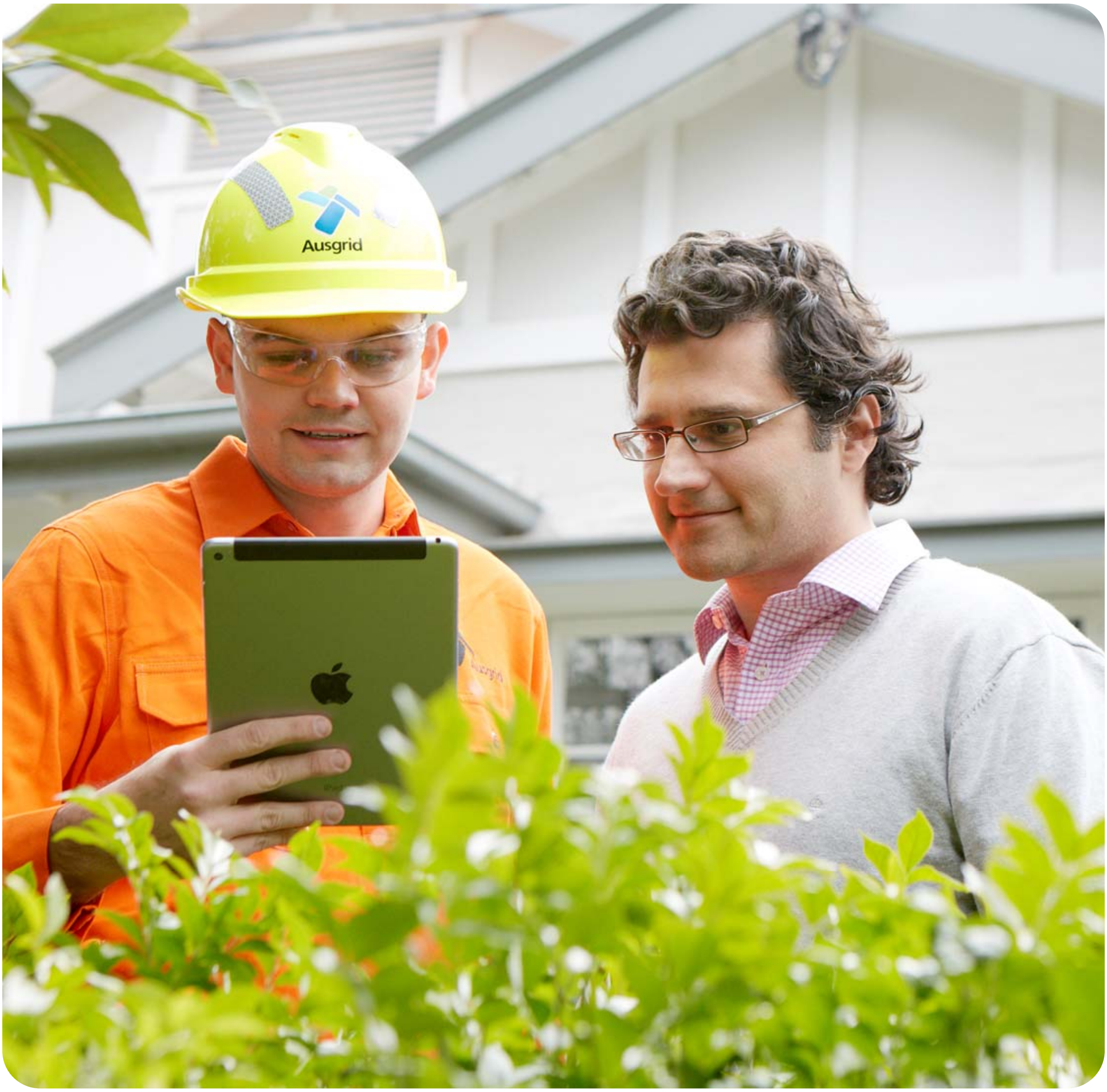
Addressing reliability requirements in the Inner West

Final Project Assessment Report

16 April 2018



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Contents

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 replacing aged electricity cables serving the Inner West

This Final Project Assessment Report (FPAR) has been prepared by Ausgrid and represents the final step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply to the Inner West network area going forward.

In particular, the underground electricity distribution lines ('feeders') supplying the 33kV Auburn zone substation and the 33kV Lidcombe zone substation were commissioned in the 1940s and 1950s, and are now reaching, or past, the end of their technical lives. These feeders utilise a mix of gas pressured cables and HSL cables, which are now considered obsolete technologies. The implication of these assets becoming less reliable is that it exposes Ausgrid's customers in the Inner West network area to a material level of supply risk to customers. As outlined in this report (Section 6.3) the present value of the benefits of this project, in terms of avoided risks, significantly outweigh the cost of the project.

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

A Draft Project Assessment Report (DPAR) for this RIT-D was published on 14 February 2018. The DPAR presented three credible options for addressing asset condition concerns in the Inner West network area, assessed each in accordance with the RIT-D framework and concluded that the preferred option was to install 33kV feeders from Camellia STS to Auburn and Lidcombe zone substations utilising the existing HSL feeder sections that run from Homebush STS to Lidcombe zone substation.

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 28 March 2018. 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 3 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.

In particular, the following three credible options have been assessed to address future reliability concerns:

- Option 1 – New feeders from Homebush (i.e. a 'like-for-like' route)
- Option 2 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe substations
- Option 3 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe, whilst utilising existing HSL sections

Option 3 has been found to be the preferred option, as it has the highest estimated net market benefits. It involves the installation of 33kV feeders from Camellia STS to Auburn and Lidcombe zone substations utilising the existing HSL feeder sections that run from Homebush STS to Lidcombe zone substation. Ausgrid is the proponent for Option 3.

In addition to having the greatest estimated net market benefits of the three options. Option 3 offers the following benefits:

- it involves the lowest cost out of all three credible options considered (and involves less than half the combined length of new feeders of a 'like-for-like' replacement under Option 1);
- it complements existing switchgears works underway at Lidcombe zone substation;

- it utilises spare capacity at Endeavour Energy's Camellia STS and avoids unnecessary duplication of network capacity;
- it defers upstream investments that would otherwise be required if supply of Auburn and Lidcombe were to continue to come from Homebush STS; and
- it addresses asset condition issues on feeders supplying Auburn and Lidcombe zone substation and therefore is expected to reduce involuntary load shedding and operating expenditure related to unplanned corrective maintenance.

The scope of Option 3 includes:

- installation of four feeders, approximately 3.5km long, from Camellia STS to Adderley Street near Auburn zone substation (i.e. the same as Option 2);
- installation of one overhead feeder, approximately 2.1km long, from Adderley Street, Auburn to Lidcombe zone substation;
- connection of existing HSL cable sections to existing transformers at the Lidcombe zone substation;
- installation of three-way ring main isolators at Auburn zone substation as one 33kV feeder would share one of the transformers at Auburn zone substation and one of the transformers at Lidcombe zone substation;
- uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA; and
- retirement of the existing underground gas pressure cable sections of the 33kV feeders supplying Auburn and Lidcombe zone substations.

The figure below depicts the new feeders proposed under Option 3. Specifically, they will originate from Camellia STS, crossing the M4 motorway underground and following the motorway east to connect to Auburn zone substation and then south to Lidcombe zone substation.

Figure 1 – Detailed route of proposed preferred option

The proposed route from Camellia STS to Auburn zone substation is mainly through industrial areas, crossing Duck Creek and the existing M4 Western Motorway by following the Duck River Cycleway. Ausgrid plans to use underground cables in certain areas in response to community feedback and to minimise risks along the M4 Western Motorway.

The proposed overhead route between Auburn zone substation and the Lidcombe zone substation will pass primarily through industrial areas in Lidcombe and cross under the main western rail line at Percy Street. Ausgrid is proposing to locate the cables on the western side of Percy Street and incorporating them on existing low voltage powerline structures, which will minimise the impact of construction. Underground cables are proposed to be installed from Adderley Street West to the Auburn zone substation at 2 Silverwater Road. Trenching will need to be laid between the eastern end of Adderley Street West and along Silverwater Road to the substation.

The estimated cost of this option is $20 million and is expected to take four years to complete construction. Ausgrid anticipates that construction will begin in 2017/18 with construction scheduled for completion in 2020/21 (commissioning in the same year) and decommissioning of gas feeders in the following year. Once commissioned, operating costs are estimated to be approximately $98,000 per annum (around 0.5 per cent of capital expenditure).

Overall, this finding confirms the earlier planning assessment exercises undertaken by Ausgrid and Endeavour in 2013.

How to make a submission and next steps

Ausgrid intends to commence work on delivering Option 3 in 2018. In particular, we intend to award the design and construction contract in late May 2018, have environmental approvals finalised in June 2018 and to commence construction in September 2018.

Any queries should be addressed to:

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Or

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Introduction

This Final Project Assessment Report (FPAR) has been prepared by Ausgrid and represents the final step in the application of the Regulatory Investment Test for Distribution (RIT-D) to options for ensuring reliable electricity supply to the Inner West network area going forward.

In particular, the underground electricity distribution lines ('feeders') supplying the Auburn zone substation and the Lidcombe zone substation were commissioned in the 1940s and 1950s, and are now reaching, or past, the end of their technical lives. These feeders utilise a mix of gas pressured cables and HSL cables, which are now considered obsolete technologies. The implication of these assets becoming less reliable is that it exposes Ausgrid's customers in the Inner West network area to a material level of supply risk. As outlined in this report (Section 6.3) the present value of the benefits of this project, in terms of avoided risks, significantly outweigh the cost of the project.

