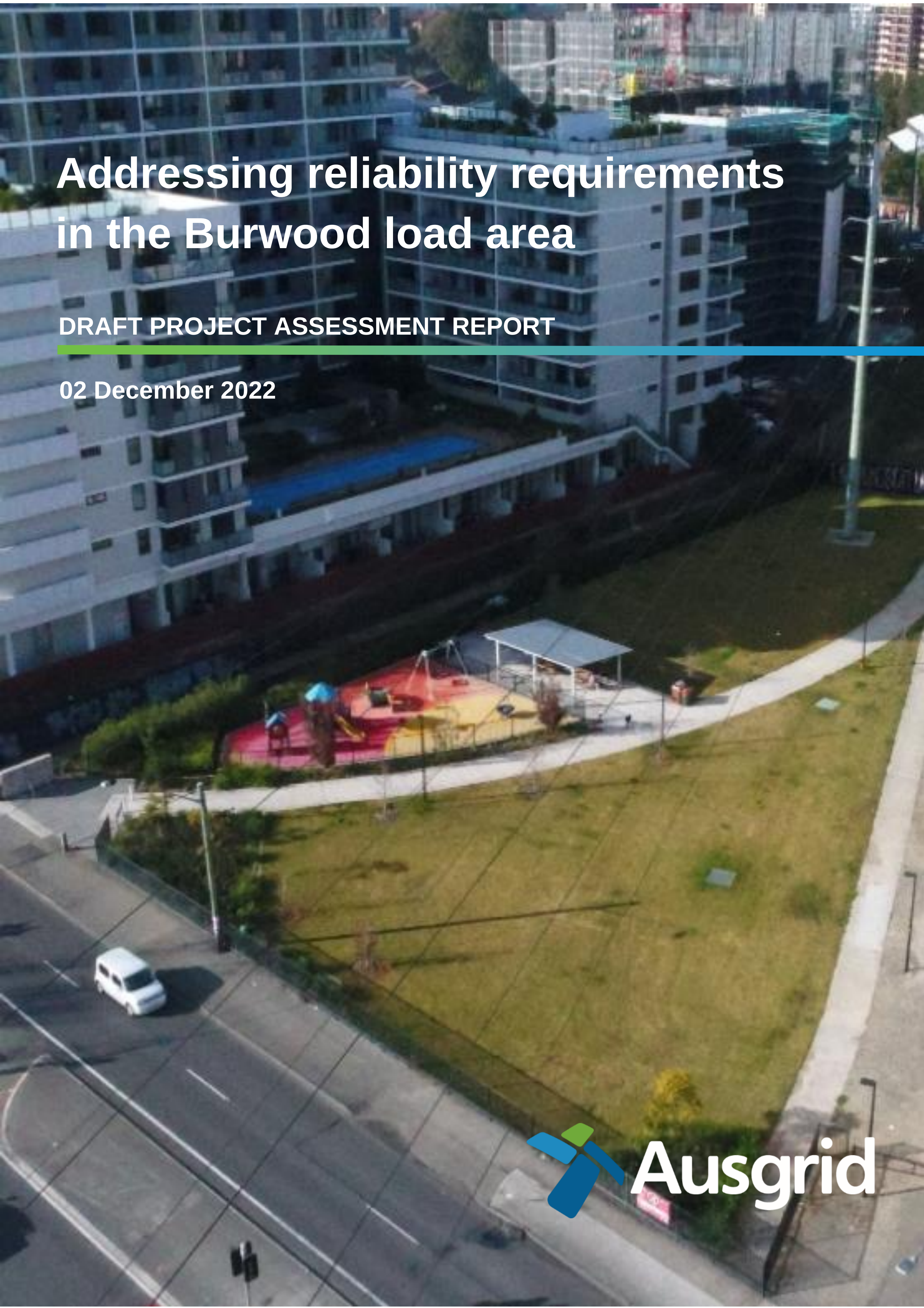
Addressing reliability requirements in the Burwood load area

DRAFT PROJECT ASSESSMENT REPORT

02 December 2022



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Addressing reliability requirements in the Burwood load area

Draft Project Assessment Report – December 2022

Contents

Executive Summary

This report represents the application of the RIT-D to options for replacing ageing fluid-filled feeders to meet reliability requirements in the Burwood load area

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**) for options for replacing aging fluid-filled feeders in the Burwood load area.

Feeders 923 and 924 are part of Ausgrid's Inner West network, supplying the Burwood load area of approximately 27,000 customers. These 132kV feeders connect the Burwood Zone Substation (ZS) to the Mason Park subtransmission switching station (STSS), via the Strathfield Transition Point (TP). The feeders include underground sections of self-contained fluid filled (**SCFF**) cable, which are considered an obsolete and outdated technology. They are becoming less reliable and approaching the point where their replacement maximises the net benefit for the community.

Ausgrid has identified the need to replace the underground SCFF sections of feeders 923 and 924. If action is not taken, significant levels of unserved energy are expected if the cables fail. In addition, increasing maintenance costs to repair and restore service would be expected, as well as increasing environmental risks of oil leaking from the cables. Without action, it is expected that electricity distribution reliability and performance standards will be breached. Therefore, Ausgrid is undertaking a RIT-D to assess options for addressing the risk that the ageing SCFF sections of feeders 923 and 924 pose and to ensure reliability and performance standards are met.

The 'identified need' for this RIT-D is to maintain the required level of reliability for customers in the Burwood load area

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 its 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.

In addition, Ausgrid has made a commitment to the NSW Environment Protection Authority (**EPA**) to a program for replacing or retiring all SCFF cables with known leaks by 2034, due to the environmental risks associated with oil leaking from these cables. Feeders 923 and 924 have experienced oil leaks over the past 15 years, with incidence of failure expected to increase materially with age. Stormwater canals in their vicinity increase environmental risks.

Two credible network options have been identified and assessed

We have identified and assessed two credible network options as part of this RIT-D.

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

Option	Capital costs	Commissioning
Option 1 – Like-for-like replacement of SCFF sections of feeders 923 and 924 in existing route using modern equivalent technology	$15.3 million	2024/25
Option 2 – Replacement of SCFF sections of feeders 923 and 924 in alternative route using modern equivalent technology	$13.2 million	2024/25

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

Non-network options and stand-alone power systems are not considered viable for this RIT-D

Ausgrid has considered the ability of any non-network or stand-alone power system (SAPS) solutions to assist in meeting the identified need. An assessment into reducing the risk of unserved energy has shown that these alternatives are unlikely to cost-effectively address the risk, compared to the network options outlined above. This is driven primarily by the significant amount of unserved energy that each network option can avoid, compared to the base case, and the cost of non-network or SAPS solutions. This is detailed further in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.

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

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

- 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 the credible option;
- central scenario – the central 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 an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected market benefits.

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

Table E.2 – Summary of the three scenarios investigated as part of this RIT-D

Variable	Scenario 1 – central	Scenario 2 – low benefits	Scenario 3 – high benefits
Demand[3]	POE50 Step Change	Minimum POE50 demand across AEMO scenarios	POE10 Step Change
VCR	$55.51/kWh[4]	$38.86/kWh (30 per cent lower than the central estimate)	$72.17/kWh (30 per cent higher than the central estimate)
Capital costs[5]	Base line capital cost estimate	115 per cent of capital cost estimate	85 per cent of capital cost estimate
Unplanned corrective maintenance	Base line estimate	70 per cent of base line estimate	130 per cent of base line estimate
Environmental risk costs	Base line estimate	70 per cent of base line estimate	130 per cent of base line estimate
Discount Rate	3.44%	5.50%	2.34%

Option 2 is the preferred option at this draft stage

Ausgrid proposes Option 2 as the preferred option based on the outcomes of our analysis in this DPAR. Expected benefits are driven by reduced involuntary load shedding that would otherwise be incurred under the base case, with additional benefits from avoided maintenance costs and environmental risk costs.

Option 2 involves the commissioning of new underground feeders using modern equivalent XLPE technology between the Burwood ZS and Ismay Reserve, as well as the decommissioning of the existing SCFF feeders, the Strathfield Transition Point and removal of 230 metres of overhead lines.

Option 2 is found to have the highest net market benefits under all scenarios, owing to its lower capital costs. The results of the NPV analysis are presented in Table E.3 below on a weighted basis across all three scenarios. The estimated capital

[3] The demand forecasts align with those used by AEMO in the 2022 ISP.

[4] Derived from the AER 2019 estimates, inflated by the CPI and load weighted to reflect the site-specific VCR at the Burwood ZS. See Appendix D for full calculation.

[5] The variation in capital cost sensitivity also affects planned maintenance since this cost is a proportion of capital expenditure. Decommissioning costs associated with each option (which are capitalised) are also included in this sensitivity.

cost of this option is $13.2 million, including $600k in decommissioning costs. The new feeders are expected to be commissioned in 2024/25, and operating costs are expected to be $13k per annum (0.1 per cent of capital expenditure).

