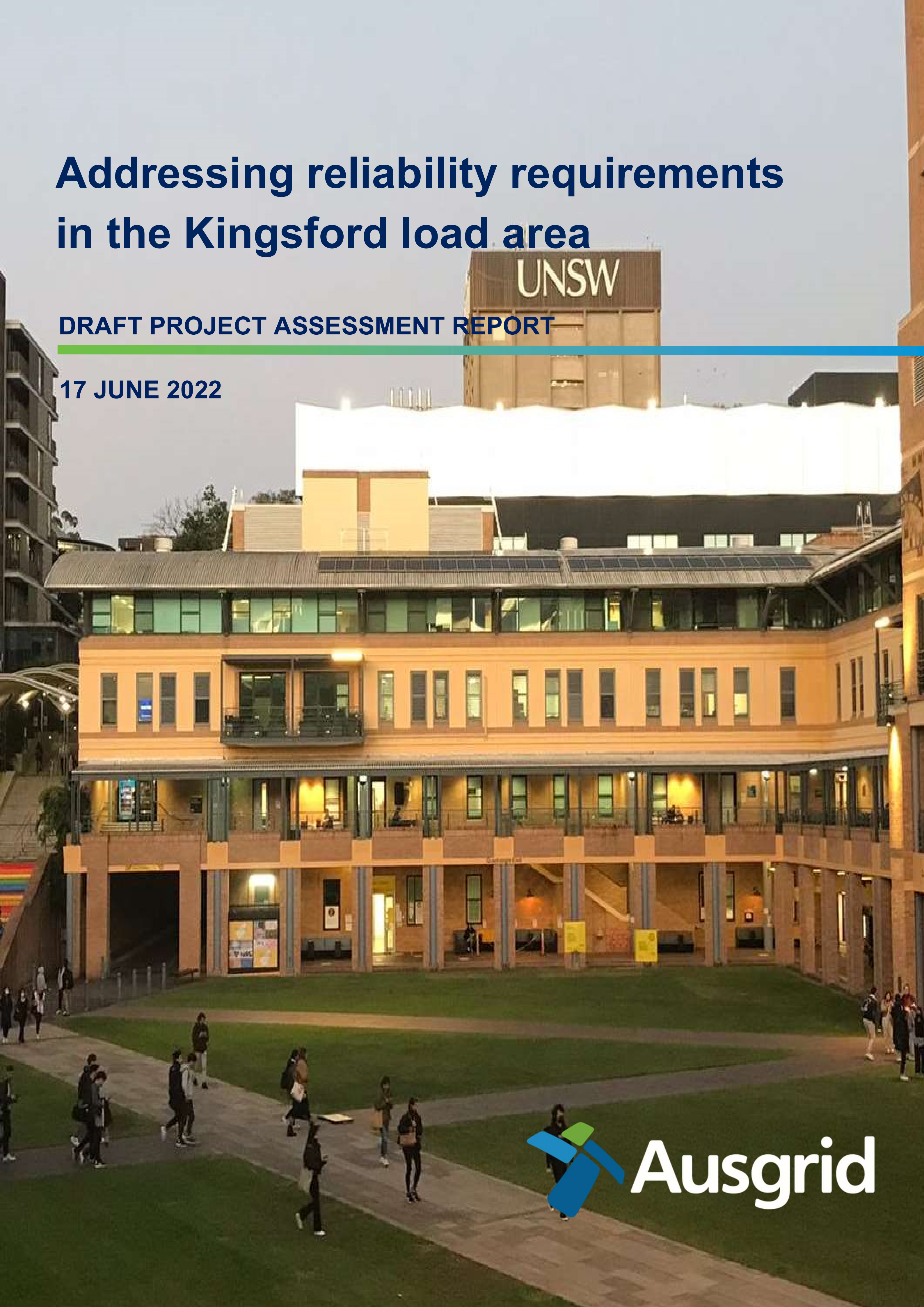
Addressing reliability requirements in the Kingsford load area

DRAFT PROJECT ASSESSMENT REPORT

17 JUNE 2022



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Addressing reliability requirements in the Kingsford load area

Draft Project Assessment Report – June 2022

Contents

Executive Summary

This report investigates the most economic option for mitigating the risks associated with the 132kV Feeder 264 supplying the Kingsford load area

This Draft Project Assessment Report (**DPAR**) has been prepared by Ausgrid and represents the first step in the application of the Regulatory Investment Test for Distribution (**RIT-D**) to options for ensuring reliable electricity supply in the Kingsford load area.

The underground electricity subtransmission cables ('feeders') supplying the Kingsford load area and more broadly the east end of the Eastern Suburbs network, include self-contained fluid filled (**SCFF**) feeders, which are now considered an obsolete and outdated technology. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community.

Ausgrid has identified the need to replace 132kV Feeder 264, which connects Kingsford Zone Substation (**ZS**) to Transgrid's Beaconsfield Bulk Supply Point (**BSP**) and identified a preferred solution to mitigating the identified risks.

Ausgrid has prepared this report consistent with the National Electricity Rules

Rule changes to the National Electricity Rules (**NER**) in July 2017 have meant that the replacement of network assets are subject to the RIT-D. Accordingly, Ausgrid has initiated this RIT-D for replacing 132kV Feeder 264 in order to investigate and consult on options to ensure Ausgrid is able to satisfy the reliability and performance standards that it is obliged to meet.

One credible network option has been assessed

Ausgrid has identified one network option. The credible option is summarised below. All costs in this section are in real $2021/22, unless otherwise stated.

Table E.1 – Summary of the credible options considered

Overview	Key components	Length of new feeders	Estimated capital cost
Option 1 – Replacement of the existing Feeder 264 like-for-like	Replacement of existing Feeder 264 like-for-like using modern equivalent technology - Cross Linked Polyethylene (**XLPE**) cable	5.5km	$25.1 million

There are no viable alternatives other than to replace the existing feeder 264, using modern equivalent technology. The retirement of feeder 264 without replacement was ruled out as it will leave customers at greater risk of outages in the event of failures of other cables in the Eastern Suburbs network.

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

Ausgrid has also considered the ability of non-network solutions to assist in meeting the identified need. A demand management assessment into reducing the risk of Expected Unserved Energy (**EUE**) from the SCFF feeders in this network area showed that non-network alternatives cannot cost-effectively address the risk, compared to the network option outlined above. This result is driven primarily by the significant amount of EUE the network option allows to be avoided, compared to a base case of business as usual, i.e. escalated maintenance and repair. The assessment is detailed further in the separate 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.

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

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

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

- High benefit scenario – this scenario reflects an optimistic set of assumptions, which have been selected to investigate an upper bound on reasonably expected potential market benefits.

