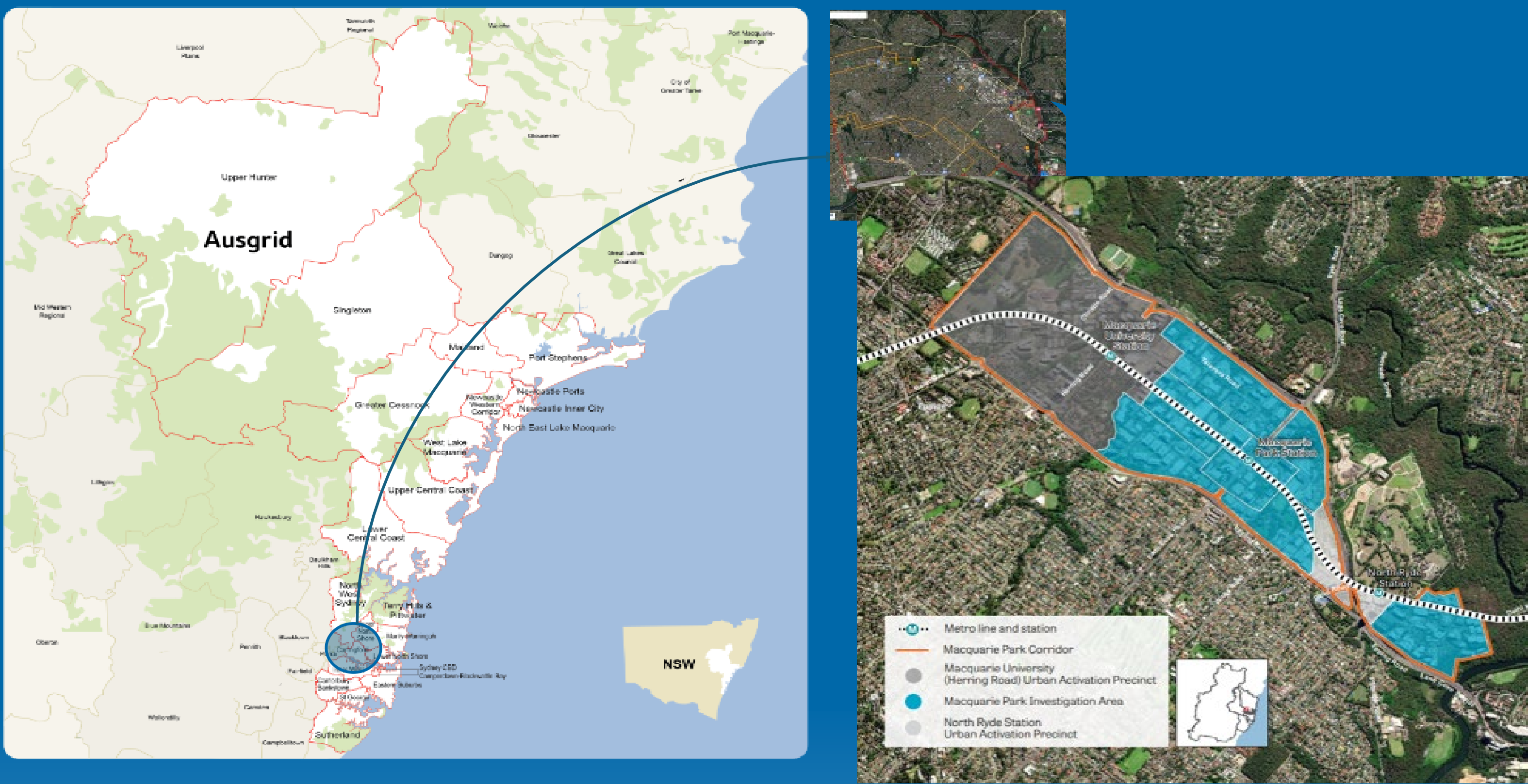
Addressing increased customer demand requirements in the Macquarie Park area

FINAL PROJECT ASSESSMENT REPORT



11 October 2024

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Addressing increased customer demand requirements in the Macquarie Park area

Final Project Assessment Report – 11 October 2024

Contents

Executive Summary

This report is the final step in the application of the RIT-D to addressing increased customer demand requirements in the Macquarie Park supply area

Macquarie Park is a suburb in Northern Sydney known for being well connected to telecommunications, electrical and transport infrastructure, making it an increasingly popular location for major load customers.

Ausgrid has received a lot of interest from new major load customers in the Macquarie Park area in recent years and has subsequently expanded the network to accommodate these loads, by commissioning a new Macquarie subtransmission substation (STS) in July 2021 and adding a third 120 MVA transformer to be commissioned by December 2025.

