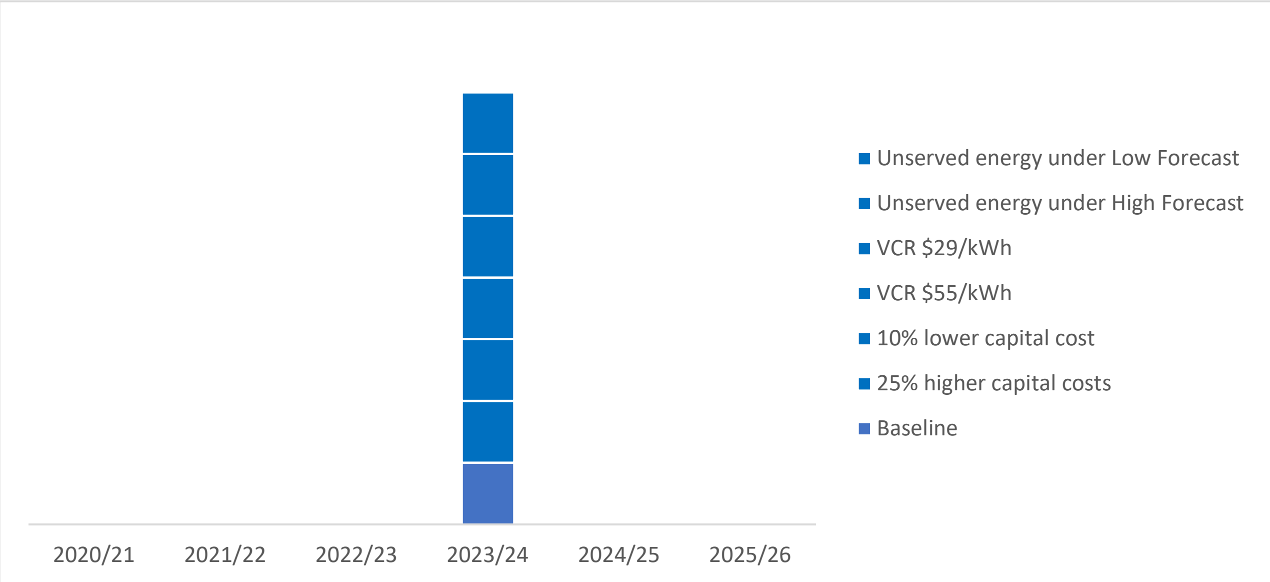
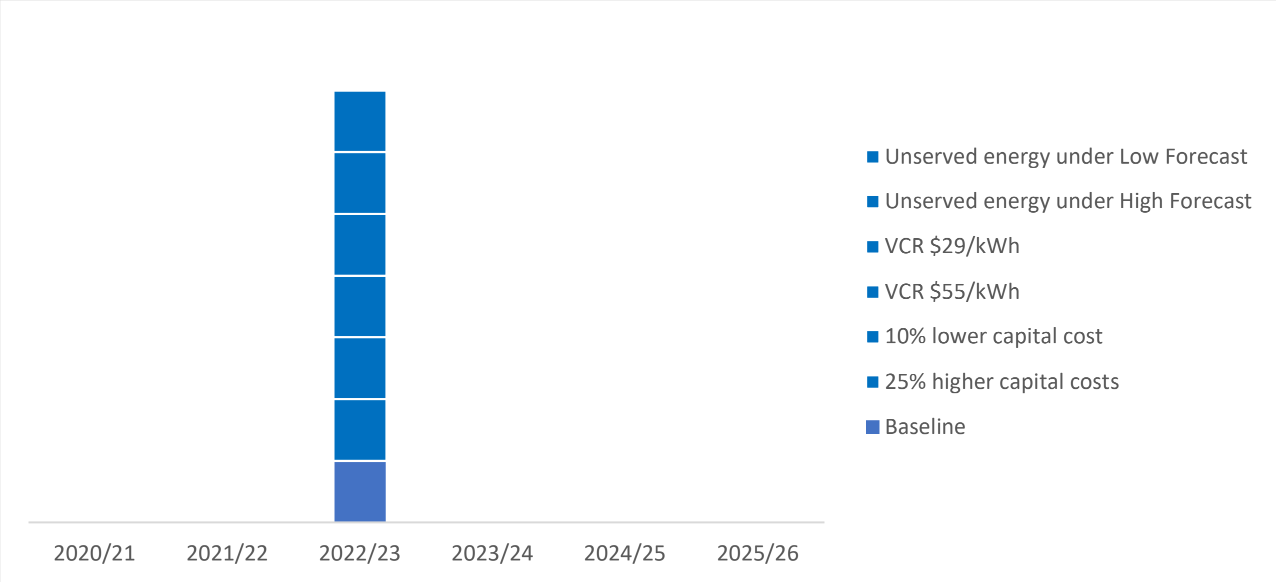


Figure 5-4 – Distribution of optimal project commissioning years under each sensitivity investigated for Option 2



For the preferred option (i.e. Option 2), 2022/23 offers the highest NPVs under all of the sensitivities tested, therefore Ausgrid is satisfied that a commissioning year of 2022/23 has been robustly determined.

