Addressing reliability requirements in the Revesby and Milperra load areas

FINAL PROJECT ASSESSMENT REPORT

10 AUGUST 2018

Ausgrid

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Addressing reliability requirements in the Revesby and Milperra load areas

Final Project Assessment Report – August 2018

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Glossary of Terms

Term	Description
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
DNSP	Distribution Network Service Provider
DPAR	Draft Project Assessment Report
FPAR	Final Project Assessment Report
IPART	Independent Pricing and Regulatory Tribunal
NPV	Net Present Value
NER	National Electricity Rules
POE	Probability of Exceedance
RIT-D	Regulatory Investment Test for Distribution
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
USE	Unserved Energy
VCR	Value of Customer Reliability

Executive Summary

This report is the final stage in a RIT-D investigating the most economic option for mitigating the risks associated with fluid-filled feeders installed in the Revesby and Milperra areas in the late 1960s and 1980s

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 customers in the Revesby and Milperra network areas.

In particular, the underground electricity distribution lines ('feeders') supplying the Revesby zone substation and Milperra zone substation were commissioned in the 1960s and 1980s, and are now reaching, or past, the end of their technical lives. These feeders are self-contained fluid filled (SCFF) cables, which are now considered an obsolete and dated technology. They are becoming less reliable and approaching the point at which their replacement maximises the net benefit for the community.

A draft report was released in June 2018 and received no submissions

A Draft Project Assessment Report (DPAR) for this RIT-D was published on 22 June 2018. The DPAR presented two credible options for addressing asset condition concerns in the Canterbury Bankstown network area, assessed in accordance with the RIT-D framework and concluded that the preferred option was to replace two feeders from Sydney South Bulk Supply Point (BSP) to Revesby zone substation using two new installations along the existing route. Specifically, this option involves the installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP.

The DPAR also summarised Ausgrid's assessment of the ability of non-network solutions to contribute the identified need, which concluded that such solutions were not viable for this particular RIT-D. The DPAR was accompanied by a separate non-network screening notice that provided further detail on this assessment, in accordance with clause 5.17.4(d) of the NER.

The DPAR called for submissions from parties by 3 August 2018. However, no submissions were received on either the DPAR or the separate non-network screening notice.

This report therefore re-presents the assessment in the draft report and maintains the conclusion that Option 1 is the preferred option

In light of there being no submissions made to either the DPAR or the separate non-network screening notice, as well as there being no significant exogenous changes to factors affecting this RIT-D assessment since the DPAR was released, this FPAR re-presents the assessment undertaken in the DPAR.

Ausgrid has identified two network options that either replace the existing feeders connecting Revesby zone substation and Sydney South BSP by installing like-for-like replacements, or replacing the existing feeders with new underground feeders from Bankstown sub-transmission substation (STS).

The two credible options are summarised below. All costs are in real $2017/18, unless otherwise stated.

Table E.1 – Summary of the credible options considered

Overview	Key components	Length of new feeders	Estimated capital cost
Option 1 – replacements of feeders like-for-like	• Installation of two new 132kV XLPE feeders from Revesby zone substation to Sydney South BSP. • Work at Revesby zone substation and South Sydney BSP to facilitate new 132kV feeder connections. • Decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.	3.3km for each feeder	$16.4 million
Option 2 – replacement of feeders with new underground feeders from Bankstown STS	• Installation of two new 132kV XLPE feeders from Revesby zone substation to Bankstown STS. • Work at Revesby zone substation and Bankstown STS to facilitate new 132kV feeder connections. • Decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.	5.0km for each feeder	$25.4 million

Option 1 has been found to be the preferred option, which satisfies the RIT-D. It involves the replacement of the two feeders from Sydney South BSP to Revesby zone substation using two new installations along the existing route. Specifically, this option involves the installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP.

The scope of the project includes:

- works at Revesby zone substation and Sydney South BSP to facilitate new 132kV feeder connections;
- installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP, with a proposed firm rating of 250MVA per feeder;
- installation of mechanical protection on the side of the trench walls to mitigate the future risk associated with strikes from Horizontal Directional Drills (HDD's), given the common trench arrangements and limited 11kV backup;
- associated control and protection communication upgrades at Revesby zone substation and Sydney South BSP; and
- decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.

The estimated capital cost of this option is approximately $16.4 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2018/19 with the proposed works expected to be completed in 2020/21. The project has been brought forward on the basis that the current analysis does not reflect the unserved energy and environmental risks that have been generated since a recent incident with one of the feeders concerned. Commissioning is expected to occur in the same year. Once the new installation is complete, operating costs are expected to be $82,000 per annum (around 0.5 per cent of capital expenditure).

While the optimal commissioning date for Option 1 has been found to be 2023/24 in this FPAR assessment, Ausgrid is proceeding with this option now and intending to commission it in 2020/21. The reason behind this is that Ausgrid has two other 132kV feeder replacement projects requiring completion as soon as practicable[1] and Ausgrid intends to release

[1] Please refer to see the concurrent Willoughby-Mosman and Kingsford-Clovelly RIT-Ds.

a competitive combined tender for all three projects to receive a discount and ultimately reduce the capital costs of each project (relative to the cost of procuring each separately).[2]

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

Next steps

Ausgrid intends to commence work on delivering Option 1 in 2018. In particular, we intend to award the construction contract in October 2018, have environmental approvals also finalised by end of 2018 and to commence construction in late 2018.

Any queries relating to this Final Project Assessment Report should be addressed to:

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email to: assetinvestment@ausgrid.com.au

[2] The economic assessment in this FPAR shows that the difference in the NPV of Option if commissioned in 2020/21, compared to 2023/24, is approximately $700,000. The combined procurement and installation of this project with the two other coincident 132 kV feeder RIT-Ds will provide economic efficiencies (i.e. cost savings) through a competitive tender process that are anticipated to be bigger than $700,000. Ausgrid therefore considers it prudent and efficient to progress this option with the other two and to procure the cable contracts at once.

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 customers in the Revesby and Milperra network areas going forward.

In particular, the underground electricity distribution lines ('feeders') supplying the Revesby zone substation and Milperra zone substation were commissioned in the 1960s and 1980s, and are now reaching, or past, the end of their technical lives. These feeders are self-contained fluid filled (SCFF) cables, which are now considered an obsolete and dated 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 these feeders in 2017 and identified a preferred solution to mitigating the identified risks.

Since early 2018, Ausgrid has undertaken a range of community engagement activities seeking feedback on the preferred replacement option identified in 2017. These activities included meeting with City of Canterbury Bankstown Council, as well as having representatives from the Ausgrid project team speak to many businesses and visiting residents in these council areas. This consultation included visiting and distributing project information to residents along the impacted streets, with a newsletter detailing the project distributed in April 2018, shortly followed by a community engagement session. These sessions are complemented by continuing engagement through social media and websites that are dedicated to this project. The feedback received through these various avenues was very helpful and resulted in a number of refinements to the preferred solution. Ausgrid wishes to thank all those consulted with for their time and suggestions.

Rule changes to the National Electricity Rules (NER) in July 2017 have meant that the replacement plans for ageing feeders are now subject to the RIT-D. Accordingly, Ausgrid has initiated this RIT-D for replacing these feeders 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.

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 final report

Ausgrid has prepared this FPAR in accordance with the requirements of the NER under clause 5.17.4.

The purpose of the FPAR 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;
- provide reasons why Ausgrid has determined that classes of market benefits or costs do not apply to a credible option(s);
- present the results of a net present value analysis of each credible option and accompanying explanation of the results; and
- identify the proposed preferred option.

This FPAR follows the DPAR released in June 2018. The FPAR represents the final stage of the formal consultation process set out in the NER in relation to the application of the RIT-D as outlined in Appendix B. The entire RIT-D process is detailed in Appendix B.

1.2 No submissions were received on the DPAR

The DPAR presented two credible options for addressing reliability concerns in the Canterbury Bankstown network area, assessed each in accordance with the RIT-D framework and concluded that the preferred option was to replace two feeders from Sydney South BSP to Revesby zone substation using two new installations along the existing route. Specifically, this option involves the installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP.

The DPAR also summarised Ausgrid's assessment of the ability of non-network solutions to contribute, which concluded that such solutions were not viable for this particular RIT-D. The DPAR was accompanied by a separate non-network screening notice which provided further detail on this assessment, in accordance with clause 5.14.4(d) of the NER.