Physical site restrictions mean that new loads cannot be accommodated at the existing STS. This was noted in the 2023 RIT-D we undertook for the third 120 MVA transformer, which stated that further network investment (covered by a separate RIT-D process) would be required to accommodate any additional major loads in the area.[1]

We have received a further four connection applications from major customers seeking to connect in the Macquarie Park area and have therefore commenced this RIT-D to investigate the options for facilitating these connections. Each of these four applications requests connection from December 2028 and that the connection is provided at 33kV.

If action is not taken, Ausgrid will fail to meet requirements to connect customers under the NER. This creates an opportunity to provide a scale-efficient, cost-effective investment in shared network assets to benefit multiple customers.

Ausgrid is therefore undertaking a Regulatory Investment Test for Distribution (RIT-D) to assess options for addressing these major customers connection requirements in the Macquarie Park area.

A draft report was released in August 2024 and received no submissions

A Draft Project Assessment Report (DPAR) for this RIT-D was published on 16 August 2024. The DPAR presented four credible options for addressing these customer demand requirements, assessed in accordance with the RIT-D framework and concluded that the preferred option was the construction of a second STS in Macquarie Park at a site located in relative proximity to these major customers. We have labelled this second STS in Macquarie Park the 'Wallumatta STS', in recognition of the original name given to the area and acknowledging its indigenous history.

The DPAR summarised Ausgrid's assessment of the non-network or stand-alone power system (SAPS) solutions to assist in meeting the identified need, reporting that such solutions were not viable for this RIT-D. The DPAR was accompanied by a separate 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 27 September 2024. No submissions were received on either the DPAR or the separate screening notice.

This report therefore re-presents the assessment of the draft report and maintains the conclusion that Option 5 is the preferred option

Considering no submissions were made to either the DPAR of the separate non-network screening notice, this FPAR re-presents the assessment undertaken in the DPAR. The assessment has been slightly updated, to reflect updated cost information, as described below.

We have assessed eleven network options following an assessment of the various potential dimensions for supply arrangements to connect the new loads, including connection to the upstream network, substation configuration and physical location. This has been narrowed down to four credible options with greater detail captured within this report. Fundamentally, the four credible options assessed differ by:

- Substation arrangement – Option 4 and Option 5 involve a new 132/33kV STS, while Option 6 and Option 7 also involve a new 132/33kV STS but include an expanded 132kV busbar to enable possible future 132kV connections; and
- Location of STS – Option 4 and Option 6 assume the same site, while Option 5 and Option 7 assume another site.[2]

[1] Ausgrid, *Addressing increased customer demand in the Macquarie Park area*, FPAR, March 2023, p. 3.

[2] Throughout this FPAR, the locations of the sites have been redacted to not affect procurement process and, instead, we only refer to 'site 1' (for Option 4 and Option 6) and 'site 2' (for Option 5 and Option 7). Both sites are nearby the proposed locations of customers.

Each of the four different credible options are summarised in the table below.

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

Option	Description	Network capital cost	Customer connection cost
Option 4	New 132/33kV STS at 'site 1' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J	$179 million	$28 million
Option 5	New 132/33kV STS at 'site 2' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J	$162 million	$12 million
Option 6	New STS with expanded 132kV busbar at 'site 1' tee connected to 132kV Feeders 92G & 92J	$186 million	$28 million
Option 7	New STS with expanded 132kV busbar at 'site 2' tee connected to 132kV Feeders 92G & 92J	$170 million	$12 million

For continuity with the contingent project business case for this project submitted as part of our regulatory determination process for the current period, we have continued with the option numbering in this FPAR, i.e., the four credible options assessed in this FPAR are 'Option 4' (which was included in the business case) through to 'Option 7' (noting that Options 5-7 were not included in the business case and have been developed as part of the FPAR).

As stated in the DPAR, three of the four options presented in the contingent project business case submitted as part of our current regulatory determination process are no longer considered credible. This is due to a fundamental change in the value of the land required since the business case was submitted, as a result of a recent rezoning by the NSW Government.

All options have an approximate 4.5 year construction time and would commence as soon as practicable after this RIT-D (and the subsequent contingent project application being approved by the AER), targeting commissioning in 2028/29.

We note that updated property valuation assessments have been received for the two sites considered since the DPAR was published, and this information has been subsequently included in the network capital cost reported in the table above.

Similarly, a contingency has been estimated and included in the capital costs above following a risk assessment, for which a cost allowance will be sought in the contingent project application for the preferred option identified in this RIT-D.