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

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

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

- a 25 per cent increase and a 10 per cent decrease in the assumed network capital costs;
- alternate forecasts of maximum demand growth, including a low forecast (10% below base case forecast) and a high forecast (15% above base case forecast); and
- a lower VCR ($29/kWh) and a higher VCR ($55/kWh).

All these sensitivities investigate the consequences of 'getting it wrong' having committed to a certain investment decision. Table 5.4 presents the results of these sensitivity tests and, for each sensitivity. The analysis reaffirms the robustness that Option 2 has a positive net market benefit for all sensitivities investigated and outperforms Option 1 under all sensitivity testing scenarios

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

Sensitivity	Option 1	Option 2
Baseline	19.4	21.7
25% higher capital costs	17.0	19.6
10% lower capital cost	20.3	22.6
VCR $55/kWh	27.3	29.9
VCR $29/kWh	11.5	13.6
Unserved energy under high forecast	45.3	48.6
Unserved energy under low forecast	10.4	12.5

6 Proposed preferred option

Ausgrid proposes Option 2 to be the preferred option, as it satisfies the RIT-D and provides a higher net market benefit than Option 1. Option 2 involves replacement of the 11kV switchgear in a new 11kV switchroom building to be constructed at Concord zone substation. The proposed scope of works for Option 2 consists of:

- installation of a new switchroom/control room to accommodate the new 11kV switchboard, comprising of six sections of single bus switchgear and 35 circuit breakers;
- installation of new 11kV feeders to transfer the existing load from the old to the new switchgear at Concord zone substation; and
- decommissioning of the existing 11kV switchgear, which will be disconnected and removed from site.

Ausgrid is the proponent for Option 2 and has presented this project to community stakeholders such as City of Canada Bay Council, Transport for NSW as well as businesses and residents adjacent to the substation. Two community newsletters have been published in April 2020[3] and in June 2020[4], these are available on Ausgrid's website. In addition, the Review of Environmental Factors[5] has been publicly exhibited and all statutory notifications have been completed.

Figure 6-1 – Concept design arrangement showing the location of the new switchroom at Concord zone substation

The work will be undertaken within the vicinity of the existing substation site. The figure above displays the concept design arrangement showing the location of the new switchroom at Concord zone substation. Construction of Option 2 is estimated to occur during 2021/22, with commissioning of the new switchroom in 2022/23, and decommissioning of the existing 11kV switchgear is expected to occur in 2023/24. The estimated capital cost of this option is $14.1 million on a real basis in 2019/20. Operating costs are expected to be approximately $70,000/year.

[3] See: https://www.ausgrid.com.au/-/media/Documents/In-your-community/Construction-projects/Concord-substation-upgrade/Newsletter-1_April-2020.pdf

[4] See: https://www.ausgrid.com.au/-/media/Documents/In-your-community/Construction-projects/Concord-substation-upgrade/Newsletter-2_-June-2020.pdf

[5] See: https://www.ausgrid.com.au/-/media/Documents/In-your-community/Construction-projects/Concord-substation-upgrade/REF/Concord-Substation-Project---REF.pdf?la=en&hash=9B3AE6719952A1A389E8565DB84895CC7225EA1E

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.