Ausgrid identified the need to replace the feeders supplying the Auburn and Lidcombe substations in 2013 as part of formulating its Inner West Area Plan and its asset management strategy for sub-transmission feeders. In addition, Ausgrid, working with Endeavour Energy, identified a preferred solution that makes use of spare capacity on the Endeavour network following closure of a Shell Australia oil refinery at Clyde in Western Sydney. Ausgrid considers that these joint planning efforts identified the most efficient solution across the respective networks as a whole. In particular, this solution was found to come at a significantly lower cost than rebuilding the existing feeders on a 'like-for-like' basis.

Since 2014, Ausgrid has undertaken a range of community engagement activities seeking feedback on the preferred replacement option identified in 2013. These activities included meetings with Parramatta City Council, Auburn City Council and local members of parliament, as well as having representatives from the Ausgrid project team speak to many businesses in Auburn and visiting residents along affected streets. Feedback received 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 has meant that the replacement plan for ageing feeders in the Inner West network area are now subject to the RIT-D. Accordingly, Ausgrid has initiated this RIT-D for replacing ageing feeders supplying the Auburn and Lidcombe zone substations in order to identify a preferred option that ensures that 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 February 2018. The FPAR represent 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 three credible options for addressing reliability concerns in the Inner West network area, assessed each in accordance with the RIT-D framework and concluded that the preferred option was to install 33kV feeders from

Camellia STS to Auburn and Lidcombe zone substations utilising the existing HSL feeder sections that run from Homebush STS to Lidcombe zone substation.

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 28 March 218. 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

email to: assetinvestment@ausgrid.com.au

2 Description of the identified need

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

2.1 Overview of the Inner West network area

The Inner West network area in Sydney extends from Homebush Bay in the north, south-west to Rozelle and Leichhardt and west as far as Auburn. The area is divided by parts of the harbour and the Lane Cove River. Parramatta Road runs through the southern part of the area.

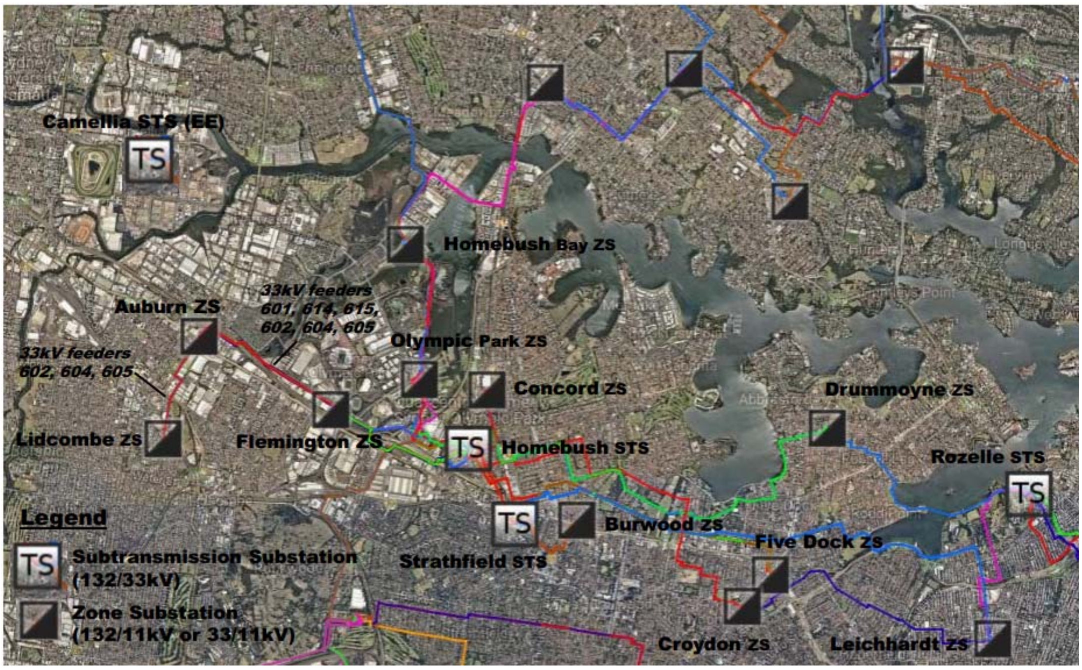
In particular, the network in the Inner West area:

- is supplied from TransGrid's Sydney North Bulk Supply Point (BSP), and via Chullora Sub-Transmission Switching Station from TransGrid's Beaconsfield and Sydney South BSP;
- includes 132/33kV sub-transmission substations (STSs) at Homebush, Strathfield and Rozelle;
- includes four 132/11kV zone substations at Burwood, Drummoyne, Flemington and Homebush Bay, which are supplied via Mason Park sub-transmission switching station; and
- includes four 33/11kV zone substations at Auburn, Lidcombe, Concord and Five Dock, supplied via Homebush STS and the Leichhardt zone substation, which is supplied via Strathfield and Rozelle STS.[1]

The Inner West network area will host New South Wales government transport infrastructure projects that will add to the load in the area in coming years, including WestConnex.[2] The Inner West network also houses a number of significant loads, such as data centres.

The figure below shows the various substations and feeders in the in the Inner West network area. It also illustrates the Camellia STS, which, while near both the Auburn and Lidcombe zone substations, is in Endeavour Energy's network.

Figure 1 – Inner West network area



[1] Projects are in place to decommission Five Dock zone substation and transfer Leichhardt zone substation to the 132kV network.

[2] This New South Wales government initiative has now 'broken ground' and is well underway. For more information on the progress of the project, please visit the WestConnex website: https://westconnex.com.au.

At the west end of the Inner West network area, close to the border of the neighbouring Endeavour Energy network, are the Auburn and Lidcombe zone substations. These two substations were first installed in the late 1920s[3], and Ausgrid has recently committed to replacing the compound insulated switchboards at Lidcombe substation by 2021.

The Auburn and Lidcombe substations are supplied by three 33kV sub-transmission feeders respectively, all of which originate at the Homebush STS. The oldest sections supplying Auburn zone substation date back to 1942 (HSL sections on feeder 601) while most feeder sections on the other feeders date back to the 1940s and 1950s. These feeders require significant amounts of corrective maintenance to keep them in service. For example, there are approximately 15.17 km of 33kV gas pressure feeders supplying these zone substations (in total), which suffer from frequent leaks that lead to poor availability and expected involuntary load shedding going forward in the Inner West network area.

Table 1 – Details of existing supply to the Auburn and Lidcombe zone substations

Feeder		HSL section	Gas pressure section	Commissioning year of oldest section
Homebush STS to Auburn substation	Feeder 601	9.30 km[4]	-	1942
	Feeder 614	0.04 km	4.55 km	1954
	Feeder 615	0.03 km	4.56 km	1949
Homebush STS to Lidcombe substation	Feeder 602	3.90 km	2.25 km	1953
	Feeder 604	4.78 km	1.55 km	1949
	Feeder 605	3.93 km	2.26 km	1953

Gas pressure cables require high pressure nitrogen to maintain insulation integrity. As gas pressure cables reach end of life gas leakage increases resulting in cable failures. The risks have now increased to a level where a single cable has had multiple failures with long repair times.

HSL cables do not have the same requirements of pressured gas (nitrogen) to maintain insulation integrity and therefore do not present the same risks as gas pressure cables. However, the HSL feeders supplying Auburn and Lidcombe are very old, with most HSL sections commissioned in 1949 and 1953, presenting a higher risk of failure.

The age and condition of these feeders has already resulted in a number of feeder outages in recent years – for example:

- Feeder 601 experienced a failure in 2010 and was out for 85 days;
- Feeder 614 experienced a failure in 2017, and was out for 69 days; and
- Feeder 605 experienced a failure in 2014, and was out for 14 days.

Ausgrid considers that, unless something is done, the risk of failure and poor availability of these assets will expose Ausgrid's customers in the Inner West area to a level of network risk that exceeds allowable levels under reliability standards required in NSW.

Consequently, Ausgrid has identified a need to undertake reliability corrective action to address issues with these feeders to maintain reliable distribution network services to customers in this network area.

Ausgrid embarked on a wider network-wide replacement plan at the beginning of the 2009-14 regulatory period to remove approximately 250km of obsolete gas cables by the end of 2018/19. This strategy has since been reviewed as a result the adoption of probabilistic planning methodologies now used for sub-transmission planning but has, to-date, retired approximately:

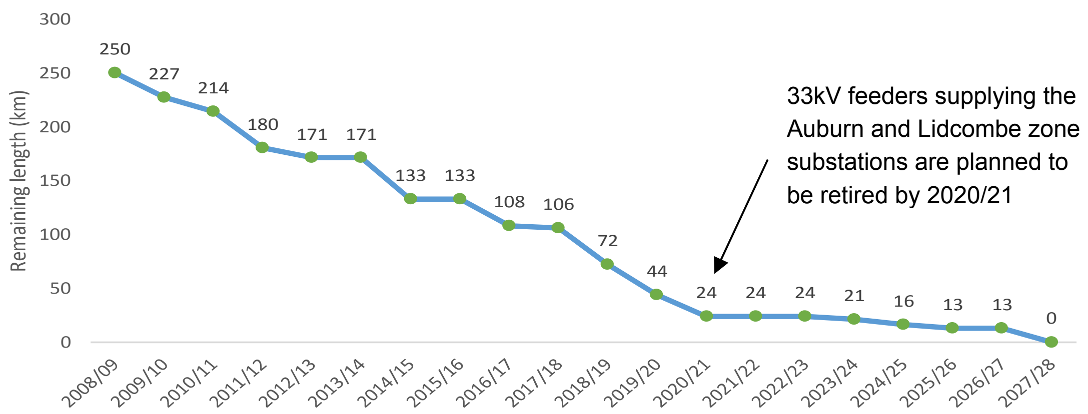
- 80km of gas cable during the 2009-14 period; and
- a further 63km during the current period.