Three demand forecast scenarios have been modelled to deal with uncertainty

RIT-D assessments are required to be based on cost-benefit analysis that includes an assessment of 'reasonable scenarios', which are designed to test alternate sets of key assumptions and whether they affect identification of the preferred option. Ausgrid has assessed three alternative future load demand scenarios – namely:

- A central forecast assuming 85% scaled load from the proposed major loads;
- A low demand forecast assuming 60% scaled load from the proposed major loads; and
- A high forecast assuming 100% scaled load from the proposed major loads.

The scenarios only differ by the demand forecasts given this is the key parameter that may affect the ranking of the credible options. How the results are affected by changes to other variables (i.e. the discount rate and capital costs) have been investigated in the sensitivity analysis. A summary of the key variables in each scenario is provided in the table below.

Table E.2 – Summary of the three scenarios investigated

Variable	Scenario 1 – central	Scenario 2 – low	Scenario 3 – high
Demand	Central forecast	Low forecast	High forecast
VCR	$52.024/kWh across all scenarios		
Discount Rate	3.54% across all scenarios		

Ausgrid has weighted each of the demand scenarios equally in the NPV assessment.

Option 5 is the preferred option at this final stage of the RIT-D

Ausgrid considers that Option 5 is the preferred option that satisfies the RIT-D as it is found to have the greatest expected net market benefits of all options. Option 5 is also the lowest cost of all four credible options assessed in this FPAR. The table in next page summarises the estimated net market benefits for each of the four options assessed.

Table E.3 – Estimated net market benefits by scenario and weighted, $2023/24m

Option / scenario	Central demand	High demand	Low demand	Weighted	Rank
Scenario weighting	1/3	1/3	1/3		
Option 4	1,313.9	1,689.1	78.2	1,027.1	3
Option 5	**1,329.5**	**1,704.8**	**93.8**	**1,042.7**	**1**
Option 6	1,309.7	1,684.9	74.0	1,022.9	4
Option 7	1,315.0	1,690.3	79.3	1,028.2	2

Option 5 involves a new STS at site 2, connected to feeders 92G and 92J. Specifically, the scope includes the:

- Acquisition of property at site 2;
- Construction of the new Wallumatta 132/33kV STS, comprising 3 transformer units and 28 indoor circuit breakers; and
- Installation of two 132kV feeder connections to tee off from East Ryde Transition Point to Wallumatta STS.

Ausgrid assumes that construction would commence as soon as practicable after this RIT-D, and the subsequent contingent project application being approved by the AER, and end in 2028/29, when customers are expected to connect.

'Re-opening triggers' for this RIT-D

Under the updated Rules relating to a Material Change in Circumstance (MCC), Ausgrid is required to set out in the DPAR (for consultation) and the FPAR (for confirmation) re-opening triggers for this RIT-D. No submissions were received on the proposed re-opening triggers.

We consider that there is only one RIT-D re-opener trigger associated with less load requesting to connect. In particular:

- If two large customers are connected (instead of four), Ausgrid would build Wallumatta STS with a reduced network arrangement initially, noting this would marginally reduce the expected capital costs overall (in the order of 3.5%).

Should this occur, Ausgrid would prepare a letter to the AER confirming it would reduce the initial number of transformers and 33kV switchgroups from three to two and that Option 5 remains the preferred option (consistent with this RIT-D). A new RIT-D would not be initiated (as it would require significant time to complete and jeopardise our ability to timely connect the large customers). Instead, Ausgrid would refer back to this RIT-D to confirm the solution.

We do not consider there are any further RIT-D re-opener triggers related to more or less load requests. In particular:

- If three large customers are connected (instead of four), we would build Wallumatta STS with no scope changes.
- If only one customer is connected, no shared network asset is required. The customer will pay the entire connection.
- If no customer is connected, Option 5 would not be preferred and therefore the investment would not proceed.
- Any demand over 345MVA will trigger investment outside of this RIT-D and thus a separate RIT-D to be undertaken.

In addition, based on this FPAR sensitivity assessment, we do not consider the following will constitute re-opening triggers for this RIT-D either:

- Real cost increases compared to those used in the RIT-D analysis;
- The assumed difference in property acquisition costs between site 1 and site 2;
- Variations to the AER estimated VCR; or
- Credible changes to the commercial discount rate.

Specifically, the finding that Option 5 is the preferred option is not found to be sensitive to changes in these variables.

Next steps

Ausgrid intends to submit a contingent project application for the preferred option as soon as practicable after this RIT-D.

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

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 address the expected capacity constraint in the Macquarie Park supply area of Ausgrid's network in the near future. It follows publication of the Options Screening Notice for this RIT-D and the Draft Project Assessment Report (DPAR).

