Addressing reliability requirements in the Ku-ring-gai load area

FINAL PROJECT ASSESSMENT REPORT

30 August 2024

Ausgrid

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Addressing reliability requirements in the Ku-ring-gai load area

Final Project Assessment Report – August 2024

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Executive Summary

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

The 132kV sub-transmission feeders 9E1 and 9E2 connecting Transgrid's Sydney East Bulk Supply Point (BSP) and Kuringai Sub-Transmission Substation (STS) via Belrose Transition Point (TP) form part of Ausgrid's Upper North Shore network area. Kuringai STS supplies four zone substations via 33kV feeders, providing electricity service to approximately 48,500 customers in this network area.

These feeders consist of underground cables sections laid in separate trenches from Sydney East BSP to Belrose TP, and overhead sections via a long double circuit tower line from the Belrose TP to Kuringai STS. The underground sections were commissioned in 1980.

The underground sections are self-contained fluid filled (SCFF) cables that are becoming less reliable. The community benefits of their replacement are such that replacing works are justified.

Ausgrid is implementing a strategy to replace/retire all SCFF feeders in the network with known leaks by 2034, considering environmental risks and expected decline in reliability. Feeders 9E1 and 9E2 are ranked in the top priority group of this investment strategy.

Ausgrid is therefore undertaking a Regulatory Investment Test for Distribution (RIT-D) to assess options for addressing the risk that the existing underground SCFF cables pose, and to ensure we continue to satisfy our reliability and performance standards.

This Final Project Assessment Report (FPAR) represents the final step in the application of the RIT-D to options for ensuring reliable electricity supply to the Ku-ring-gai load area and follows publication of the Options Screening Notice.

A Draft Project Assessment Report (DPAR) has not been prepared for this RIT-D as permitted under clause 5.17.4(n) of the National Electricity Rules (NER), i.e., since there are not expected to be any non-network or stand-alone power system (SAPS) solutions and the capital cost of the preferred option is less than the $12 million threshold[1].

The 'identified need' for this RIT-D is to maintain the required level of reliability for customers in the Ku-ring-gai 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 the license, reliability and performance standards are expressed in two measures:

- SAIDI[2] – 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[3] – 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 9E1 and 9E2 have experienced oil leaks, with incidence of failure expected to increase materially with age. National parkland in their vicinity increase the environmental risks.

[1] AER, Final Determination – 2021 RIT and APR cost thresholds review, 19 November 2021, p 5.
[2] System Average Interruption Duration Index.
[3] System Average Interruption Frequency Index.

Two credible network options have been assessed

We have identified and assessed two credible options at part of this FPAR.

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

Option	Capital cost (inc. decommissioning)	Expected commissioning
Option 1 – Replacement of SCFF sections of feeders 9E1 and 9E2 with XLPE along existing route	$12.5 million	2025/26
Option 2 – Replacement of SCFF sections of feeders 9E1 and 9E2 with overhead lines	$7.8 million	2025/26

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

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

Ausgrid has considered the ability of any non-network options (NNOs), as well as 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:

- Scenario 1: central scenario – the central scenario consists of load assumptions that reflect Ausgrid's central demand forecast (based on the 2024 ISP Step Change scenario) and central risk cost estimates. In Ausgrid's opinion, this provides the most likely scenario;
- Scenario 2: low scenario – Ausgrid has adopted a scenario which reflects lower demand forecasts and lower risk costs, to represent a conservative future state of the world with respect to potential market benefits that could be realised under the credible option; and
- Scenario 3: high scenario – this scenario reflects higher than anticipated demand load on feeders 9E1 and 9E2, and higher risk costs, which investigates a state of the world which would have higher market benefits.

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

Table E.2 – Summary of the three scenarios investigated

Variable	Scenario 1 – central scenario	Scenario 2 – low scenario	Scenario 3 – high scenario
Demand	POE50 2024 Step Change	POE90 2024 Step Change	POE10 2024 Step Change
Avoided environmental risk costs	Central estimate	70 per cent of central estimate	130 per cent of central estimate
Avoided reactive maintenance costs	Central estimate	70 per cent of central estimate	130 per cent of central estimate
VCR	$52.024/kWh across all scenarios		
Discount Rate	3.54% across all scenarios		

The scenarios have been weighed equally since they represent equally probable "future states of the world".

Option 2 is the preferred option at this final stage

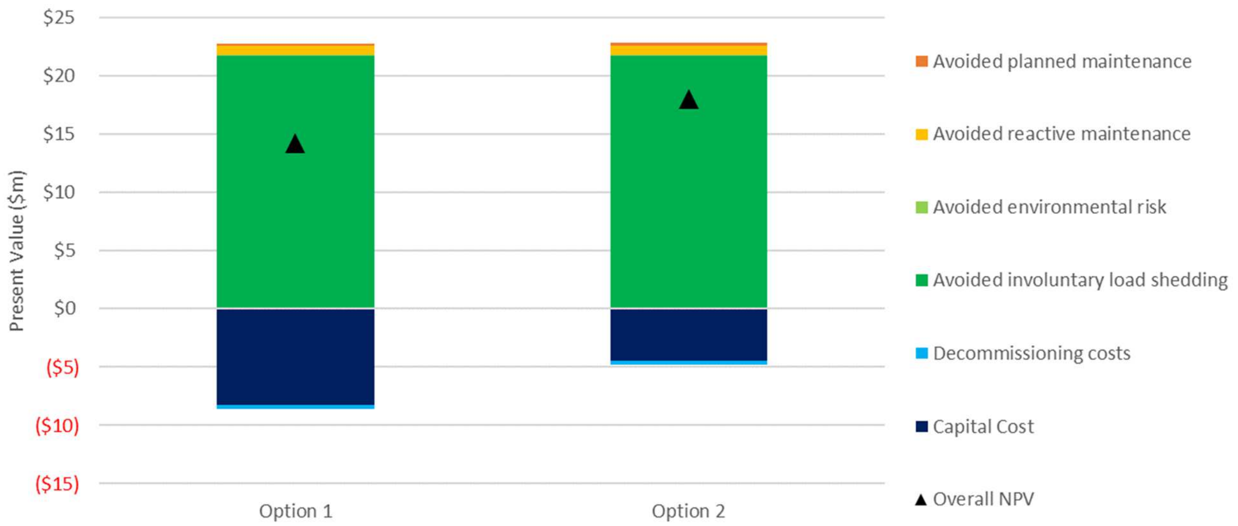
Ausgrid has identified Option 2 as the preferred option at this final stage since it results in the greatest estimated net market benefits of the two options and satisfies the RIT-D requirements. Ausgrid is the proponent for Option 2.

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

Option	NPV	Rank
Option 1	14.2	2
Option 2	**18.0**	**1**

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

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



Ausgrid proposes Option 2 as the preferred option based on the outcomes of our analysis in this FPAR. 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 overhead feeders between the Sydney East BSP and Belrose TP, as well as the decommissioning of the existing SCFF feeders and Belrose TP.

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 total capital cost associated with this option is $7.8 million.

Ausgrid has started engaging with key stakeholders such as the Northern Beaches Council, Metropolitan Local Aboriginal Land Council and the local community to obtain early feedback on the preferred feeder route.

How to make a submission and next steps

This FPAR represents the final step in the application of the RIT-D to options for ensuring reliable electricity supply to the Ku-ring-gai load area.

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

Ausgrid intends to commence work on delivering Option 2 in November 2024.

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

Mark Appleton
Head of Asset Management & Planning (Acting)
Ausgrid
GPO Box 4009
Sydney 2001

Or

email to: assetinvestment@ausgrid.com.au

1 Introduction

This Final Project Assessment Report (FPAR) has been prepared by Ausgrid and represents the final step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply to the Ku-ring-gai load area. It follows the publication of an Options Screening Notice for this RIT-D.