[3] The NSW Government Office of Environment & Heritage states that the substations were first built in the 1920s. Feeders were then replaced in the 1940s to satisfy expanding load requirements.

[4] Feeder 601 is approximately twice the length of feeder 614 and feeder 615 as feeder 601 consists of two cables connected in parallel along the route between Homebush STS and Auburn substation.

At the beginning of FY18 there was approximately 108km of gas cable remaining on the network and Ausgrid determined, based on the Area Plan modelling completed in August 2017, that all gas cables will be retired by the end of 2028/29. Approximately 83km (77 percent), including those supplying the both the Auburn and Lidcombe substations, are planned to be retired by the end of 2020/21. The figure below illustrates how replacing the 33kV gas cables supplying Auburn and Lidcombe are part of a wider, network-wide, replacement of these cables.

Figure 2 – Planned remaining km of 33kV gas cables across the Ausgrid network



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 aspects of supply disruptions on electricity customers, 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 Inner West network area (classified as an 'urban' feeder type) are shown in the table below.

[5] Granted by the Minster 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.

Table 2 – 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

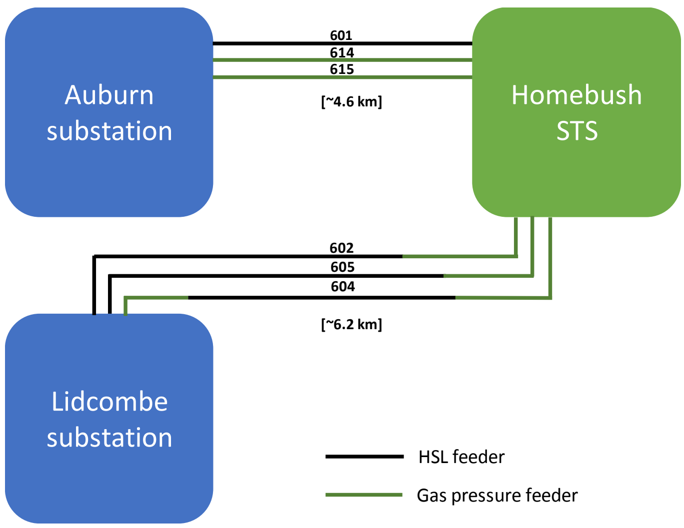
2.3 Key assumptions underpinning the identified need

The need to undertake reliability corrective action is predicated on the deteriorating condition of the feeders supplying Auburn and Lidcombe zone substations, and the characteristics of any resultant outages. Key assumptions underpinning the identified need are presented in this section.

2.3.1 Ageing feeders supplying the Auburn and Lidcombe substations are expected to increase the risk of involuntary load shedding going forward

The Auburn and Lidcombe zone substations are both currently supplied by 33kV feeders (feeders 601, 614 and 615 at Auburn and feeders 602, 604 and 605 at Lidcombe) that originate from Homebush STS and were mostly commissioned in the late 1940s and 1950s. These feeders consist of both gas pressure and HSL sections, as illustrated in the stylised network diagram below.

Figure 3 – Current supply arrangements for the Auburn and Lidcombe zone substations[9]



These feeders have reached or exceeded their useful lives. The oldest feeder sections were commissioned in 1942 and are now 31 years past their expected useful life, while most sections are approximately 24 to 20 years past their expected useful life. Gas pressure sections on feeders 605 and 614 are among the worst 40 feeders for gas leakages and worst 20 feeders for unavailability among the wider Ausgrid gas feeder fleet.

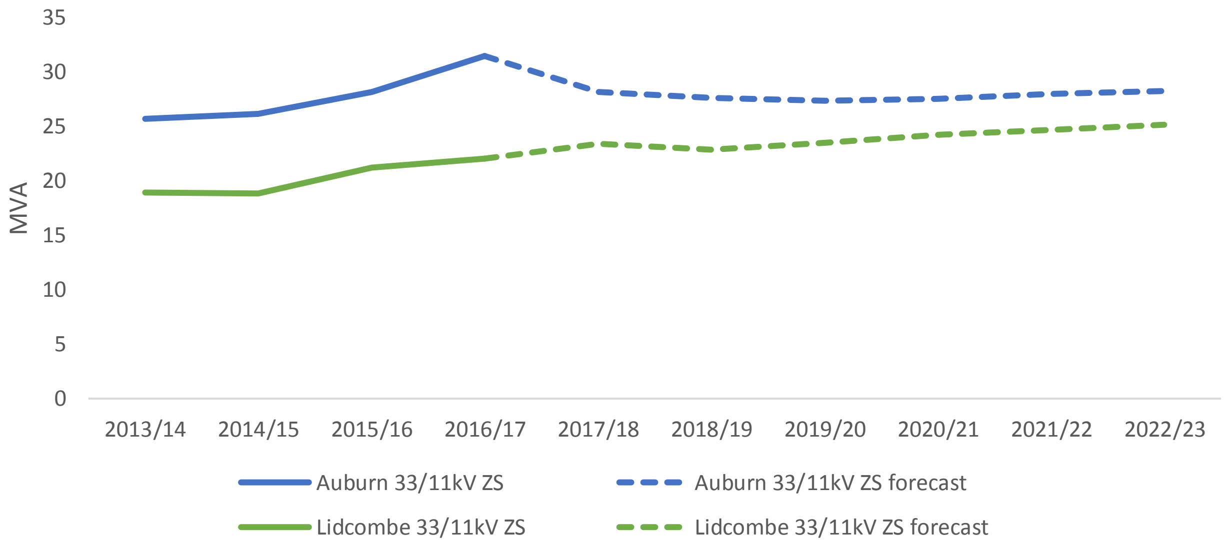
As outlined in section 2.1 above, the age and condition of these feeders has already resulted in a number of feeder outages in recent years.

[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

[9] Please note that this figure is designed to be illustrative of the types, and distances, of each feeder technology. To do so, it illustrates the distances of each feeder type, relative to one-another. It is not intended to be an accurate depiction of the *location* of each feeder type.

Both Auburn and Lidcombe substations are considered to serve an enduring need for distributing electricity in the Inner West network area. Each of these two substations are expected to serve between 20 and 25 MVA of load between 2016/17 and 2020/21, as shown in Figure 4.

Figure 4 – Auburn and Lidcombe substation load forecast



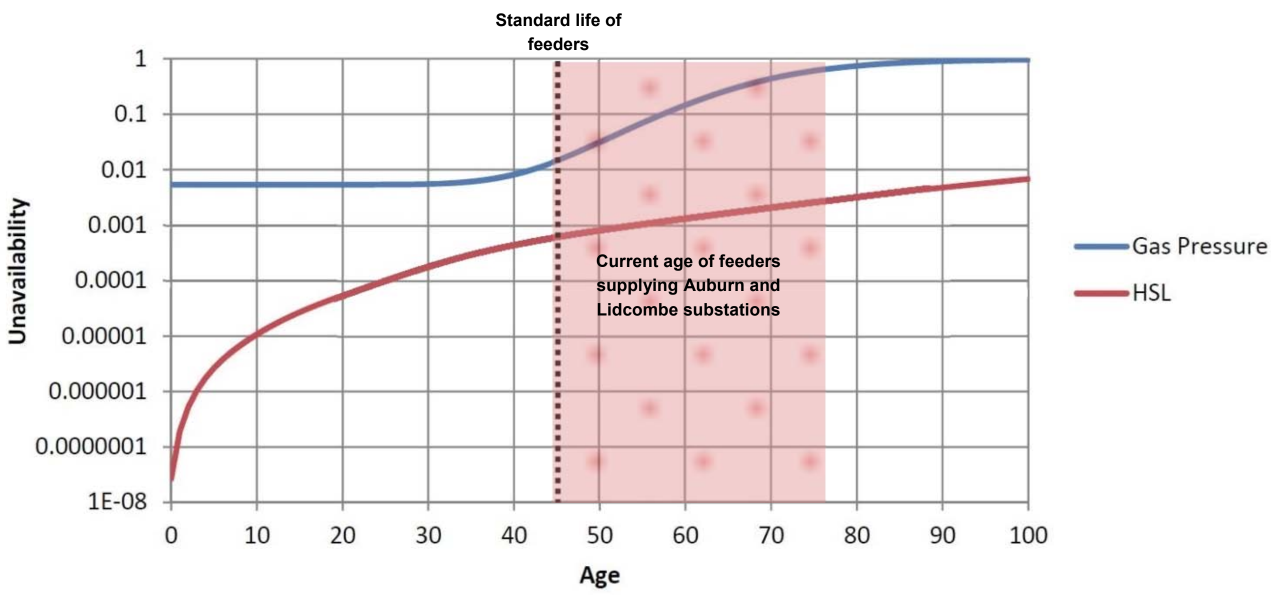
Ausgrid has committed to replace the 11kV switchboard at Lidcombe to ensure the substation continues to meet reliability and performance standards and minimize operating costs. This work is expected to be completed in 2021.

2.3.2 Probability of assets failing increases with age

Network asset failure probabilities and asset unavailability have a significant effect on the expected level of involuntary load shedding. Ausgrid has adopted well-accepted models for feeders to estimate the probability of failure. In general, the probability of failure increases with asset age.

Figure 5 below shows unavailability plotted, on a logarithmic scale, for a representative 10km stretch of cables aged zero to one hundred years. It also maps to these curves the age of the current underground gas pressure feeders and HSL feeders supplying Auburn and Lidcombe substations and, in doing so, illustrates how older sections of these feeders are now 24 years past the 'standard' asset life for such cables (and will be around 28 years passed by the time one of the credible options is commissioned).

Figure 5 – Unavailability of underground cable technologies



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 gas pressure 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 customer impact from any involuntary load shedding is dependent on the level of feeder redundancy and the load transfer capacity to other substations capable of supplying the area served by Auburn and Lidcombe substations.