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

Table E.2 – Summary of the three scenarios investigated

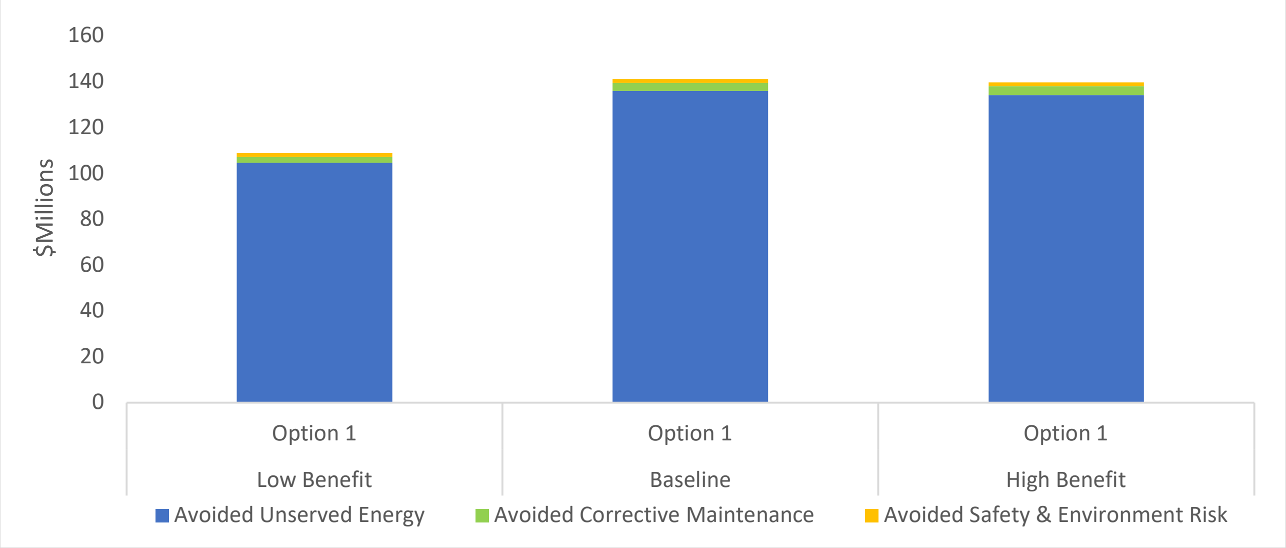
Variable	Scenario 1 – baseline	Scenario 2 – low benefits	Scenario 3 – high benefits
Demand	POE50	POE90	POE10
VCR	$43.69/kWh (Derived from the AER VCR 2019 estimates and updated by CPI variations authorised by AER)	$30.58/kWh (30 per cent lower than the central, AER-derived estimate)	$56.79/kWh (30 per cent higher than the central, AER-derived estimate)
Capital Costs (including future capital costs)	100 per cent of capital cost estimate	125 per cent of capital cost estimate	75 per cent of capital cost estimate
Discount Rate	2.99 per cent	2.99 per cent	4.05 per cent

Option 1 is the preferred option at this draft stage

Ausgrid proposed Option 1 to be the preferred option as it is the only credible option identified and satisfies RIT-D requirements. Ausgrid is proponent for Option 1.

Option 1 provides positive gross benefits across all scenarios largely from avoiding involuntary load shedding that would otherwise be incurred under the base case, as illustrated in Figure E.1. While there are other benefits from avoiding safety, environmental risk and corrective maintenance costs, these benefits are relatively small.

Figure E.1 – Present value of gross benefits of each credible option relative to the base case



The table below provides a summary of the net market benefit in NPV terms for the credible option, on a weighted basis across the three scenarios. Overall, Option 1 exhibits a positive net market benefit.

Table E.3 – Present value of weighted net benefits relative to the base case, $m 2021/22

Option	PV of Capital costs	PV of Operating costs	Weighted PV of Gross Benefits	Weighted NPV	Ranking
Option 1	-15.0	-1.9	132.6	115.7	1

Option 1 has been found to be the preferred option, which satisfies the RIT-D. It involves the replacement of the existing feeder from Beaconsfield BSP to Kingsford ZS with a new 132kV XLPE cable.

The scope of this project includes:

- works at Beaconsfield BSP and Kingsford ZS to facilitate the new 132kV feeder connection;
- extending the existing dual circuit 132kV ductline between Beaconsfield BSP to O'Riordan Street, Mascot to accommodate replacement of SCFF Feeder 264 and future replacement of Feeder 9FF;
- construction of a 4.5km single circuit ductline to accommodate Feeder 264, between O'Riordan St, Mascot and Kingsford ZS;
- installation of one 132kV XLPE feeder of approximately 5.5km from Beaconsfield BSP to Kingsford ZS, with a proposed firm rating of 230MVA;
- metering, control and protection communication upgrades at both ends; and
- decommissioning of existing SCFF feeder between Beaconsfield BSP and Kingsford ZS.

In November 2021, Ausgrid started engaging with key stakeholders such as the Australian Golf Course, City of Sydney Council, Bayside Council and Randwick City Council to obtain early feedback on the preferred cable route. In February 2022, Ausgrid commenced engagement with residents and businesses along and in a buffer zone around, the preferred cable route. In March 2022, Ausgrid held two live online information sessions (due to the ongoing COVID-19 pandemic, face-to-face information sessions were unable to occur), to seek local information and further community feedback on the preferred cable route. Ausgrid encourages community feedback and has committed to keep the community informed as the project progresses through:

- the Environmental Assessment process, including 3 week public exhibition of the assessment report and further drop-in information session
- 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.

The estimated capital cost of this option is approximately $25.1 million. Ausgrid is planning that the necessary construction to install the new feeders would commence in 2022/23 and end in 2023/24. Once the new installation is complete, operating costs are expected to be approximately $48,000 per annum (around 0.2 per cent of capital expenditure).

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

How to make a submission and next steps

Ausgrid welcomes written submissions on this DPAR. Submissions are due on or before 29 July 2022. 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 first step in the application of the Regulatory Investment Test for Distribution (**RIT-D**) to options for ensuring reliable electricity supply to the Kingsford load area and more broadly in the Eastern Suburbs network area.

The underground 132kV electricity subtransmission cables (‘feeders’) commissioned in the 1960s and 1970s, are now reaching, or past, the end of their technical lives. In particular, the self-contained fluid filled (**SCFF**) feeders are now considered an obsolete and outdated technology. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community.

Ausgrid identified the need to replace 132kV Feeder 264 supplying the Kingsford load area and has identified a preferred solution to mitigate the identified risks.

Ausgrid has initiated this RIT-D for replacing the ageing Feeder 264 to investigate and consult on options to ensure Ausgrid is able to satisfy reliability and performance standards that it is obliged to meet.

Ausgrid has determined that non-network solutions are unlikely to form a standalone credible option, or form a significant part of a credible option, as set out in the separate notice released in accordance with clause 5.17.4(d) of the 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 first stage of the formal consultation process set out in the NER in relation to the application of the RIT-D.

The purpose of the DPAR is to:

- describe the identified need Ausgrid is seeking to address, together with the assumptions used in identifying it;
- 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 credible options;
- present the results of a net present value analysis of each credible option, including an explanation of results; and
- identify the proposed preferred option.

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

1.2 Submissions and queries

Ausgrid welcomes written submissions on this DPAR. Submissions are due on 29 July 2022 and should be addressed to:

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

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email to: assetinvestment@ausgrid.com.au