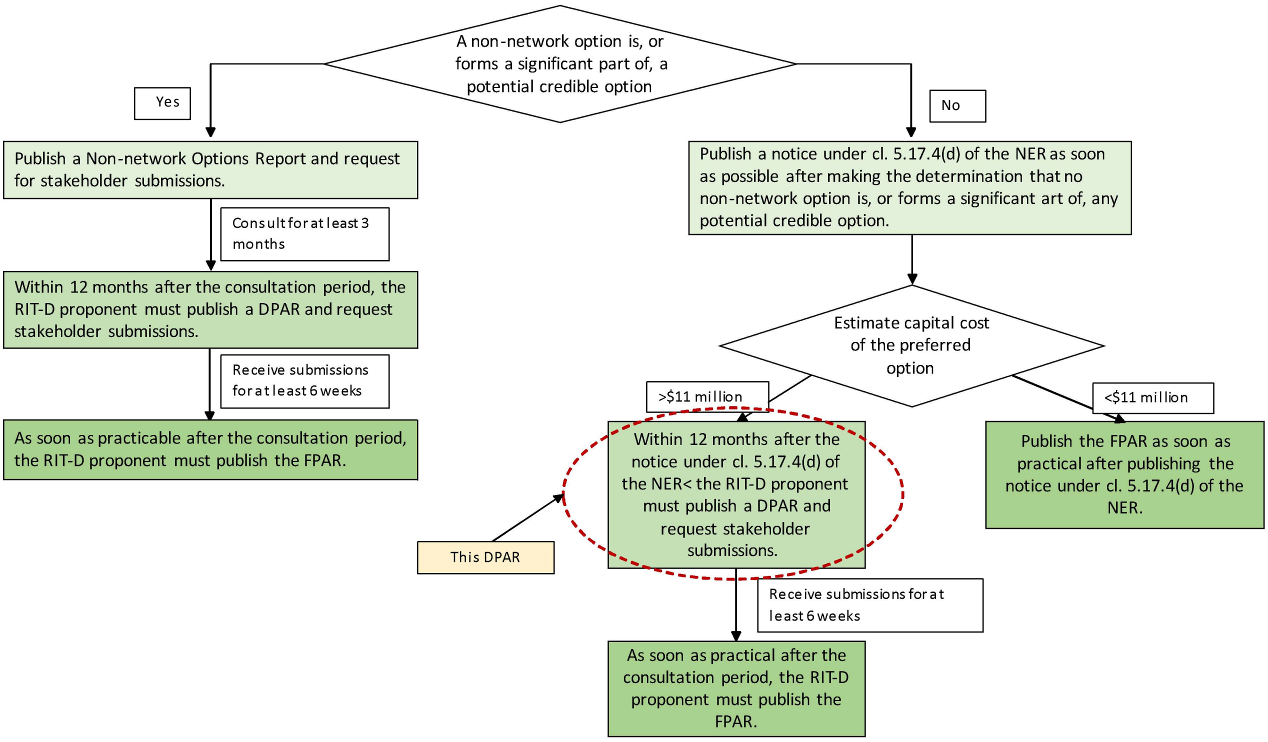
Appendix A – Checklist of compliance clauses

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

Rules clause	Summary of requirements	Relevant sections in the DPAR
5.17.4(j)	(1) a description of the identified need for the investment	2
	(2) the assumptions used in identifying the identified need	2.3, 4 & Appendix C
	(3) if applicable, a summary of, and commentary on, the submissions on the non-network options report	NA
	(4) a description of each credible option assessed	3
	(5) where a DNSP has quantified market benefits, a quantification of each applicable market benefit for each credible option;	5.1
	(6) a quantification of each applicable cost for each credible option, including a breakdown of operating and capital expenditure	3 & 5.2
	(7) a detailed description of the methodologies used in quantifying each class of cost and market benefit	2.3, 4 & Appendix C
	(8) where relevant, the reasons why the RIT-D proponent has determined that a class or classes of market benefits or costs do not apply to a credible option	Appendix D
	(9) The results of a net present value analysis of each of credible option and accompanying explanatory statements regarding the results	5
	(10) the identification of the proposed preferred option	6
	(11) for the proposed preferred option, the RIT-D proponent must provide: (i) details of technical characteristics; (ii) the estimated construction timetable and commissioning date (where relevant); (iii) the indicative capital and operating cost (where relevant); (iv) a statement and accompanying detailed analysis that the proposed preferred option satisfies the regulatory investment test for distribution; and (v) if the proposed preferred option is for reliability corrective action and that option has a proponent, the name of the proponent	6
	(12) Contact details for a suitably qualified staff member of the RIT-D proponent to whom queries on the draft report may be directed.	1.2