The 132kV electricity subtransmission cables ('feeders') 9E1 and 9E2 are part of Ausgrid's Upper North Shore network, connecting Transgrid's Sydney East BSP and Kuringai STS via Belrose TP. Kuringai STS supplies four zone substations via 33kV feeders (St Ives, Turramurra, Lindfield and Pymble), providing electricity service to approximately 48,500 customers in this network area.

Feeders 9E1 and 9E2 consist of underground cables sections (0.91km and 1.05km long respectively) laid in separate trenches from Sydney East BSP to Belrose TP, and overhead sections via a 5.5km long double circuit tower line from the Belrose TP to Kuringai STS.

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 1980 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 9E1 and 9E2, to ensure we continue to satisfy our reliability and performance standards.

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

1.1 Role of this final report

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

The purpose of the FPAR is to:

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

A Draft Project Assessment Report (DPAR) has not been prepared for this RIT-D as permitted under clause 5.17.4(n) of the NER, i.e., since there are not expected to be any non-network or SAPS solutions and the capital cost of the preferred option is less than the $12 million threshold[4]. The RIT-D process is detailed in Appendix B

1.2 Next steps and contact details for queries in relation to this RIT-D

This FPAR represents the final step in the application of the RIT-D to options for ensuring reliable electricity supply to the Ku-ring-gai load area. Under the NER, parties have 30 days from the date of this report to dispute the application of the RIT-D. Disputes are only able to be made on the grounds that Ausgrid has not applied the RIT-D in accordance with the NER, or that Ausgrid preformed a manifest calculation error in applying the RIT-D. Disputing parties cannot dispute issues

[4] AER, Final Determination – 2021 RIT and APR cost thresholds review, 19 November 2021, p 5.

in this FPAR that the RIT-D treats as externalities, or relate to an individual's personal detriment or property rights. Clause 5.17.5 of the NER sets out the full process and requirements regarding a dispute of how the RIT-D has been applied.

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

Mark Appleton
Head of Asset Management & Planning (Acting)
Ausgrid
GPO Box 4009
Sydney 2001

Or

email to: assetinvestment@ausgrid.com.au

2 Description of the identified need

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

2.1 Overview of the Upper North Shore subtransmission network and existing supply arrangements for the Ku-ring-gai load area

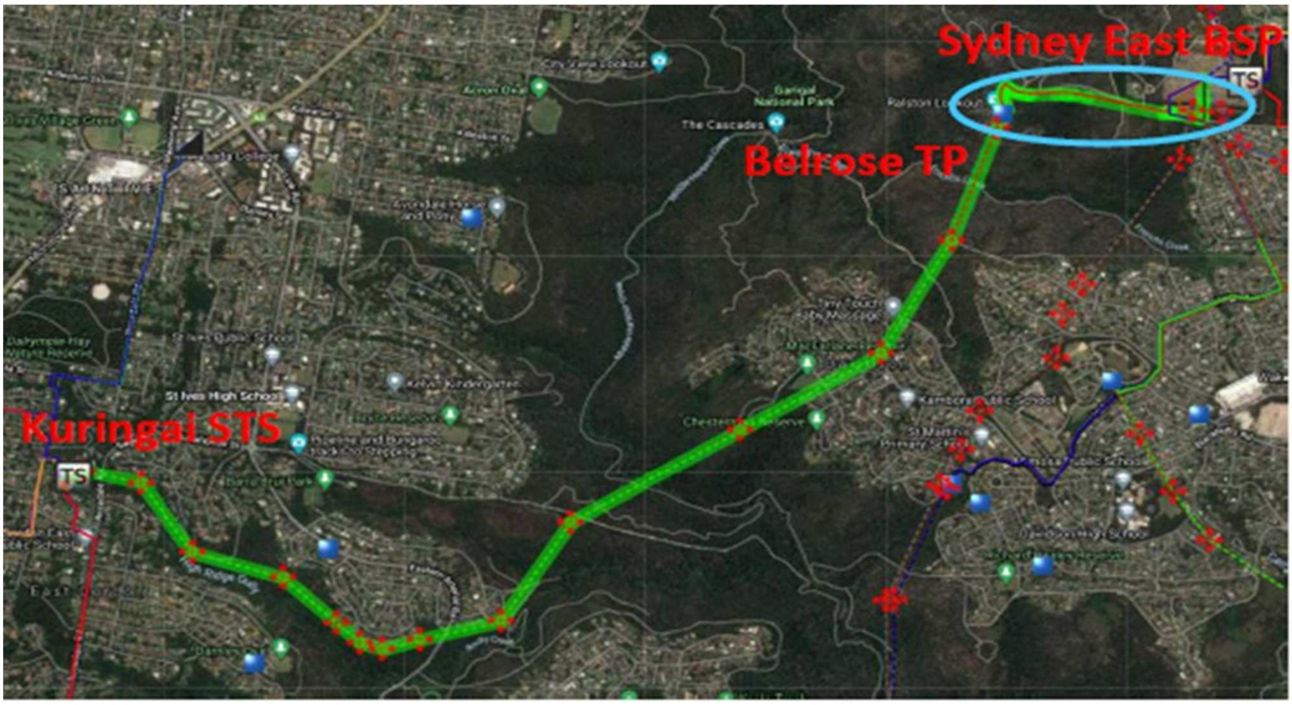
Ausgrid's Upper North Shore network extends from St Ives in the north, west to Turramurra, through Pymble and south to Lindfield. The Pacific Highway and the "North Shore" and "Western" railway lines run through the area. The Upper North Shore is a predominantly urban area that includes residential and commercial load, including standby supplies to Railcorp.

The network in the Upper North Shore area is supplied via 132kV feeders 9E1 and 9E2 from Transgrid's transmission system at Sydney East BSP to Kuringai STS. Feeders 9E1 and 9E2 form an important part of this network, suppling approximately 48,500 customers via a radial 33kV underground network. These feeders are the single source of supply to the Upper North Shore network.

Feeders 9E1 and 9E2 were commissioned in 1980 and consist of underground cable sections (0.91km and 1.05km long respectively) laid in separate trenches from Sydney East BSP to Belrose TP, and overhead sections via a 5.5km long double circuit tower line from the Belrose TP to Kuringai STS (Figure 2.1).

Figure 2.1 presents the routes of feeders 9E1 and 9E2 with respect to the Sydney East BSP and Kuringai STS, 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 9E1 and 9E2



The feeders' availability is critical to supplying Kuringai STS. Ausgrid's predictive failure models for the underground sections of feeders 9E1 and 9E2, 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 Kuringai STS since the feeders are its only source of supply. This could lead to the loss of supply to the zone substations: St Ives, Turramurra, Pymble, and Lindfield. Given that the area has limited interconnections to adjoining network areas, there is a low, but increasing, probability that some of the customers will experience a very long outage.

The underground sections of feeders 9E1 and 9E2 have experienced leaks in the past and have previously failed. They are also situated near national parkland, 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.

2.2 Summary of the 'identified need'

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

- SAIDI[5] – which means the average derived from the sum of the durations of each sustained customer interruption (measured in minutes), divided by the total number of customers (averaged over the financial year); and
- SAIFI[6] – which means the average derived from the total number of sustained customer interruptions divided by the total number of customers (averaged over the financial year).

These two reliability measures capture two key sources of inconvenience to electricity customers from supply disruptions, i.e., how long their electricity supply is off for as well as how often their electricity supply is off. Customers experience less inconvenience (i.e., a better level of supply reliability), the lower each of these measures are. Reliability standards applied to distribution networks typically set maximums in relation to each of these two measures.

The main concern relates to increasing customer supply, 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 would result in the loss of supply to Kuringai STS, leading to loss of supply to the zone substations: St Ives, Turramurra, Pymble, and Lindfield.