The DPAR called for submissions from parties by the 3 August 218. However, no submissions were received on either the DPAR or the separate non-network screening notice.

1.3 Contact details for queries in relation to this RIT-D

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

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Or

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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 Canterbury Bankstown network area

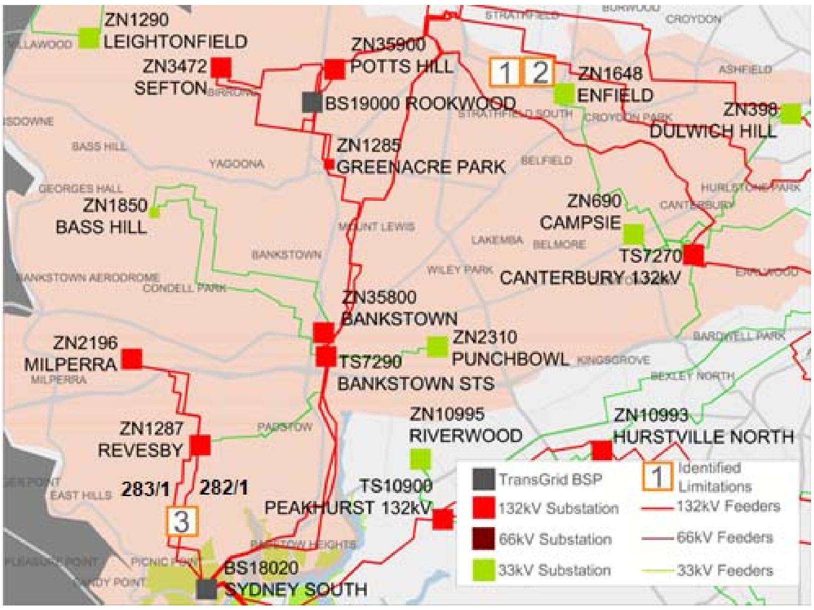
The Canterbury Bankstown network area extends from Leightonfield in the north-west, Revesby in the south, and as far east as Dulwich Hill. The distribution network:

- is supplied from Ausgrid's Inner Metropolitan transmission system, except for Revesby and Milperra zone substations, which are supplied from TransGrid's Sydney South Bulk Supply Point (BSP);
- includes 132/33kV sub-transmission substations at Bankstown and Canterbury which supply five 33/11kV zone substations and provide 33kV supply to Sydney Trains and the M5 motorway;
- includes six zone 132/11kV substations at Greenacre Park, Bankstown, Potts Hill, Sefton, Revesby and Milperra;
- includes a 'stand-alone' 33kV zone substation at Leightonfield, which is supplied from Endeavour Energy's network at Guildford sub-transmission substation;
- includes substantial lengths of 33kV gas-pressure cables, which are an obsolete technology;[3] and
- is traversed by transmission feeders 92C, 92X, 91X2, 91Y2, 910, and 911.

The figure below illustrates the geographic spread of the Canterbury Bankstown network area, as well as the various 132kV and 33kV zone substations and their feeders.

The figure also highlights the identified limitations of the network area. For the purpose of this FPAR, the identified limitation of interest is number three – feeders 282/1 and 283/1 connecting Sydney South BSP to Revesby zone substation, situated in the south-west of the network.

Figure 2.1 – Canterbury Bankstown network area



3 Please note that the replacement of these gas-pressure cables is in the process of being resolved and formed part of the coincident Enfield RIT-D.

The 132kV self-contained fluid filled (SCFF) underground cables 282/1 and 283/1 supply Revesby zone substation and then two feeders 282/2 and 283/2 from Revesby zone substation supply Milperra zone substation. The lengths of the 132kV fluid filled cables 282/1 and 283/1 are 3.3km and 3.7km, respectively. The feeders were installed in 1963 and 1981, respectively.

Both Revesby zone substation and Milperra zone substation supply major customers, including Bankstown Hospital, Western Sydney University Bankstown Campus, Padstow TAFE, Bankstown Airport, and substantial industrial precincts. This is indicative of the broader Canterbury Bankstown network area, which encompasses load types ranging from low density residential through to large commercial and industrial users.

Owing to their age, the underground fluid filled feeders connecting Revesby zone substation to Sydney South BSP are an obsolete technology. As a result, these feeders require specialist skills to repair and maintain, meaning outage times can be lengthy and spare parts are not readily available.

These issues are pertinent as there is a low, but increasing, probability that a significant portion of the customers in this area will experience an extended outage. This would affect the approximately 25,000 NMIs (customer meters) across the areas served by the Revesby and Milperra zone substations. Ausgrid's risk and outage modelling, for example, estimates that the aggregated expected unserved energy associated with these feeders is estimated to be approximately 130MWh in the FY2020-2024 regulatory period if no investment is made to reduce this risk. Further, these feeders are ranked third across Ausgrid's network based on expected unserved energy per million dollars of expenditure.

These performance issues are exacerbated by the fact that these feeders are the sole supply to Milperra and Revesby zone substations in the Canterbury Bankstown area, meaning their integrity is essential in ensuring reliable supply for customers in these areas. Indeed, the concurrent outage of these feeders would result in the loss of supply to both Revesby and Milperra zone substations. These outage issues are compounded by the fact that there is very limited supply restoration via 11kV connections to other nearby zone substations.

Further, failing to replace these feeders would also place Ausgrid at risk of violating its agreement under the EPA Act. The feeders have experienced minor fluid leaks over the past 15 years. However; the risk of further leaks is anticipated to increase as insulation resistance testing on feeders of similar age indicates that there are potential problems with the outer serving of the feeders, with failure models forecasting that the reliability of these feeders will deteriorate into the future if corrective action (i.e. replacement) is not taken. An assessment of the environmental risk derived from using fluid filled cables conducted in 2017 has determined that these feeders contributed 0.01 per cent of the total environmental risk assigned to Ausgrid's fluid filled cable network.

While feeder 283/1 has been a relatively well performing feeder with no leaks in the past 5 years, and only 125 litres lost in the past 15 years, on 15 February 2018, 970 litres were lost due to the third-party damage. This recent failure has not been captured in the assessment but would add further to the identified need as its inclusion would increase the benefit associated with avoided environmental risks and costs.[4]

A risk based cost-benefit analysis applied to these feeders has determined that the benefits of reduced expected unserved energy exceed the annualised costs of replacing the assets from 2020/21 onwards. In addition, the reliability of these cables is forecast to deteriorate in the future should they not be replaced.

Accordingly, Ausgrid has initiated this RIT-D in order to identify a preferred option that would ensure Ausgrid is able to satisfy its reliability and performance standards in supplying the Canterbury Bankstown load area in light of these emerging risks.

[4] To calculate the resulting environmental risk, a complete review of the risk model applied to all SCFF cables is required, because the risk score for each circuit is the product of its weighted *annual* leak rate and environmental sensitivity (i.e. vulnerability of the environment along the cable route, considering water ways, underground petroleum storage systems and other areas). The weighted annual leak rate is calculated considering the performance of the 88 SCFF cables currently in service at Ausgrid network. Given the magnitude of the network, the risk model is reviewed on annual basis in the first term of every financial year.

2.2 Overview of Ausgrid's relevant distribution reliability standards

All New South Wales electricity distribution businesses, including Ausgrid, are obliged to comply with reliability and performance standards as part of their distributor's license.[5] These standards are determined by the New South Wales Government.

At a high-level, the reliability and performance standards are specified in terms of both:

- the average frequency of interruptions a customer may face each year; and
- the average time those outages may last.

Specifically, under the current Ausgrid license, reliability and performance standards are expressed in two measures – namely:

- the System Average Interruption Frequency Index – 'SAIFI' – which measures the number of times on average that customers have their electricity interrupted over the year;[6] and
- the System Average Interruption Duration Index – 'SAIDI' – which measures the total length of time (in minutes) that, on average, a customer would have their electricity supply interrupted over a given period.[7]

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 these measures are. Reliability standards applied to distribution networks typically set minimum requirements in relation to each of these two measures.

The current reliability standards applying to the Canterbury-Bankstown network area (classified as an 'urban' feeder type) are shown in Table 2.1 below.