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

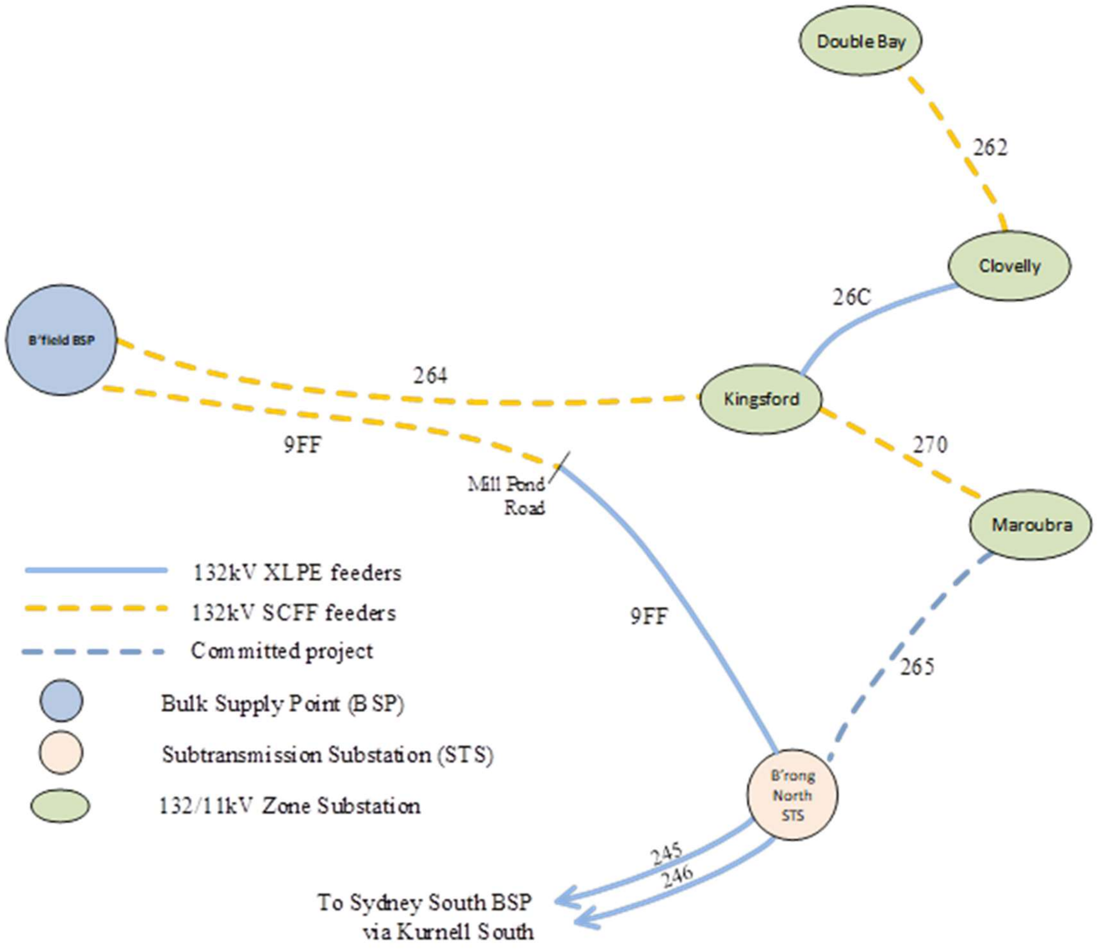
2 Description of the identified need

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

2.1 Overview of the Eastern Suburb subtransmission network and existing supply arrangements for the Kingsford load area

The Eastern Suburbs network area extends from South Head to La Perouse, inland to Surry Hills, and west as far as Marrickville. Within this area there is a 132kV network which supports the inner metropolitan transmission network. This network consists of 132/11kV and 33/11kV zone substations (**ZS**) as well as gas pressured, SCFF and paper insulated feeders. Feeder 264 forms part of this network.

Figure 2-1 – Schematic view of the 132kV network including feeder 264



Feeder 264 is a SCFF cable commissioned in 1977. It is approximately 5.5km long and connects Kingsford ZS with Transgrid's Beaconsfield Bulk Supply Point (**BSP**). Its availability is critical to supplying the zone substations connected to the ring in the event of an outage of any one of the other cables. While the current network arrangement ensures a level of redundancy, any outage of this feeder at the same time as an outage on Feeders 265 and 262 (Double Bay ZS to Clovelly ZS) would result in the loss of supply to Clovelly, Kingsford and Maroubra ZS's, affecting nearly 60,000 customers in this area, including the University of New South Wales, the Prince of Wales Hospital, and the Sydney Light Rail.

To minimise the environmental risks of fluid leaks in SCFF feeders, Ausgrid has a program to replace all SCFF on its network with known leaks and this program has been provided to the Environmental Protection Authority. Replacement of Feeder 264 with modern cables forms part of this program by removing 5.5km of SCFF feeder from service.

2.2 Key assumptions underpinning the identified need

The need to undertake action is predicated on the deteriorating condition of the existing 132kV underground Feeder 264 from the Kingsford ZS to Beaconsfield BSP 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.

2.2.1 Ageing SCFF 132kV Feeder 264 is expected to increase the risk of involuntary load shedding

A critical assumption underpinning the identified need is that retaining the SCFF 132kV Feeder 264 is expected to increase the risk of involuntary load shedding.

The major factor contributing to the risk of involuntary load shedding is that the feeder is reaching the end of its technical life. The SCFF technology used by the feeder is also obsolete and requires specialist skills to repair and maintain. Consequently, outage times can be lengthy and spares are not readily available.

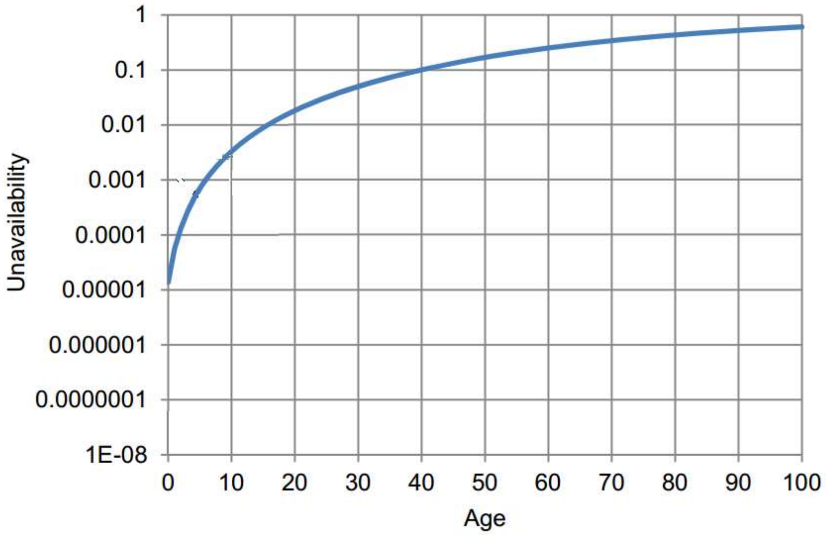
Feeder 264 has experienced multiple oil leaks over the past 15 years. Analysis of the condition of Feeder 264 has determined that the risk of prolonged outages is growing. Predictive failure models for this feeder (informed by ongoing condition assessments) suggests that immediate replacement investment is justified, primarily driven by expected unserved energy in the event of outages. Therefore, action to mitigate the growing supply risk should be taken as soon as practicable.

2.2.2 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[1]. 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 2-2 – 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.

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[1] 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.

2.2.3 Feeder redundancy exists but capacity to undertake load transfers are 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.

Current supply arrangements for the Kingsford and Maroubra zone substations have a degree of redundancy. However, outages of multiple feeders supplying each substation would likely lead to some degree of involuntary load shedding. Further, as feeders age, the likelihood of multiple feeder failures increases which, in turn, is likely to lead to involuntary load shedding.

Cable failure modelling indicates involuntary supply interruptions related to predicted failures of the SCFF feeders in this network area is approximately 52MWh in FY25, increasing to 66MWh by FY29 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 Expected Unserved Energy (**EUE**). EUE has been valued using the Value of Customer Reliability (VCR) figures determined and published by the AER[2] in 2019, adjusted by the Consumer Price Index (CPI) increases experienced in the past two years, following AER's advice.

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

3 One credible option can address the identified need

This section provides details of the single credible option that Ausgrid has identified as part of its network planning activities to date. Other options could technically address the identified need but are likely to cost significantly more than the credible option identified without any corresponding increase in benefits. Ausgrid has therefore identified only one credible option as other options are deemed non-credible on the basis they are not economically feasible. More details of other options are set out in section 3.2 below.

The credible option identified by Ausgrid involves the replacement of 132kV Feeder 264 from Beaconsfield BSP to Kingsford ZS by undertaking a like-for-like replacement using contemporary technology, which is expected to improve reliability, reduce unserved energy levels and reduce operating expenditure over time. Section 3.1 below provides a summary of this option. All costs in this section are in $2021/22, unless otherwise stated.