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

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 9E1 and 9E2 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 Kuringai STS 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.

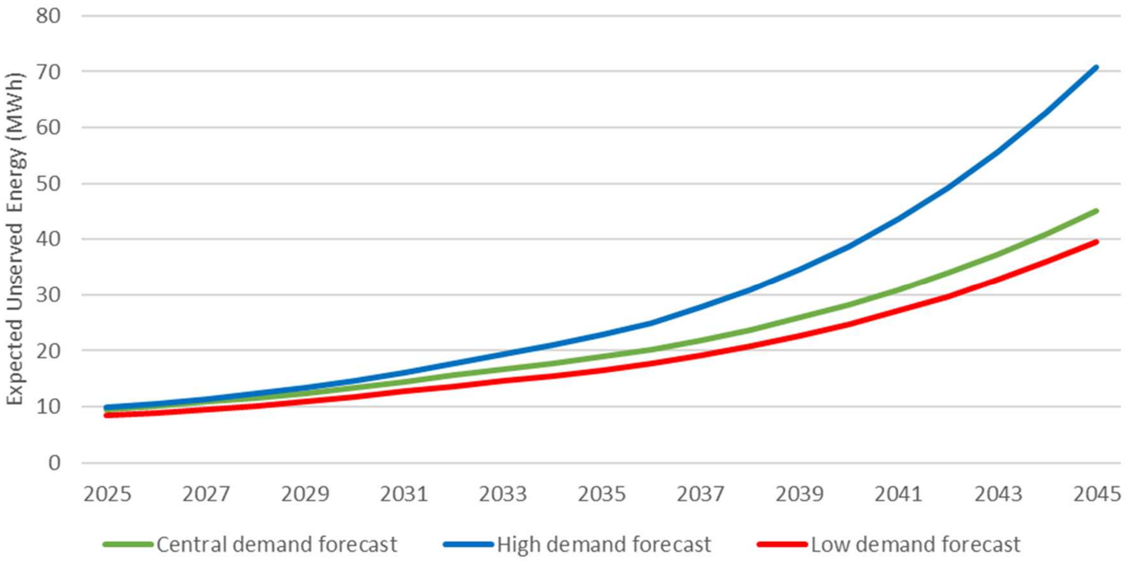
Feeders 9E1 and 9E2 are reaching the end of their technical and serviceable lives. The outage duration for SCFF cable leaks can be lengthy, with repairs taking much longer than for other assets in Ausgrid's network. Leaking cables must be removed from service to determine the source of the leak, requiring 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 9E1 and 9E2 (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.

[5] System Average Interruption Duration Index.

[6] System Average Interruption Frequency Index.

Figure 2.2 – Expected Unserved Energy Forecast for feeders 9E1 and 9E2



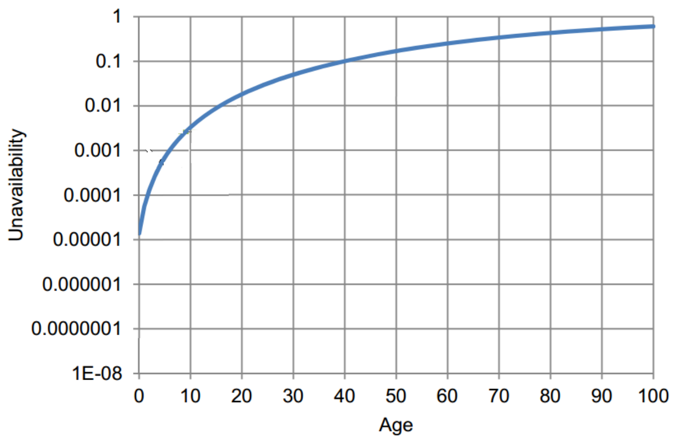
Ausgrid has developed a model to quantify the failure parameters (probabilistic distribution of outage frequency and duration) of each cable, relative to its observable condition. Supply or network risk is assigned for each cable based on the network configuration, available capacity under defined contingency 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. 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



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 these feeders would result in the loss of supply to Kuringai STS, leading to loss of supply to the zone substations: St Ives, Turramurra, Pymble, and Lindfield.

Cable failure modelling indicates that expected involuntary supply interruptions related to predicted failures of feeders 9E1 and 9E2 is approximately 9.6MWh in 2024/25 under the central scenario, increasing to 34MWh 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). Ausgrid has applied a central VCR estimate of $52.024/kWh reflecting the NSW state-wide VCR estimated by the AER in its December 2019 VCR Final Report, adjusted by the Consumer Price Index (CPI) to be in 2023/24 dollars[7].

2.3.4 Environmental risk

In addition to the expected unserved energy, 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 9E1 and 9E2 have experienced oil leaks over the past 10 years, with incidence of failure expected to increase significantly with cable age. Feeders 9E1 and 9E2 are situated near national parkland, increasing the environmental risks as insulating fluid has the potential to enter the environment.

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

[7] AER, Values of Customer Reliability – Final report on VCR values, December 2019, pp 71 and 87-88. The NSW state-wide VCR has been inflated to $2023/24 using the Australian Bureau of Statistics CPI weighted average of eight capital cities (series ID: A2325846C)

3 Two credible options have been assessed

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

3.1 Option 1 – Replacement of SCFF sections of feeders 9E1 and 9E2 with XLPE along existing route

Option 1 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.

Specifically, Option 1 involves the replacement of approximately 1.0 kilometres of underground SCFF cable along the existing route configuration. This would require:

- works at Sydney East BSP, Belrose TP and Kuringai STS;
- installation of two 132kV XLPE feeders of approximately 1.0km from Sydney East BSP to Belrose TP, with a proposed firm rating of 230MVA;
- metering, control and protection communication upgrades at Sydney East Bulk supply Point and Kuringai STS, including installation of fibre inside Transgrid's Sydney East;
- decommissioning the Belrose transition point, and
- decommissioning of the existing SCFF feeder between Sydney East BSP and Belrose TP.

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 $12.5 million (including decommissioning costs of approximately $565k). Optimal timing analysis indicates that construction of this option would commence in 2024/25, with commissioning a year later in 2025/26. Once commissioned, operating costs are expected to be approximately $12,500 per annum (0.1 per cent of capital expenditure)

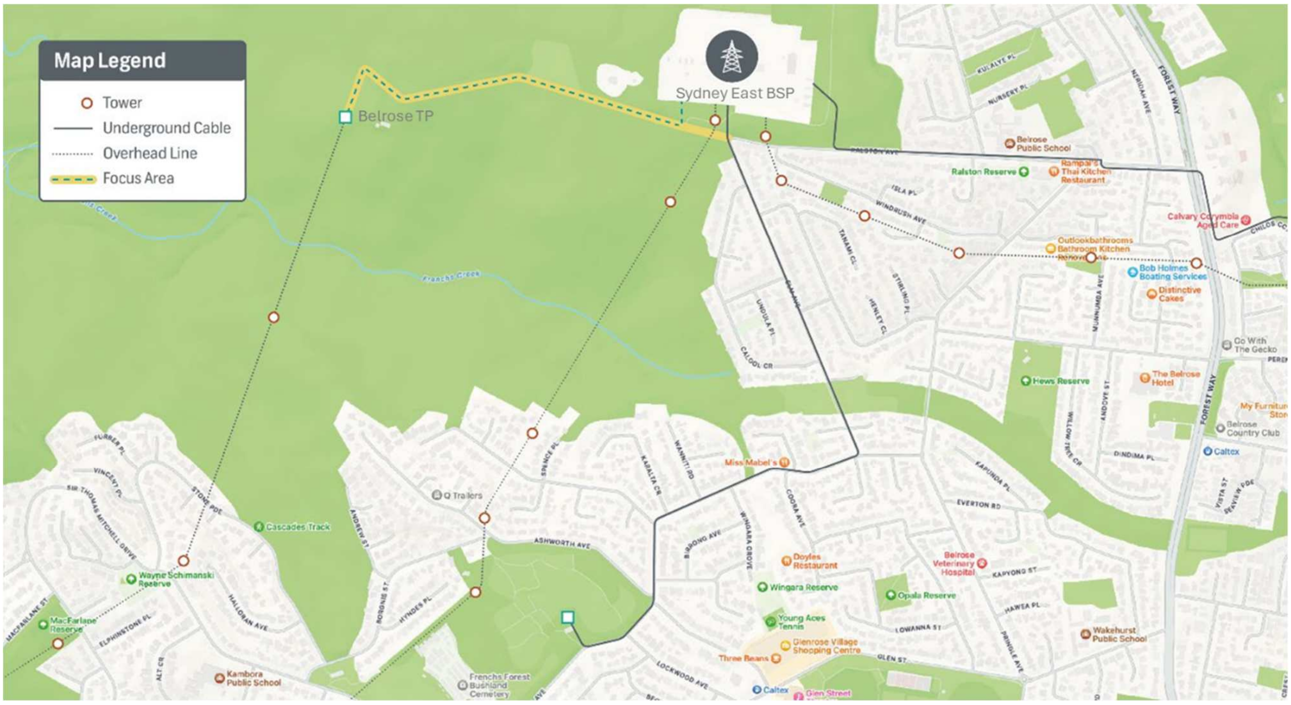
Further analysis underpinning the optimal timing assessment for this option is set out in section 5.4.