Appendix B – Process for implementing the RIT-D

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



Appendix C – Additional detail on key assumptions

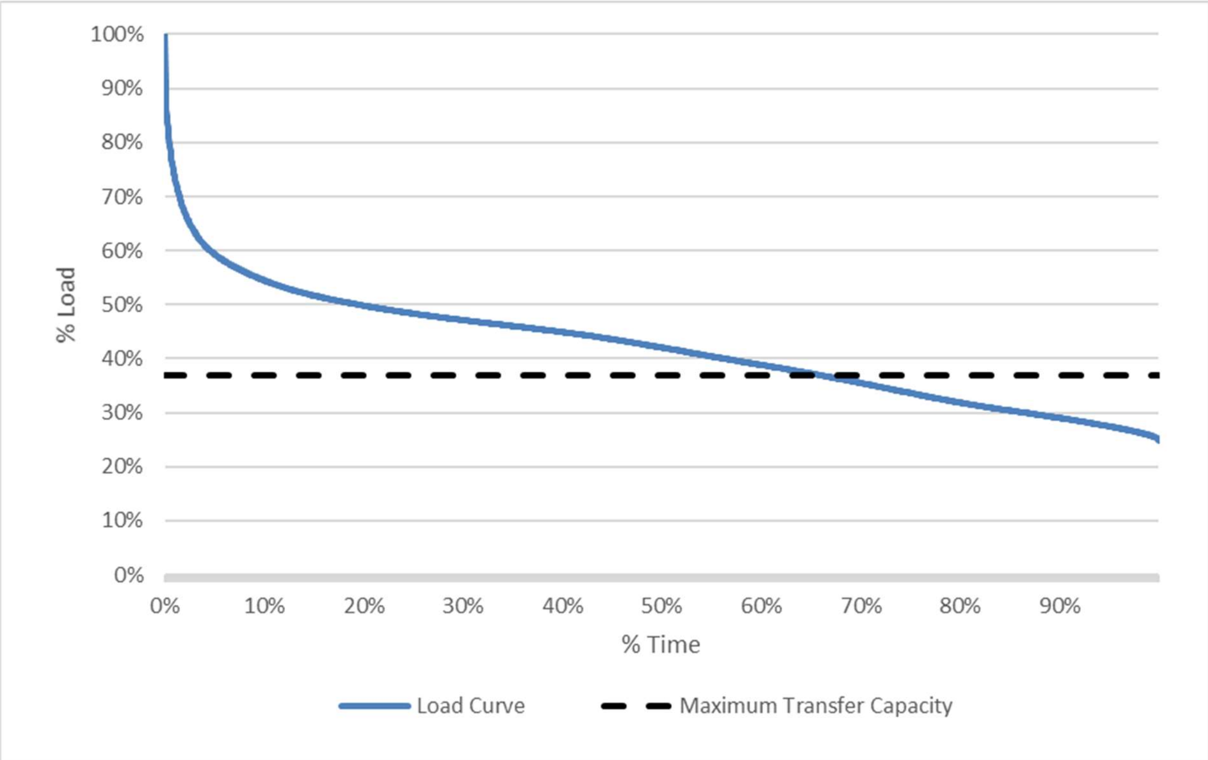
This appendix provides additional detail on key input assumptions that are used in the evaluation of the base case and the credible option.

C.1 Charactertistic load duration curves

Load duration curves for Concord zone substation is presented in Figure C.1 below.

The load duration curves display similar characteristics because of the similar load types supplied by the substations. It is assumed that the load types supplied by these substations will not change substantially into the future and therefore the load duration curves will maintain their characteristic shape regardless of the zone substation supplying the existing load at Concord.

Figure C.1: Load duration curve for Concord Zone Substation



C.2 Load transfer capacity and supply restoration

Concord zone substation load area is classified as urban and has potential 11kV interconnection with Burwood, Meadowbank and Olympic Park zone substations. In the event of a total loss of supply to Concord zone substation, approximately 37% 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 C.1: Equipment outage assumptions

Equipment outage	Action	Outage duration (Days)
Transformer/Feeder Panel	Time between failure and access	1
	Time to undertake causal analysis	1
	Time to engineer solution (T&D Engineering)	1
	Time to manufacturer/repair engineered solution	6
	Time to implement engineered solution	6
	Ancillary Work - testing etc.	2
	Total - MAJOR FAILURE	**17**
	Total - MINOR FAILURE	**8.5**

C.3 Forecast availability of equipment

A range of models have been used to forecast the availability of equipment relevant to this RIT-D. These models utilise Ausgrid's historical 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.

C.3.1 Availability of 11kV 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 Concord zone substation compound 11kV switchboard are assigned condition band poor.

The resultant Weibull parameters are given in the table below.