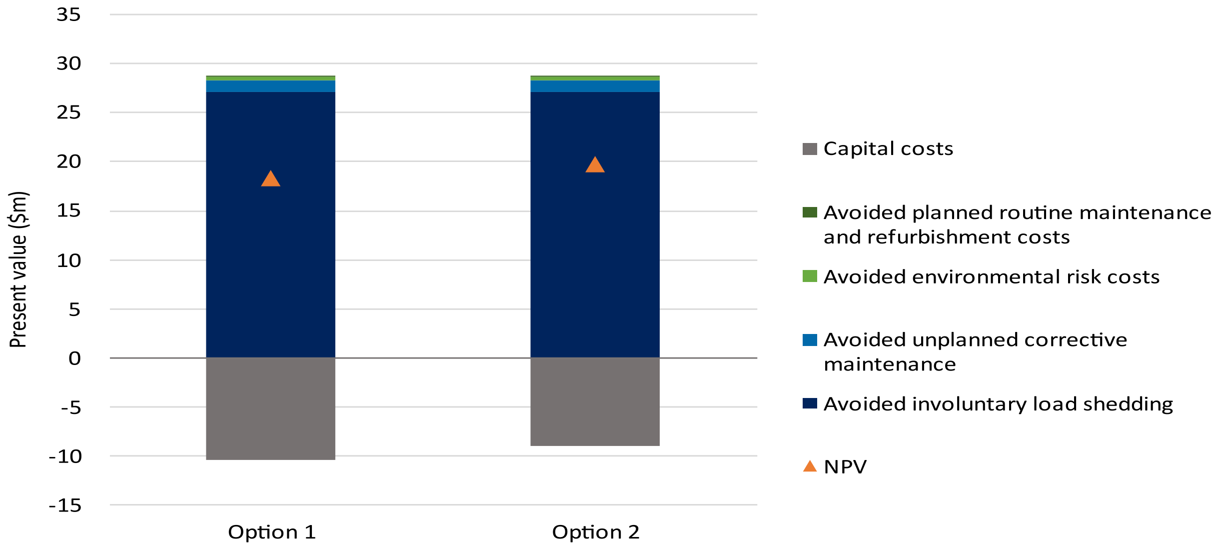
Ausgrid considers that this DPAR and the accompanying detailed analysis identify Option 2 as the preferred option and that this satisfies the RIT-D requirements. Ausgrid is the proponent for Option 2.

Table E.3 – Net Present Value benefits relative to base case, weighed across scenarios, $m 2022/23

Option	PV of costs	PV of gross benefits	Weighted NPV	Ranking
Option 1	-10.3	28.7	18.4	2
Option 2	-8.9	28.7	19.8	1

Figure E.1 presents the present value of cost and benefit components, weighted across the three scenarios. Most of the expected benefits arise from a reduction in unserved energy, while the costs arise from the capital costs of the new feeders.

Figure E 1: Present value of costs and benefits relative to the base case



Ausgrid has started engaging with the City of Canada Bay Council and Strathfield Council, Transport for NSW, Sydney Trains, Bakehouse Quarter and the local community to obtain early feedback on the preferred cable route.

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 Burwood load area and follows the publication of the Options Screening Notice. Ausgrid welcomes written submissions on this DPAR. Submissions are due on or before 13 January 2023. 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

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.

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 Burwood load area. It follows the publication of an Options Screening Notice for this RIT-D.

The 132kV electricity subtransmission cables ('feeders') 923 and 924 are part of Ausgrid's Inner West network, connecting the Burwood Zone Substation (**ZS**) to the Mason Park subtransmission switching station (**STSS**), via the Strathfield Transition Point (**TP**). The feeders consist of overhead sections from Mason Park STSS to Strathfield TP and underground sections from Strathfield TP to Burwood ZS. The feeders serve approximately 27,000 customers, including large commercial loads such as the Burwood Westfield and the Strathfield Plaza.

The underground feeder sections are of the self-contained fluid filled (**SCFF**) type, which are considered an obsolete and outdated technology. They were commissioned in the 1970s and are now reaching the end of their service life. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community.

Ausgrid's planning studies indicate that there will be substantial Expected Unserved Energy (**EUE**) to loads in this area of our network if these cables fail, as well as reactive maintenance costs associated with having to repair and restore service, and environmental risks from oil leaking from the cables. If action is not taken, it is expected that Ausgrid's electricity distribution license reliability and performance standards will be breached.

Ausgrid is therefore undertaking a RIT-D to assess options for addressing the risk associated with the ageing underground SCFF sections of feeders 923 and 924, to ensure we continue to satisfy our reliability and performance standards.

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

1.1 Role of this draft report

Ausgrid has prepared this DPAR in accordance with the requirements of the NER under clause 5.17.4. It is the second stage of the formal consultation process set out in the NER in relation to the application of the RIT-D and follows the publication of the Options Screening Notice.

The purpose of the DPAR is to:

- describe the identified need Ausgrid is seeking to address, and 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 some classes of market benefits or costs do not apply to credible options;
- present and explain the results of a net present value (NPV) analysis of each credible option, and
- identify the proposed preferred option.

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 different investment options, in light of any submissions received on this DPAR. The entire RIT-D process is detailed in Appendix B.

1.2 Submissions and queries

Ausgrid welcomes written submissions on this DPAR and are due on 13 January 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 the key assumptions underpinning the identified need.

2.1 Overview of the Inner West subtransmission network and existing supply arrangements for the Burwood load area

Ausgrid's Inner West network extends from Homebush Bay in the north, south-east to Rozelle and Leichhardt, and west to Auburn. The Inner West network comprises of 132/11kV and 33/11kV ZS as well as gas pressure, SCFF and paper insulated feeders. Feeders 923 and 924 form an important part of this network, suppling approximately 27,000 customers including commercial loads such as the Burwood Westfield and Strathfield Plaza.

Feeders 923 and 924 were commissioned in 1972 and are approximately 3.7km and 3.8km in length, respectively. The feeders consist of overhead lines that run from the Mason Park STSS to the Strathfield TP, where the lines transition into underground SCFF that extend 1.6km to Burwood ZS (Figure 2.1).

The feeders' availability is critical to supplying Burwood ZS. Ausgrid's predictive failure models for the underground sections of feeders 923 and 924, which are informed by condition assessments, indicate that large quantities of unserved energy are expected to arise if action is not taken.

While the current network arrangement ensures a level of redundancy, any concurrent outage of these two feeders would result in the loss of supply to Burwood ZS. Partial loads could be recovered via 11kV load transfers to Concord, Olympic Park and Croydon ZS's using existing connections but extended outages for some customers would be likely.

The underground sections of feeders 923 and 924 have experienced leaks over the last 15 years and have previously failed. They are also situated near stormwater canals, increasing the environmental risk costs associated with oil fluid leaks. To minimise the environmental risk of fluid leaks in SCFF feeders, Ausgrid has made a commitment to the NSW Environment Protection Authority (**EPA**) to replace or retire all SCFF cables with known leaks by 2034.

Figure 2.1 presents the routes of feeders 923 and 924 with respect to the Mason Park STSS and the Burwood ZS, where the blue ring specifies the location of the underground sections of the feeders that are in need of replacement.

Figure 2.1 – Schematic view of the 132kV network including Feeders 923 and 924

2.2 Summary of the 'identified need'

Condition assessments and predictive failure models for feeders 923 and 924 indicate that the risk of prolonged outages is growing. Significant EUE is likely in the near-term if no remedial action is taken.

Ausgrid is obliged to comply with reliability and performance standards as part of its distribution license granted by the Minister for Industry, Resources and Energy under the Electricity Supply Act 1995 (NSW). Under its license, reliability and performance standards are expressed in two measures:

- SAIDI[6] – 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[7] – 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, maintenance and environmental risks derived from the fact the these SCFF feeders have failed in the past and experienced fluid leaks.

A concurrent outage of these feeders, which are installed in a common trench, would result in the loss of supply to Burwood ZS. Partial loads would be recovered via 11kV load transfers to Concord, Olympic Park and Croydon ZS's using existing connections, but extended outages for some customers would be likely.

SCFF cables also impose environmental risks associated with oil leakages that increase as they age. Ausgrid has developed a SCFF cable management strategy which has been reviewed by the EPA and which we continue to follow. A supporting investment strategy has been implemented to replace or retire all SCFF feeders with known leaks by 2034. This strategy prioritises investments considering the expected decline in network reliability as well as environmental risks.

2.3 Key assumptions underpinning the identified need

The need to undertake action is predicated on the deteriorating condition of the existing 132kV underground sections of Feeders 923 and 924 from the Strathfield TP to Burwood ZS and the characteristics of any resultant outages, as well as the fact that maintaining technologies present heightened maintenance and asset failure risks.

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

2.3.1 Ageing SCFF 132kV feeders 923 and 924 are expected to increase the risk of involuntary load shedding

A key assumption underpinning the identified need is the increasing probability of significant and sustained unserved energy at the Burwood ZS in the event of concurrent feeder outages. Probabilistic failure modelling, which is informed by condition assessment, indicates an increasing risk of significant involuntary load shedding on these feeders.