3.2 Option 2 – Replacement of SCFF sections of feeders 9E1 and 9E2 with predominantly overhead lines

Option 2 involves replacing the underground SCFF feeder sections with predominantly overhead lines along the existing route. This option will improve reliability, reduce unserved energy and decrease operating expenditure over time compared to the base case of maintaining the existing cables. The scope includes:

- works at Sydney East BSP, Belrose TP and Kuringai STS to facilitate the new 132kV feeder connection;
- installation of two 132kV XLPE feeders of approximately 100m from Sydney East BSP to Ralston Ave, with a proposed firm rating of 230MVA;
- installation of two 132kV overhead powerlines of approximately 0.9 km from Ralston Ave to Belrose TP, with a proposed firm rating of 230MVA;
- metering, control and protection communication upgrades at Sydney East Bulk Supply Point and Kuringai STS, including installation of fibre inside Transgrid's Sydney East;
- installation of a new 132kV auto-closing scheme on both feeders;
- decommissioning the Belrose transition point, and
- decommissioning of the existing SCFF feeder between Sydney East BSP and Belrose TP.

Figure 3.1 - Feeders 9E1 and 9E2 proposed route



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 $7.8 million (including decommissioning costs of approximately $565k). Optimal timing analysis indicates that construction of this option would commence in 2024/25, with commissioning a year later in 2025/26. Once commissioned, operating costs are expected to be approximately $7,800 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.

3.3 Options considered but not progressed

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

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

Table 3.1 – Options considered but not progressed

Option	Description	Reason why option was not progressed
Replace SCFF feeders with XLPE cables in separate trenches along existing route	Replace the SCFF feeders with XLPE cables in a separate trench	This option achieves the same outcome as Option 1 above, with a much higher capital cost without providing a commensurate increase in benefits. Therefore, this option is considered not economically feasible.
Retire 132kV feeders 9E1 and 9E2	Retirement of 132kV feeders 9E1 and 9E2, supplying Kuringai STS and downstream zone substations from an alternative source	This option would require an alternative source of supply to the four zone substations (St Ives, Pymble, Lindfield and Turramurra) in the upper north shore network area. The resulting cost would be considerably higher than the cost of options 1 and 2 and would take longer to be delivered.

Option	Description	Reason why option was not progressed
Non-network options	Using non-network solutions either in combination with, or in-place of, a network option.	Ausgrid has considered how demand management could defer the timing of the preferred network solution and whether the EUE could be cost effectively reduced. An assessment of demand management options has shown that non-network alternatives would not be cost effective due to the magnitude of the load reduction required. This result is driven primarily by the significant amount of EUE that the identified network option allows to be avoided, compared to the base case, and the cost of demand management solutions. This is detailed further in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.
SAPS options	Transferring and/or connecting customers to SAPS	Ausgrid has considered the feasibility of SAPS, informed by its trial of SAPS with selected customers living in fringe-of-grid areas of Ausgrid's network. Based on Ausgrid's trial, the cost of SAPS would limit the number of customers available to reduce demand given the deferral funds available and consequently, the reduction in demand would not be sufficient to defer or postpone the network solution. This is detailed further in the separate Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.

4 How the options have been assessed

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

4.1 General overview of the assessment framework

All costs and benefits for each credible option 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 2024-25 to 2043-44. 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.

Ausgrid has adopted a real, pre-tax discount rate of 3.54% for the NPV analysis. This represents Ausgrid's 2024-25 opportunity cost for its capital investments as included in the AER's final decision for Ausgrid's current distribution determination.[8] As non-network or SAPS options have been found to be not viable, Ausgrid considers that the appropriate discount rate is the regulated cost of capital.

To test the results against variations in the discount rate, an upper value sensitivity of 10.5% has been adopted to align with the parameters prepared and consulted on by AEMO as part of preparing the 2023 Inputs, Assumptions and Scenarios Report[9]. For a lower value sensitivity for this RIT-D, this would ordinarily be aligned with the latest AER Final Decision for a Distribution Network Service Provider's (DNSP's) regulated weighted average cost of capital (WACC) at the time of preparing this FPAR; however, in this instance that regulated WACC is currently Ausgrid's.

4.2 Ausgrid's approach to estimating project costs

Ausgrid has estimated capital costs by considering the scope of works necessary under the credible options together with costing experience from previous projects of a similar nature. Where possible, Ausgrid has also estimated capital costs for each credible option using supplier quotes or other pricing information. Where costs for design work have been incurred prior to 2024-25, we have adjusted these costs to reflect the opportunity cost of this expenditure using Ausgrid's regulated cost of capital.

All cost estimates are prepared in real, 2023/24 dollars based on the information and pricing history available at the time that they were estimated. The cost estimates do not include or forecast any real cost escalation for materials.

Routine operating and maintenance costs are based on a fleet level assessment of assets and works of similar nature. These costs are included for each year in the planning period from when the options are commissioned.

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

[8] See: AER, *Final decision – Ausgrid distribution determination 2024-29 – PTRM – distribution*, April 2024, 'WACC' sheet.

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

- 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 EUE.

The approach Ausgrid has adopted to estimating reductions in EUE are outlined in section 4.3.1 below. Further details on the assumptions and methodology considered are presented in Appendix D.

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

4.3.1 Reduced involuntary load shedding

Involuntary load shedding, 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 EUE from the options, relative to the base case, results in a positive contribution to market benefits of the credible options being assessed.

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

Ausgrid has applied a central VCR estimate of $52.024/kWh reflecting the NSW state-wide VCR estimated by the AER in its December 2019 VCR Final Report, adjusted by the Consumer Price Index (CPI) to be in 2023/24 dollars.[10] We have also tested the VCR as a sensitivity with values that are 30% lower and 30% higher than the central rate, consistent with the AER's specified +/- 30% confidence interval.[11]

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

- the central forecast uses 50 percent probability of exceedance ('POE50') under AEMO's 2024 ISP Step Change scenario;
- the low forecast reflects POE90 demand from AEMO's 2024 ISP Step Change scenario; and
- the high forecast reflects POE10 demand from AEMO's 2024 ISP Step Change scenario.