Table 2.1 – Current distribution reliability standards applying to Ausgrid[8]

Feeder type	Network Overall Reliability Standards		Individual Feeder Reliability Standard	
	SAIDI (Minutes per customer)	SAIFI (Number per customer)	SAIDI (Minutes per customer)	SAIFI (Number per customer)
Urban	80	1.2	350	4

2.3 Key assumptions underpinning the identified need

The need to undertake action is predicated on the deteriorating condition of the two existing 132kV underground feeders, from the Sydney South BSP to the Revesby zone substation and the characteristics of any resultant outages, as well as the fact that maintaining the existing technologies presents heightened maintenance and asset failure risks.

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

[5] Granted by the Minister for Industry, Resources and Energy under the *Electricity Supply Act 1995 (NSW)*.

[6] SAIFI is calculated as the total number of interruptions that have occurred during the relevant period, divided by the number of customers. Momentary interruptions (which in NSW are currently defined as interruptions less than one minute) are typically not included.

[7] SAIDI is calculated as the sum of the duration of all customer interruptions over the period divided by the number of customers. Momentary interruptions (i.e. those of less than one minute) are typically not included.

[8] The Hon. Anthony Roberts MP Minister for Industry, Resources & Energy, Reliability and Performance Licence Conditions for Electricity Distributors, 1 December 2016, pp. 18-19 - available at: https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/licensing-administrative-electricity-network-operations-proposed-new-licence-conditions/ausgrid-ministerial-licence-conditions-1-december-2016.pdf

2.3.1 Ageing feeders supplying the Revesby zone substation from Sydney South BSP are expected to increase the risk of involuntary load shedding going forward

The 132kV SCFF underground feeders 282/1 and 283/1 supplying Revesby ZS from Sydney South BSP are an obsolete technology. These feeders require specialist skills to repair and maintain, outage times can be lengthy, and spares are not readily available.

The cables are the sole supply to Milperra and Revesby zone substations in the Canterbury Bankstown area and their integrity are essential to ensure reliable supply for customers in these areas.

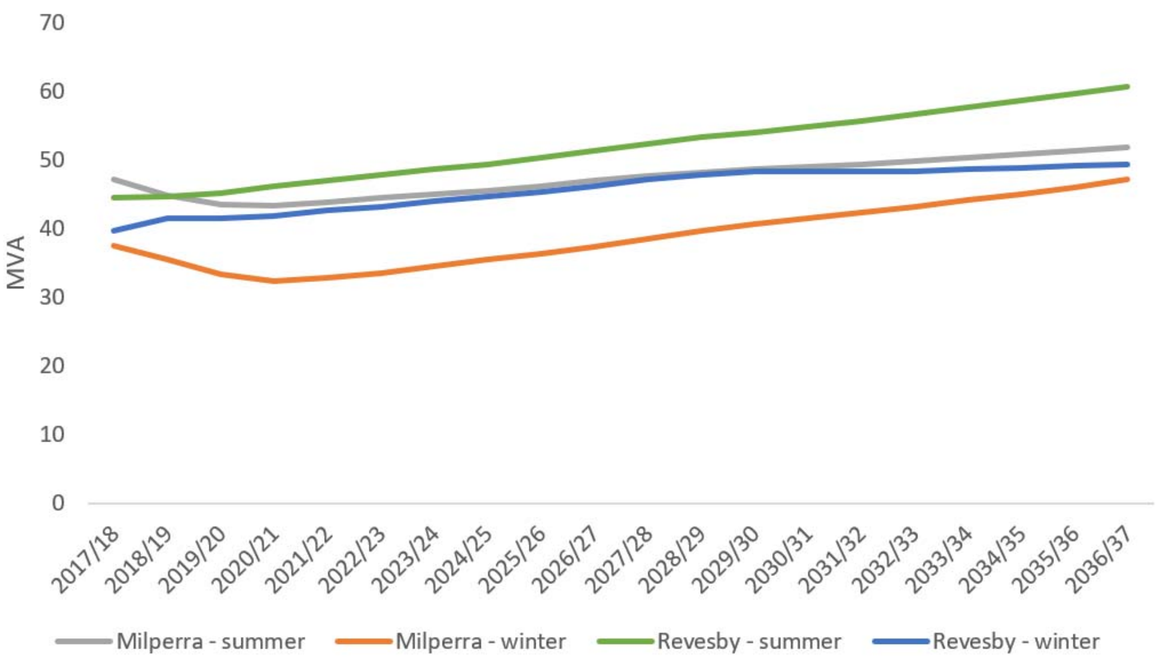
The concurrent outage of these feeders would result in the loss of supply to both Revesby and Milperra Zone Substations. There is a very limited supply restoration via 11kV connections to other nearby zone substations.

Essentially there is a low, but increasing, probability that a significant portion of the customers in this area will experience a very long blackout. The aggregated expected unserved energy associated with these feeders has been calculated to be approximately 130MWh in the FY2020-2024 regulatory period. This would be the result of the low probability of complete failure of supply to Revesby and Milperra Zones resulting in unplanned load shedding of 83MVA for several hours.

Furthermore, these feeders have been responsible for insulating fluid leaks, failures, and increased rates of corrective works. Insulation resistance testing on feeders of similar age indicates that there are potential problems with the outer serving of the feeders, with failure models forecasting that the reliability of these feeders will deteriorate into the future if they are not replaced. An assessment of the environmental risk derived from using fluid filled cables conducted in 2017 has determined that these feeders contributed 0.01 per cent of the total environmental risk assigned to Ausgrid's fluid filled cable network.

Both of these substations are considered to serve an enduring need for distributing electricity in the Canterbury Bankstown network area. These two substations combined are expected to serve between 72 and 113 MVA of load between 2017/18 and 2036/37, as shown below.

Figure 2.2 – Revesby and Milperra substation load forecasts

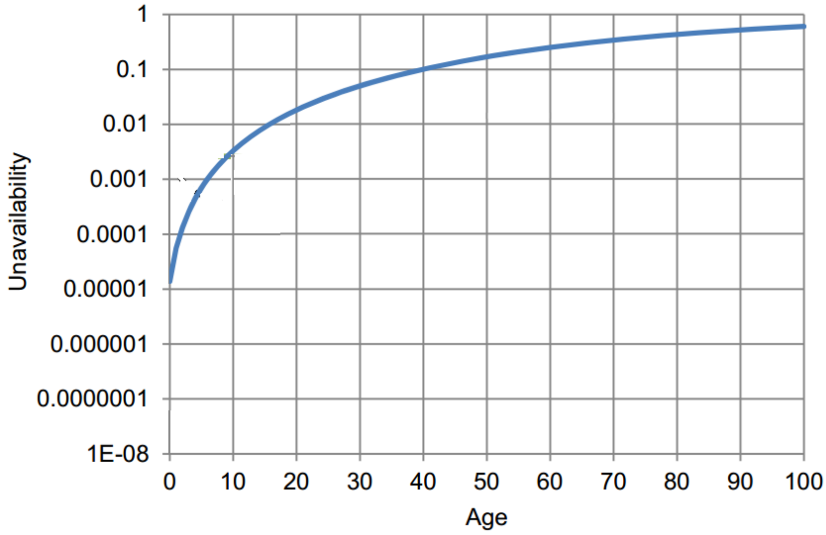


2.3.2 Possibility of assets failing increases with age

Network assets 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. In general, the probability of failure increases with asset age.

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

Figure 2.3 – Unavailability of fluid filled feeders



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 filed 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 are limited

The level of cost expected from any involuntary load shedding is dependent on the underlying assumptions relating to the level of redundancy in feeders and the capacity to transfer load to other substations that could supply load currently served by the Revesby and Milperra zone substations.

Current supply arrangement for these zone substations do not have a degree of redundancy, but there is the potential to transfer load as there are existing 11kV connections to other substations. However, as set out above, the capacity to transfer is extremely limited. Ausgrid estimates that the capacity to transfer is limited to 10.5MVA, which is small relative to the overall demand of 83MVA, meaning the transfer capabilities could only continue supply for approximately 13 per cent of the load. Consequently, restoration of supply to customers in these areas would depend on the time needed to return feeders to service.

Both the degree of redundancy and the ability to transfer load elsewhere have been taken into account by Ausgrid in forecasting expected unserved energy.

3 Two credible options have been assessed

This section provides descriptions of the two credible options Ausgrid has identified as part of its network planning activities to date.