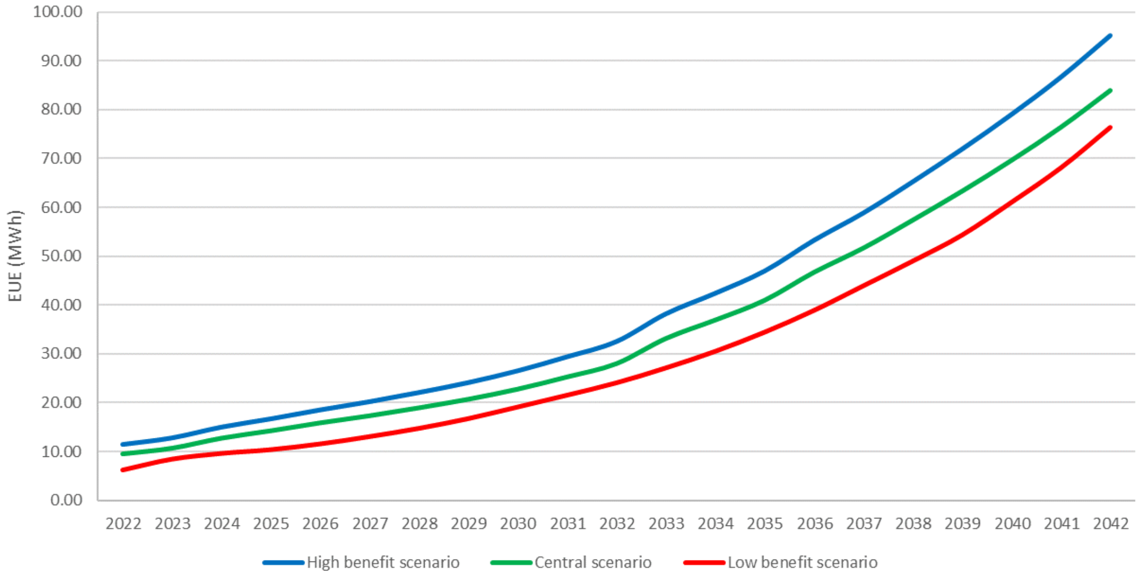
Feeders 923 and 924 are reaching the end of their technical and serviceable lives. The outage duration for SCFF cable leaks can be lengthy, with repairs taking much longer than for other assets in Ausgrid's network. Leaking cables must be removed from service to determine the source of the leak, requiring extensive excavation of heavily trafficked streets. Repair of these cables also requires specialist skills given the technology has been obsolete for over 30 years and manufacturers no longer produce the cables, nor the accessories required for their repair.

EUE forecasts for feeders 923 and 924 (Figure 2.2) are based on cable failure frequency and failure duration and are combined with a model of the electricity network, including the forecast pattern of demand. The cable failures are assumed to occur at a frequency determined by the cable failure model, but their impact depends on the load level at that time.

[6] System Average Interruption Duration Index.

[7] System Average Interruption Frequency Index.

Figure 2.2 – Expected Unserved Energy forecast for feeders 923 and 924



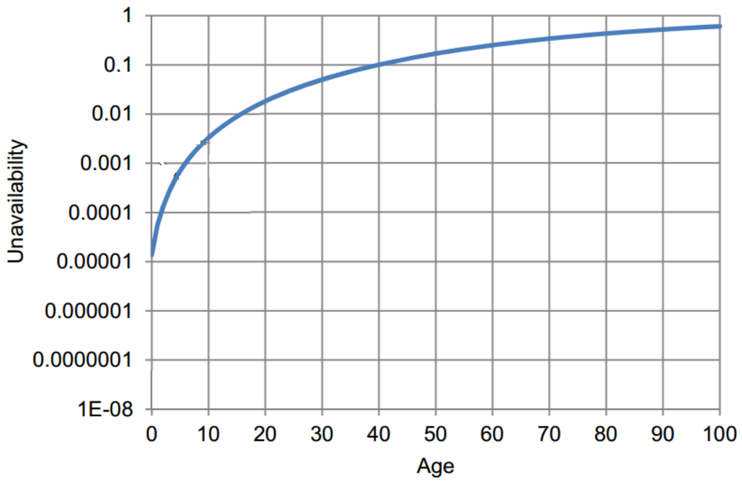
Ausgrid has developed a model to quantify the failure parameters (probabilistic distribution of outage frequency and duration) of each cable, relative to its observable condition. Supply or network risk is assigned for each cable based on the network configuration, available capacity under defined contingency conditions, demand forecasts and historical asset management records. A key component to this assessment is the cable failure model that forecasts the frequency of future cable failures. This model is developed from historical failure records, and then modified by cable condition indicators including Insulation Resistance tests. The failure model is applied to a probabilistic model of the network and the demand it is supplying, to estimate the long-term average amount of annual energy that is beyond the technical capability of the depleted network and therefore cannot be supplied.

2.3.2 Probability of assets failing increases with age

Network asset failure probabilities and asset unavailability have a significant effect on the expected level of involuntary load shedding. Ausgrid has adopted well-accepted models for feeders to estimate the probability of failure. For underground cables, the Crow-AMSAA model is used to determine both the probability of failure and unavailability.[8] In general, the probability of failure increases with asset age.

The figure below shows unavailability plotted, on a logarithmic scale, for a representative 10km stretch of fluid-filled cables aged zero to one hundred years.

Figure 2.3 – Unavailability of fluid-filled feeders



[8] The Crow-AMSAA model was first developed at the US Army Material Systems Analysis Activity (AMSAA). Details of equations, parameters and application of the model to network assets such as underground cables are presented in Appendix D, section D.3.

This model is also based on the relationship between the condition of a cable and its age. The Crow-AMSAA model shows that the availability of fluid-filled cables is expected to decline significantly if the cables are retained past an age of 50 years. Ausgrid considers this methodology is consistent with industry practice. A detailed discussion of the probability of failure and asset availability is provided in Appendix D.

2.3.3 Feeder redundancy exists but capacity to undertake load transfers is limited

The level of impact on customers expected from any involuntary load shedding is dependent on the level of redundancy in backup 132kV feeders and the capacity to transfer load to other zone substations in the event of 132kV cable failures.

As noted above, a concurrent outage of feeders 923 and 924, which are installed in a common trench, would result in loss of supply to Burwood ZS. Partial loads could be recovered via manual 11kV load transfers to other nearby zone substations using 11kV connections but extended outages for some customers would be likely.

Cable failure modelling indicates that expected involuntary supply interruptions related to predicted failures of feeders 923 and 924 is approximately 11MWh in 2022/23 under the central scenario, increasing to 84MWh per year by 2041/42 if no corrective action is taken.

Both the degree of redundancy and the ability to transfer load elsewhere have been considered by Ausgrid in forecasting EUE. This EUE is then valued using the value of customer reliability (**VCR**) using values published by the Australian Energy Regulator (**AER).** The calculation of the VCR for Burwood ZS, weighted by the load characteristics of that area, is set out in Appendix D.

2.3.4 Environmental risk

In addition to the EUE, Ausgrid also models unplanned repairs and environmental risks associated with the existing SCFF feeders. A significant problem associated with SCFF feeders is the leaking of cable dielectric fluid into the surrounding environment. Environmental risk for each cable is quantified based on historical cable fluid leak volume records and knowledge of environmental sensitivity along the cable route.

Feeders 923 and 924 have experienced multiple oil leaks over the past 15 years, with incidence of failure expected to increase significantly with cable age. Feeders 923 and 924 are situated near stormwater canals, increasing the environmental risks as insulating fluid has the potential to enter the water table.

Further details of Ausgrid’s approach to modelling environmental risk is contained in Appendix D.

3 Two credible options can address the identified need

This section sets out details of the two credible options that Ausgrid has identified as part of its network planning activities to date. We also outline the options that were considered, but not progressed, as part of this RIT-D process. All costs in this section are in 2022/23 dollars unless otherwise stated.

3.1 Option 1 – Like-for-like replacement of underground sections of feeders 923 and 924 in current network configuration

This option involves the like-for-like replacement of the existing underground SCFF feeder sections with a modern equivalent (Cross Linked Polyethylene cables (XLPE)) in their existing configuration. This option will improve reliability, reduce unserved energy and decrease operating expenditure over time compared to the base case of maintaining the existing cables.

Specifically, Option 1 involves the replacement of approximately 1.6 kilometres of underground SCFF cable along the existing route configuration. This would require:

- works at Mason Park STSS, Strathfield TP and Burwood ZS to facilitate the new 132kV feeder connection;
- installation of two 132kV XLPE feeders of approximately 1.6km from Strathfield TP to Burwood ZS, with a proposed firm rating of 230MVA;
- metering, control and protection communication upgrades at both ends; and
- decommissioning of the existing SCFF feeder between Strathfield TP and Burwood ZS.

Upon commissioning of the new feeders, the existing SCFF feeder sections will be disconnected at both ends, oil tanks will be removed and insulating fluid purged, with cable ends sealed and left in situ.