Auburn and Lidcombe zone substations currently have a degree of redundancy. As noted above, three feeders supply each substation and therefore load could be transferred to the two remaining feeders should one of the three feeders experience a fault or be out of service. However, outages of two out or three feeders supplying each substation would lead to some level of involuntary load shedding. Given the condition of the feeders, there is a higher level of risk of multiple feeder failures.

In the event of multiple failures, there is limited capacity to transfer load away from Auburn and Lidcombe substations given network constraints in the Inner West network area. Consequently, the time to restore supply to customers would depend on the time needed to return the failed feeders to service. Based on recent experience, this would take between 10 and 25 days.

Both the level of redundancy and load transfer capability have been considered in forecasting expected unserved energy.

3 Community engagement undertaken to-date

Ausgrid identified the need to replace the feeders supplying the Auburn and Lidcombe substations in 2013 as part of formulating its Inner West Area Plan.

Working with Endeavour Energy, Ausgrid identified a preferred solution at the time that made use of spare capacity on the Endeavour network following closure of a Shell Australia oil refinery at Clyde in Western Sydney. Ausgrid considers these joint planning efforts identified the most efficient solution across the respective networks as a whole. In particular, this solution was found to come at a significantly lower cost than rebuilding the existing feeders on a 'like-for-like' basis.

Since 2014, Ausgrid has undertaken a range of community engagement activities seeking feedback on the preferred replacement option identified in 2013. These activities included meeting with local councils and members of parliament, as well as having representatives from the Ausgrid project team speak to many businesses in Auburn and visit residents along affected streets.

As part of Ausgrid's community engagement, a project introduction letter and community newsletter was sent to properties that have been identified as directly impacted stakeholders, or stakeholders directly adjacent to the preferred route. Representatives from the Ausgrid project team spoke to most of the businesses in Auburn, including Auburn North Public School and Choice Preschool Kindergarten. Team members also door knocked residents along Percy Street (where overhead lines will run). The aim was to provide a brief overview of the project, seek feedback on the three key topics and to introduce members of the project team to the community.

Community members were invited to provide their feedback. The consultation period was extended to allow additional time for stakeholders to submit their comments or concerns about the project. Local information and feedback was sought on:

- the preferred powerline route from Camellia to Lidcombe;
- the design options for the new power poles; and
- tree trimming and removal work.

Submissions received between August 2016 and November 2016 reflected a preference that cables would be installed underground. However, there were no objections with overhead powerlines that run through industrial areas. Schools and other stakeholders also expressed the preference to minimise the impact of the project by timing construction during school holidays.

As part of this RIT-D process, Ausgrid has taken stakeholder submissions and feedback into consideration resulting in several updates to the initial proposal to accommodate community preferences where they did not impose additional undue costs.

A full summary of the community and stakeholder engagement undertaken to-date can be found in a separate summary document on Ausgrid's website.[10]

[10] Ausgrid, *Camellia to Lidcombe powerline project – Community consultation summary, for feedback period 11 August 2016 to November 2016*. Available at: https://www.ausgrid.com.au/-/media/Files/Network/Network-Projects/Sydney-South/Camellia-to-Lidcombe-33kV/Community-consultation-summary.pdf?la=en&hash=B388E2F0001C3E0B4BBD70542A6150B573E810A3

4 Three credible options have been assessed

This section provides descriptions of the credible options Ausgrid has identified as part of its network planning activities to date. In particular, Ausgrid has identified three network options that involve the replacement of critical network assets, either on a 'like-for-like' basis (i.e. retaining supply from the Homebush STS) or connecting each substation to the Camellia STS in Endeavour Energy's network.

The three credible options are summarised below. All costs in this section are in $2017/18, unless otherwise stated.

Table 3 – Summary of the credible options considered

Network option	Key components	Approximate total length of new feeders	Estimated capital cost
Option 1 – New feeders from Homebush (i.e. a 'like-for-like' route)	• Three XLPE 33kV underground feeders from Homebush to Auburn • Three XLPE 33kV underground feeders from Homebush to Lidcombe • Retirement of the existing underground gas pressure and HSL sections of the 33kV feeders supplying the Auburn and Lidcombe substations • Installation of additional capacity at the Homebush STS	40km	$36 million
Option 2 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe substations	• Four 33kV feeders from Endeavour's Camellia STS to Adderley Street, Auburn using a combination of overhead and underground connections • Two 33kV feeders from Adderley Street to Auburn zone substation • Two 33kV underground feeders from Adderley Street to Lidcombe zone substation • Three-way ring main isolators at the Auburn zone substation • Uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA • Retirement of the existing underground gas pressure and HSL cable sections of the 33kV feeders supplying the Auburn and Lidcombe zone substations	20km	$26 million
Option 3 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe, whilst utilising existing HSL sections	• Four 33kV feeders from Endeavour's Camellia STS to Adderley Street Auburn, using a combination of overhead and underground connections • Installation of two 33kV feeders from Adderley Street to Auburn zone substation • Installation of one 33kV overhead feeder from Adderley Street to Lidcombe zone substation • Connection of existing HSL cable sections of existing feeders to form one 33kV underground feeder from the Adderley Street to Lidcombe substations • Three-way ring main isolators at the Auburn zone substation • Uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA • Retirement of the existing underground gas pressure and HSL cable sections of the 33kV feeders supplying the Auburn and Lidcombe zone substations	15km	$20 million

Several options were considered in addition to those set out in Table 3 but were found to be non-credible. These options are discussed in section 4.4.

Ausgrid has also determined that non-network solutions are unlikely to form a standalone credible option, or form a significant part of a potential credible option, as set out in the separate notice released in accordance with clause 5.17.4(d) of the NER. A summary of Ausgrid's consideration of non-network options is provided in section 4.4. below.

4.1 Option 1 – New feeders from Homebush (ie, a 'like-for-like' route)

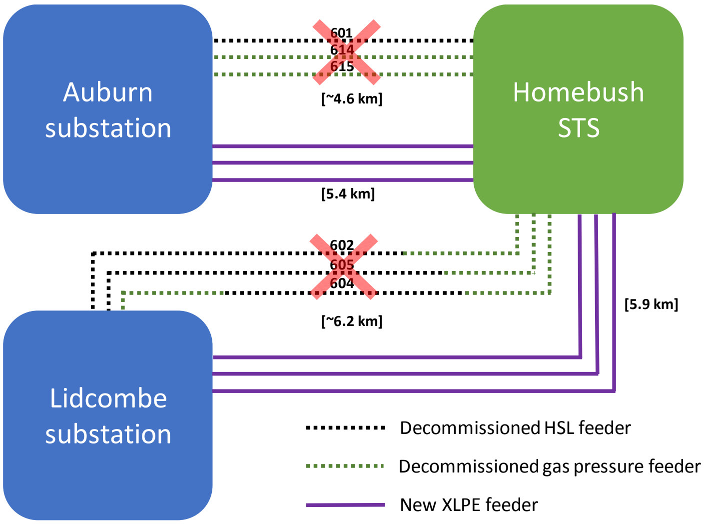
This option involves the replacement of the three 33kV feeders between Homebush STS and Auburn zone substation, as well as the three 33kV feeders between Homebush STS and Lidcombe zone substation.

These replacement feeders would be installed in two separate routes. The proposed scope involves:

- installation of three XLPE 33kV underground feeders covering a distance of 5.4km between Homebush STS and Auburn zone substation;
- installation of three XLPE 33kV underground feeders covering a distance of 5.9km between Homebush STS and Lidcombe zone substation; and
- retirement of the existing underground gas pressure and HSL cable sections of the 33kV feeders supplying Auburn and Lidcombe zone substations.

The supply to each substation under this option is depicted in the network diagram below.

Figure 6 – Option 1: Like for like replacement with six feeders supplied from Homebush STS[11]



This option is also likely to require the installation of additional capacity at Homebush STS to accommodate future load growth. This augmentation will consist of the installation of a third 132kV feeder originated from Mason Park sub-transmission switching station and the commissioning of the third transformer already on site at Homebush STS. The timing of this upstream augmentation will be dependent on major customer connections expected in the area, as well as the general load growth in the Inner West network.

The estimated cost of this option is $36 million and is estimated to take four years to complete construction. Ausgrid assumes construction is started in 2017/18 with construction scheduled for completion in 2020/21 (commissioning in the same year) and decommissioning of existing feeders in the following year. Once commissioned, operating costs are estimated to be approximately $180,000 per annum (around 0.5 per cent of capital expenditure).

Ausgrid notes that Option 1 involves traversing more difficult terrain than options 2 and 3. In particular, there are a lot more concreted sections associated with installing new feeders from Homebush to Auburn and Lidcombe, than installing feeders from Camellia to these substations, which involves greater excavation and engineering costs. Ausgrid also notes that the total length of new cable required under Option 1 is more than double that of options 2 and 3.

[11] Please note that this figure is designed to be illustrative of the types, and distances, of each feeder technology. To do so, it illustrates the distances of each feeder type, relative to one-another. It is not intended to be an accurate depiction of the *location* of each feeder type.

4.2 Option 2 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe substations

This option involves replacement of the existing 33kV feeders from a different supply point to Option 1. It became feasible when Shell Australia closed its oil refinery located at Clyde in Western Sydney in 2013. The oil refinery was supplied from Endeavour owned Camellia transmission substation and, once closed, it made approximately 70MVA of 33kV supply available near the Auburn zone substation.