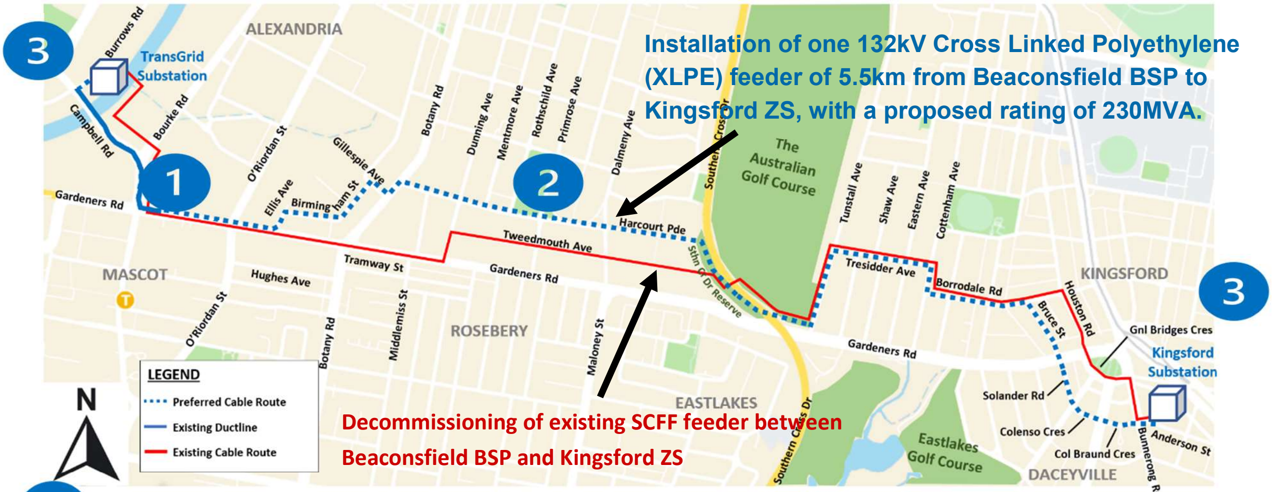
Table 3.1 – Summary of the credible option considered and base case

Option Details	Option 1
Option description	Replace 132kV feeder 264 from Beaconsfield BSP to Kingsford ZS like-for-like
Capital Costs	$25.1 million
Construction period	From 2022/23 to 2023/24
Commissioning date	2023/2024

3.1 Option 1 – Like-for-like replacement of existing Feeder 264

This option involves a like-for-like replacement of the existing feeder that connects Beaconsfield BSP and Kingsford ZS. The figure below illustrates the route of the existing Feeder 264 as well as the proposed route.

Figure 3-1 – Existing and proposed route of feeder 264



Installation of one 132kV Cross Linked Polyethylene (XLPE) feeder of 5.5km from Beaconsfield BSP to Kingsford ZS, with a proposed rating of 230MVA.

Decommissioning of existing SCFF feeder between Beaconsfield BSP and Kingsford ZS

1. **Existing dual circuit 132kV ductline from Transgrid's Beaconsfield BSP extended by 400metres to reach O'Riordan Street, Mascot. This will accommodate the new Feeder 264 and the future replacement**
2. **Construction of 4.5km single circuit 132kV ductline to accommodate Feeder 264, between O'Riordan St, Mascot and Kingsford ZS.**
3. **Civil works and secondary systems (i.e. metering, control and protection communications) upgrades at Beaconsfield BSP and Kingsford ZS to facilitate the new feeder connection**

The project would include:

- works at Beaconsfield BSP and Kingsford ZS to facilitate the new 132kV feeder connection;
- extending the existing dual circuit 132kV ductline between Beaconsfield BSP to O'Riordan Street, Mascot to accommodate replacement of SCFF Feeder 264 and future replacement of Feeder 9FF;
- construction of a 4.5km single circuit ductline to accommodate Feeder 264, between O'Riordan St, Mascot and Kingsford ZS;
- installation of one 132kV XLPE feeder of approximately 5.5km from Beaconsfield BSP to Kingsford 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 Beaconsfield BSP and Kingsford ZS.

The estimated cost of this option is approximately $25.1 million. Ausgrid assumes that the like-for-like replacement would commence construction in 2022/23, with the replacement scheduled to finish in 2023/24, with commissioning occurring in the same year. Once the replacement is complete, operating costs are expected to be approximately $48k per annum (around 0.2 per cent of capital expenditure).

It should be noted that the installation of 400 metres of spare ducts to reach O'Riordan Street, Mascot results in a cost increase of approximately $0.6 million to this option. This is considered to be a marginal increase in cost that provides an opportunity to reduce costs/complexities of the works to replace the SCFF section of Feeder 9FF between Beaconsfield BSP to Mill Pond Rd, anticipated to be required by 2033/2034.

The analysis underpinning the timing assessment of this option is set out in section 5.4.1.

3.2 Options considered but not progressed

Ausgrid has considered one additional network option involving the decommissioning of the existing Feeder 264 without replacement. However, this option was ruled out as it leaves the remaining network not secure.

Ausgrid has also considered the ability of other 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 the identified network option allows to be avoided, compared to base case, and is detailed further in the separate 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.

4 How the option has been assessed

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

4.1 General overview of the assessment framework

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

The RIT-D analysis has been undertaken over a 20-year period, from 2022 to 2041. Ausgrid considers that a 20-year period takes into account the size, complexity and expected life of the relevant credible option to provide a reasonable indication of the market benefits and costs of the option. While the capital components of the credible option have asset lives greater than 20 years, Ausgrid has taken a terminal value approach to 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.

Given that no non-network options have been found to be viable, the appropriate discount rate is considered to be the regulated cost of capital. As a result, Ausgrid has adopted a real, pre-tax discount rate of 2.99 per cent, based on the latest AER final decision for a Ausgrid’s regulatory[3]. The adopted discount rate is adjusted annually, according to guidelines provided in the AER Final Decision Report and the rate of return instrument. The value of 2.99% will also be used for the low benefit scenario, whereas, a 30% higher value will be used for the high benefit scenario (4.05%).

4.2 Ausgrid’s approach to estimating project costs

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

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

Operating costs have been estimated for 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.

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, and are found to be immaterial in the analysis, both in terms of absolute values as well as being the same across the options, as illustrated in section 5.1. Details of the assumptions and methodologies adopted to estimate these avoided costs are presented in Appendix D.

4.3 Benefits are expected from reduced involuntary load shedding

Ausgrid considers that the relevant categories of market benefits prescribed under the NER for this RIT-D relate to changes in involuntary load shedding.

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

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

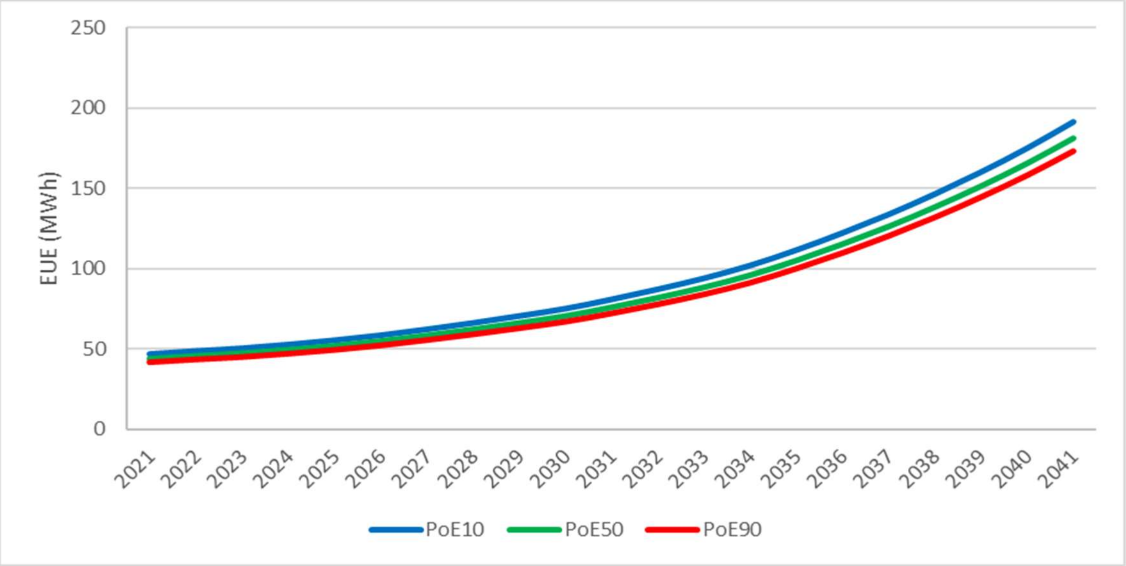
The market benefit that results from reducing the involuntary load shedding with a network solution is estimated by multiplying the quantity of EUE in MWh by the Value of Customer Reliability (**VCR**). The VCR is measured in dollars per MWh and is used as proxy to evaluate the economic impact of unserved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

Ausgrid has applied a central VCR estimate of $43.69/kWh, which is the load weighted value calculated for the NSW and ACT region by the AER in its VCR Final Report[4] (table 5.22 of the report), adjusted by the Consumer Price Index (CPI) increases experienced in the past two years, following AER's advice. The report also recommends using values of ± 30% of the base case VCR for the purposes of testing how sensitive investment decisions are to the VCR input (section 7.2 of the report). Thus, a lower VCR of $31/kWh and a higher VCR of $57/kWh have been chosen as reasonable for the low and high benefit scenarios.