Macquarie Park is a suburb in Northern Sydney known for being a sizeable business hub. In particular, the suburb is well connected to telecommunications, electrical and transport infrastructure, making it an attractive location for major loads.

Ausgrid has received a lot of interest from new major load customers in the Macquarie Park area in recent years and has subsequently expanded the capacity of the distribution network to accommodate these loads. Specifically:

- In 2018, we undertook a RIT-D to address the connection of several new major loads, which found that a new 132/33kV Macquarie subtransmission substation (STS) was the preferred option in light of the expected demand at that time – the new STS was commissioned in July 2021, with customers connected the following years.
- In early 2023, we completed a subsequent RIT-D to accommodate connection requests of two additional major customer loads in the Macquarie Park area, which concluded that the preferred option was to install a third 120 MVA transformer at the Macquarie STS, to be commissioned by December 2025.

Once the third transformer is installed at the existing Macquarie STS, there will be five major customer loads connected to that STS using all available connection bays at that STS. Physical site restrictions mean that new loads cannot be accommodated at the existing STS. This was noted in the 2023 RIT-D, which stated that further network investment (covered by a separate RIT-D process) would be required to accommodate any additional major loads in the area.[3]

We have received a further four connection applications from major customers seeking to connect in the Macquarie Park area and have commenced this RIT-D to investigate the options for facilitating these connections. Each of these four applications request connection from December 2028 and that the connection is provided at 33kV.

As outlined in this FPAR, we expect that the construction of a second STS in Macquarie Park is required to accommodate these customers. We have labelled this second STS in Macquarie Park the 'Wallumatta STS', in recognition of the original name given to the area and acknowledging its indigenous history.

Ausgrid has been aware of the potential need for the Wallumatta STS since these customers submitted formal connection enquires in 2023. Given that these customers indicated that they would require supply during the 2024-29 regulatory period, Ausgrid included a business case for the Wallumatta STS[4] and identified it as a contingent project in its revised 2024-29 regulatory application. After engaging with Ausgrid to seek additional information about its options analysis, the AER approved this as a contingent project as part of its determination on our revised regulatory proposal in April 2024, with an estimated capex of $128 million (real FY24).[5]

The AER being satisfied that Ausgrid has satisfactorily completed a RIT-D to determine the preferred option for connecting additional major customer loads in this area is a key trigger event for the contingent project (op. cit., pp 50). The other trigger events are (op. cit., pp 50-51):

- Ausgrid receiving a connection application for a major load that requests supply at 33kV or higher voltage from the existing Macquarie STS – we consider that this has now been met as we have received a formal connection application from each of the four major customers; and
- Ausgrid making a commitment to proceed with the preferred credible option from the RIT-D, subject to the AER amending Ausgrid's 2024-29 regulatory determination pursuant to the National Electricity Rules (NER) (and to provide objective verification of this trigger, a letter from the Chief Executive Officer of Ausgrid is to be sent to the AER to confirm such commitment) – this trigger event is expected to occur following completion of this RIT-D.

Once all trigger events are met, Ausgrid will submit a formal contingent project application to the AER.

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[3] Ausgrid, *Addressing increased customer demand in the Macquarie Park area*, FPAR, March 2023, p. 3.

[4] Ausgrid, *Ausgrid's 2024-29 Revised Proposal Attachment 5.6: New Wallumatta STS Business Case*, 30 November 2023.

[5] AER, *Ausgrid electricity distribution determination 2024 to 2029 (1 July 2024 to 30 June 2029)*, Final decision, Attachment 5, Capital expenditure, April 2024, pp 47.

As the new major customers are expected to utilise a significant portion of the new STS installed capacity, specific tariff arrangements will be established to recover the majority of the cost of the augmentation from the beneficiaries (i.e., the new major customers), taking into account their share in the capacity of the new STS.

1.1 Role of this final report

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

The purpose of the FPAR is to:

- Describe the need Ausgrid is seeking to address, including the assumptions used in identifying this need;
- Provide a description of each credible option assessed;
- Quantify relevant costs and market benefits for each credible option;
- Describe the methodologies used in quantifying each class of cost and market benefit;
- Explain why Ausgrid determined that some classes of market benefits or costs do not apply to options considered;
- Present the results of a net present value (NPV) analysis of each credible option and explain these results; and
- Identify the preferred option.

This FPAR has updated the quantitative assessment of the net benefit associated with the investment options, to consider updated information on property values for the two sites considered in the DPAR, and to include a contingency value, for which a cost allowance will be sought in the contingent project application for the preferred option identified in this RIT-D.