In particular, Ausgrid has identified two network options that either replace the existing feeders connection Revesby zone substation and Sydney South BSP by installing like-for-like replacements, or replacing the existing feeders with new underground feeders from Bankstown sub-transmission substation (STS).

The two credible options are summarized below. All costs are in real $2017/18, unless otherwise stated.

Table 3.1 – Summary of the credible options considered

Overview	Key components	Length of new feeders	Estimated capital cost
Option 1 – replacements of feeders like-for-like	• Installation of two new 132kV XLPE feeders from Revesby zone substation to Sydney South BSP. • Work at Revesby zone substation and South Sydney BSP to facilitate new 132kV feeder connections. • Decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.	3.3km for each feeder	$16.4 million
Option 2 – replacement of feeders with new underground feeders from Bankstown STS	• Installation of two new 132kV XLPE feeders from Revesby zone substation to Bankstown STS. • Work at Revesby zone substation and Bankstown STS to facilitate new 132kV feeder connections. • Decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.	5.0km for each feeder	$25.4 million

One further option was considered in addition to those set out above, which involves supplying Revesby zone substation from Bankstown STS via overhead cables. However, the option was found to be non-credible. This option is discussed in section 3.3 below.

3.1 Option 1 – Like-for-like replacement of existing feeders from Revesby zone substation to South Sydney

This option involves the installation of two new 132kV feeders from Sydney South BSP to Revesby zone substation in a combined trench, including secondary systems works and civil works as required. These feeders will replace existing 132kV SCFF feeders 282/1 and 283/1 between Revesby zone substation and Sydney South BSP.

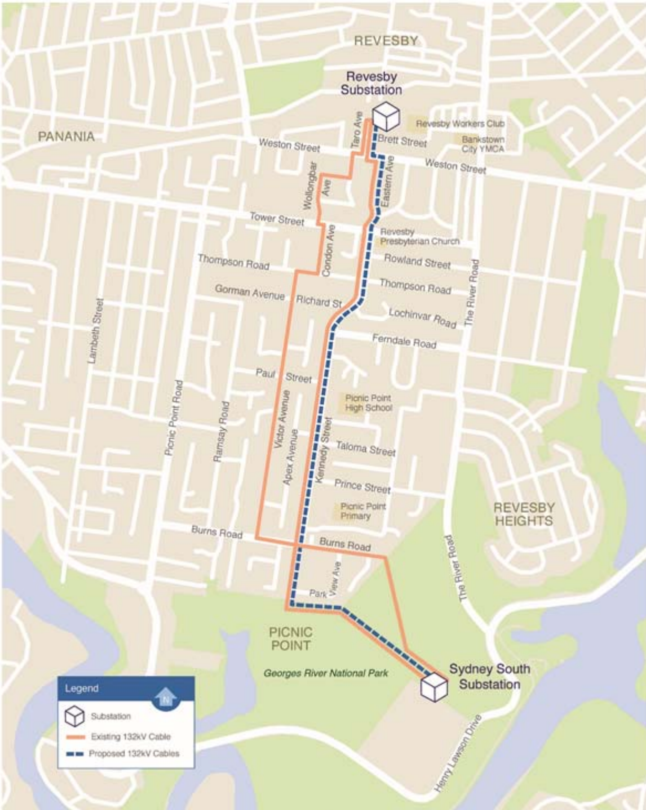
The scope of the project includes:

- works at Revesby zone substation and Sydney South BSP to facilitate new 132kV feeder connections;
- installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP, with a proposed firm rating of 250MVA per feeder;
- installation of mechanical protection on the side of the trench walls to mitigate the future risk associated with strikes from Horizontal Directional Drills (HDD's), given the common trench arrangements and limited 11kV backup;

- associated control and protection communication upgrades at Revesby zone substation and Sydney South BSP; and
- decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.

The proposed route under this option is set out in the figure below.

Figure 3.1 – Existing route and proposed route under Option 1



Ausgrid has identified the following benefits that are related to proceeding with Option 1 as set out above:

- improved reliability through solving existing asset condition issues and mitigates identified risks;
- the most cost-effective option due to synergies such as not requiring planning a new feeder route or obtaining easements; and
- less scope for community concerns given the like-for-like replacement will occur along the existing route.

While proceeding with Option 1 provides the above benefits, Ausgrid acknowledges that under this option there is the drawback of requiring construction to occur both under and adjacent to the Georges River National Park. While it is inevitable that any replacement will be required to go through the National Park, consideration has been given to install the replacement cables within an access track through the park - causing minimal disruption.

The estimated capital cost of this option is approximately $16.4 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2018/19, with the proposed works expected to be completed in 2021. Commissioning is expected to occur in the same year. While the optimal timing of Option 1 is found to be 2024, Ausgrid considers it prudent to progress this option now, and in combination with two other concurrent 132 kV feeder RIT-Ds, as outlined in section 6 below.

It is anticipated that a turn-key design-and-construct model using external contractors will be used, incorporating trenching and feeder installation to achieve the nominated feeder ratings, with commissioning and other electrical works carried out by Ausgrid staff.

Once the new installation is complete, operating costs are expected to be $82,000 per annum (around 0.5 per cent of capital expenditure).

3.2 Option 2 – Replacement of feeders with new underground feeders from Bankstown STS

This option involves the replacement of feeders 282/1 and 283/1 with underground feeders from Bankstown STS to Revesby zone substation.

The scope of the project includes:

- installation of two new 132kV XLPE feeders from Revesby zone substation to Bankstown STS;
- work at Revesby zone substation and Bankstown STS to facilitate new 132kV feeder connections; and
- decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.

Ausgrid recognises that proceeding with Option 2 as set out above would provide the benefit of improving network area reliability, as it would solve the existing asset condition issues. However, it is also associated with key risks and drawbacks, namely:

- it is less cost-effective than the like-for-like replacement described under option 1, owing to the longer feeder route; and
- greater scope for community concerns due to the need for a new feeder route, meaning an extended period of time dedicated to extensive community consultation as well as the design and acquisition of easements.

The estimated capital cost of this option is approximately $25.4 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2022/23 and be completed in 2025/26, with commissioning in the same year.

Once the new installation is complete, operating costs are expected to be $127,000 per annum (around 0.5 per cent of capital expenditure).

3.3 Options considered but not progressed

Ausgrid has also considered replacing the existing 282/1 and 283/1 feeders with new overhead feeders from Sydney South BSP to Revesby zone substation. However, this option was found to be non-credible for the following reasons:

- the route through the Georges River National Park is completely overgrown and would require substantial works (and cost) to clear the area and facilitate the installation of the new feeders;
- the route would require significant expansion in Ausgrid's easements (an issue not associated with the using the existing underground route);
- the project is technically difficult as it would require consent to traverse the Georges River National Park;
- there are limited street options exist for the route to Revesby (viable options would only be Kennedy/Victoria St) and all trees along this street in the path of the route would need to be removed; and
- the use of overhead wires would cause a major community impact on existing, heavily developed areas – an impact communities have historically opposed in the area.

In addition, Ausgrid's network standards for the construction of this type of feeders state that 'two sub-transmission circuits shall not be permitted on the same line of structures where the two lines supply the same load area'. This means that two separate high voltage sub-transmission lines would need to be constructed, which would increase the cost of any such option significantly.

Ausgrid has also considered the ability of any 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. As part of the review, an estimate of option value, realised as a result of any deferral of the network investment, was included in the cost benefit assessment. The addition of this option value did not change the conclusion that non-network alternatives cannot cost-effectively address the risk.

In particular, a demand management assessment into reducing the risk of unserved energy from the 132 kV feeders showed that non-network alternatives cannot cost effectively address the risk, compared to the two network options outlined above. This result is driven primarily by the significant amount of unserved energy that each 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.[9]

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

[9] Ausgrid notes that as part of its recently published regulatory proposal for the 2019-24 regulatory control period, it states that a Non-Network Options Report ('NNOR') will be published as part of the demand management engagement process associated with this RIT-D (see: Ausgrid, *Proposal for the 2019-24 Regulatory Control Period*, Attachment 5.14.2, p. 28). Since the regulatory proposal was finalised and submitted to the AER, Ausgrid has further assessed the capability of non-network solutions to form a credible option, or form a significant part of a credible option, for this RIT-D and has decided that they cannot. Ausgrid has consequently released a non-network screening notice in-place of a NNOR, in accordance with NER clause 5.17.4(c), which sets out the methodologies and assumptions used in reaching this conclusion.