In addition, while load forecasts are not a key determinant of the identified need, Ausgrid has investigated how assuming different load forecasts going forward changes expected market benefits under each option. In particular, three future load forecasts for the area in question were investigated – namely a central forecast using our 50 percent probability of exceedance ('POE50'), as well as a low forecast using the POE90 and a high forecast using the POE10 forecasts.

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

Figure 4-1 – Assumed expected unserved energy (EUE) under each of the three demand forecasts



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[4] 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

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;
- baseline scenario – the baseline scenario consists of assumptions that reflect Ausgrid's central set of variable estimates which, in Ausgrid's opinion, provides the most likely scenario; and
- high benefit scenario – this scenario reflects 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 – baseline	Scenario 2 – low benefits	Scenario 3 – high benefits
Demand	POE50	POE90	POE10
VCR	$43.69/kWh (Derived from the AER VCR 2019 estimates and updated by CPI variations authorised by AER)	$30.58/kWh (30 per cent lower than the central, AER-derived estimate)	$56.79/kWh (30 per cent higher than the central, AER-derived estimate)
Capital Costs (including future capital costs)	100 per cent of capital cost estimate	125 per cent of capital cost estimate	75 per cent of capital cost estimate
Discount Rate	2.99%	2.99%	4.05%

Ausgrid considers that the baseline 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 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.

5 Assessment of the credible option

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

5.1 Gross market benefits estimated for the credible option

The table below summarises the gross benefit of the credible option 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.

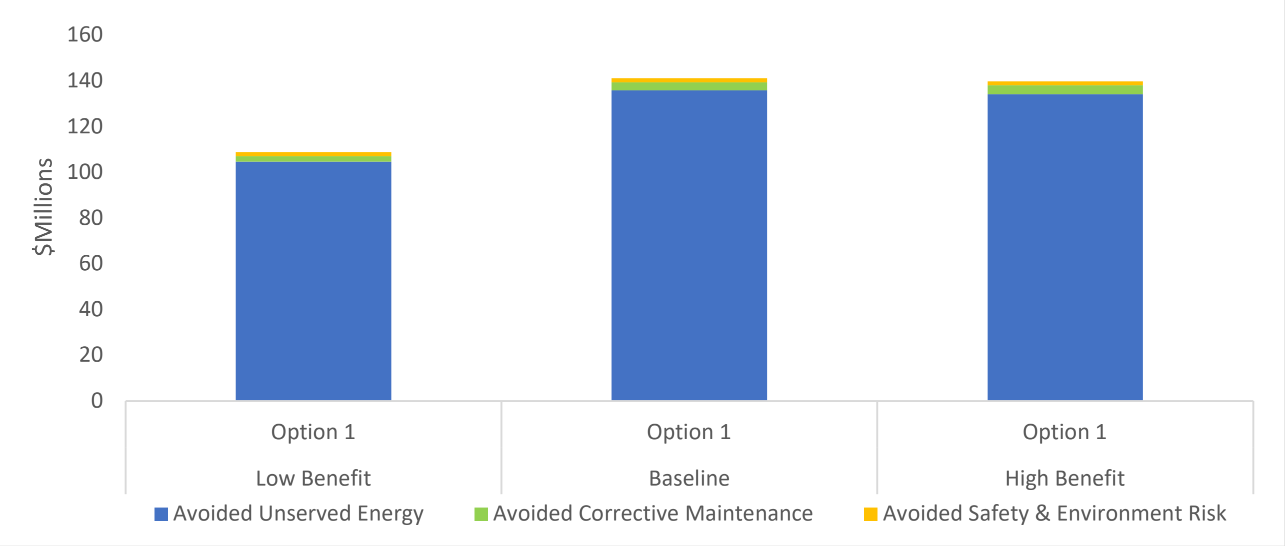
Table 5.1 – Present value of gross benefits of credible options relative to the base case, $m 2021/22

Option	Baseline scenario	Low benefit scenario	High benefit scenario	Weighted benefits
Scenario weighting	50%	25%	25%	
Option 1	141.0	108.7	139.6	132.6

The figure below provides a breakdown of all benefits relating to the credible option. For clarity, we have combined in this chart the categories of 'market benefit' (i.e. reduced involuntary load shedding) with avoided corrective maintenance cost benefits (i.e. reduced unplanned corrective maintenance when assets fail and reduced operating costs associated with environmental costs).

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.

Figure 5-1 – Breakdown of gross benefits of the credible options relative to the base case



5.2 Estimated costs for the credible option

The table below summarises the costs of the credible option relative to the base in present value terms. The cost is the sum of the project capital costs and the operating costs associated with running and maintaining the new cable.

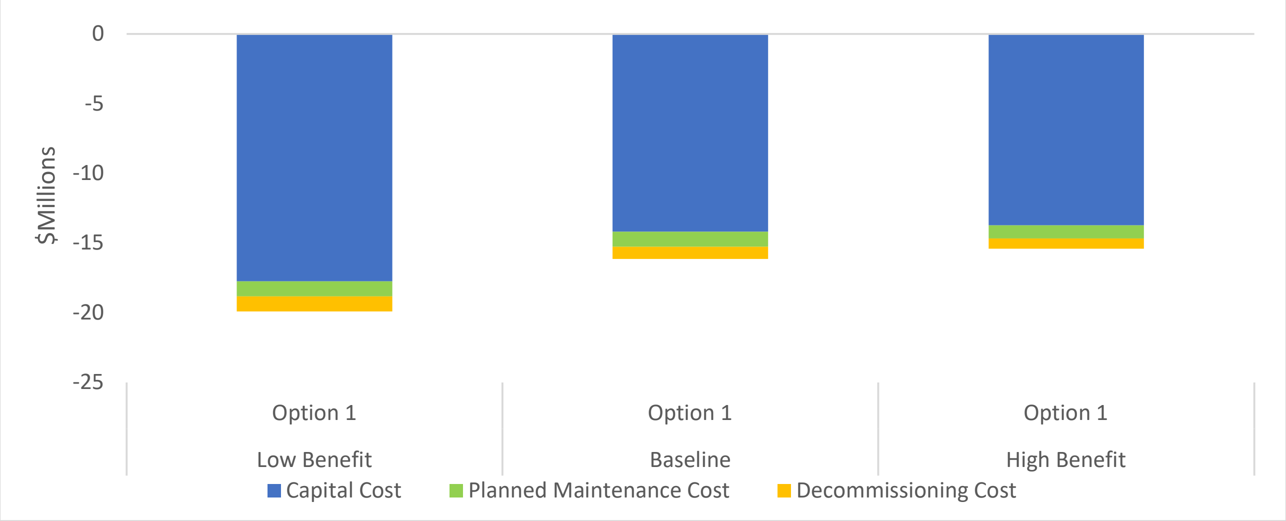
The cost of each option has been calculated for each of the three reasonable scenarios, in accordance with the approaches set out in Section 4.

Table 5.2 – Present value of costs of the credible options relative to the base case, NPV $m 2021/22

Option	Baseline scenario	Low benefit scenario	High benefit scenario	Weighted costs
Scenario weighting	50%	25%	25%	
Option 1	-16.1	-19.9	-15.4	-16.9

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.

Figure 5-2 – 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 option under each scenario. The net market benefit is the gross market benefit (as set out in Table 5.1) minus the cost of the option (as set out in Table 5.2), all in present value terms. Overall, Option 1 exhibits the highest estimated net market benefit.