1.2 No submissions were received on the DPAR

A Draft Project Assessment Report (DPAR) for this RIT-D was published on 16 August 2024. The DPAR presented four credible options for addressing these customer demand requirements, assessed in accordance with the RIT-D framework and concluded that the preferred option was the construction of a second STS in Macquarie Park at a site located in relative proximity to these major customers. We have labelled this second STS in Macquarie Park the ‘Wallumatta STS’, in recognition of the original name given to the area and acknowledging its indigenous history.

The DPAR summarised Ausgrid’s assessment of the non-network or stand-alone power system (SAPS) solutions to assist in meeting the identified need, reporting that such solutions were not viable for this RIT-D. The DPAR was accompanied by a separate 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 27 September 2024. No submissions were received on either the DPAR or the separate 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:

Mark Ragusa
Head of Asset Management and Planning
Ausgrid
GPO Box 4009
Sydney 2001

Or

email to: assetinvestment@ausgrid.com.au

2 Description of the identified need

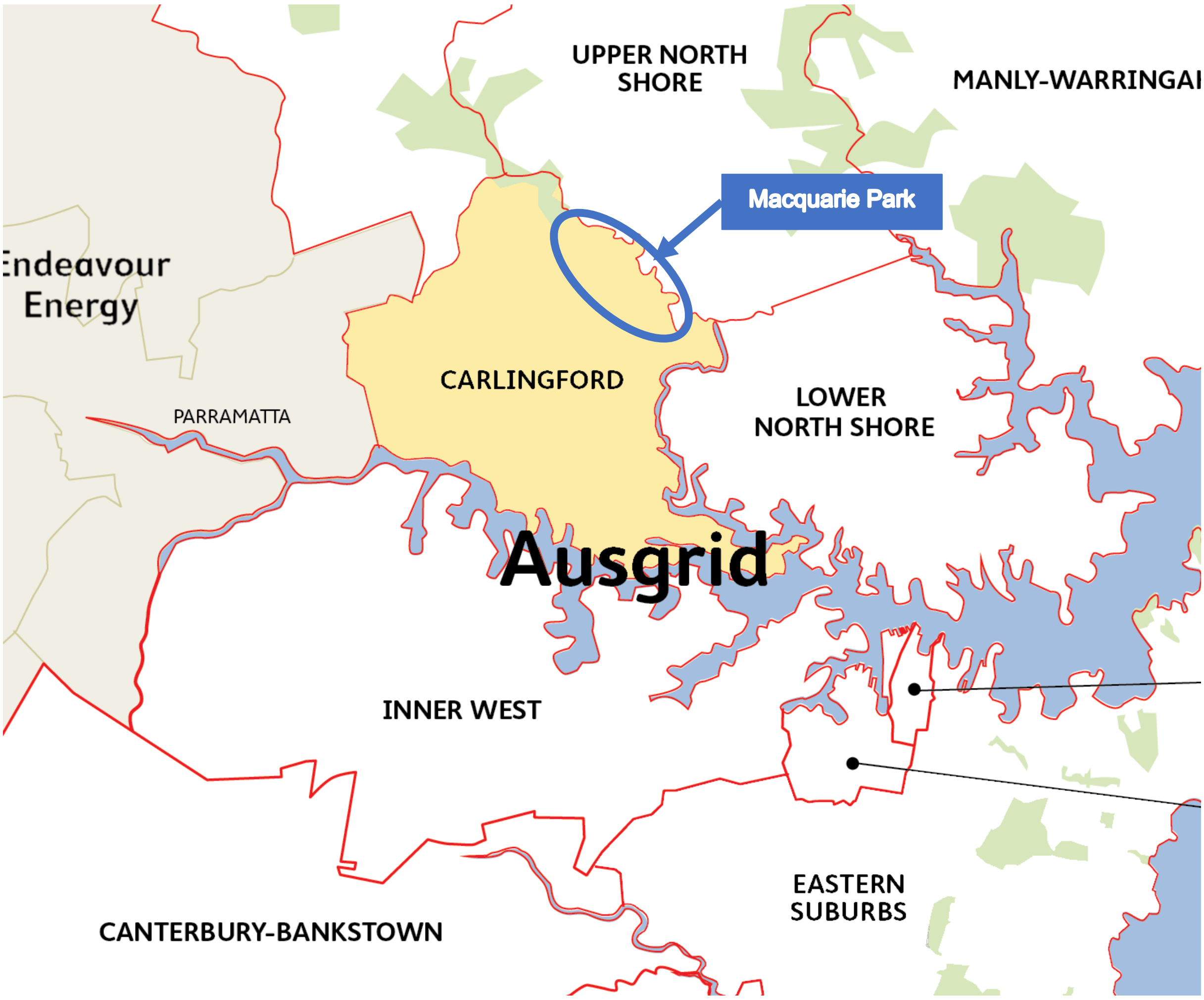
This section provides a description of the network area and the 'identified need' for this RIT-D, before presenting the key assumptions underlying the identified need.