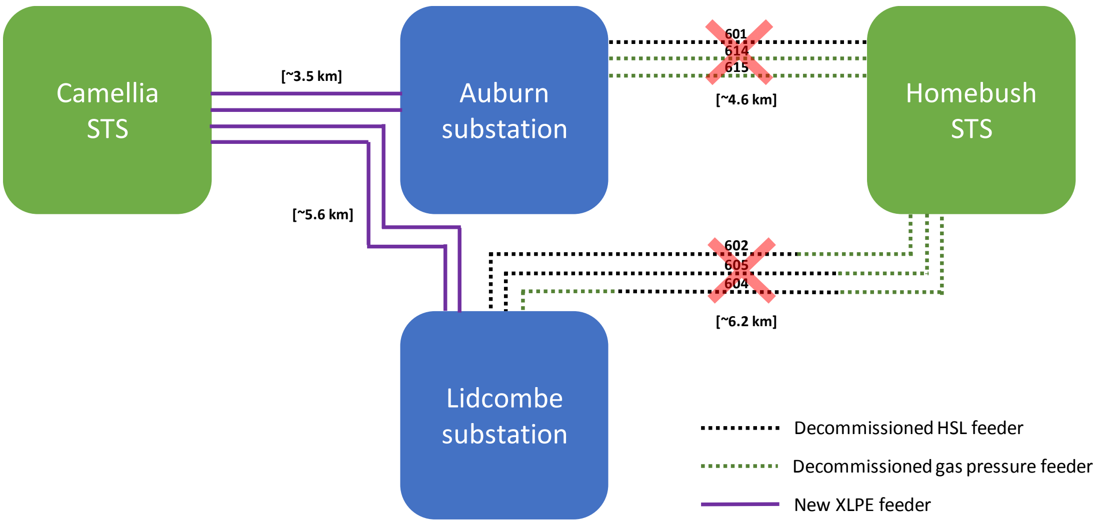
The proposed scope for this option involves:

- installation of four feeders, approximately 3.5km long, from Camellia TS to Adderley Street near Auburn zone substation, using a combination of overhead and underground connections;
- installation of two underground feeders, approximately 2.1km long, from Adderley Street to Lidcombe zone substation;
- installation of three-way ring main isolators at Auburn zone substation as one 33kV feeder would share one of the transformers at Auburn zone substation and one of the transformers at Lidcombe zone substation;
- uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA; and
- retirement of the existing underground gas pressure and HSL cable sections of the 33kV feeders supplying Auburn and Lidcombe zone substations.

Option 2 involves replacing the existing feeders supplying both the Auburn and Lidcombe substations from Homebush with significantly shorter feeders from Camellia.

The new supply to each substation under this option is depicted in the network diagram below.

Figure 7 – Option 2: Four new feeders supplied from Endeavour Energy's Camellia STS[12]



The estimated cost of this option is $26 million and it is estimated to take four years to complete construction. Ausgrid assumes construction commences in 2017/18 with construction scheduled for completion in 2020/21 (commissioning in the same year) and decommissioning of the gas pressure cables in the following year. Once commissioned, operating costs are estimated to be approximately $130,000 per annum (around 0.5 per cent of capital expenditure).

Option 2 was developed jointly with Endeavour Energy and makes use of spare capacity on the Endeavour network following closure of a Shell Australia oil refinery at Clyde.

[12] Please note that this figure is designed to be illustrative of the types, and distances, of each feeder technology. To do so, it illustrates the distances of each feeder type, relative to one-another. It is not intended to be an accurate depiction of the *location* of each feeder type.

4.3 Option 3 – New feeders from Endeavour Energy's Camellia substation to both Auburn and Lidcombe, whilst utilising existing HSL sections

This option is a refinement of Option 2 above that takes advantage of opportunities to maintain sections of the existing cables in service, as they are considered to be in reasonably adequate condition.

Instead of installing two underground feeders from Auburn to Lidcombe zone substation, one of the 33kV feeders will predominantly consist of an overhead connection and the other 33kV feeders will form a tee connection to existing HSL sections of feeders 602 and 605 to supply Lidcombe zone substation.

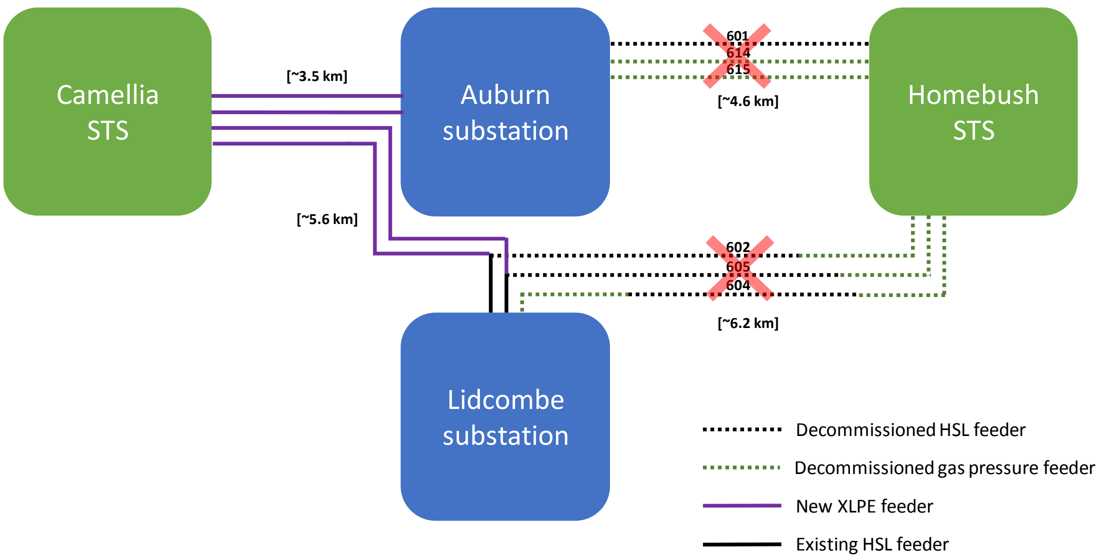
The proposed scope for this option is largely the same as Option 2 and involves:

- installation of four feeders, approximately 3.5km long, from Camellia TS to Adderley Street near Auburn zone substation (i.e. the same as Option 2);
- installation of one overhead feeder, approximately 2.1km long, from Adderley Street to Lidcombe zone substation;
- connection of existing HSL cable sections to existing transformers at the Lidcombe zone substation;
- installation of three-way ring main isolators at Auburn zone substation as one 33kV feeder would share one of the transformers at Auburn zone substation and one of the transformers at Lidcombe zone substation;
- uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA; and
- retirement of the existing underground gas pressure cable sections of the 33kV feeders supplying Auburn and Lidcombe zone substations.

Like Option 2, Option 3 involves replacing the existing feeders supplying both the Auburn and Lidcombe substations from Homebush with significantly shorter feeders from Camellia. The key difference between Option 3 and Option 2 is that Option 3 utilises HSL sections on the existing feeders supplying Lidcombe.

The new supply to each substation under this option is depicted in the network diagram below.

Figure 8 – Option 3: Four new feeders supplied from Endeavour Energy's Camellia STS, utilising existing HSL feeders to Lidcombe[13]



The estimated cost of this option is $20 million, which is slightly less than Option 2 on account of being able to utilise existing HSL cable sections.

[13] Please note that this figure is designed to be illustrative of the types, and distances, of each feeder technology. To do so, it illustrates the distances of each feeder type, relative to one-another. It is not intended to be an accurate depiction of the *location* of each feeder type.

Option 3 is assumed to take four years to complete construction. Ausgrid assumes that construction begins in 2017/18 with construction scheduled for completion in 2020/21 (commissioning in the same year) and decommissioning of the gas pressure cables in the following year. Once commissioned, operating costs are estimated to be approximately $98,000 per annum (around 0.5 per cent of capital expenditure).

4.4 Options considered but not progressed

Ausgrid has considered two options that have not been progressed. In general, these options were not progressed because they were not considered technically feasible and/or commercially feasible, or they are materially similar to other options considered above.

The table below summarises Ausgrid's consideration of other such options.

Table 4 – Options considered but not progressed

Option not progressed	Reason why option was not progressed
Retire one of the zone substations (i.e. Auburn or Lidcombe) and uprate the other in order to shift load	Considered not technically feasible since there is insufficient spare capacity at either substation, even with reasonable uprating, to transfer load. Ausgrid also considers that such an option would have detrimental effects in terms of reliability since there would be a lower number of 11kV feeder panels (on account of one substation being retired).
Upgrading Auburn zone substation to 132kV operation and decommissioning the Lidcombe substation, or vice versa.	Considered not commercially feasible due to its materially higher costs (in the order of $100 million) than the options outlined above (i.e. $20-36 million), without providing a commensurate level of market benefits, or avoided cost benefits. Ausgrid also considers that easements for a 132kV option are difficult/expensive to negotiate. For example, one easement would need to go through the Rookwood cemetery.

Ausgrid has also considered the ability of any non-network solutions to assist in meeting the identified need. A demand management assessment into reducing the risk of unserved energy from the 33kV 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 a the separate notice released alongside the DPAR in accordance with clause 5.17.4(d) of the NER.

5 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.

5.1 General overview of the assessment framework

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

The RIT-D analysis has been undertaken over a 20-year period, from 2018 to 2037. 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.[14]

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[15]), and an upper bound discount rate of 8.07 per cent (i.e. a symmetrical upwards adjustment).

5.2 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.

A table of more common equipment outage costs used in the cost benefit analysis are set out below. These costs cover the corrective capital expenditure required when an asset fails.

[14] 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

[15] 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

Table 5 – Direct costs of equipment outages

Equipment outage	Direct costs
Gas cable corrective action	$22,331
HSL cable corrective action	$9,862

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 three options, as illustrated in section 5.1.

5.3 Market benefits are expected from both reduced involuntary load shedding and deferrred upstream distribution investment

Ausgrid considers that the only relevant categories of market benefits prescribed under the NER for this RIT-D relate to changes in involuntary load shedding as well as changes in the timing of unrelated expenditure. The approaches and assumptions Ausgrid has made to estimating each of these is outlined in the sections below.