4 How the options have been assessed

This section outlines the methodology that Ausgrid has applied in assessing market benefits and costs associated with each of the credible options considered in this RIT-D.

4.1 General overview of the assessment framework

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

The RIT-D analysis has been undertaken over a 20-year period, from 2019 to 2039. Ausgrid considers that a 20-year period takes into account the size, complexity and expected life of the relevant credible options to provide a reasonable indication of the market benefits and costs of the options. While the capital components of the credible options have asset lives greater than 20 years, Ausgrid has taken a terminal value approach to incorporating capital costs in the assessment, which ensures that the capital cost of long-lived options is appropriately captured in the 20-year assessment period.

Ausgrid has adopted a central real, pre-tax discount rate of 6.13 per cent as the central assumption for the NPV analysis presented in this report. Ausgrid considers that this is a reasonable contemporary approximation of a 'commercial' discount rate (a different concept to a regulatory WACC), consistent with the RIT-D.[10]

Ausgrid has also tested the sensitivity of the results to changes in this discount rate assumption, and specifically to the adoption of a lower bound real, pre-tax discount rate of 4.19 per cent (equal to the latest AER Final Decision for a DNSP's regulatory proposal at the time of preparing this FPAR[11]), and an upper bound discount rate of 8.07 per cent (i.e. a symmetrical upwards adjustment).

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 for each credible option using supplier quotes or other pricing information.

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

Operating costs have been estimated for each credible option and the base case by taking into account:

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

All options reduce the incidence of asset failures 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 safety 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 below.

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[10] Ausgrid notes that it has been sourced from the discount rate recently independently estimated as part of the Powering Sydney's Future RIT-T. See: TransGrid and Ausgrid, *Project Assessment Conclusions Report*, Powering Sydney's Future, November 2017, p. 62 – available at: https://www.transgrid.com.au/news-views/lets-connect/consultations/current-consultations/Documents/Powering%20Sydney%27s%20Future%20-%20PACR.pdf

[11] See TasNetworks' PTRM for the 2017-19 period, available at: https://www.aer.gov.au/networks-pipelines/determinations-access-arrangements/tasnetworks-determination-2017-2019/final-decision

4.3 Market benefits are expected from reduced involuntary load shedding

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

The approaches and assumptions Ausgrid has made to estimating valuing reductions in involuntary load shedding are outlined in section 4.3.1 below.

Appendix C outlines the categories of market benefit that Ausgrid considers are not material for this particular RIT-D.

4.3.1 Reduced involuntary load shedding

Involuntary load shedding is where a customer's load is interrupted from the network without their agreement or prior warning. Ausgrid has forecast load over the assessment period and has quantified the expected unserved energy 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.

Involuntary load shedding of a credible option is derived by the quantity in MWh of involuntary load shedding required assuming the credible option is completed multiplied by the Value of Customer Reliability (VCR). The VCR is measured in dollars per MWh and is used as a proxy to evaluate the economic impact of unserved energy on customers under the RIT-D.

Ausgrid has applied a central VCR estimate of $40/kWh, which has been derived from the 2014 AEMO VCR estimates.[12] In particular, Ausgrid has escalated the AEMO estimate to dollars of the day and weighted the AEMO estimates according to the make-up of the specific load considered.

We have also investigated the effect of assuming both a lower and higher underlying VCR estimate. The lower sensitivity has been derived by reducing the AEMO-derived estimate by 30 per cent, consistent with the AEMO-stated level of confidence in its estimates, and results in an estimate of $28/kWh.[13] The higher sensitivity involves applying a VCR of $90/kWh, consistent with the recent Independent Pricing and Regulatory Tribunal (IPART) review of the transmission reliability standards for Inner Sydney, as well as the recently finalised Powering Sydney's Future RIT-T.[14]

In addition, while load forecasts are not a determinant of the identified need (since the reliability standards expected to be breached relate to the duration and frequency of supply interruptions – neither of which are affected by underlying load), Ausgrid has investigated how assuming different load forecasts going forward changes the expected net market benefits under the options. In particular, we have investigated three future load forecasts for the area in question – 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.

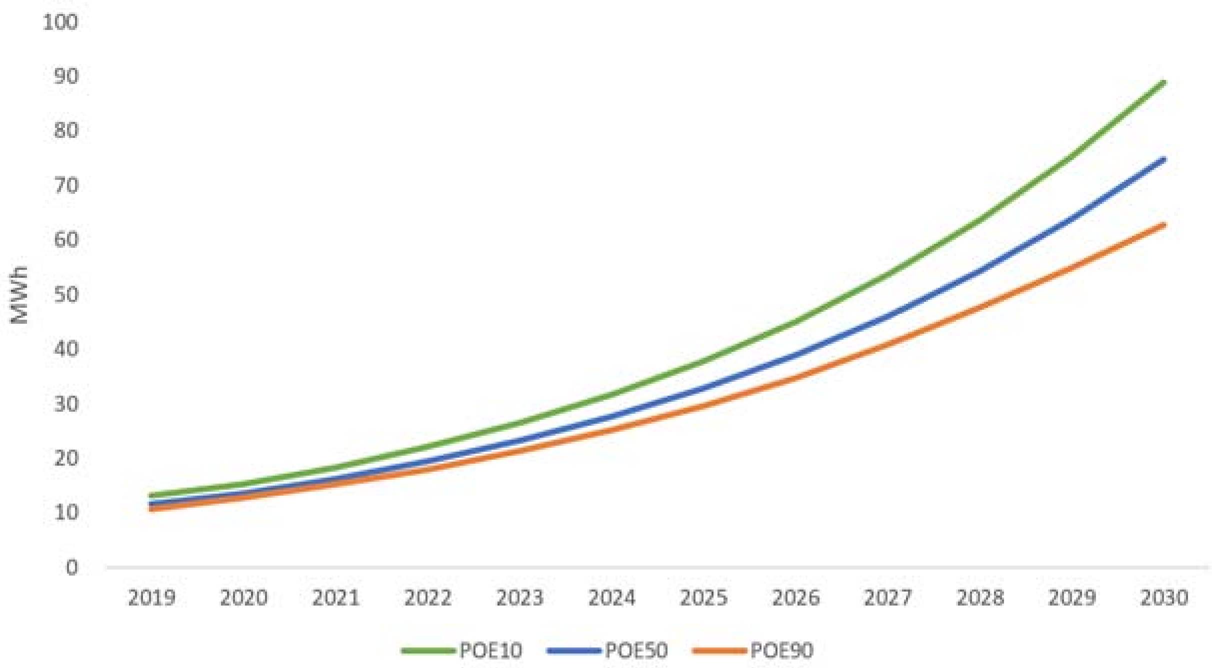
The figure on the next page shows the assumed levels of unserved energy (USE), under each of the three underlying demand forecasts investigated over the next ten years. For clarity, this figure illustrates the MWh of unserved energy assumed under each load forecast if none of the credible options are commissioned, i.e. it reflects both the underlying demand forecasts and the assumed failure rates associated with keeping assets in service.

[12] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.

[13] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report, p. 31.

[14] TransGrid and Ausgrid, *Project Assessment Conclusions Report*, Powering Sydney's Future, November 2017 – available at: https://www.transgrid.com.au/news-views/lets-connect/consultations/current-consultations/Documents/Powering%20Sydney%27s%20Future%20-%20PACR.pdf

Figure 4.1 – Assumed level of USE under each of the three demand forecasts



Ausgrid has capped the level of USE under each of these assumed demand forecasts at the value in the tenth year for all remaining years in the assessment period. Since the base case reflects a 'do nothing' approach, in which the reliability standard is breached (and which is therefore unrealistic), Ausgrid considers it appropriate to cap the level of USE at the level reached after ten years, since it is considered particularly uncertain after this. This also avoids a situation where an exponential increase in USE in later years[15] dwarfs other market benefits and skews the results,[16] and does not affect identification of the preferred option at all.

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 're asonable 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 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 market benefits.

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

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[15] An exponential increase in USE results from assumptions that failure rates increase exponentially with asset age. 'Capping' the USE level recognises that in reality action would be taken before this occurred.