Table 5.3 – Present value of weighted net benefits relative to the base case, $m 2021/22

Option	PV of Capital costs	PV of Operating costs	Weighted PV of Gross Benefits	Weighted NPV	Ranking
Option 1	-15.0	-1.9	132.6	115.7	1

5.4 Sensitivity analysis results

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

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

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

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

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

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

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

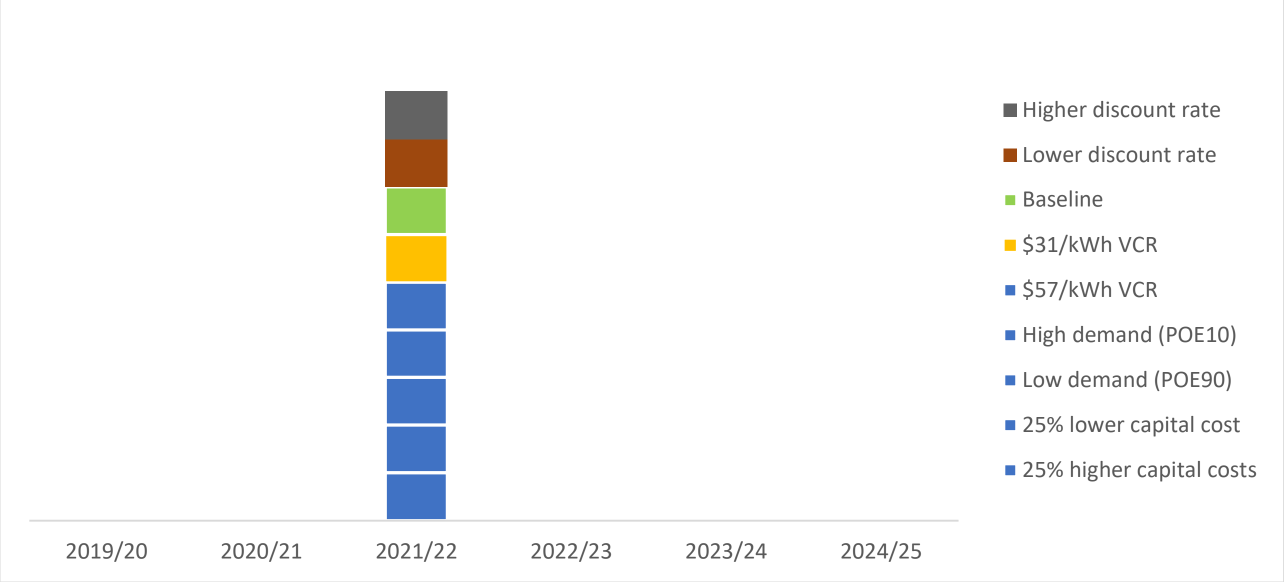
Ausgrid has estimated the optimal timing for each option based on the year in which the NPV of each option is maximised. This process was undertaken for both the baseline set of assumptions and also a range of alternative assumptions for key variables.

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 25 per cent increase/decrease in the assumed network capital costs;
- alternative forecasts of maximum demand growth, based on POE10 (high) and POE90 (low);
- a lower VCR ($31/kWh) and a higher VCR ($57/kWh); and
- a higher/lower discount rate.

The figures below outline the impact on the optimal commissioning year for each option, under a range of alternative assumptions. They illustrate that for Option 1, the optimal commissioning date is found to be in 2021/22.

Figure 5-3 – Option 1's distribution of optimal project commissioning years under each sensitivity



5.4.2 Step 2 – Sensitivity of the overall net market benefit

Ausgrid has also conducted sensitivity analysis on the overall NPV of the net market benefit, based on the assumption 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;
- alternative forecasts of maximum demand growth, based on POE10 (high) and POE90 (low);
- a lower VCR ($31/kWh) and a higher VCR ($57/kWh); and
- a higher/lower discount rate.

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

Table 5.4 – Sensitivity testing results, $m PV 2021/22

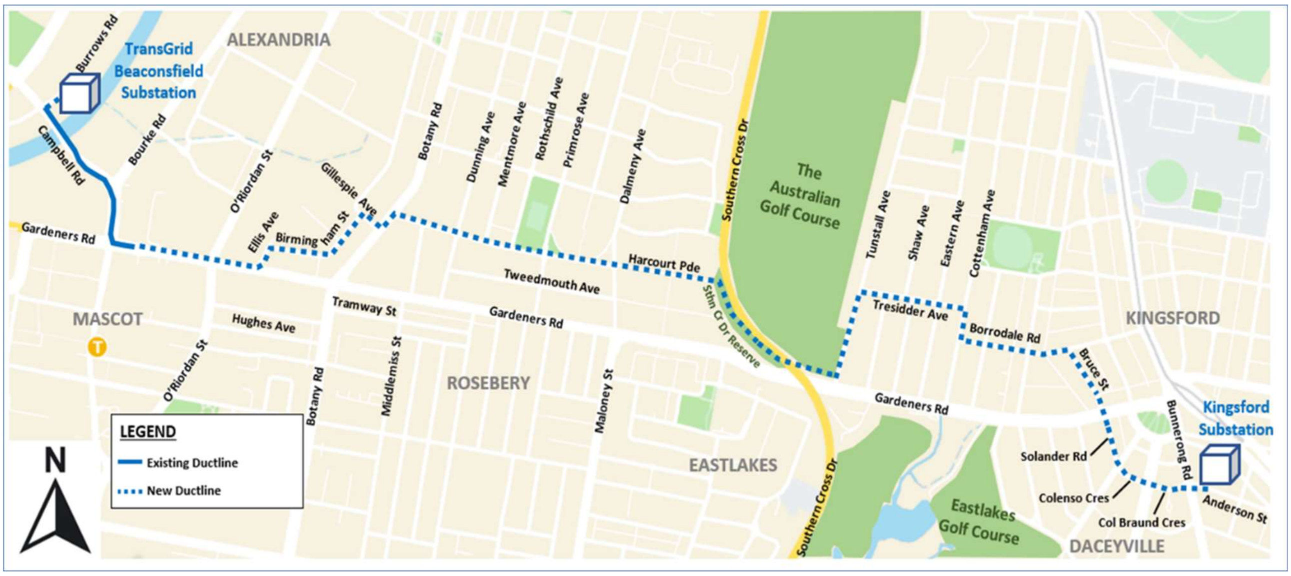
Sensitivity	Option 1
Baseline	124.8
25 per cent higher capital cost	121.3
25 per cent lower capital cost	126.3
Unserved energy under POE10	138.4
Unserved energy under POE 90	111.3
VCR $57/kWh	165.6
VCR $31/kWh	84.1
Lower discount rate	124.8
Higher discount rate	101.9

6 Proposed preferred option

Ausgrid proposes Option 1 as the preferred option, which satisfies the RIT-D. It involves the replacement of the existing SCFF Feeder from Beaconsfield BSP to Kingsford ZS with a new 132kV XLPE feeder 5.5km long. Once installed, the existing SCFF feeder will be decommissioned.

The route of the proposed feeder under Option 1 is depicted in Figure 6-1 below.

Figure 6-1 - Proposed Route Plan for the new 132kV feeder



In November 2021, Ausgrid started engaging with key stakeholders such as the Australian Golf Course, City of Sydney Council, Bayside Council and Randwick City Council to obtain early feedback on the preferred cable route. In February 2022, Ausgrid commenced engagement with residents and businesses along and a buffer around the preferred cable route. In March 2022, Ausgrid held two live online information sessions (due to the ongoing COVID-19 pandemic, face-to-face information sessions were unable to occur), to seek local information and further community feedback on the preferred cable route. Ausgrid encourages community feedback and has committed to keep the community informed as the project progresses through:

- the Environmental Assessment process, including 3 week public exhibition of the assessment report and further drop-in information session
- 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.

The estimated capital cost of this option is $25.1 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2022/23 and end in 2023/24. Once the new installation is complete, operating costs are expected to be approximately $48,000 per annum (around 0.2 per cent of capital expenditure).