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

5.3.1 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 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.[16] 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.

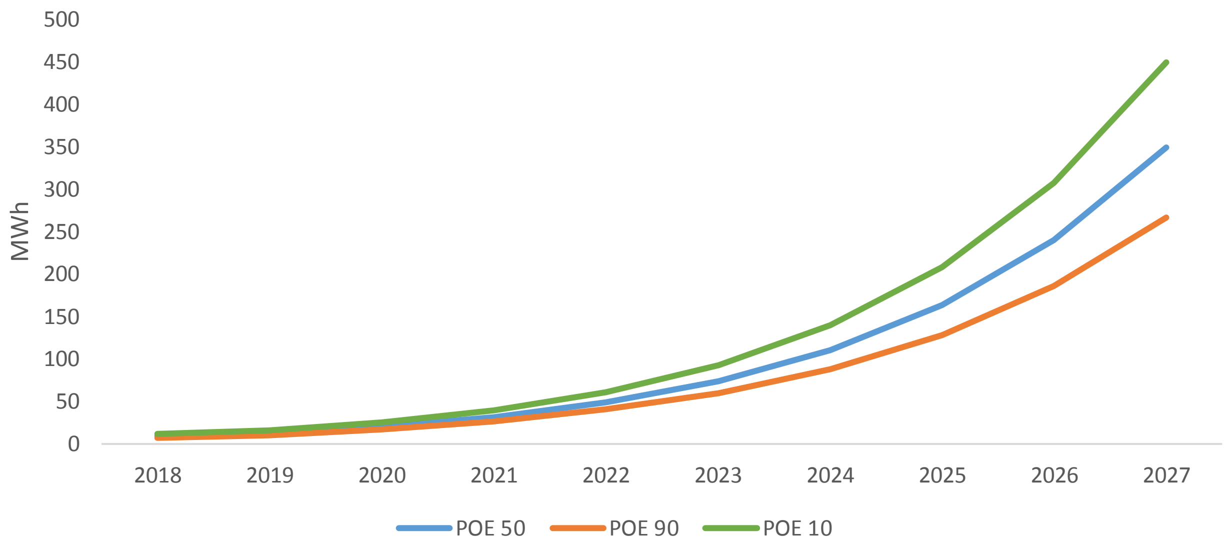
We have also investigated the effect of assuming both a lower and higher underlying VCR estimate. The lower sensitivity has derived by reducing the AEMO-derived estimate by 30 per cent, consistent with the AEMO-stated level of confidence in its estimates, and results in an estimate of $28/kWh.[17] The 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 (a region that includes Auburn and Lidcombe), as well as the recently finalised Powering Sydney's Future RIT-T.[18]

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 per cent probability of exceedance ('POE50') forecasts, as well as a low forecast using the POE90 forecasts and a high forecast using the POE10 forecasts.

[16] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report.
[17] AEMO, *Value of Customer Reliability Review*, September 2014, Final Report, p. 31.
[18] 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

The figure below shows the assumed levels of unserved energy, 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.

Figure 9 – 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 'business as usual' 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[19] dwarfs other market benefits and skews the results,[20] and does not affect the ranking of credible options at all.

5.3.2 Deferring the need for unrelated network expenditure

Under Option 1, where Auburn and Lidcombe continue to be supplied from Homebush STS, the installation of additional capacity at Homebush STS is expected to be required in the future. This augmentation will consist of the installation of a third 132kV feeder originated from Mason Park sub-transmission switching station and the commissioning of the third transformer already on site at Homebush STS. While the timing of this upstream augmentation will be dependent on major customer connections expected in the area, as well as the general load growth in the Inner West network, Ausgrid has assumed $7 million of capital expenditure is required in 2025 under Option 1.

Options 2 and 3 both transfer load from the Homebush STS to the Camellia STS and thus free-up distribution capacity at Homebush. Ausgrid assumes that the installation of additional capacity at Homebush is consequently deferred by ten years under options 2 and 3, relative to Option 1.

The benefit for options 2 and 3 of this deferral has been calculated as the difference in the present value of the capital expenditure. While Ausgrid has explicitly modelled this market benefit, as outlined in section 6 below, it is found to be immaterial in the overall benefits due to the extent of the benefit associated with unserved energy avoided.

[19] 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.

[20] 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

5.4 Three different ‘scenarios’ have been modelled to address uncertainity

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

Ausgrid has elected to assess three alternative future scenarios – 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 potential market benefits.

Table 6 – Summary of the three scenarios investigated

Variable	Scenario 1 – low benefits	Scenario 2 – baseline	Scenario 3 – high benefits
Demand	POE90	POE50	POE10
VCR	$28/kWh (30 per cent lower than the central, AEMO-derived estimate)	$40/kWh (Derived from the AEMO VCR estimates)	$90/kWh (Consistent with the recent IPART review of transmission reliability standards for this area)
Commercial discount rate	8.07 per cent	6.13 per cent	4.19 per cent

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

6 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.

6.1 Gross market benefits estimated for each credible option

Table 7 below summarises the gross 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 7 – Present value of gross economic benefits of each credible option relative to the base case $m 2017/18

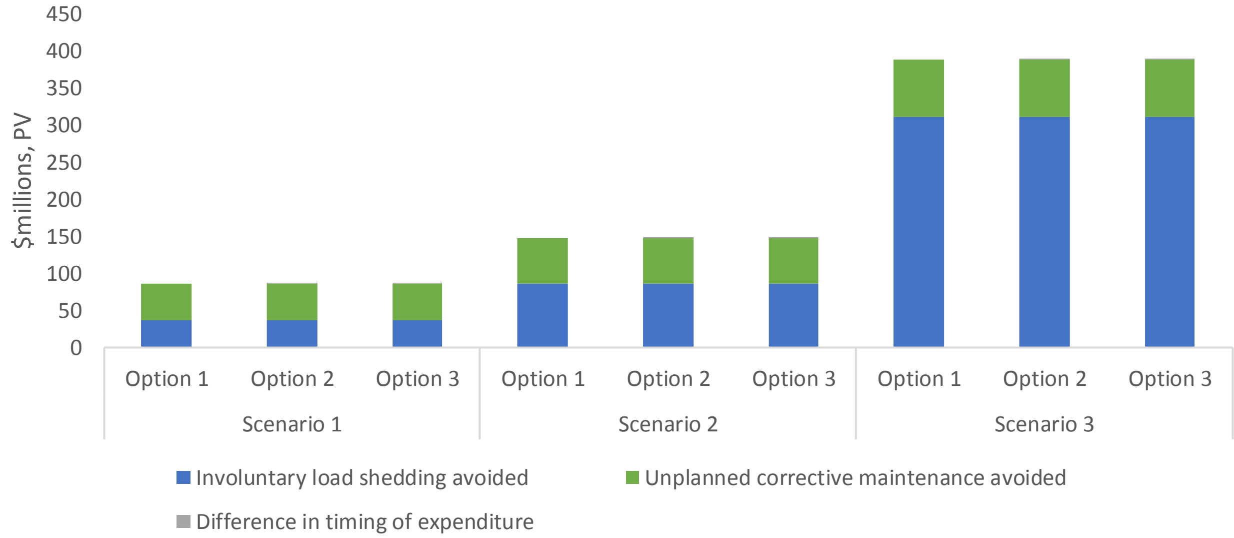
Option	Scenario 1	Scenario 2	Scenario 3	Weighted PV of gross benefits
Scenario weighting	25%	50%	25%	
Option 1	85.9	146.8	387.5	191.8
Option 2	87.6	148.9	389.7	193.8
Option 3	87.6	148.9	389.7	193.8

Figure 10 provides a breakdown of all benefits relating to each credible option. For clarity, we have combined in this chart the two categories of 'market benefit' (ie, reduced involuntary load shedding and differences in the timing of unrelated expenditure) with avoided corrective maintenance cost benefits (ie, reduced planned routine maintenance and refurbishment of ageing assets, reduced unplanned corrective maintenance when assets fail and reduced operating costs associated with safety and environmental costs).

All options are found to have essentially the same overall benefit. This is driven by the fact that all options are assumed to be commisioned in the same year and so avoid similar levels of expected unserved energy and corrective maintenance costs. Options 2 and 3 have marginally higher benefits than Option 1 on account of these options being able to defer the time at which additional capacity at Homebush STS is required.

The benefit associated with avoided corrective maintenance is estimated to be significant for this RIT-D on account of the escalating failure rates of the assets in question, which are already 25 to 30 years past their standard technical lives (as outlined in section 2 above).

Figure 10 – Breakdown of gross economic benefits of each credible option relative to the base case



6.2 Estimated costs for each credible option

The table below summarises the gross costs of each credible option relative to the base case in present value terms. The gross cost is the sum of the project capital costs and decommissioning costs associated with retiring the existing feeders.

The gross cost of each option has been calculated for each of the three reasonable scenarios, in accordance with the approaches set out in Section 5.4.