Table C.2: Switchboard parameters for the Weibull analysis

Equipment	Condition	Shape	Scale
Compound insulated 11kV switchboard	Poor	6.1	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:

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

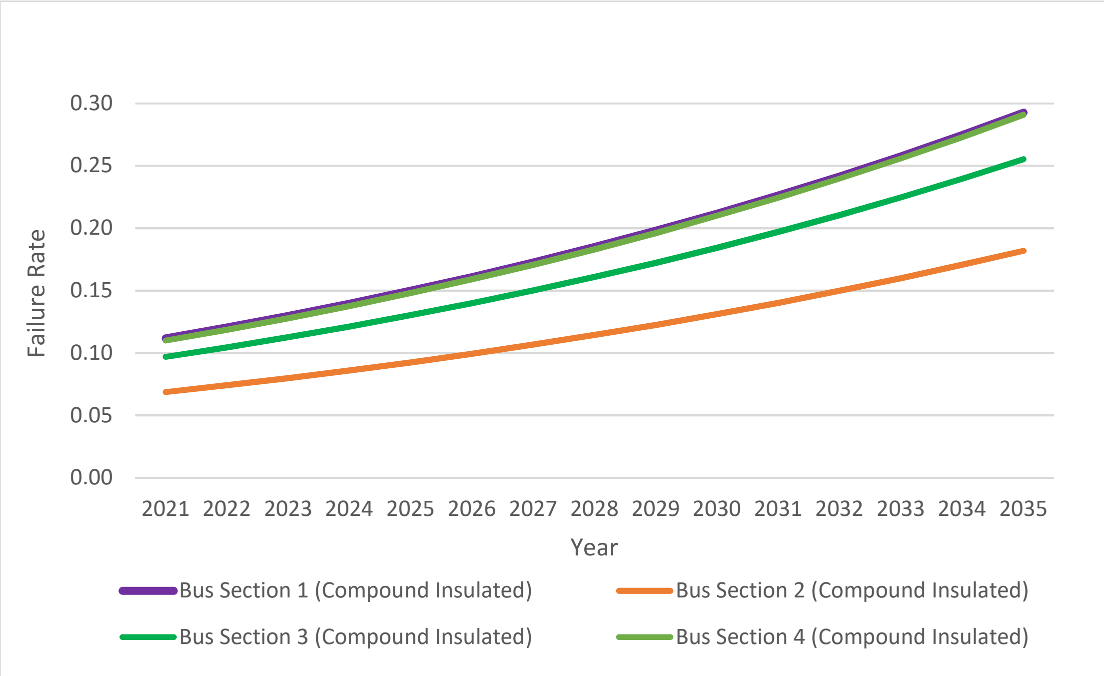
Unavailability is calculated by using a restore time, so the unavailability represents the percentage of time that a particular busbar is not available to supply load. The unavailability (U) of a switchboard is calculated for each year by applying Equation 2:

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

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 C.2 shows cumulative probability of failure for the11kV switchboards at Concord zone substation.

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



C.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.

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 C.3: Direct costs of equipment outages

Equipment outage		Direct cost ($)
Transformer/Feeder Panel	Time between failure and access	2320
	Time to undertake causal analysis	8000
	Time to engineer solution (T&D Engineering)	8640
	Time to manufacturer/repair engineered solution	16800
	Time to implement engineered solution	71040
	Ancillary Work - testing etc.	70000
	Return to Service (RTS)	5120
	Total - MAJOR FAILURE	**181,920**
	Total - MINOR FAILURE	**90,960**

Appendix D – Market benefit classes considered not relevent

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

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

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

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

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated network expenditure	Ausgrid does not expect any changes in unrelated network expenditure in both size of expenditure or timing of expenditure as a consequence of implementing Option 1. Ausgrid has therefore excluded from timing of unrelated network expenditure benefits from this RIT-D.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the NEM is limited. Where the implementation of a credible option affects pool price outcomes, and in particular results in pool prices reaching higher levels on some occasions than in the base case, this may have an impact on the extent of voluntary load curtailment. Ausgrid notes that the option is not expected to affect the pool price and so there is not expected to be any changes in voluntary load curtailment.
Costs to other parties	This category of market benefit typically relates to impacts on generation investment from the option. Ausgrid notes that the option will not affect the wholesale market and so we have not estimated this category of market benefit.
Changes in load transfer capacity and embedded generators	Load transfer capacity between substations is limited by the high voltage feeders that connect substations. The credible option under consideration does not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, Option 2 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. Consequently, Ausgrid has not attempted to estimate 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 would lead to significant changes in network losses and so have not estimated this category of market benefits.
Deferring the need for unrelated network expenditure	Option 2 does not affect the timing of any other network investment.

Ausgrid