The estimated cost of this option is approximately $15.3 million (including decommissioning costs of approximately $600k). Optimal timing analysis indicates that construction of this option would commence in 2022/23, with commissioning two years later in 2024/25. Once commissioned, operating costs are expected to be approximately $15k per annum (0.1 per cent of capital expenditure)

Further analysis underpinning the optimal timing assessment for this option is set out in section 5.4.

3.2 Option 2 – Optimised replacement of underground sections of feeders 923 and 924 using alternative route alignment

Option 2 uses an alternative, optimised underground route from the Burwood ZS to the Ismay Reserve that enables the decommissioning of the Strathfield TP and removal of approximately 230 metres of dual circuit overhead lines from Paramatta Road to Strathfield TP. Similar to Option 1, this option involves the installation of underground XLPE cables to improve reliability, reduce unserved energy and decrease operating expenditure over time compared to the base case of maintaining the existing cables.

The use of this route alignment results in considerable cost savings compared to Option 1, due to:

- a shorter route alignment (Option 2 is approximately 100 metres shorter than Option 1);
- the use of existing conduits installed as part of the WestConnex motorway project over part of the route; and
- construction taking place along smaller residential streets (compared to Option 1) which minimises traffic management costs and enables the construction to be completed during day-time hours.

Under this option, the Strathfield TP can be decommissioned. Additionally, the removal of overhead lines increases visual amenity and results in an associated reduction in safety risk from the potential for overhead cable strikes.

Specifically, the works for this option include:

- construction of 1.5 km of dual circuit ductline between Lloyd George Avenue, Burwood and Ismay Reserve, Strathfield;
- construction of one joint bay mid-way along the proposed route;
- installation of new XLPE cables along the dual circuit ductline;

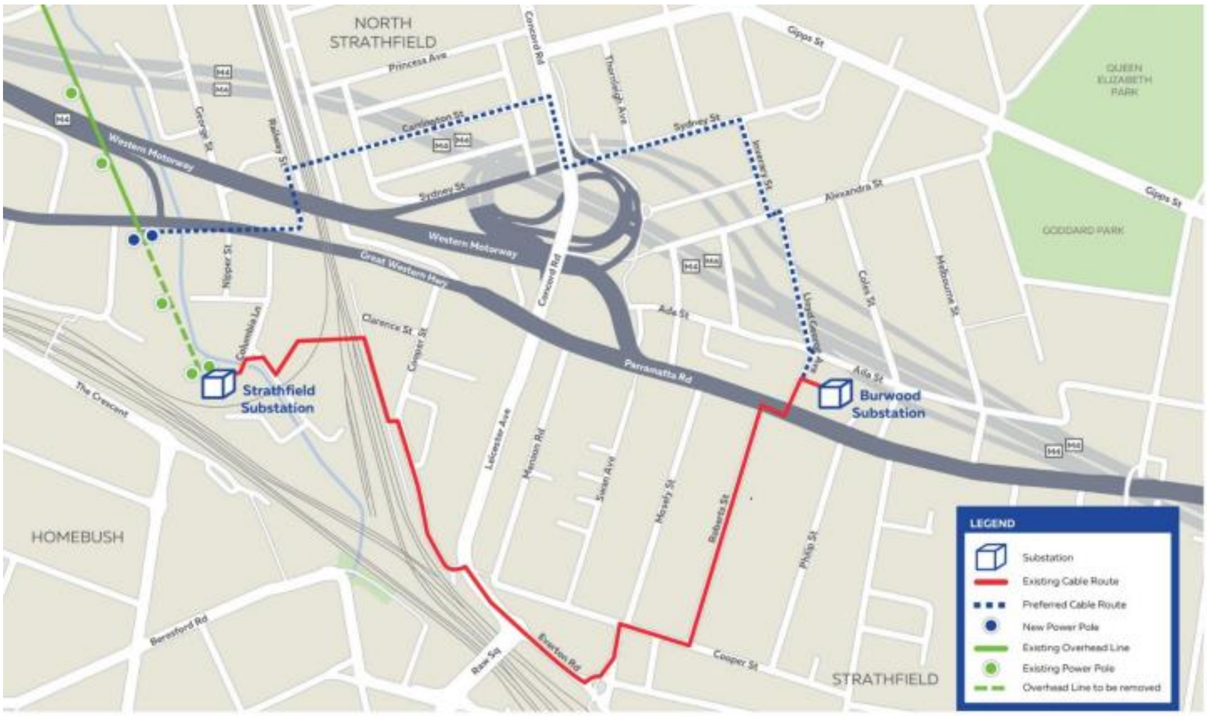
- relocation of 11kV feeder along Concord Rd and recovery of redundant 33kV cables;
- installation of two new steel UGOH (underground to overhead) poles in the Ismay Reserve;
- removal of 230m section of dual circuit overhead wires and poles between Paramatta Rd and Strathfield TP;
- protection and communication upgrades at Burwood ZS and Mason Park STSS;
- decommissioning of the Strathfield TP at Columbia Lane, Strathfield and preparing the site for divestment; and
- decommissioning existing SCFF sections of feeders 923 and 924.

Upon commissioning of the new feeders, the existing SCFF feeder sections will be disconnected at both ends, oil tanks will be removed, insulating fluid purged with cable ends sealed and left in situ.

The estimated cost of this option is approximately $13.2 million including decommissioning costs (of approximately $600k). Optimal timing analysis indicates that construction would commence in 2022/23 for a commissioning in 2024/25. Once commissioned, the operating costs for this option are expected to be approximately $13k per annum (0.1 per cent of capital expenditure).

The analysis underpinning the optimal timing assessment of this option is set out in section 5.4.

Figure 3.1 – Comparison of proposed route alignments for Option 1 (existing route) and Option 2



3.3 Options considered but not progressed

Ausgrid has considered one additional network option involving decommissioning the existing Burwood ZS and associated feeders 923 and 924 supplying the Burwood ZS. The costs for this option were found to be materially higher than Options 1 and 2, due to the extensive 11kV feeder installation works required to transfer the load to adjacent zone substations, as well as network augmentations at these sites.

Ausgrid also considered the ability of non-network solutions to assist in meeting the identified need. Specifically, an analysis of non-network options considered how demand management could defer the timing of the preferred network solution and whether the estimated unserved energy at risk could be cost effectively reduced. A cost benefit assessment of demand management options has shown that non-network alternatives would not be cost effective due to the magnitude of the load reduction required.

This result is driven primarily by the significant amount of unserved energy that network options can avoided, compared to base case, and is detailed further in the separate Option Screening Notice released in accordance with clause 5.17.4(d) of the NER.

If, during the course of this RIT-D process, a cost-effective non-network solution emerges, it will be assessed alongside the other options in the FPAR.

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 options considered in this RIT-D. Appendix D presents additional detail on the assumptions and methodologies employed to assess the option.

4.1 General overview of the assessment framework

All costs and benefits for each credible option are measured against a 'business as usual' base case. Under this base case, Ausgrid escalates 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 escalation of unserved energy and environmental risk costs.

The RIT-D analysis has been undertaken over a 20-year period, from 2023 to 2042. Ausgrid considers that a 20-year period takes into account the size, complexity and expected life of the relevant credible option to provide a reasonable indication of the market benefits and costs of the option.

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

A real, pre-tax commercial discount rate of 3.44 per cent has been adopted as the central assumption for the NPV analysis based Ausgrid's prevailing opportunity cost for capital investments that has been calculated consistent with the AER's rate of return instrument. We have also tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound real, pre-tax discount rate of 2.34 per cent (consistent with paragraph 17 of the RIT-D instrument[9] and based on an average of the AER's Final Decisions for DNSP's regulated weighted average cost of capital (WACC) at the time of preparing this DPAR[10]), and an upper bound discount rate of 5.50 per cent (i.e. the central assumption used in the Inputs, Assumptions and Scenarios (IASR) report prepared by AEMO for the 2022 Integrated System Plan (ISP)[11]).

4.2 Ausgrid's approach to estimating project costs

Ausgrid has been able to substantially reduce the costs of SCFF cable replacement initiatives through bundling projects together into a single tender. Specifically, Ausgrid has bundled the cable replacement works for three projects of work, including the:

- Strathfield cable project (RIT-D: Addressing reliability requirements in the Burwood load area);
- Waterloo to Surry Hills Cable Project (RIT-D: Addressing reliability requirements in Zetland and Waterloo load areas); and
- Alexandria to Kingsford Cable Project (RIT-D: Addressing reliability requirements in the Kingsford load area).

The costs from this tender process have been used as the basis for the capital costs in this RIT-D. We have also adopted a lower capital cost sensitivity of +/- 15 per cent (rather than the typical +/- 25 per cent) in recognition of increased cost certainty provided by the recent tender process.[12]

In estimating capital costs, Ausgrid has included capitalised network planning and project scoping costs incurred in past financial years to ensure capital costs are complete and fully accounted for.[13]

[9] Paragraph 17 of the RIT-D instrument states that the lower boundary discount rate should be the regulated cost of capital.

[10] 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).