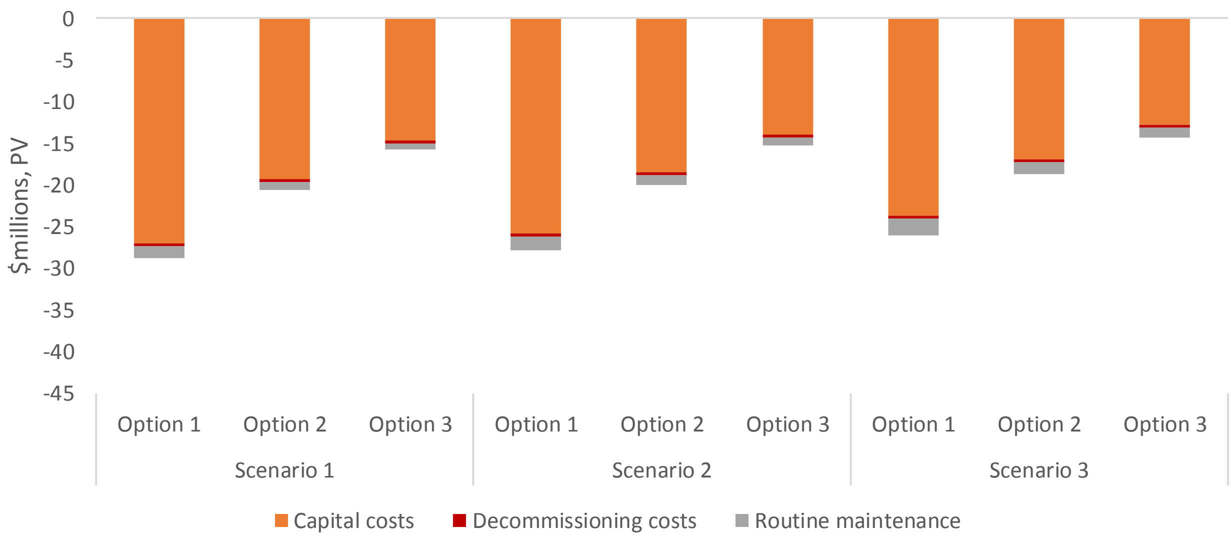
Table 8 – Present value of gross costs of each credible option relative to the base case, $m 2017/18

Option	Scenario 1	Scenario 2	Scenario 3	Weighted costs
Scenario weighting	25%	50%	25%	
Option 1	28.8	27.8	26.0	27.6
Option 2	20.7	20.0	18.7	19.8
Option 3	15.8	15.2	14.3	15.1

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

Under all scenarios, Option 3 involve the lowest capital costs due to it making use of existing feeders from Homebush STS to Lidcombe zone substation, which reduces the scope of works required compared to Option 1 and Option 2. Option 1 has the highest costs under all scenarios, on account of the adverse terrain it traverses and the additional length of feeders installed (as outlined in section 4 above).

Figure 11 – Breakdown of gross costs of each credible option relative to the base case



6.3 Net present value assessment outcomes

Table 9 summaries 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 7) minus the cost of each option (as outlined in Table 8), all in present value terms.

Overall, Option 3 exhibits the highest estimated net market benefit, which is driven primarily by it having the lowest capital costs out of the three credible options considered.

Table 9 – Present value of expected economic benefits of credible options relative to the base case, $m 2017/18

Option	Capital costs	Operating costs	Weighted PV of gross benefits	Weighted PV of net benefits	Option ranking
Option 1	(25.6)	(2.0)	191.8	164.1	3
Option 2	(18.3)	(1.6)	193.8	173.9	2
Option 3	(13.9)	(1.3)	193.8	178.6	1

6.4 A range of sensitivity tests have also been undertaken on key assumptions

Ausgrid has undertaken a through 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 have been applied to test the sensitivity of the key findings.

6.4.1 Step 1 – Sensitivity testing of the assumed optimal timing for each option

Ausgrid has estimated the optimal timing for each option based on the year in which the annualised cost of the project falls below the expected market benefit from commissioning the project that year. This process was undertaken for both the baseline set of assumptions and also a range of alternate assumptions for key variables.

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

- a 25 per cent increase/decrease in the assumed network capital costs;
- alternate forecasts of maximum demand growth, based on POE10 (high) and POE90 (low);
- a lower VCR ($28/kWh) and higher VCR value ($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 trigger year for each option, under a range of alternate assumptions. They illustrate that the optimal commissioning date for all credible options is found to be 2021/22.

Figure 12 – Distribution of project need years under each sensitivity investigated – Option 1

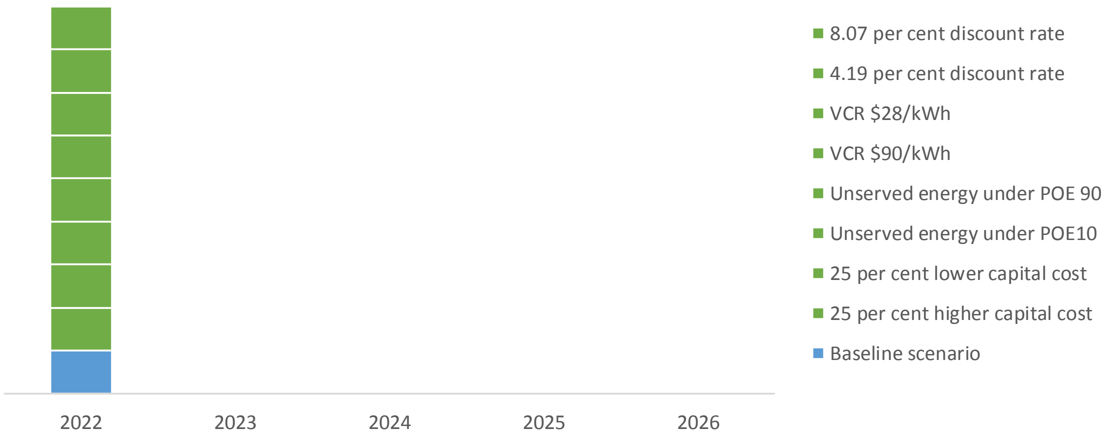


Figure 13 – Distribution of project need years under each sensitivity investigated – Option 2

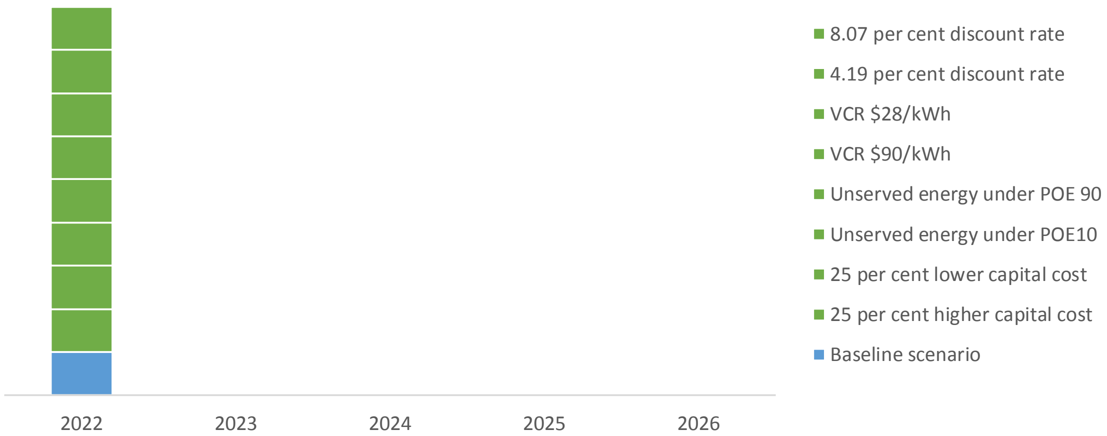
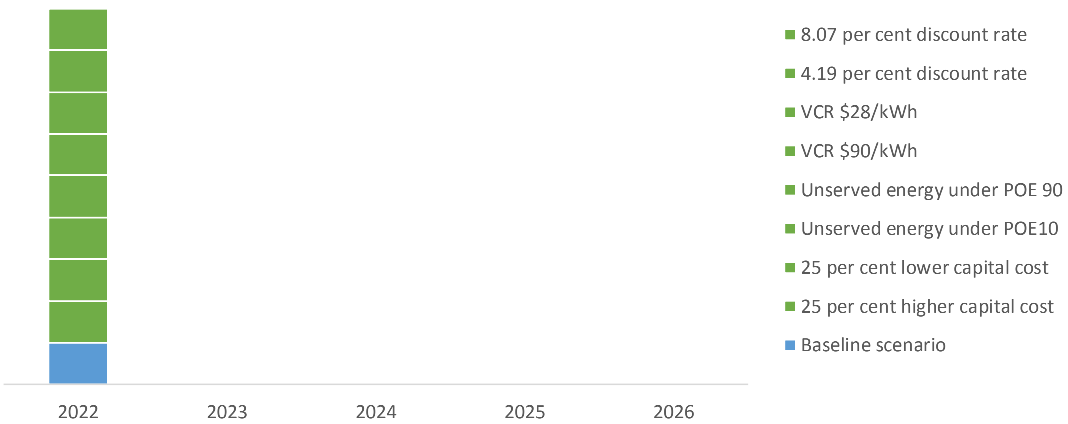


Figure 14 - Distribution of project need years under each sensitivity investigated – Option 3



On balance, Ausgrid considers that the identification of the central trigger years for all options has been robustly determined and tested.

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

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

Specifically, Ausgrid has investigated the same sensitivities under this second step as the first step, ie:

- a 25 per cent increase/decrease in the assumed network capital costs;
- alternate forecasts of maximum demand growth, based on POE10 (high) and POE90 (low);
- a lower VCR ($28/kWh) and higher VCR value ($90/kWh);
- 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.

Table 10 presents the results of these sensitivity tests and, for each sensitivity, labels the highest ranked option using bold text. The analysis reaffirms the finding that Option 3 is found to be the preferred credible option, and has a positive net market benefit.

Table 10 - Sensitivity testing results (Net Present Values $'m 2017/18)

Sensitivity	Option 1	Option 2	Option 3
25 per cent higher capital cost	112.5	124.3	**130.2**
25 per cent lower capital cost	125.4	133.5	**137.1**
Unserved energy under POE10	143.3	153.2	**158.0**
Unserved energy under POE 90	99.1	109.0	**113.7**
VCR $90/kWh	226.5	236.5	**241.2**
VCR $28/kWh	93.2	103.1	**107.8**
4.19 per cent discount rate	158.5	167.6	**172.1**
8.07 per cent discount rate	89.2	99.5	**104.4**

7 Proposed preferred option

Option 3 has been found to be the preferred option, which satisfies the RIT-D. It involves the installation of 33kV feeders from Camellia STS to Auburn and Lidcombe zone substations utilising the existing HSL feeder sections that run from Homebush STS to Lidcombe zone substation. Ausgrid is the proponent for Option 3.