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

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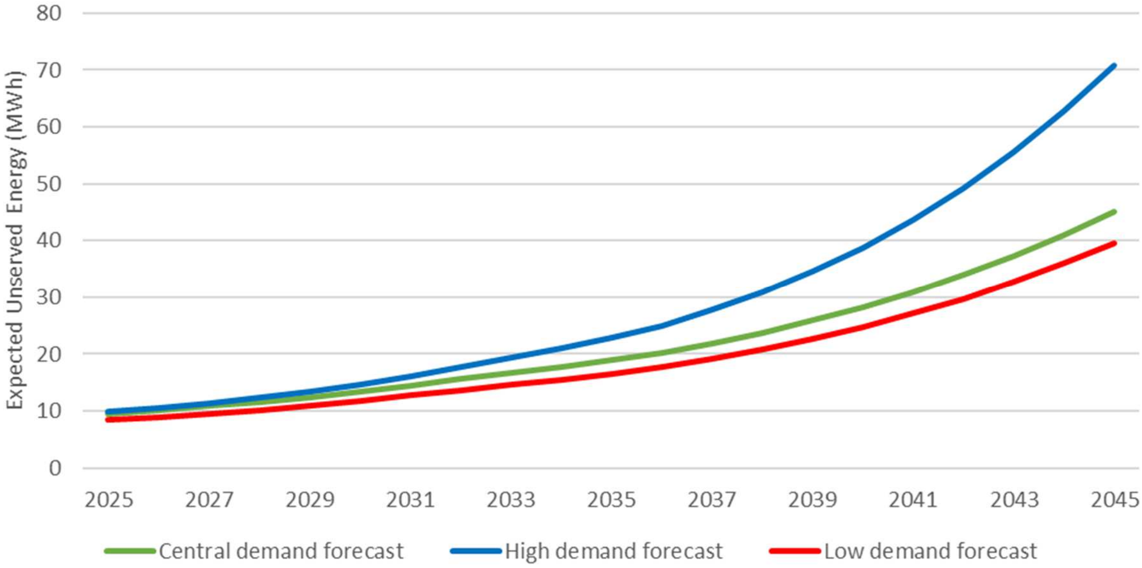
[10] AER, Values of Customer Reliability – Final report on VCR values, December 2019, p 71. The NSW state-wide VCR has been inflated to $2023/24 using the Australian Bureau of Statistics CPI weighted average of eight capital cities (series ID: A2325846C).

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

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



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

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

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

- central scenario – the central scenario consists of load assumptions that reflect Ausgrid's central set of demand estimates, together with our central estimate of environmental risk costs and reactive maintenance costs. The central demand forecasts reflect the 50 percent probability of exceedance ('POE50') forecast under AEMO's 2024 ISP Step Change scenario.
- low scenario – Ausgrid has adopted a scenario that reflects a lower demand forecast and 30 per cent lower assumed environmental risk costs and reactive maintenance costs, to represent a conservative future state of the world with respect to potential market benefits that could be realised under the credible options. The low demand load forecast comprises POE90 demand conditions from AEMO's 2024 ISP Step Change scenario; and
- high scenario – this scenario reflects higher than anticipated demand load at Kuringai STS, and 30 per cent higher assumed environmental risk costs and reactive maintenance costs, to investigate the higher end of reasonably expected market benefits. The high demand load forecast comprises POE10 demand conditions from AEMO's 2024 ISP Step Change scenario.

The scenarios only differ by the demand forecasts and the assumed levels of risk costs and reactive maintenance costs, given these are key parameters that may affect the ranking of the credible options. How the results are affected by changes to other variables (i.e., the discount rate and capital costs) have been investigated in the sensitivity analysis.

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

Table 4.1 – Summary of the three scenarios investigated

Variable	Scenario 1 – central scenario	Scenario 2 – low scenario	Scenario 3 – high scenario
Demand	POE50 2024 Step Change	POE90 2024 Step Change	POE10 2024 Step Change
VCR	$52.024/kWh across all scenarios		
Discount Rate	3.54% across all scenarios		

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

5 Assessment of the credible options

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

5.1 Gross market benefits estimated for the credible options

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

Table 5.1 – Present value of gross benefits of credible options relative to the base case, $m 2023/24

Option	Central scenario	Low scenario	High scenario	Weighted benefits
Scenario weighting	1/3	1/3	1/3	
Option 1	20.9	18.5	28.9	22.8
Option 2	21.0	18.5	29.0	22.8

The primary benefit is avoided EUE, comprising approximately 95 per cent of total benefits on average, on account of the increasing likelihood of failure of the cables in question which are nearing the end of their technical life.

Secondary benefits such as avoided planned and unplanned maintenance (corrective maintenance) and avoided environmental risks costs reflect only a small proportion of the benefits for each proposed option (approximately 5 per cent, combined, of gross benefits on a present value basis).

The estimated market gross benefits are very similar for both options in this RIT-D as they avoid the same EUE. There is a non-material difference in favour of Option 2 due to a reduced planned maintenance costs compared to Option 1.

5.2 Estimated costs for the credible options

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

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

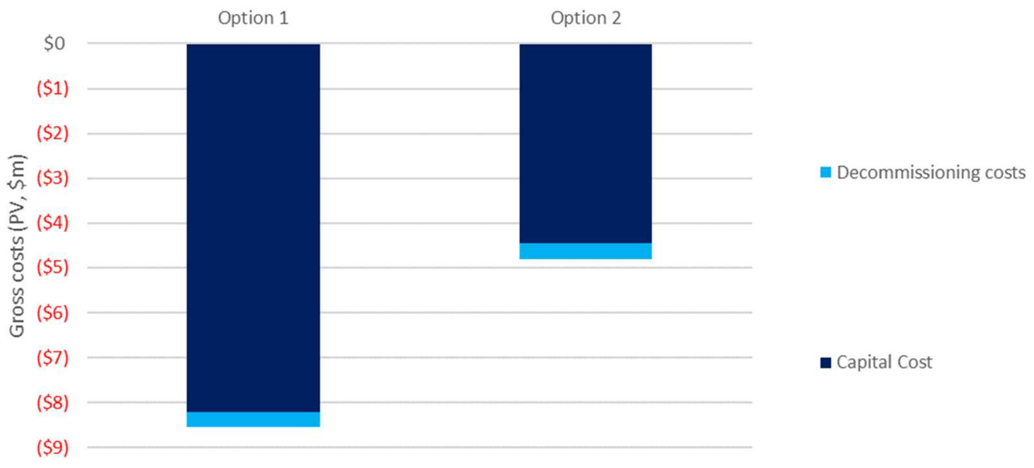
Table 5.2 – Present value of costs of the credible options relative to the base case, $m 2023/24

Option	Central scenario	Low scenario	High scenario	Weighted costs
Scenario weighting	1/3	1/3	1/3	
Option 1	8.2	8.7	8.7	8.6
Option 2	4.5	5.0	5.0	4.8

Figure 5.1 below presents the costs for each option in present value terms and demonstrates that most of the costs relate to capital expenditure to commission the proposed options in the near term.