[16] Ausgrid notes that this approach was commented on and supported by Dr Darryl Biggar in his recent review of the modelling undertaken for the Powering Sydney's Future RIT-T. See: Biggar, D., *An Assessment of the Modelling Conduced by TransGrid and Ausgrid for the "Powering Sydney's Future" Program*, May 2017, available at: https://www.aer.gov.au/system/files/Biggar%2C%20Darryl%20-%20An%20assessment%20of%20the%20modelling%20conducted%20by%20TransGrid%20and%20Ausgrid%20for%20the%20%20Powering%20Sydney%20s%20Future%20%20program%20-%20May%202017.pdf

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	$40/kWh (Derived from the AEMO VCR estimates)	$28/kWh (30 per cent lower than the central, AEMO-derived estimate)	$90/kWh (Consistent with the recent IPART review of transmission reliability standards for this area)
Commercial discount rate	6.13 per cent	8.07 per cent	4.19 per cent

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 credible options

This section summarises the results of the NPV analysis, including the sensitivity analysis undertaken. All credible options assessed as part of this RIT-D have been compared against a 'business as usual' base case.

5.1 Gross market benefits estimated for each credible option

The table below summarises the gross market benefit of each 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 economic benefits of each credible option relative to the base case, $m 2017/18

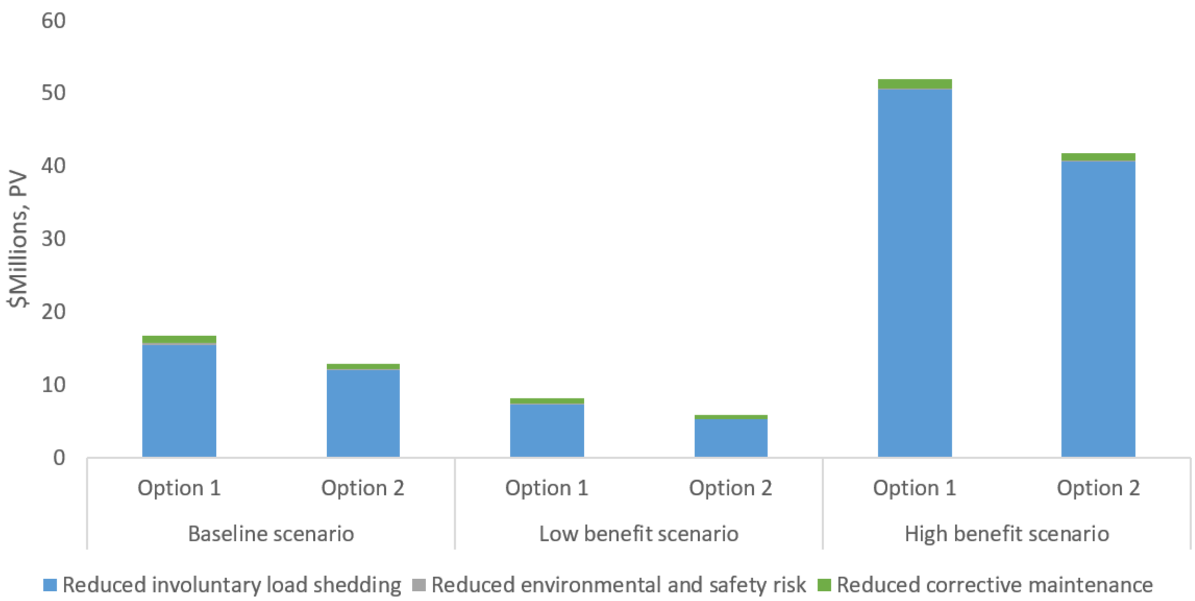
Option	Baseline scenario	Low benefit scenario	High benefit scenario	Weighted benefits
Scenario weighting	50%	25%	25%	
Option 1	16.7	8.2	51.9	23.4
Option 2	12.9	5.9	41.7	18.3

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

Option 1 is found to have a greater overall benefit relative to Option 2. This is driven by the fact that Option 1 is commissioned five years in advance of Option 2, meaning that there is additional five years that benefits are being generated. Throughout this five-year period Option 1 would be avoiding expected unserved energy and corrective maintenance costs, while under Option 2 these would still be incurred.

The primary benefits are estimated to be avoided unserved energy and reduced corrective maintenance 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 economic benefits of each credible option relative to the base case



5.2 Estimated costs for each credible option

The table below summarises the costs of each credible option relative to the base case 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 cables.

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.

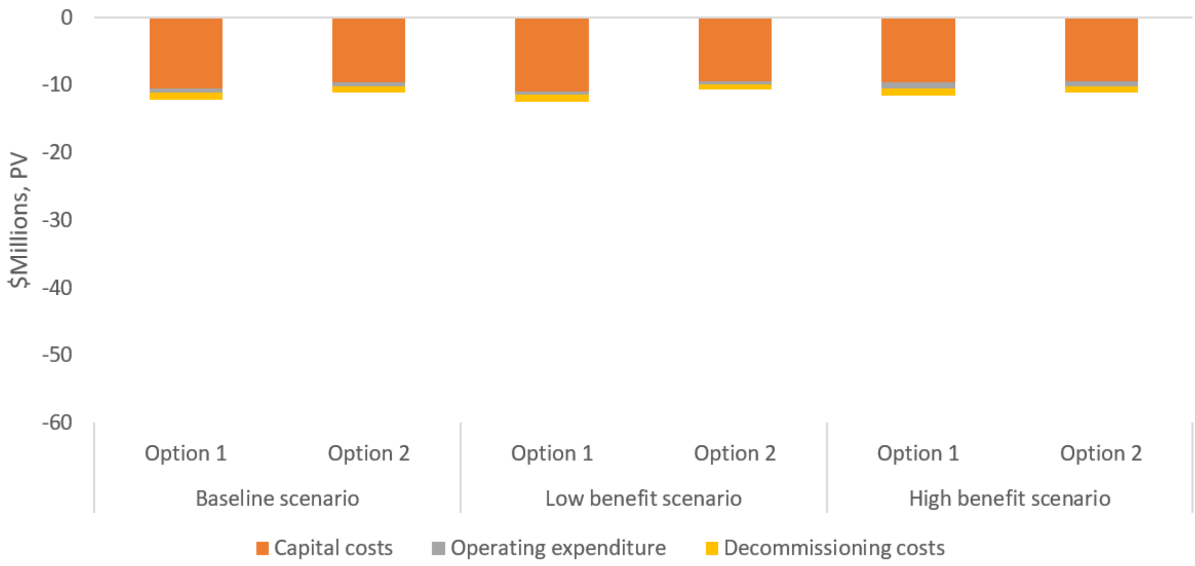
Table 5.2 – Present value of costs of each credible relative to the base case, $m 2017/18

Option	Baseline scenario	Low benefit scenario	High benefit scenario	Weighted costs
Scenario weighting	50%	25%	25%	
Option 1	-12.2	-12.5	-11.6	-12.1
Option 2	-11.1	-10.6	-11.2	-11.0

The figure below provides a breakdown of costs relating to each credible option.

Under all scenarios, Option 2 is found to have the lowest cost. However, an important factor driving this result is that the costs associated with Option 2 are incurred further into the future than the costs under Option 1, given the respective commissioning years of 2026 and 2021. As a result, despite having a greater capital costs in absolute terms, in present value terms Option 2 incurs lower costs owing to the delayed commissioning.

Figure 5.2 – Breakdown of costs of each credible option relative to the base case



5.3 Net present value assessment outcomes

Table 5.3 summarises the net market benefit in NPV terms for each 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 each option (as set out in Table 5.2), all in present value terms.

Overall, Option 1 exhibits the highest estimated net market benefit, which is primarily driven by it having greater overall market benefits of the two options considered. This is owing to its earlier commissioning, as it generates benefits for a further five years than would occur under Option 2.

Table 5.3 – Present value of weighted net benefits relative to the base case, $m 2017/18

Option	Capital costs	Operating costs	Decommissioning costs	USE benefits	Weighted NPV	Ranking
Option 1	-10.4	-0.68	-1.1	23.4	11.2	1
Option 2	-9.6	-0.63	-0.78	18.3	7.3	2

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 ($28/kWh) and a higher VCR ($90/kWh); and
- a lower discount rate of 4.19 per cent as well as a higher rate of 8.07 per cent.