2.1 Overview of the existing supply arrangements for the Macquarie Park area

Macquarie Park is a major commercial and retail district in Sydney's northern suburbs and supplies major loads at the Macquarie shopping centre, Macquarie University, telecommunication and data centre facilities, as well as high-density residential developments.

The Macquarie Park area sits along the northern boundary of the wider Carlingford area of Ausgrid's network, as shown in figure 1 below.

Figure 1. Overview of the Carlingford network area



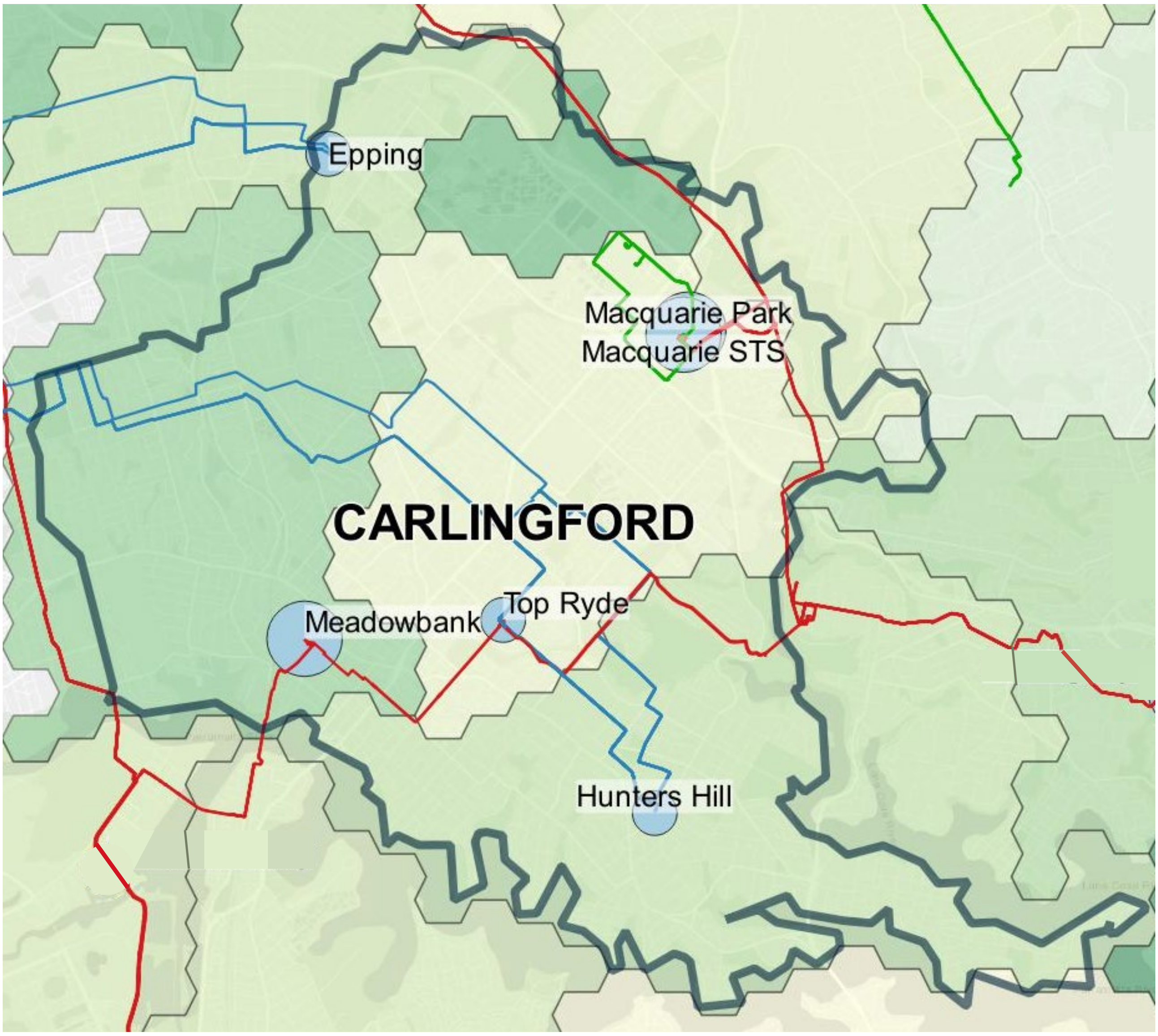
The Carlingford area is supplied at 132kV from Transgrid's Sydney North Bulk Supply Point (BSP), Mason Park and Lane Cove Subtransmission Switching Stations (STSS), as well as at 66kV from Endeavour Energy's Carlingford STS.