Option 3 provides the following benefits:

- it involves the lowest cost out of all three credible options considered (and involves less than half the combined length of new feeders of a ‘like-for-like’ replacement under Option 1);
- it complements existing switchgears works underway at Lidcombe zone substation;
- it utilises spare capacity at Endeavour Energy’s Camellia STS and avoids unnecessary duplication of network capacity;
- it defers upstream investments that would otherwise be required if supply of Auburn and Lidcombe were to continue to come from Homebush STS; and
- it addresses asset condition issues on feeders supplying Auburn and Lidcombe zone substation and therefore is expected to reduce involuntary load shedding and operating expenditure related to unplanned corrective maintenance.

The scope of Option 3 includes:

- installation of four feeders, approximately 3.5km long, from Camellia STS to Adderley Street near Auburn zone substation (i.e. the same as Option 2);
- installation of one overhead feeder, approximately 2.1km long, from Adderley Street, Auburn to Lidcombe zone substation;
- connection of existing HSL cable sections to existing transformers at the Lidcombe zone substation;
- installation of three-way ring main isolators at Auburn zone substation as one 33kV feeder would share one of the transformers at Auburn zone substation and one of the transformers at Lidcombe zone substation;
- uprate of existing Transformer 5 at Auburn zone substation to increase the emergency rating to 31 MVA; and
- retirement of the existing underground gas pressure cable sections of the 33kV feeders supplying Auburn and Lidcombe zone substations.

The figure below depicts the new feeders proposed under Option 3. Specifically, they will originate from Camellia STS, crossing the M4 motorway underground and following the motorway east to connect to Auburn zone substation and then south to Lidcombe zone substation.

Figure 1 – Detailed route of proposed preferred option

The proposed route from Camellia STS to Auburn zone substation is mainly through industrial areas, crossing Duck Creek and the existing M4 Western Motorway by following the Duck River Cycleway. Ausgrid plans to use underground cables in certain areas in response to community feedback and to minimise risks along the M4 Western Motorway.

The proposed overhead route between Adderley Street and the Lidcombe zone substation will pass primarily through industrial areas in Lidcombe and cross under the main western rail line at Percy Street. Ausgrid is proposing to locate the cables on the western side of Percy Street and incorporating them on existing low voltage powerline structures, which will minimise the impact of construction. Underground cables will continue to be installed from Adderley Street West to the Auburn zone substation at 2 Silverwater Road. Trenching will need to be laid between the eastern end of Adderley Street West and along Silverwater Road to the substation.

The estimated cost of this option is $20 million and is assumed to take four years to complete construction. Ausgrid assumes that construction begins in 2017/18 with construction scheduled for completion in 2020/21 (commissioning in the same year) and the decommissioning of gas cables the following year. Once commissioned, operating costs are estimated to be approximately $98,000 per annum (around 0.5 per cent of capital expenditure).

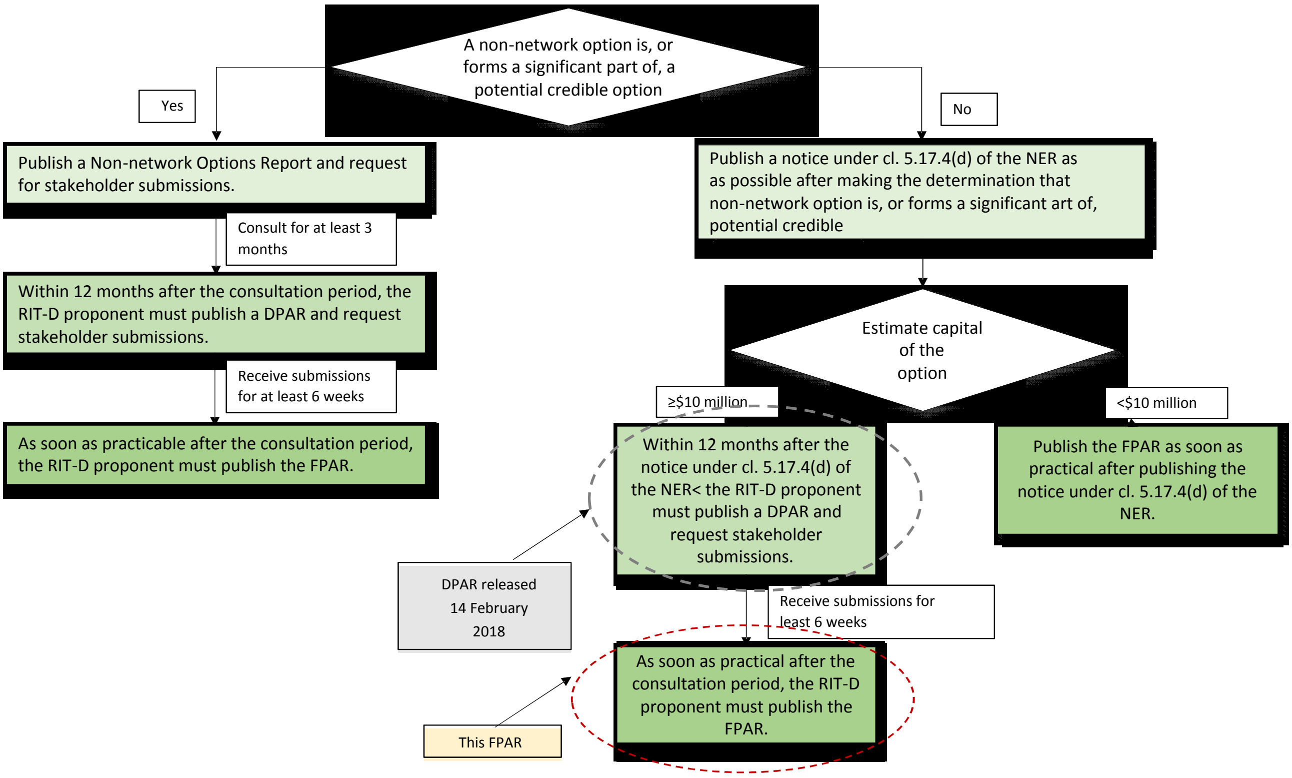
Appendix A – Checklist of compliance clauses

This section sets out a compliance checklist that demonstrates the compliance of this FPAR with the requirements of clause 5.17.4(j) of the National Electricity Rules version 103.

Rules clause	Summary of requirements	Relevant sections in the DPAR
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	4
	(5) where a DNSP has quantified market benefits, a quantification of each applicable market benefit for each credible option;	6.1
	(6) a quantification of each applicable cost for each credible option, including a breakdown of operating and capital expenditure	6.2
	(7) a detailed description of the methodologies used in quantifying each class of cost and market benefit	5.3
	(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	6
	(10) the identification of the proposed preferred option	7
	(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	7
	(12) Contact details for a suitably qualified staff member of the RIT-D proponent to whom queries on the draft report may be directed.	1.3

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 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 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 11 – Market benefit categories under the RIT-D not expected to be material

Market benefits	Reason for excluding 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 sufficiently flexible 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.
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.

Supply restoration assumptions

Table 12 – Supply restoration assumptions

Equipment outage	Action	Time
Gas cable failure	Repair – the cable is repaired on site. Extensive time is required to de-gas and re-gas the cable	24.5 days
Gas cable third party damage	Repair – the cable is repaired on site. Extensive time is required to de-gas and re-gas the cable. Additional time is typically required to repair third party damage	28 days
HSL cable failure	Repair – the cable is repaired on site	10.5 days
HSL cable third party damage	Repair – the cable is repaired on site. Additional time is typically required to repair third party damage	14 days
Tower line failure	Repair – the tower line is repaired	1 day
Pole line failure	Repair – the pole line is repaired	8 hours

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 13 – 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

$$n(t) = \lambda t^{\eta}$$

where:

n(t) is the cumulative number of failures (per km)
t is the cumulative time (i.e. age of the cable at failure, in years)
η is a measure of the failure rate
λ is a scale parameter

The above process is carried out for corrective actions, failures and third party damage for gas pressure, HSL and XLPE cables. Table 14 shows the modelled Cow-AMSAA parameters for each cable type.

Table 14 – Underground cable parameters

Cable type	Corrective action			Failure			Third party damage		
	η	λ	Repair time	η	Λ	Repair time	η	λ	Repair time
Gas pressure	1.1	2×10^{-2}	-	11.1	2.2×10^{-20}	24.5 days	1.0	7×10^{-3}	28 days
HSL	6.0	8.2×10^{-13}	-	4.6	2.6×10^{-10}	10.5 days	3.0	7×10^{-8}	14 days
XLPE 33kV	0.5	3.5×10^{-2}	-	0.9	6.6×10^{-3}	14 days	1.0	1.4×10^{-3}	21 days
XLPE 132kV	1.7	8.6×10^{-4}	-	0.2	2.1×10^{-2}	14 days	N/A	N/A	N/A

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

Equation 2

$$f = L\lambda\left(t_2^{\eta} - t_1^{\eta}\right)$$

Where:

L is the length of the cable section (km)
t_1 is the age of the cable section at the start of the year (years)
t_2 is the age of the cable section at the end of the year (years)

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

$$U = \frac{f\ .\ Repair\ Time}{f\ .Repair\ Time + 365}$$

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 5 on page 14 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 gas pressure cables is expected to decline if the cables are retained past an age of 50.