[11] AEMO, *2021 Inputs, Assumptions and Scenarios Report*, July 2021, p. 105; and AEMO, *2022 Integrated System Plan*, June 2022, p. 91.

[12] The outcome of the tender process will be finalised following the outcome of this RIT-D assessment.

[13] Project design and technical development cost incurred in 2021/22 have been adjusted using Ausgrid's prevailing cost of capital and included in 2022/23 capital expenditure.

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 analysis 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 the credible option and the base case by taking into account:

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

All options reduce the incidence of asset failures relative to the base case, and hence the expected operating and maintenance costs associated with restoring supply is also assumed to decrease.

Ausgrid has also included the financial costs associated with corrective maintenance and environmental 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. Details of the assumptions and methodologies adopted to estimate these avoided costs are presented in Appendix 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 involuntary load shedding.

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

In addition, Appendix C 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, or EUE 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 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 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 $55.5/kWh, reflecting a load weighted value for the affected load at Burwood ZS calculated using the NSW and ACT VCR estimates (for residential, commercial and industrial load) derived by the AER in its VCR Final Report, [14], adjusted

[14] 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

by the Consumer Price Index (CPI) to be in 2022/23 dollars.[15] A breakdown of how the central load weighted VCR has been calculated is provided in Appendix D.

We have also reflected VCR estimates in the scenarios 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.[16]

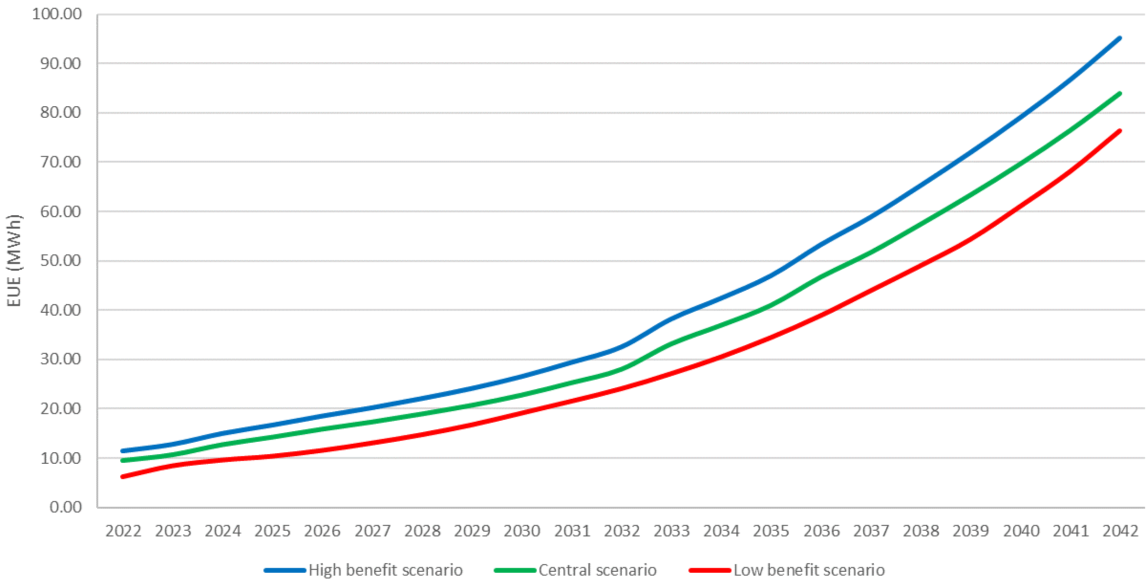
In addition, Ausgrid has investigated how assuming different load forecasts going forward changes expected market benefits under each option. Ausgrid has developed an updated set of load forecasts that draw on the latest ISP released by AEMO on 30 June 2022. Three future load forecasts for the area in question have been investigated:

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

These updated forecasts consider an increased uptake of energy efficiency and electrification to account for an accelerated decarbonisation to meet net zero by 2050, as well as an electric vehicle forecast that is much higher in the earlier years compared to previous forecasts and a rapid conversion of residential gas to electricity. The load forecasts provide a reasonable representation of what can be expected in the Burwood load area.

Figure 4.1 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 EUE prior to feeder replacement, taking into consideration the underlying demand forecasts and the assumed failure rates associated with keeping the existing network assets in service.

Figure 4.1 – EUE under defined load scenarios



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

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

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

- low 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 the credible option;

[15] Inflated to 2022/23 dollars using the CPI for the September 2022 quarter.
[16] AER, *Values of Customer Reliability – Final Report on VCR values*, December 2019, p. 84.

- central scenario – the central 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 an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected market benefits.

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 2 – low benefits	Scenario 3 – high benefits
Demand[17]	POE50 Step Change	Minimum POE50 demand across AEMO scenarios	POE10 Step Change
VCR	\$55.51/kWh[18]	\$38.86/kWh 30 per cent lower than the central estimate	\$72.17/kWh 30 per cent higher than the central estimate
Capital costs[19]	Base line capital cost estimate	115 per cent of capital cost estimate	85 per cent of capital cost estimate
Unplanned corrective maintenance	Base line estimate	70 per cent of base line estimate	130 per cent of base line estimate
Environmental risk costs	Base line estimate	70 per cent of base line estimate	130 per cent of base line estimate
Discount Rate	3.44%	5.50%	2.34%

Ausgrid has developed demand forecasts consistent with AEMO's 2022 Integrated System Plan (ISP) forecasts for future demand growth, with AEMO's POE50 forecasts for the 'Step Change' assumed in the central scenario.

Ausgrid considers that the central scenario is the most likely, since it is based primarily on a set of expected/central assumptions. Ausgrid has therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being weighted equally with symmetric 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.

[17] The demand forecasts align with those used by AEMO in the 2022 ISP.

[18] Derived from the AER 2019 estimates, inflated by the CPI and load weighted to reflect the site-specific VCR at the Burwood ZS. See Appendix D for full calculation.

[19] The variation in capital cost sensitivity also affects planned maintenance since this cost is a proportion of capital expenditure. Decommissioning costs associated with each option (which are capitalised) are also included in this sensitivity.

5 Assessment of the credible options

This section presents the result of the NPV assessment for the credible network options, compared against the base case 'do nothing' option.

5.1 Gross market benefits estimated for the credible options

The table below summarises the gross benefit of the credible options relative to the 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.

Both options are found to deliver almost identical gross market benefits as both options would be commissioned in the same year and result in avoided unserved energy, reduced environmental risk costs and a reduction in unplanned corrective maintenance costs. There are also benefits from reduced planned maintenance as the new XLPE cables entail a lower level of ongoing operating expenditure than existing SCFF cables.

Option 2 is found to have a slightly higher gross market benefit, arising from lower expected operating costs of $13k per annum for Option 2 versus $15k per annum for Option 2.[20]

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

Option	Central scenario	Low benefit scenario	High benefit scenario	Weighted benefits
Scenario weighting	50%	25%	25%	
Option 1	27.6	12.9	46.7	28.7
Option 2	27.6	13.0	46.7	28.7

The primary benefit is estimated to be avoided unserved energy for both options on account of the increasing likelihood of failure of the assets in question, which are nearing the end of their technical lives.

5.2 Estimated costs for the credible options

Table 5.2 below summarises the costs of the credible options relative to the base case in present value terms. The cost is the sum of the project capital costs associated with each option. [21] The central scenario reflects the most likely expected costs of each option, while the low and high benefit scenarios reflect (among other things) +/- 15 per cent adjustment to capital costs and higher/lower discount rates to account for uncertainty.

The cost of each option has been calculated for each of the three reasonable scenarios, in accordance with the approaches set out in section 4. Option 2 is found to have the lowest capital cost across all scenarios, with capital costs of approximately $1.4m less than Option 1, in present value terms under the central scenario.

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

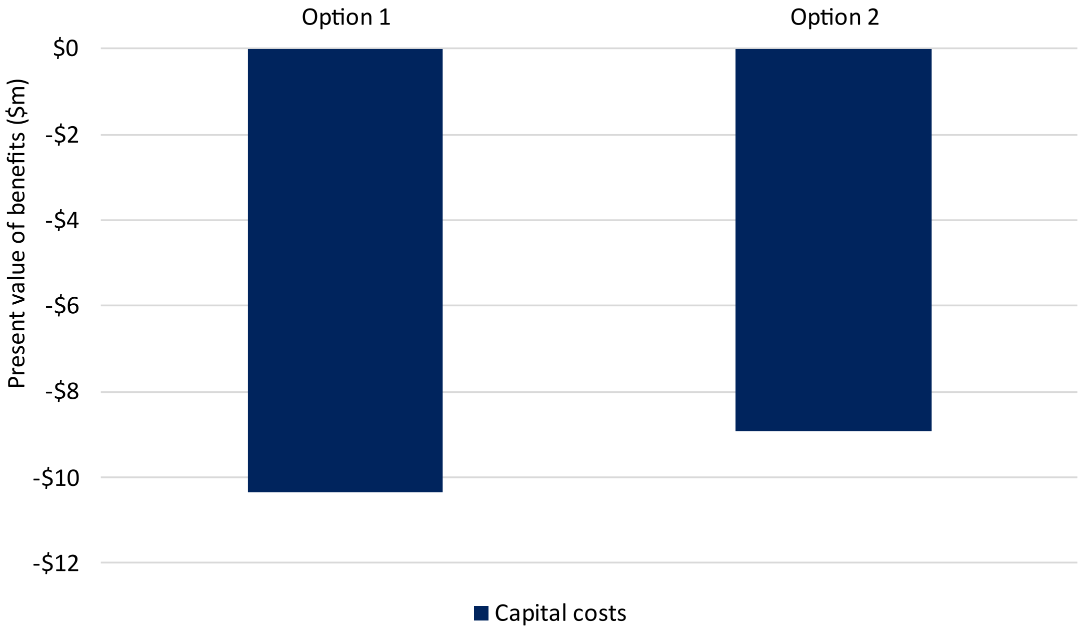
Option	Central scenario	Low benefit scenario	High benefit scenario	Weighted costs
Scenario weighting	50%	25%	25%	
Option 1	10.2	13.2	7.8	10.3
Option 2	8.8	11.4	6.7	8.9

The figure below provides a breakdown of costs relating to each credible option. Capital costs are the determining factor for the ranking of the credible option considered.