The proximity to Transgrid's 330kV network and the availability of multiple 132kV supplies offer potential for expansion in the Carlingford network area. Ausgrid's intention is to maintain primary supply at 132kV (from Transgrid) and 66kV (from Endeavour), supply zone substations and large customer loads from a mixed 132kV/66kV subtransmission network and supply commercial and residential loads from the 11kV network.

The Macquarie Park area has become a precinct for data centres and has also been selected by the NSW Department of Planning, Housing and Infrastructure (DPHI) to accommodate new residential dwellings and commercial floorspace, which will increase demand on the 11kV distribution network.

Figure 2 below shows a diagram of the Ausgrid's subtransmission network infrastructure in the Carlingford network area, using red lines to represent 132kV connections, blue lines to represent 66kV connections, and circles to represent both subtransmission and zone substations.

Figure 2. Overview of the subtransmission network supplying the Carlingford area



The Macquarie Park area has developed into a significant hub in Sydney for large customers with major loads due to the proximity of telecommunications (i.e. major optical fibre trunk connections), electricity and transportation infrastructure.

In the last two years, Ausgrid has connected three large customers and is in the process of connecting a further two (both of which are due to be connected by December 2025). The network was significantly augmented to accommodate the connection of these five major loads – specifically:

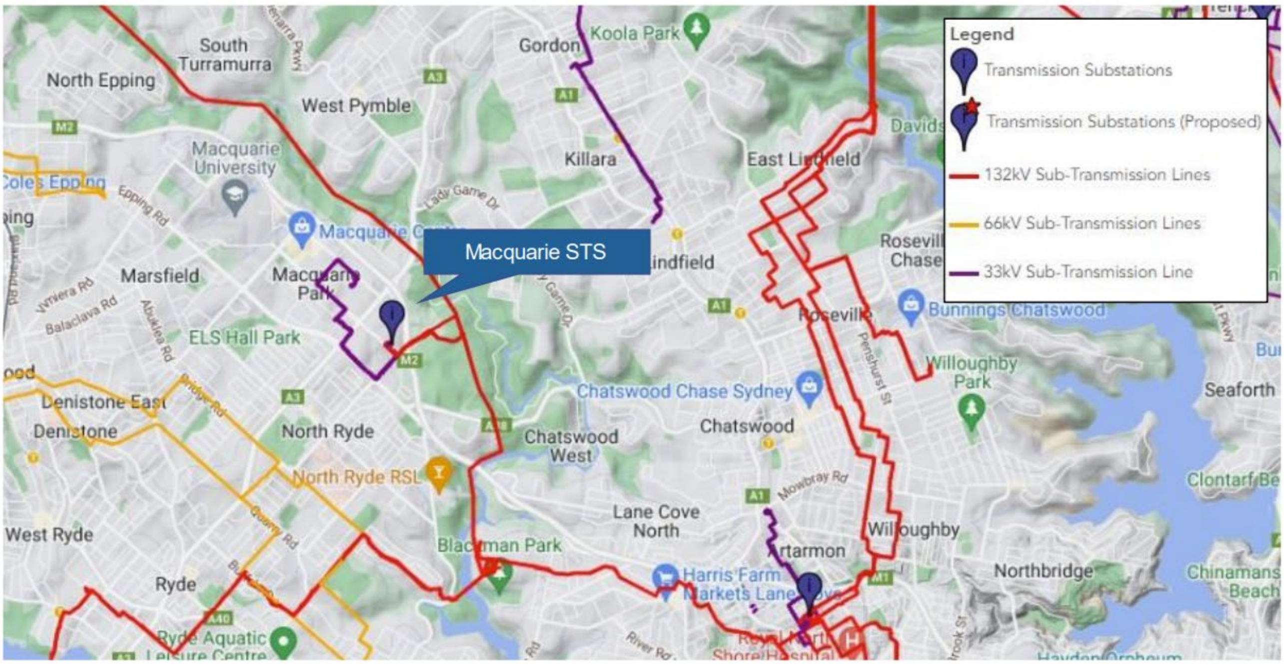
- During the second half of 2018, we undertook a RIT-D to address connection of these new loads in the area, which found that a new 132/33kV Macquarie STS was the preferred option in light of the expected demand at that point in time; and
- In early 2023, we completed a subsequent RIT-D to accommodate the connection requests of two additional major customer loads in the Macquarie Park area, which concluded that the preferred option was to install a third 120 MVA 132/33kV transformer at the Macquarie 132/33kV STS.