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 2023/24 for the baseline case. As the figure illustrates, the optimal commissioning date varies depending on the relevant sensitivity. However, due to reasons set out in section 6 below, Ausgrid is of the view that it is prudent to move forward the commissioning date to 2020/21 (which is what has been modelled in section 5.1-5.3).

With respect to Option 2, 2025/26 is found to be the optimal commissioning year for all sensitivities with the exception of USE under POE90, higher capital costs, a higher discount rate and a lower VCR.

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

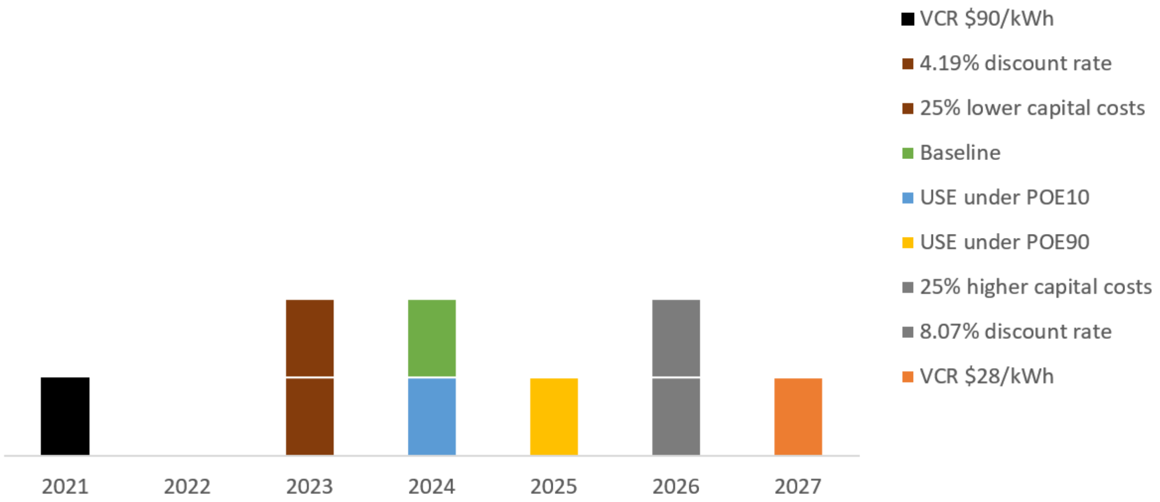
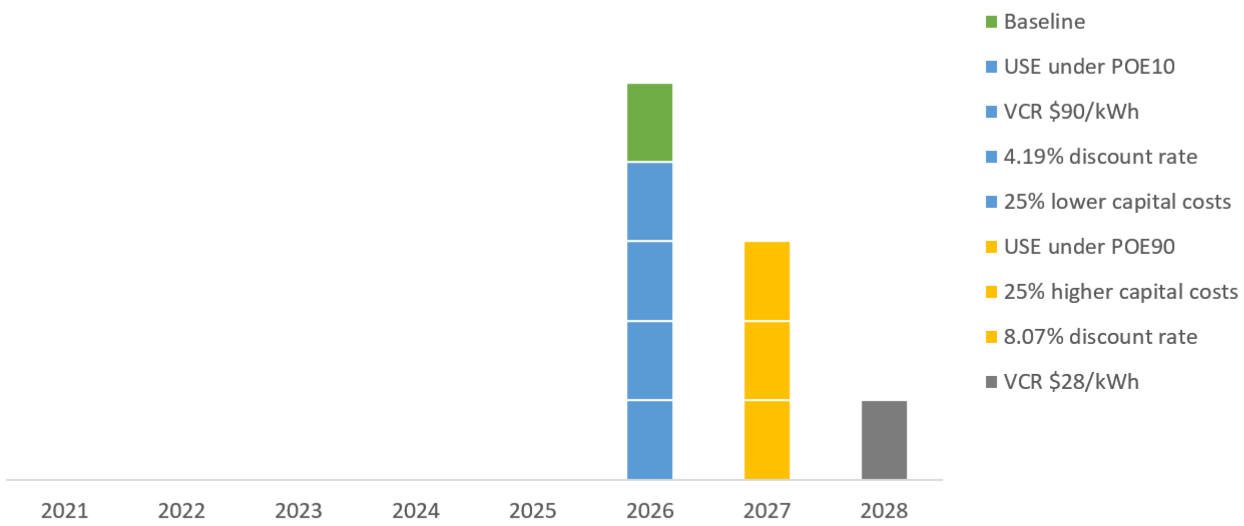


Figure 5.4 – Option 2's distribution of optimal project commissioning years under each sensitivity



5.4.2 Step 2 – Sensitivity of the overall net market benefit

Ausgrid has also conducted sensitivity analysis on 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, ie:

- 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 ($28/kWh) and a higher VCR ($90/kWh); and
- a lower discount rate of 4.19 per cent as well as a higher rate of 8.07 per cent.

All these sensitivities investigate the consequences of 'getting it wrong' having committed to a certain investment decision. The table below presents the results of these sensitivity tests for Option 1 and Option 2 respectively. Option 1 is found to be the preferred option across all sensitivities investigated.

Table 5.4 – Sensitivity testing results, $m 2017/18

Sensitivity	Option 1	Option 2
Baseline	**4.5**	1.8
25 per cent higher capital cost	**1.9**	-0.6
25 per cent lower capital cost	**7.1**	4.2
Unserved energy under POE10	**7.0**	3.9
Unserved energy under POE 90	**1.5**	-0.9
VCR $90/kWh	**23.9**	16.8
VCR $28/kWh	**-0.2**	-1.8
4.19 per cent discount rate	**9.1**	5.4
8.07 per cent discount rate	**1.1**	-0.5

6 Proposed preferred option

Option 1 has been found to be the preferred option, which satisfies the RIT-D. It involves the replacement of the two feeders from Sydney South BSP to Revesby zone substation using two new installations along the existing route. Specifically, this option involves the installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP.

The scope of the project includes:

- works at Revesby zone substation and Sydney South BSP to facilitate new 132kV feeder connections;
- installation of two new 132kV XLPE feeders of approximately 3.3km each from Revesby zone substation to Sydney South BSP, with a proposed firm rating of 250MVA per feeder;
- installation of mechanical protection on the side of the trench walls to mitigate the future risk associated with strikes from Horizontal Directional Drills (HDD's), given the common trench arrangements and limited 11kV backup;
- associated control and protection communication upgrades at Revesby zone substation and Sydney South BSP; and
- decommissioning of existing SCFF feeders between Revesby zone substation and Sydney South BSP.

The estimated capital cost of this option is approximately $16.4 million. Ausgrid assumes that the necessary construction to install the new feeders would commence in 2018/19 with the proposed works expected to be completed in 2020/21. The project has been brought forward on the basis that the current analysis does not reflect the unserved energy and environmental risks that have been generated since a recent incident with one of the feeders concerned. Commissioning is expected to occur in the same year. Once the new installation is complete, operating costs are expected to be $82,000 per annum (around 0.5 per cent of capital expenditure).

While the optimal commissioning date for Option 1 has been found to be 2023/24 (see section 5.4.1), Ausgrid is proceeding with this option now and intends to commission it in 2020/21. The reason behind this is that Ausgrid has two other 132kV feeder replacement projects requiring completion as soon as practicable (see the concurrent Willoughby-Mosman and Kingsford-Clovelly RIT-Ds) and Ausgrid intends to release a competitive combined tender for all three projects and to receive a discount and ultimately reduce the capital costs of each project (relative to the cost of procuring each separately).

The economic assessment in this FPAR shows that the difference in the NPV of Option if commissioned in 2020/21, compared to 2023/24, is approximately $700,000. The combined procurement and installation of this project with the two other coincident 132 kV feeder RIT-Ds will provide economic efficiencies (i.e. cost savings) through a competitive tender process that are anticipated to be bigger than $700,000. Ausgrid therefore considers it prudent and efficient to progress this option with the other two and to procure the cable contracts at once.