[20] The difference is minor and does not show in the table due to rounding.

[21] Operating expenditure associated with a reduction in planned maintenance costs is captured as a benefit and is reflected in the figures presented in Table 5.1.

Figure 5.1 – Breakdown of costs of each credible option relative to the base case



5.3 Net present value assessment outcomes

The table below summarises the net market benefit in NPV terms for the credible options. The net market benefit is the gross market benefit (as set out in Table 5.1) minus the cost of the options (as set out in Table 5.2), all in present value terms. Overall, Option 2 exhibits the highest estimated net market benefit on a weighted basis across all scenarios and is the preferred option identified in this RIT-D.

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

Option	Central	Low benefits	High benefits	Weighted
Option 1	17.4	-0.3	38.9	18.4
Option 2	18.8	1.5	40.0	19.8

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.

Specifically, 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 of each option is maximised. This process was undertaken for the central set of assumptions and a range of alternative assumptions for key variables.

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

- a 15 per cent increase/decrease in the assumed network capital costs;
- alternative forecasts of maximum demand growth, based on POE10 Step Change (high) and aggregated minimum demand values from ISP scenarios (low);
- a lower VCR ($38.86/kWh) and a higher VCR ($72.17/kWh); and
- a higher (5.50 per cent) and a lower discount rate (2.34 per cent).

The figures below outline the impact on the optimal commissioning year for each option, under a range of alternative assumptions. The figures demonstrate the optimal commissioning year for Option 1 is 2024/25 for all sensitivities except the 'low VCR' and 'high discount rate' sensitivities. For Option 2, the optimal timing analysis indicates that the year of commissioning is invariant to the sensitivities tested, with the optimal commissioning year in 2024/25 under all scenarios.

Figure 5.2 – Option 1's distribution of optimal project commissioning years under each sensitivity

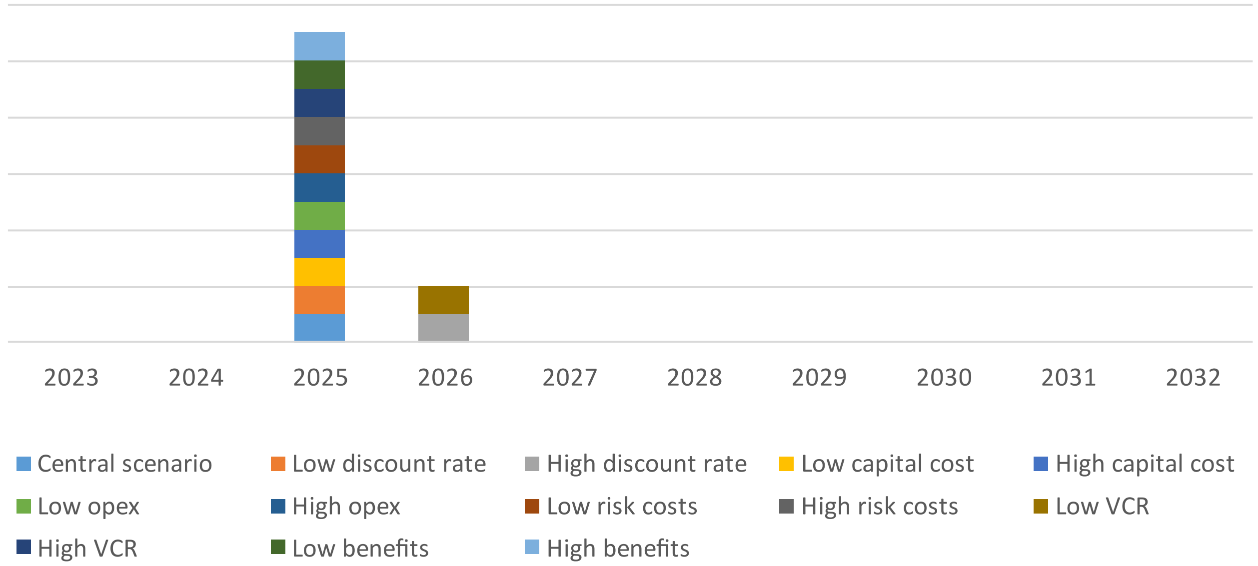
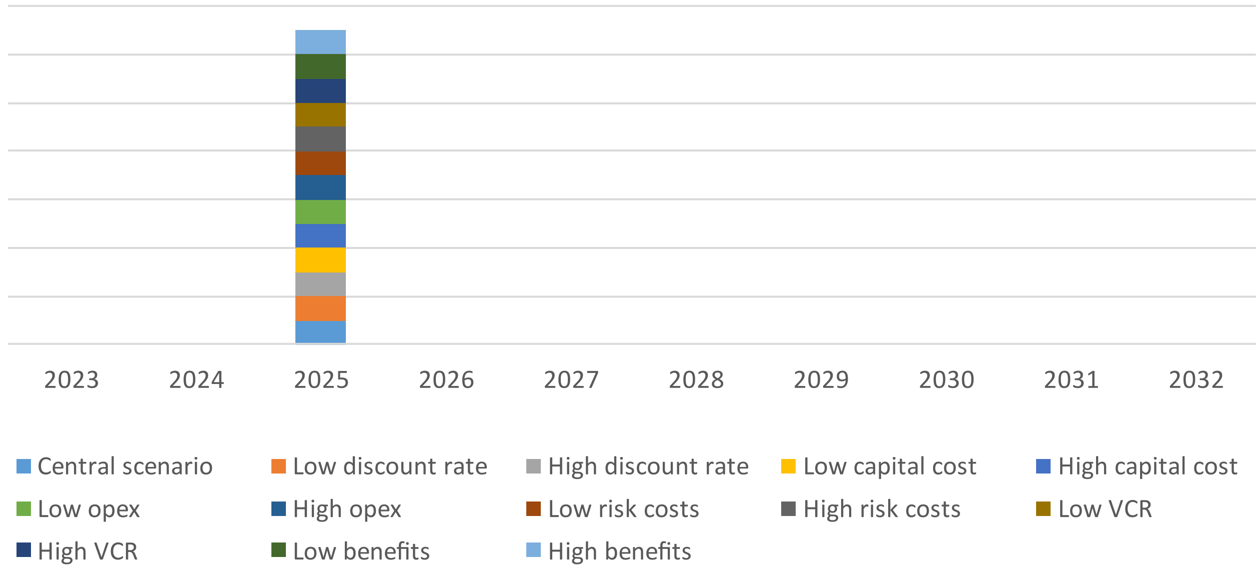


Figure 5.3 - Option 2's distribution of optimal project commissioning years under each sensitivity



5.4.2 Step 2 – Sensitivity of the overall net market benefit

Ausgrid has also conducted sensitivity analysis on 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 in the first step, i.e.:

- a 15 per cent increase/decrease in the assumed network capital costs[22];
- alternative forecasts of maximum demand growth, based on POE10 Step Change (high) and aggregated minimum demand values from ISP scenarios (low);
- a lower VCR ($38.86/kWh) and a higher VCR ($72.17/kWh); and
- a higher (5.50 per cent) and a lower discount rate (2.34 per cent).

The results of the sensitivity test are presented in the table below, showing that Option 2 remains the options with the greatest positive net market benefit across all the variables tested.

Table 5.4 – Sensitivity testing results, central scenario, $m PV 2022/23

Sensitivity	Option 1	Option 2
Central	**17.4**	**18.8**
15 per cent higher capital cost	14.9	16.6
15 per cent lower capital cost	19.9	21.0
Unserved energy under POE10 Step Change	21.3	22.7
Unserved energy under aggregated minimum demand values from ISP scenarios	13.4	14.8
30 per cent higher unplanned corrective maintenance	17.8	19.2
30 per cent lower unplanned corrective maintenance	17.0	18.5
30 per cent higher environmental risk costs	17.5	18.9
30 per cent lower environmental risk costs	17.3	18.7
VCR $72/kWh	25.2	26.6
VCR $39/kWh	9.6	11.0
Lower discount rate	22.3	23.6
Higher discount rate	10.2	11.8

[22] This sensitivity also accounts for uncertainty with respect to decommissioning costs which are capitalised as part of this RIT-D assessment.