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

Figure 5.1 - Breakdown of gross costs of the credible options relative to the base case, $m 2023/24



5.3 Net present value assessment outcomes

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

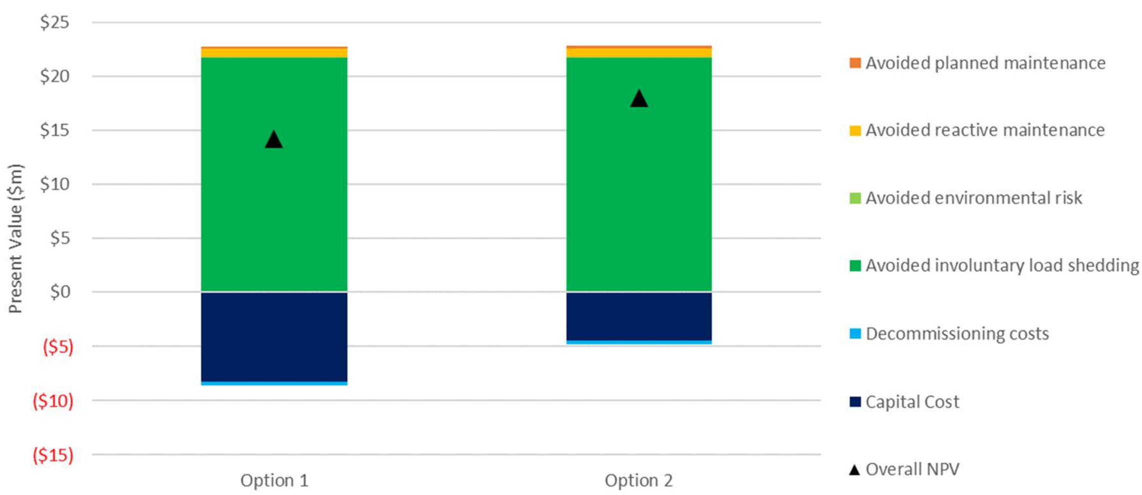
The net market benefit is positive across the three scenarios, and on a weighted basis, and ranges from approximately $14.2 million to $18.0 million across the options on a weighted basis. Option 2 has the greatest estimated net market benefits of all options across each of the scenarios investigated.

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

Option	Central scenario	Low scenario	High scenario	Weighted	Rank
Scenario weighting	1/3	1/3	1/3		
Option 1	12.7	9.7	20.2	14.2	2
Option 2	**16.5**	**13.6**	**24.0**	**18.0**	**1**

Figure 5.2 presents a breakdown of net present costs and benefits across the three scenarios, and on a weighted basis.

Figure 3.2 - Present value of benefits and costs by scenario, $m 2023/24



5.4 Sensitivity analysis results

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

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

- step 1 – testing the sensitivity of the optimal timing of the project ('trigger year') to different assumptions in relation to key variables; and
- step 2 – once a trigger year has been determined, testing the sensitivity of the total NPV benefit associated with the investment proceeding in that year, in the event that actual circumstances turn out to be different.

That is, Ausgrid has undertaken sensitivity analysis to first determine the optimal timing of the project, to conclude that a particular year represents the 'most likely' date at which the project will be needed.

Having assumed to have committed to the project by this date, Ausgrid has also looked at the consequences of 'getting it wrong' under step 2 of the sensitivity testing. That is, if demand turns out to be lower than expected, for example, what would be the impact on the net market benefit associated with the project continuing to go ahead on that date.

We outline how each of these two steps has been applied to test the sensitivity of the key findings.

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

Ausgrid has estimated the optimal timing for each option according to when the expected annual benefit from the proposed option exceeds its annualised cost, consistent with the AER guidance on how to determine the economically prudent and efficient timing for asset retirement.[12] This process was undertaken for both the central set of assumptions (i.e., the central scenario) as well as a range of alternative assumptions for key variables.

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

- a 25 per cent increase/decrease in the assumed network capital costs (including the capital costs of future works);
- a 25 per cent increase/decrease in the assumed operating costs;
- a lower ($36.42/kWh) and higher ($67.63/kWh) VCR;
- a lower and higher assumed risk costs), i.e. avoided reactive maintenance and environmental risks (+/-30 per cent; and
- a higher (10.5 per cent) discount rate.

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

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

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

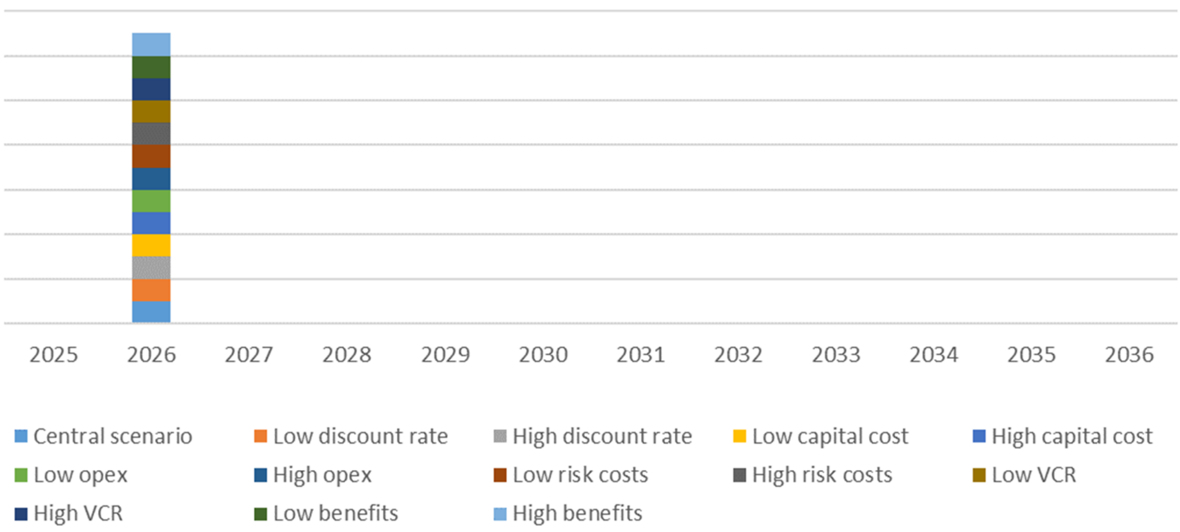
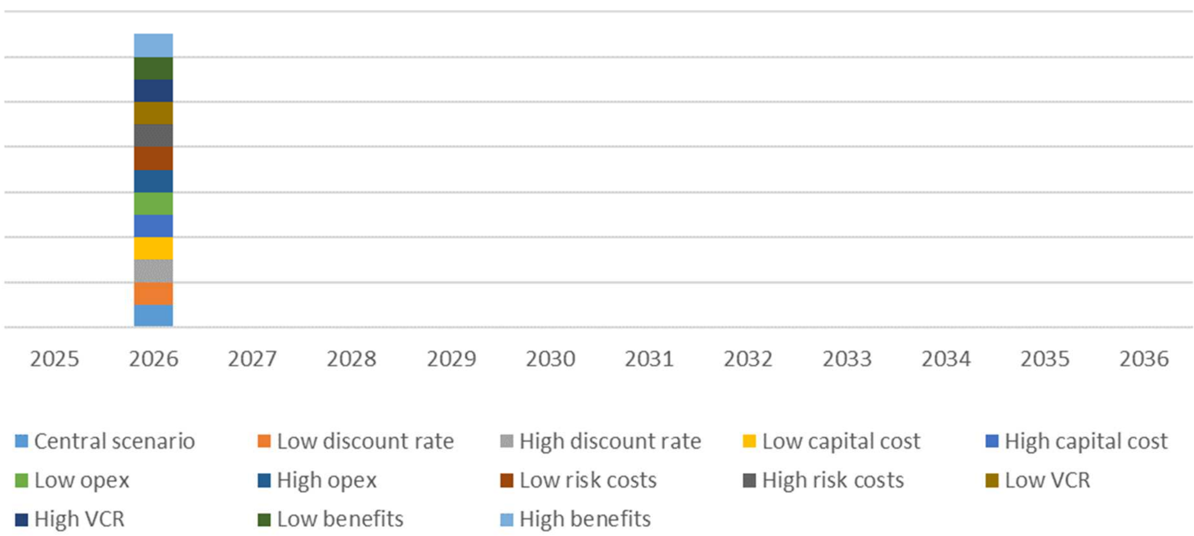


Figure 5.4 – Option 2's distribution of optimal project commissioning years under each sensitivity



5.4.2 Step 2 – Sensitivity of the overall net market benefit

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

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

- a 25 per cent increase/decrease in the assumed network capital costs;
- a 25 per cent increase/decrease in the assumed planned maintenance costs;
- a lower VCR ($36.42/kWh) and a higher VCR ($67.63/kWh);
- lower and higher assumed avoided unplanned corrective maintenance costs (+/- 30 per cent);
- lower and higher assumed environmental risk costs (+/- 30 per cent); and
- a higher/lower discount rate.