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

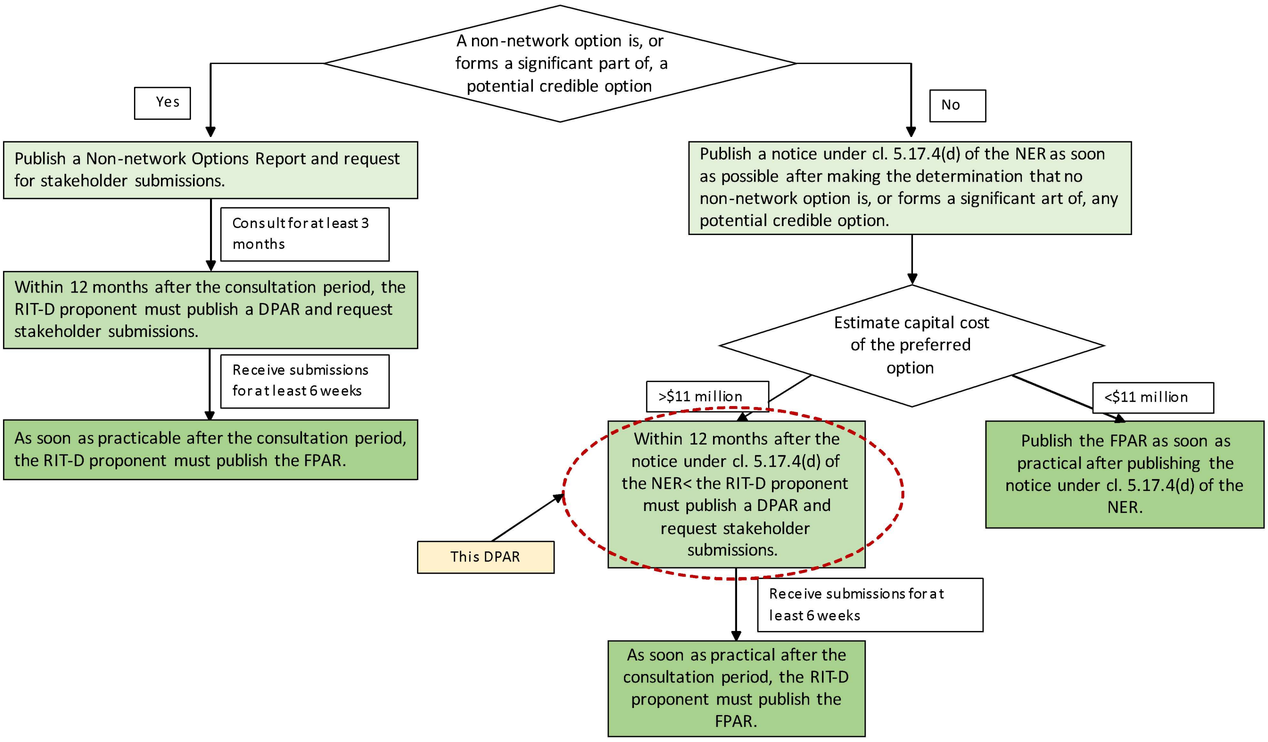
Appendix A – Checklist of compliance clauses

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

Rules clause	Summary of requirements	Relevant sections in the DPAR
5.17.4(j)	(1) a description of the identified need for the investment	2
	(2) the assumptions used in identifying the identified need	2.3
	(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 is not expected to be material for this RIT-D are outlined in the table below.

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

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated expenditure	Ausgrid does not expect the project will have any effect on unrelated expenditures in other parts of the network. Accordingly, Ausgrid considers the market benefit from changes in timing of unrelated expenditure is not material.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the 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 values arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered have sufficiently flexible to respond to that change. Ausgrid notes that the credible option assessed does not involve stages or any other flexibility and so we do not consider that option value is relevant.
Changes in electrical energy losses	Ausgrid does not expect that any of the credible options considered would 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 presents additional detail on the supply restoration assumptions and probability of failure assumptions.

D.1 Characteric load duration curves

The load duration curves for Kingsford, Maroubra and Clovelly ZSs is presented in Figure D.1, Figure D.2 and Figure D.3 below.

It is assumed that the load types supplied by these substations will not change substantially into the future and therefore the load duration curves will maintain their characteristic shape regardless of the zone substation supplying the existing load at Kingsford, Maroubra and Clovelly.

No load transfer capability has been included at Clovelly ZS as there is negligible impact on the assessment of this project.