6 Proposed preferred option

Ausgrid proposes Option 2 as the preferred option that satisfies the RIT-D. This option involves the commissioning of new underground sections of feeders 923 and 924, using XLPE technology between Burwood ZS and Ismay Reserve, as well as the decommissioning of the Strathfield TP and removal of 230 metres of overhead lines.

Option 2 has been determined to be the preferred option as it results in the highest net present value in the NPV modelling assessment across all scenarios, largely due to the lower capital costs associated with this option.

This option also enables the decommissioning of the Strathfield TP and the removal of 230 metres of overhead lines between the Strathfield TP and Parramatta Road. The removal of overhead lines provides amenity improvements and reduced safety risk, causing the least impact to the community, in addition to the benefits quantified as part of the RIT-D assessment.

The estimated capital cost of this option is $15.3 million, including decommissioning costs of approximately $600k. Ausgrid assumes that the necessary construction to install the new feeders will commence in 2022/23 following completion of the regulatory process, for commissioning in 2024/25.

Once the new installation is complete, operating costs are expected to be approximately $13k per annum (0.1 per cent of capital expenditure per annum).

Ausgrid considers that this DPAR, and the accompanying detailed analysis, identifies Option 2 as the preferred option and that this satisfies the RIT-D. Ausgrid is the proponent for Option 2. Ausgrid has started engaging with key stakeholders such as the City of Canada Bay Council and Strathfield Council, Transport for NSW, Sydney Trains, Bakehouse Quarter and the local community to obtain early feedback on the preferred cable route.

Ausgrid encourages community feedback and has committed to keep the community informed as the project progresses through:

- bespoke newsletters and community drop-in information sessions;
- in the lead up to and during construction, by door-knocks (as required), issuing notification letters and newsletters;
- launching and maintaining a dedicated project website, through the life of the project; and
- maintaining project email address and 24/7 community contact number.

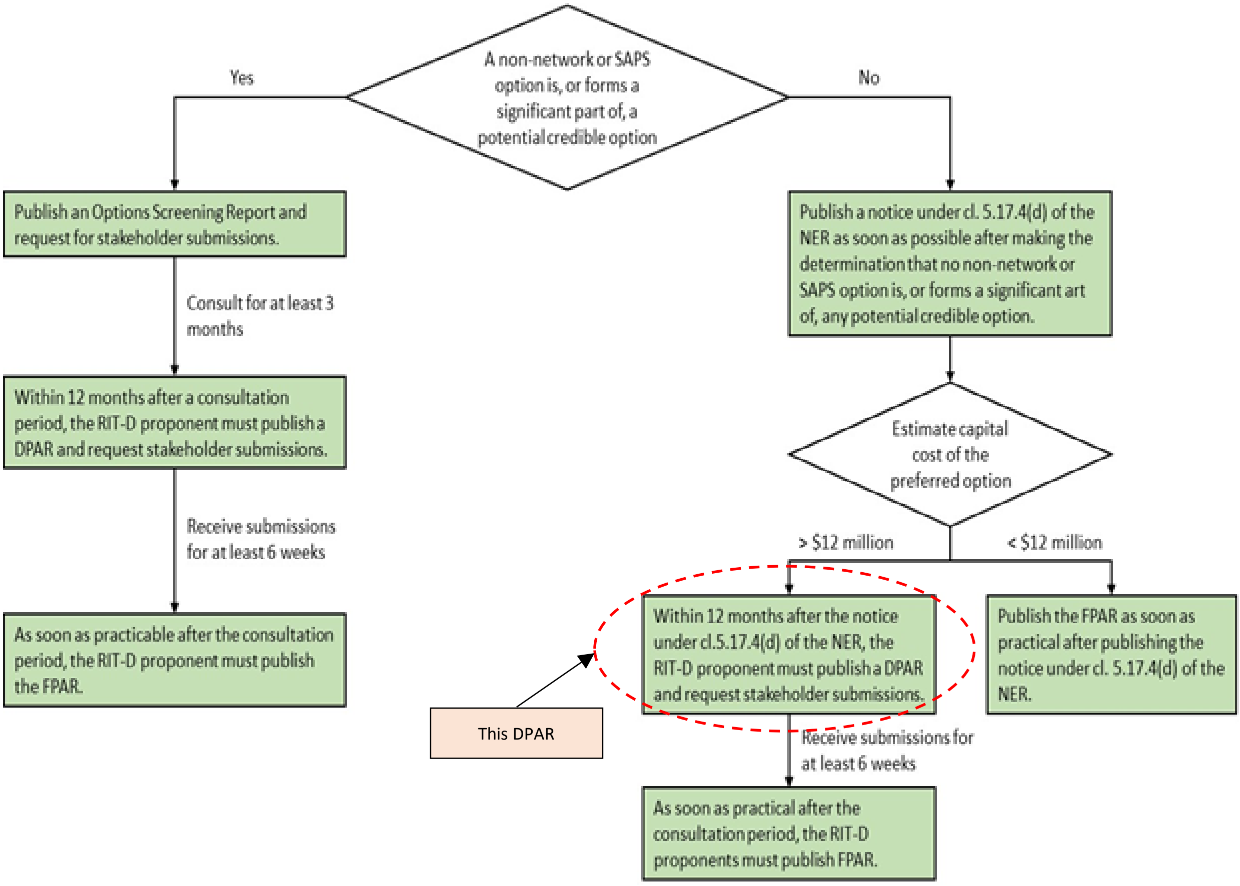
Appendix A – Checklist of compliance clauses

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 191.

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
	(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.	1.2

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 – 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 are not expected to be material for this RIT-D are outlined in the table below.

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

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated expenditure	Ausgrid does not expect the project will have any effect on unrelated expenditure in other parts of the network. Accordingly, Ausgrid considers the market benefit from changes in timing of unrelated expenditure is not material.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the 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 none of the options are 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 none of the options will 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. Credible options under consideration do not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, credible 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.
Option value	Option value arises where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered have sufficiently flexible to respond to that change. Ausgrid notes that the credible options assessed for this RIT-D 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 any of the credible options considered would lead to significant changes in network losses and so has not estimated this category of market benefits.

Appendix D – Additional detail on the assessment methodology and assumptions

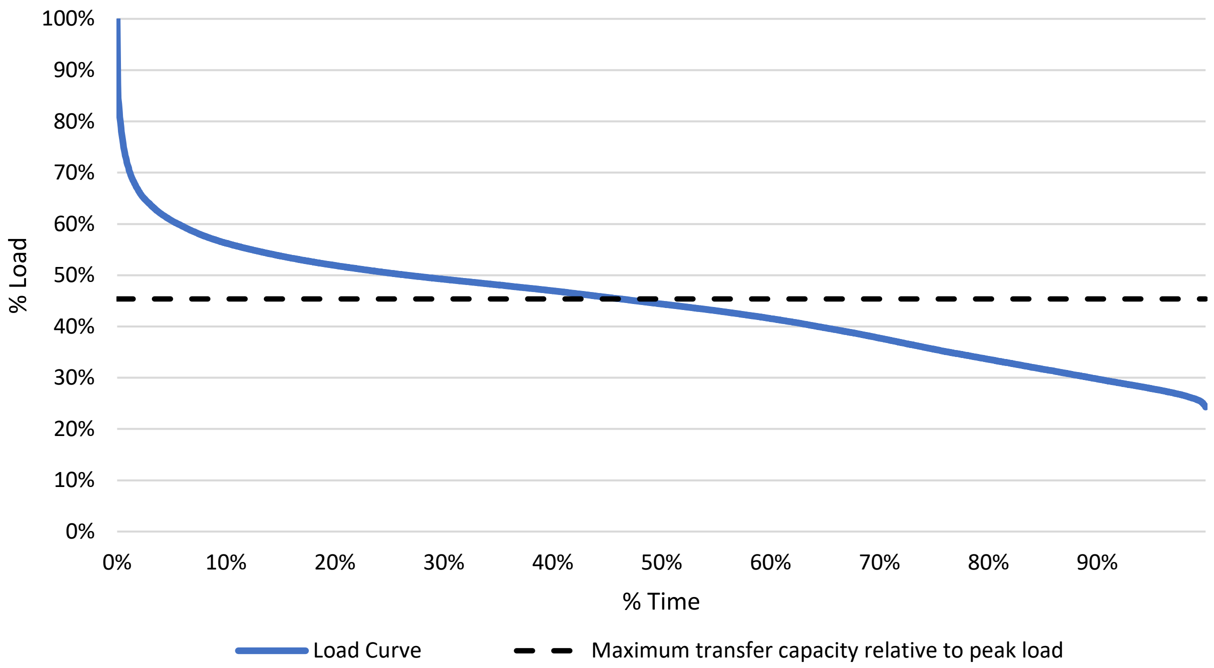
This appendix presents additional detail on the supply restoration assumptions and probability of failure assumptions, as well as the calculation of environmental risk costs and the load weighted VCR calculation.