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

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

Sensitivity	Option 1	Option 2	Preferred Option
Baseline weighted outcome across scenarios	14.2	**18.0**	Option 2
High capital costs (+25%)	12.8	**17.3**	Option 2
Low capital costs (-25%)	15.6	**18.8**	Option 2
High planned maintenance costs (+25%)	13.6	**17.7**	Option 2
Low planned maintenance costs (-25%)	14.9	**18.3**	Option 2
High VCR ($67.63/kWh)	20.7	**24.5**	Option 2
Low VCR ($36.42/kWh)	7.7	**11.5**	Option 2
High discount rate (10.5%)	-0.6	**3.4**	Option 2
Low discount rate (3.54%)	14.2	**18.0**	Option 2
High environmental risk costs (+30%)	14.2	**18.0**	Option 2
Low environmental risk costs (-30%)	14.2	**18.0**	Option 2
High unplanned corrective maintenance (30%)	14.4	**18.2**	Option 2
Low unplanned corrective maintenance (-30%)	14.0	**17.8**	Option 2

6 Proposed preferred option

Ausgrid considers that Option 2 is the preferred option that satisfies the RIT-D. It involves the commissioning of feeders 9E1 and 9E2, using overhead poles and wires.

Specifically, the scope includes:

- installation of two 132kV XLPE feeders of approximately 100m from Sydney East BSP to Ralston Ave;
- installation of two 132kV overhead poles and wires of approximately 0.9 km from Ralston Ave to Belrose TP;
- metering, control and protection communication upgrades at Sydney East Bulk Supply Point and Kuringai STS, including installation of fibre inside Transgrid's Sydney East;
- installation of a new 132kV auto-closing scheme on both feeders;
- decommissioning the Belrose transition point; and
- decommissioning of the existing SCFF feeder between Sydney East BSP and Belrose TP.

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.

The estimated capital cost of this option is $7.8 million, including decommissioning costs of approximately $565k. Ausgrid assumes that the necessary construction to install the new feeders will commence in late 2024 following completion of the regulatory process, for commissioning in 2025/26.

Once the new installation is complete, operating costs are expected to be approximately $7,800 per annum (0.1 per cent of capital expenditure per annum).

Ausgrid has started engaging with key stakeholders such as the Northern Beaches Council, Metropolitan Local Aboriginal Land Council and the local community to obtain early feedback on the preferred feeder 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.

Ausgrid considers that this FPAR, 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 FPAR with the requirements of clause 5.17.4(r) of the National Electricity Rules version 214.

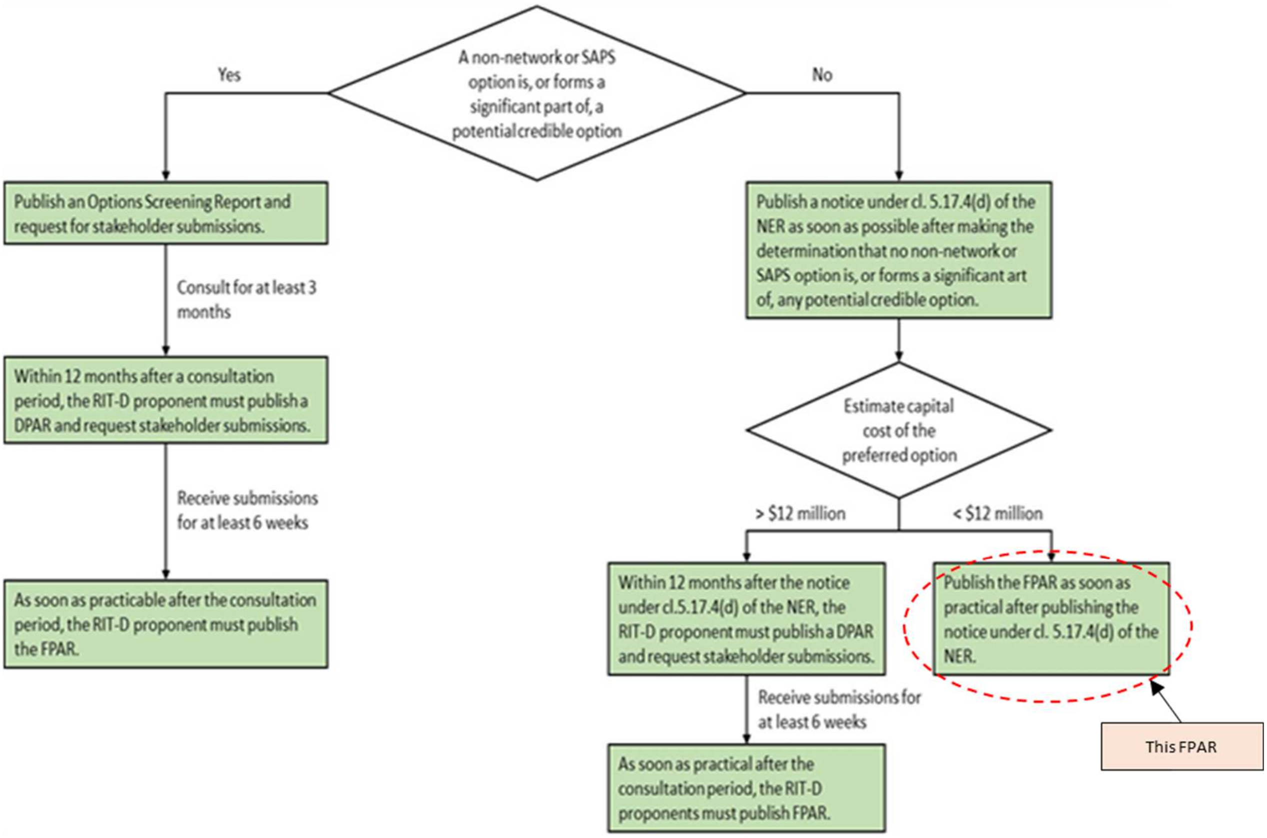
Clause	Summary of requirements	Section in the FPAR
5.17.4(r)	A summary of any submissions received on the draft project assessment report and the RIT-D proponent's response to each such submission	NA
5.17.4(j)	(1) a description of the identified need for the investment	2.2
	(2) the assumptions used in identifying the identified need	2.3
	(3) if applicable, a summary of, and commentary on, the submissions on the non-network options report	NA
	(4) a description of each credible option assessed	3
	(5) where a DNSP has quantified market benefits, a quantification of each applicable market benefit for each credible option	5.1
	(6) a quantification of each applicable cost for each credible option, including a breakdown of operating and capital expenditure	5.2
	(7) a detailed description of the methodologies used in quantifying each class of cost and market benefit	4
	(8) where relevant, the reasons why the RIT-D proponent has determined that a class or classes of market benefits or costs do not apply to a credible option	Appendix C
	(9) The results of a net present value analysis of each of credible option and accompanying explanatory statements regarding the results	5
	(10) the identification of the proposed preferred option	6
	(11) for the proposed preferred option, the RIT-D proponent must provide: (i) details of technical characteristics; (ii) the estimated construction timetable and commissioning date (where relevant); (iii) the indicative capital and operating cost (where relevant); (iv) a statement and accompanying detailed analysis that the proposed preferred option satisfies the regulatory investment test for distribution; and (v) if the proposed preferred option is for reliability corrective action and that option has a proponent, the name of the proponent	6
	(12) Contact details for a suitably qualified staff member of the RIT-D proponent to whom queries on the draft report may be directed.	1.2
	(13) if the estimated capital cost of the proposed preferred option is greater than $100 million (as varied in accordance with a cost threshold determination), include the RIT reopening triggers applying to the RIT-D project.	NA

In addition, the table below outlines a separate compliance checklist demonstrating compliance with the binding guidance in the latest AER RIT-D guidelines relating to cost estimation (i.e., the new requirements added from the AER's review of the guidelines following the MCC Rule change).