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

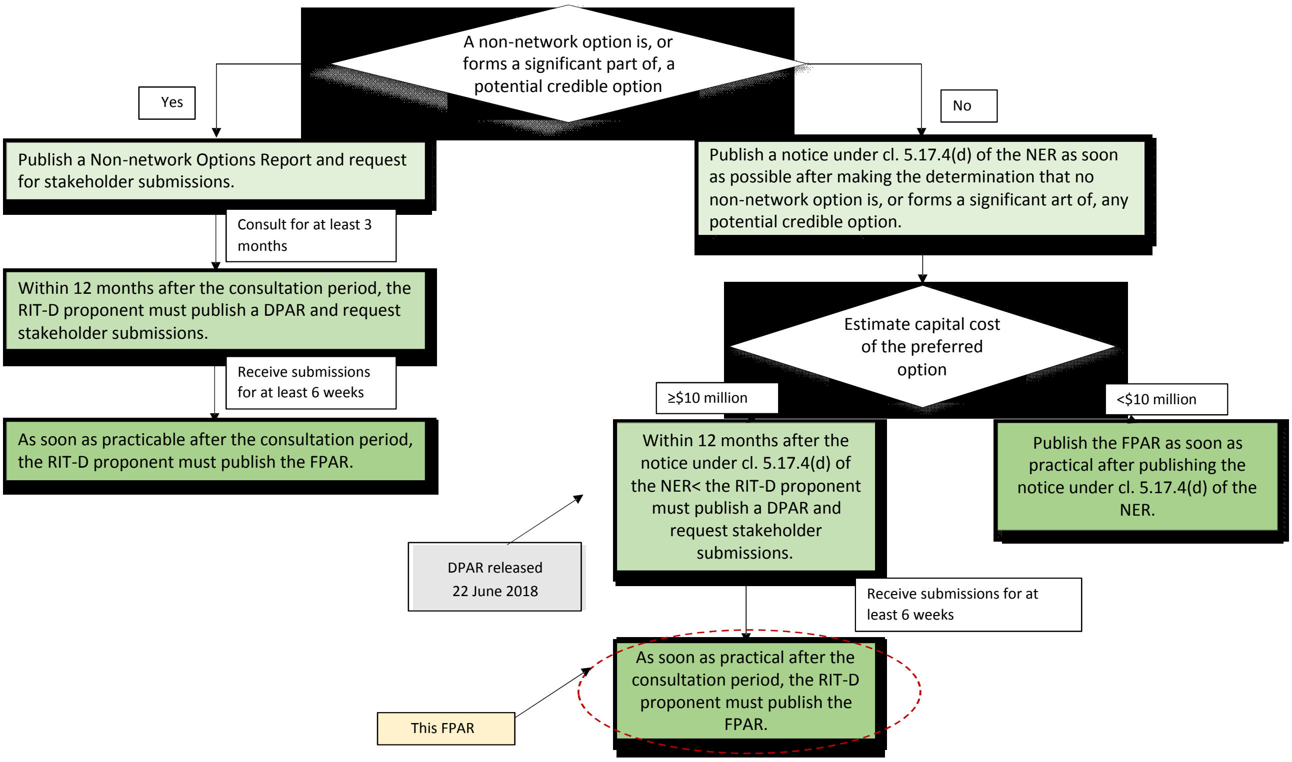
Appenidx A – Checklist of compliance clauses

This section sets out a com pliance checklist that demons trates the compliance of this FPAR 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 FPAR
5.17.4(r)	The matters detailed in that report as required under 5.17.4(j)	See rows below
	A summary of any submissions received on the DPAR and the RIT-D proponent's response to each such submission	Section 1.2
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	**Error! Reference source not found.**
	(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 final report may be directed.	1.3

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 ste p); (2) the DP AR; and (3) the FPAR. This p rocess 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:

- avoided unrelated distribution network expenditure;
- changes in voluntary load curtailment;
- costs to other parties;
- load transfer capability and embedded generators;
- option value; and
- 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
Avoided unrelated distribution network expenditure	Ausgrid does not expect any changes in unrelated network expenditure in both size of expenditure or timing of expenditure as a consequence of implementing either option. Ausgrid has therefore excluded from timing of unrelated network expenditure benefits from this RIT-D.
Changes in voluntary load curtailment	Ausgrid notes that the level of voluntary load curtailment currently present in the NEM is limited. Where the implementation of a credible option affects pool price outcomes, and in particular results in pool prices reaching higher levels on some occasions than in the base case, this may have an impact on the extent of voluntary load curtailment. Ausgrid notes that 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 sufficient flexibility to respond to that change. Ausgrid notes that none of the credible options assessed involve stages or any other flexibility and so we do not consider that option value is relevant with respect to staging. Ausgrid considered an estimated option value as part of its assessment of non-network alternatives but the inclusion of an option value resulted in no change in the viability of non-network options to form part of the least cost solution.
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

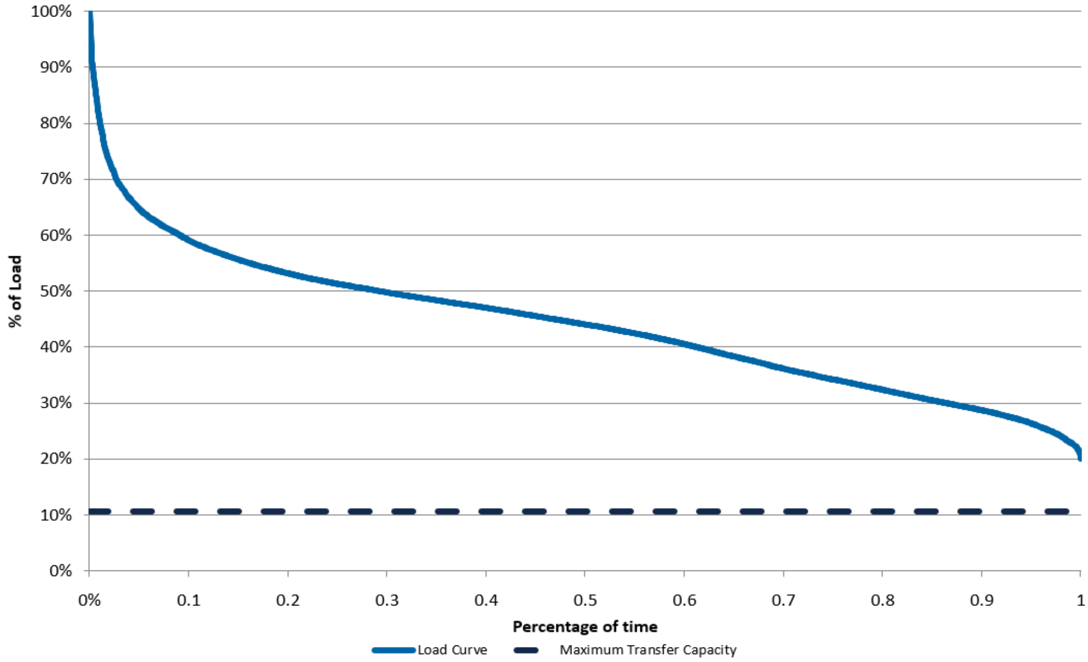
This appendix presents additional detail on the supply restoration assumptions and probability of failure assumptions made by Ausgrid.

D.1 Characteric load duration curves

The load duration curve for the combined Revesby and Milperra zone subtations is presented in Figure D.1 below.

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

Figure D.1 – Load duration curve – combine Revesby and Milperra zones



D.2 Supply restoration assumptions

Table D.1 – Supply restoration assumptions

Equipment outage	Action	Outage duration
Fluid filled cable failure	<u>Repair</u> The cable is repaired on site.	7.0 weeks
Fluid filled cable third party damage	<u>Repair</u> The cable is repaired on site. Additional time is typically required to repair third party damage.	5.5 weeks
Fluid filled cable corrective action	<u>Repair</u> One of the following repairs may take place depending on the failure mode: 1. in service repair (65 per cent) 2. out of service repair (35 per cent)	1. In service repair (no outage) 2. 1.06 weeks

D.3 Probability of failure

Ausgrid has adopted probability models to estimate e xpected failure of different net work assets. A summar y 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 gas pressure, 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 Cow-AMSAA parameters for each cable type.

Table D.3 – Underground cable parameters

Feeder	Type	B factor	Λ factor	MTTR (weeks)*
282/1	Corrective action	4.69	1.93E-08	1.06
282/1	Breakdowns	5.63	1.35E-11	7.00
282/1	Third party damage	1.43	8.78E-05	5.50
283/1	Corrective action	4.69	1.93E-08	1.06
283/1	Breakdowns	5.63	1.35E-11	7.00
283/1	Third party damage	1.43	8.78E-05	5.50

*Mean Time to Repair

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 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.

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