Figure D.1-1 – Load duration curve for Kingsford

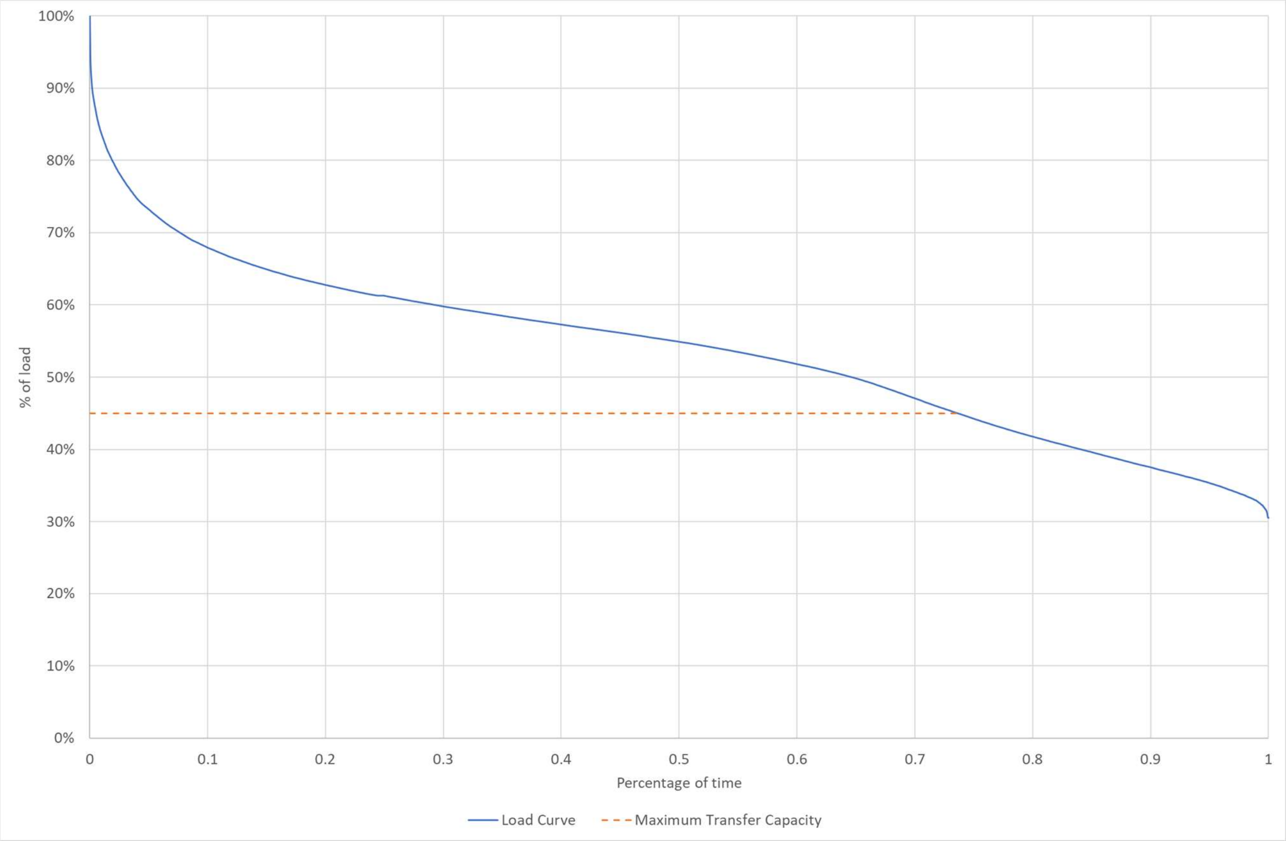


Figure D.1-1 – Load duration curve for Maroubra

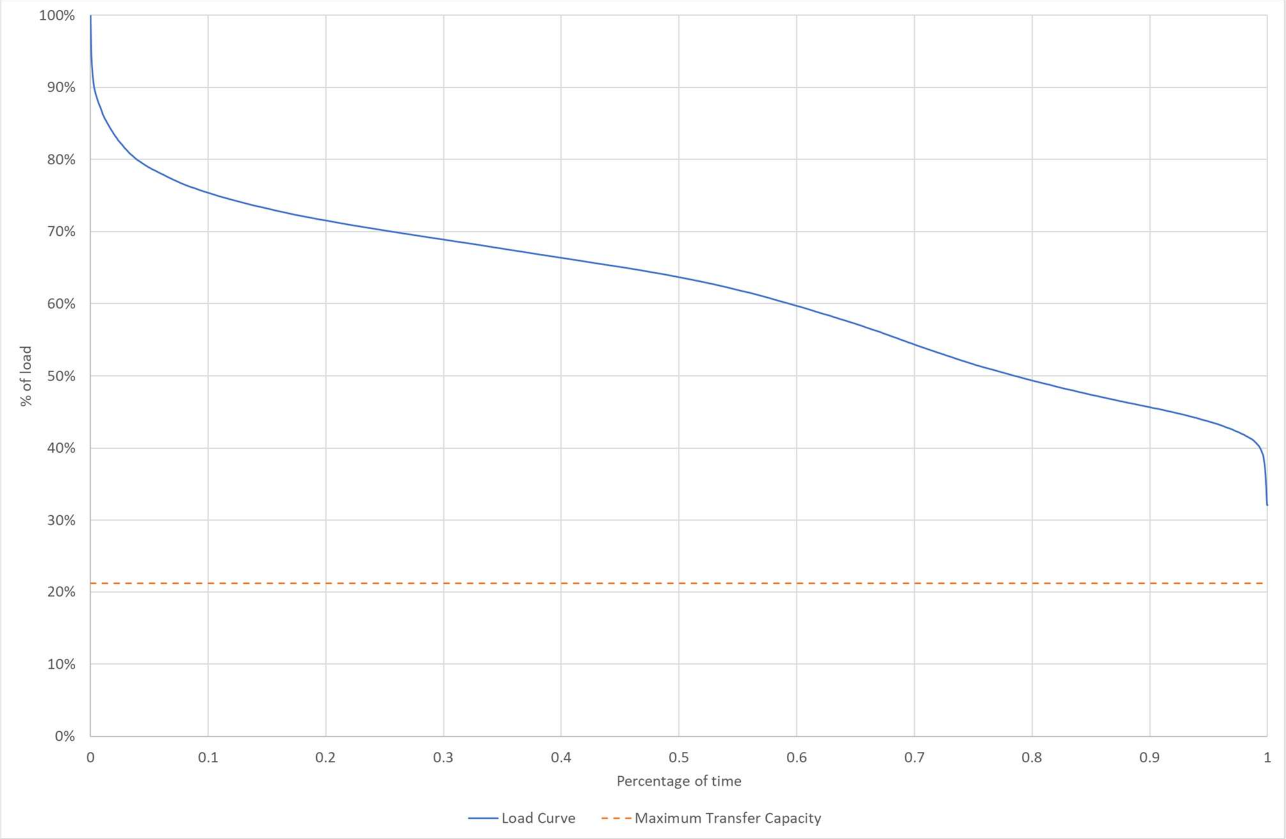
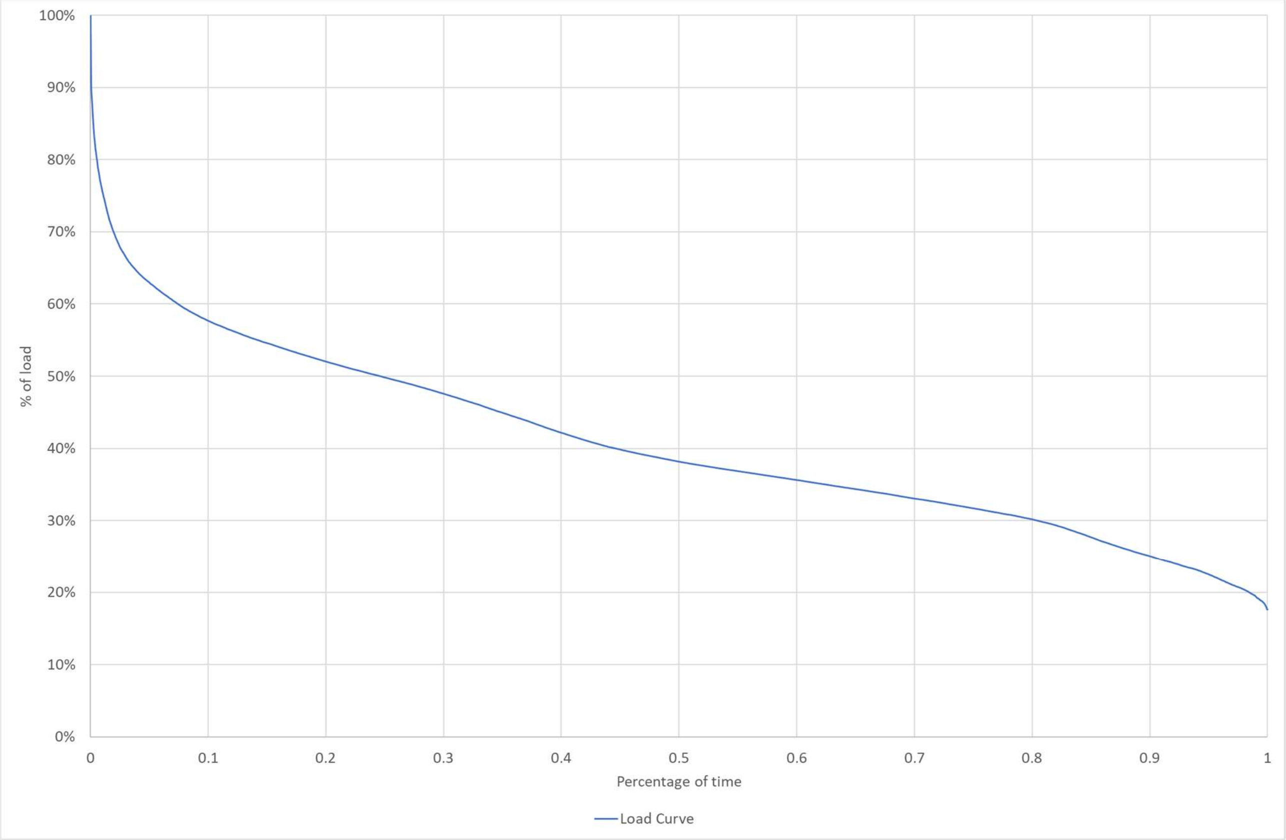


Figure D.1-2 – Load duration curve for Clovelly



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[5] (weeks)
264	Corrective action	6.35	5.82E-11	1.06
264	Breakdowns	5.97	1.83E-12	6.00
264	Third party damage	1.00	2.91E-02	5.50
265	Breakdowns	0.24	0.02	2.00
270	Corrective action	6.32	5.82E-11	1.06
270	Breakdowns	5.94	1.83E-12	6.00
270	Third party damage	1.00	2.91E-02	5.50
26C	Breakdowns	0.24	0.02	2.00
262	Corrective action	6.39	5.82E-11	1.06
262	Breakdowns	6.01	1.83E-12	6.00
262	Third party damage	1.00	2.91E-02	5.50

* XLPE cables do not have corrective actions as they are not fluid filled
* There is insufficient data on third party damage of XLPE cables to develop Crow-AMSAA parameters
* As the replacement of Feeder 265 is currently in construction, it is assumed to be completed for the purposes of this assessment.

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 2.4 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.

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[5] Mean Time To Repair

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.

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[6] (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 264

Factor Description	Corrective Action	Breakdown	Third Party Damage
Environmental Criticality	$111,883	$632,936	$580,191
Conditional probability of ground water impact (β)	0.0778	0.2240	0.1478

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

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[6] 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)…*"

Ausgrid