D.1 Characteristic load duration curves

The load duration curve used in the analysis is presented in Figure D.1 below.

It is assumed that the load types supplied will not change substantially into the future and therefore the load duration curve will maintain its characteristic shape.

Figure D.1 – Load duration curve



D.2 Supply restoration assumptions

Table D.1 – Supply restoration assumptions

Equipment outage	Action	Outage duration
Fluid filled cable failure	Repair The cable is repaired on site.	6.0 weeks
XLPE cable failure	Repair The cable is repaired on site.	2.0 weeks
Fluid filled cable third party damage	Repair The cable is repaired on site. Additional time is typically required to repair third party damage.	5.5 weeks
Fluid filled cable corrective action	Repair One of the following repairs may take place depending on the failure mode: 1. in service repair (80 per cent) 2. out of service repair (20 per cent)	1. In service repair (no outage) 2. 1.06 weeks

D.3 Probability of failure

Ausgrid has adopted probability models to estimate expected failure of different network assets. A summary of the models adopted and the key parameters used are summarised in the table below.

Table D.2 – Summary of failure probability models used to estimate failure probability

Network asset type	Failure probability model	Key parameters
Underground cables	Crow-AMSAA model	Cumulative number of failures per km Age of cable at failure in years Measure of the failure rate

Underground cables

The Crow-AMSAA model is used to determine the probability of failure and unavailability for underground cables. Crow-AMSAA models are fitted for fluid filled, HSL and XLPE cables.

The Crow-AMSAA model can be used to evaluate probability of failure for repairable systems. As a result, it can be used to model a cable section that has failed and has been repaired multiple times over its lifetime. The model is also capable of handling a mixture of failure modes. Events affecting Ausgrid's underground sub-transmission cables are classified as corrective action, failure or third-party damage.

An analysis is undertaken of failure data to ascertain the age of the cable at the time of each event. A log-log plot of cumulative failures (per km) versus cumulative time (i.e. age in years) is produced and a line of best fit determined. The resulting log-log plot is linear and the line of best fit can be described by Equation 1 below.

Equation 1

$$z(T) = \lambda\beta T^{\beta-1}$$

where:

$z(T)$ is the current failure intensity at time T (normalised per km length)
T is the cumulative time (i.e. age of the cable at failure, in years)
β is the shape parameter
λ is a scale parameter

The above process is carried out for corrective actions, failures and third party damage for fluid filled cables. Table D.3 shows the modelled Crow-AMSAA parameters for each cable type.

Table D.3 – Underground cable parameters

Feeder	Type	B factor	Λ factor	MTTR[23] (weeks)
923 (Oil portion)	Corrective action	6.361	5.82E-11	1.06
923 (Oil portion)	Breakdowns	5.980	1.83E-12	6.00
923 (Oil portion)	Third party damage	1.00	2.91E-02	5.50
924 (Oil portion)	Corrective action	6.320	5.82E-11	1.06
924 (Oil portion)	Breakdowns	5.942	1.83E-12	6.00
924 (Oil portion)	Third party damage	1.00	2.91E-02	5.50

Note: Feeders 923 and 924 comprise of both overhead and underground oil filled sections. Only underground sections are being replaced as part of this project.

The frequency of corrective action, failure or third party damage can then be determined by applying Equation 2 to each cable section.

Equation 2

$$f = L\lambda((T+1)^{\beta} - T^{\beta})$$

Where:

f is the frequency of failures

L is the length of the cable segment (km)

Failures and third party damage result in cables being taken out of service. Corrective actions do not typically result in cables being taken out of service. Equation 3 shows how the frequency is used to calculate unavailability for failures or third party damage.

Equation 3

$$U = \frac{f \times MTTR_{weeks}}{52 + f \times MTTR_{weeks}}$$

The total cable section unavailability is calculated taking the union of the failure and third-party damage unavailabilities as shown in Equation 4. If a feeder consists of multiple cable sections, the feeder unavailability is calculated by taking the union all the respective section unavailabilities.

Equation 4

$$U_{total} = U_{failure} \cup U_{TPD}$$

Figure 2.3 in section 2.3.2 shows unavailability plotted on a logarithmic scale when the above equations are applied to 10km cables aged 0 – 100 years. This model is also based on the assumption that the condition of a cable is dependent upon its age. The Crow-AMSAA model shows that the availability of fluid filled cables is expected to decline if the cables are retained past an age of 50.

D.4 Enviromental costs

Ausgrid has experienced major leaks from SCFF cables and some Ausgrid cables leak smaller amounts of oil into the environment that are difficult to locate and repair. Ausgrid policy is to minimise environmental impact to the extent it is practical. Regardless, fluid leaks expose Ausgrid to a risk of liability under the Protection of the Environment Operations Act 1997 (NSW), particularly in relation to pollution of water and pollution of land. It is necessary to include the environmental risk in the cost benefit analysis as the continued service of SCFF cables will result in further deterioration in

[23] Mean Time To Repair

condition and an increasing number of failures that are random in nature. These failures have the potential to cause damage to the environment. The quantification of environmental risk is calculated as follows.

Equation 5

$$Environmental\ risk\ cost = F \times EC \times \beta$$

Where;

F is the failure rate of the equipment

EC is the environmental criticality of the failure mode

β is a factor calculated based on the conditional probability of ground water impacts from a fluid leak of the feeder 264 (based on the length of feeder in waterways)

The Environmental Criticality (EC) is calculated for the three feeder failure types described in Table D.1, namely;

- corrective actions;
- breakdowns; and
- third party damage.

Each failure type is made up by a group of possible failure modes. For each failure type, the Mean Time To Repair is determined by taking the average of the repair times for each failure mode assuming equal likelihood for each failure mode within that failure type. The proportion of the year that would be impacted by a single equivalent failure is then used to weight the monetised consequence of a significant fluid leak to produce the Environmental Criticality for each failure type.

Equation 6

$$Environmental\ Criticality = \frac{MTTR}{52} \times Sig.oil\ leak\ cost$$

Where;

$MTTR$ is the Mean Time To Repair in weeks

$Sig.oil\ leak\ cost$ is the monetised worth of a detectable fluid leak of 5L per day for one year multiplied by $3,000/L[24] (5L x 365 days x $3,000 = $5.475M) plus an amount of $10,446 being a weighted tier two and/or three fine under the POEO Act.

Table D.4: Environmental Criticality for each failure type

Factor Description	Corrective Action	Breakdown	Third Party Damage
Environmental Criticality	$111,883	$632,936	$580,191
923 Conditional probability of ground water impact (β)	0.0455	0.1311	0.0865
924 Conditional probability of ground water impact (β)	0.0497	0.1431	0.0944

D.5 Direct costs of equipment failures

In the event of a serious failure of a fluid filled cable, repairs would need to be done to return the cable into service. As this cost is avoided if the cable is replaced before any failure takes place, this repair cost represents a saving and is factored into the cost benefit analysis. The following equation is used to calculate the impact of repair cost.

Equation 7

$$Repair\ cost = F \times D$$

Where;

F is the failure rate

D is the repair cost per event

[24] NSW EPA's Regulatory Impact Statement – Proposed Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2014 – states "*Petroleum can contaminate large volumes of groundwater. For example, according to Environment Canada, one litre of gasoline can contaminate 1,000,000 litres of groundwater. If water used for domestic purposes is priced at about $3,000/ML (Deloitte Access Economics 2013)…*"

D.6 Calculation of central VCR estimate for Burwood ZS

Table D.5 – Breakdown of the central VCR estimate for the Burwood ZS

	Unit	Residential	Small non-residential	Large non-residential (LV)	Large non-residential (HV)
Annual consumption	MWh	100,642	44,510	124,988	2,773
Per cent of annual consumption	%	36.9%	16.3%	45.8%	1.0%
2021 AER VCR estimate	$/kWh	$30.37	$70.84	$61.87	$65.20
Load-weighted VCR for Burwood (AER 2021 values)	$/kWh	$51.75			
Load-weighted VCR for Burwood (adjusted by September CPI)	$/kWh	**$55.51**			

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

- For residential loads, the VCR is determined by using the postcode of the area (ie Burwood, NSW, 2134), which is located under Climate Zone 5 CBD & Suburban NSW, as determined by the AER[25] and adjusted by CPI.
- Small non-residential loads are considered to be small businesses, for which the VCR determined by the AER[26] for commercial small-medium businesses is applied, adjusted by CPI.
- Large non-residential Low Voltage (LV) loads are predominantly industrial loads in this area. For this reason, the VCR calculated for average industrial loads[17] is applied, adjusted by CPI.
- Large non-residential High Voltage (HV) loads are considered to be large industrial businesses, for which the VCR calculated for industrial large businesses[17] is applied, adjusted by CPI.

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

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