Guidelines section	Summary of requirements	Section in the FPAR
3.5A.1	Where the estimated capital costs of the preferred option exceeds $100 million (as varied in accordance with a cost threshold determination), a RIT–D proponent must, in a RIT-D application: • outline the process it has applied, or intends to apply, to ensure that the estimated costs are accurate to the extent practicable having regard to the purpose of that stage of the RIT-D • for all credible options (including the preferred option), either o apply the cost estimate classification system published by the AACE, or o if it does not apply the AACE cost estimate classification system, identify the alternative cost estimation system or cost estimation arrangements it intends to apply, and provide reasons to explain why applying that alternative system or arrangements is more appropriate or suitable than applying the AACE cost estimate classification system in producing an accurate cost estimate	NA
3.5A.2	For each credible option, a RIT-D proponent must specify, to the extent practicable and in a manner which is fit for purpose for that stage of the RIT-D: • all key inputs and assumptions adopted in deriving the cost estimate • a breakdown of the main components of the cost estimate • the methodologies and processes applied in deriving the cost estimate (e.g. market testing, unit costs from recent projects, and engineering-based cost estimates) • the reasons in support of the key inputs and assumptions adopted and methodologies and processes applied • the level of any contingency allowance that have been included in the cost estimate, and the reasons for that level of contingency allowance	4.2
3.8.1	Where the estimated capital cost of the preferred option exceeds $100 million (as varied in accordance with an applicable cost threshold determination), a RIT-D proponent must undertake sensitivity analysis on all credible options, by varying one or more inputs and/or assumptions.	NA
3.9.4	If a contingency allowance is included in a cost estimate for a credible option, the RIT-D proponent must explain: • the reasons and basis for the contingency allowance, including the particular costs that the contingency allowance may relate to, and • how the level or quantum of the contingency allowance was determined.	NA

Appendix B – Process for implementing the RIT-D

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



Appendix C – Market benefit classes considered not relevent

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

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

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

Table C.0.12 – Market benefit categories under the RIT-D not expected to be material

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated expenditure	The credible options proposed are not expected to affect the timing or amount of any other expenditure of unrelated needs.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the National Electricity Market (NEM) is limited. Where the implementation of a credible option affects pool price outcomes, and in particular results in pool prices reaching higher levels on some occasions than in the base case, this may have an impact on the extent of voluntary load curtailment. Ausgrid notes that the options are not expected to affect the pool price and so there is not expected to be any changes in voluntary load curtailment.
Costs to other parties	This category of market benefit typically relates to impacts on generation investment from the options. Ausgrid notes that the options will not affect the wholesale market and so we have not estimated this category of market benefit.
Changes in load transfer capacity and embedded generators	Load transfer capacity between substations is predominantly limited by the high voltage feeders that connect substations. The options under consideration do not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, the options are unlikely to enable embedded generators in Ausgrid's network to be able to take up load given the size and profile of the load serviced by network assets considered. Consequently, Ausgrid has not attempted to estimate any benefits from changes in load transfer capacity and embedded generators.
Option value	Option values arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered have sufficiently flexible to respond to that change. Ausgrid notes that the credible options assessed do not involve stages or any other flexibility and so we do not consider that option value is relevant.
Changes in electrical energy losses	Ausgrid does not expect that the credible options considered will lead to significant changes in network losses and so have not estimated this category of market benefits.

Appendix D – Additional detail on the assessment methodology and assumptions

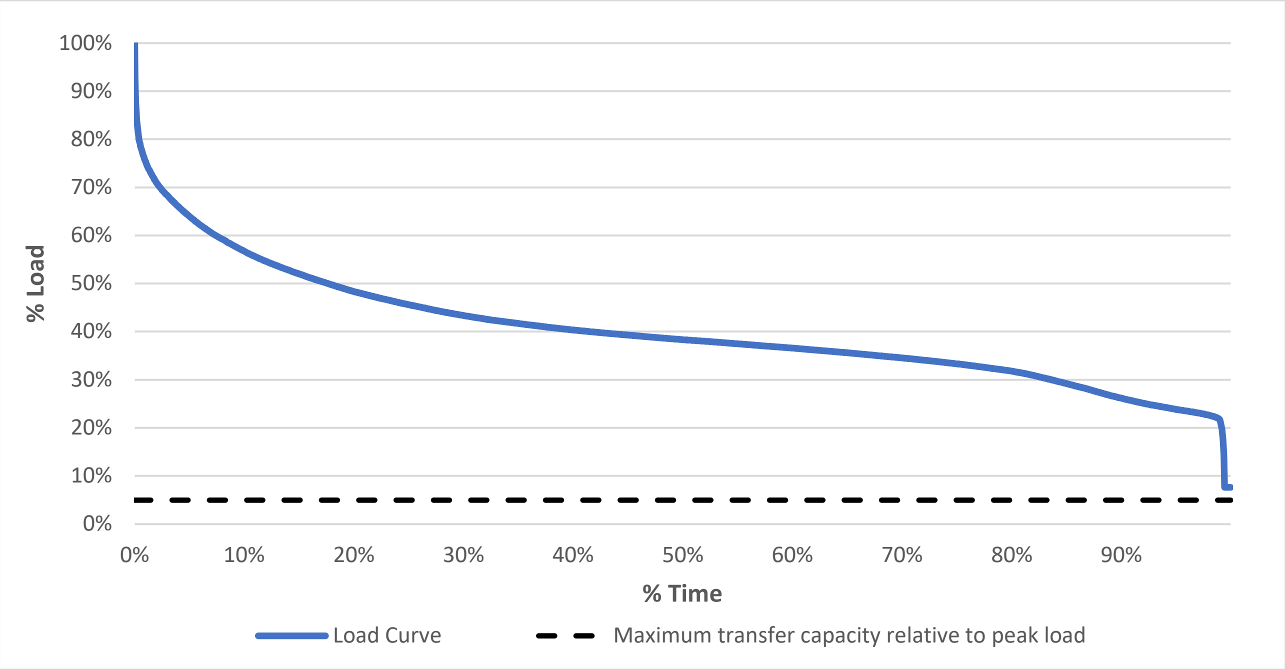
This appendix provides additional detail on key input assumptions that are used in the evaluation of the base case and the credible options.

D.1 Characteristic load duration curve

The load duration curve 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.

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	Β factor	Λ factor	MTTR[13] (weeks)
9E1 (Oil portion)	Corrective action	6.377	5.82E-11	1.06
9E1 (Oil portion)	Breakdowns	5.995	1.83E-12	6.00
9E1 (Oil portion)	Third party damage	1.00	2.91E-02	5.50
9E2 (Oil portion)	Corrective action	6.328	5.82E-11	1.06
9E2 (Oil portion)	Breakdowns	5.950	1.83E-12	6.00
9E2 (Oil portion)	Third party damage	1.00	2.91E-02	5.50

Note: Feeders 9E1 and 9E2 comprises 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 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.

[13] Mean Time To Repair

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 9E1 and 9E2.

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[14] (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 for Feeder 9E1 and 9E2

Factor Description	Corrective Action	Breakdown	Third Party Damage
Environmental Criticality	$111,883	$632,936	$580,191
9E1 Conditional probability of ground water impact (β)	0.0174	0.0500	0.0330
9E2 Conditional probability of ground water impact (β)	0.0174	0.0500	0.0330

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

[14] 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)…*"

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