The Macquarie STS was subsequently built and commissioned in July 2021, and the three initial major customers were connected between June 2022 and April 2023. The third transformer is on track to be commissioned by December 2025, with the two additional major customers expected to be connected around the same time.

The existing Macquarie STS is supplied via 132kV feeders teed off from Ausgrid's 132kV feeders 92A and 92B between the Sydney North BSP and the Lane Cove STSS. It is co-located within the same site as the existing Macquarie 132/11kV Zone Substation (ZS), in Waterloo Rd, Macquarie Park.

Figure 3 illustrates where the existing Macquarie 132/33kV STS sits in the wider Carlingford network area.

Figure 3 Location of Macquarie STS within the Carlingford network area



Once the third transformer is installed at the existing Macquarie STS, there will be five major customer loads connected to that STS and these loads will use up all available connection bays at that site. Physical site restrictions mean that additional bays, and thus new major loads, cannot be accommodated at the existing STS and so any new loads would need to be accommodated using other means. This was recognised in the 2023 RIT-D, which stated that further network investment (covered by a separate RIT-D process) would be required to accommodate any additional major loads in the Macquarie Park area due to the site limitations regarding adding any further transformers at the Macquarie STS.[6]

We have since received a further four connection applications from major customers seeking to connect in the Macquarie Park area. Each of these four applications are seeking connection from December 2028 at 33kV, since 132kV (or 66kV) supply points would require the developers to allocate space on their property for cables and equipment, and because their current design models are based on 33kV input supply modules.

The names and individual loads of the most recent customers requesting connection have been redacted for confidentiality reasons. However, they have a total expected eventual load of 345MVA with secured "N-1" supply requirements. Further, there is an overlap between some of the customers seeking new connections and the customers that triggered the installation of the Macquarie STS, and so there is evidence and history regarding commitment to connecting shown by these customers.

There is also additional connection interest from major customers other than those who have already made formal connection applications. These companies have plans to expand their footprint in the Macquarie Park vicinity and the broader Sydney region. So far Ausgrid has received one formal connection enquiry and expects to receive more in the near term.

Considering the scale of the forecast load, Ausgrid considers that establishing a new 33kV supply at Macquarie Park is the most efficient way to meet customer requirements.

[6] Ausgrid, *Addressing increased customer demand in the Macquarie Park area*, FPAR, March 2023, p. 3.

2.2 Summary of the 'identified need'

This RIT-D has been initiated to investigate, and consult on, how to most efficiently facilitate the connection of new major loads in the Macquarie Park area. Importantly, no construction will commence until a property is secured and material components of connection agreement contracts have been executed.

If action is not taken, Ausgrid will fail to meet the requirements to connect customers under section 5.2.3(d) of the NER, which include the requirements that a Network Service Provider must:

> (1) Review and process applications to connect or modify a connection which are submitted to it and must enter into a connection agreement…
> (…)
> (6) Permit and participate in commissioning of facilities and equipment which are to be connected to its network in accordance with rule 5.8;"

We therefore consider the identified need for this investment to be a 'reliability corrective action' under the RIT-D since investment is required to comply with the above NER obligations.

The identified need creates an opportunity to provide a scale-efficient and cost-effective investment in shared network assets to benefit multiple customers.

While any new network augmentation will become part of Ausgrid's Regulatory Asset Base, site-specific network tariff arrangements will be established to recover the majority of the cost of the augmentation from the beneficiaries (i.e. the new customers), taking into account their share of the capacity of the new STS. These charges will include the underlying transmission prices as the proposed project assets are classified as dual function under the NER. The dual function costs apportioned to each customer will be based on the amount of network capacity required from the nearest transmission node supplying the site.

The timing of the identified need, and so the required timing for credible options to address the need, is determined by when the loads are requesting connection (as there is no ability to accommodate new loads at the existing Macquarie STS due to all bays being utilised). This is currently anticipated to be December 2028 for all four loads.

2.3 Key assumptions underpinning the identified need

The key driver for this RIT-D is the requested connection of load in the Macquarie Park area. If action is not taken, these loads will not be able to connect.

To demonstrate the need, the base case is established as the 'do nothing' case. The 'do nothing' case for connection of major loads in the Macquarie Park area is limited to supply from Macquarie Park STS. As outlined in section 2.1, the 'do nothing' case has identified a number of constraints to utilisation of Macquarie Park STS for connection of major load in the Macquarie Park area:

- Physical site restrictions prohibit further 33kV connection points via brownfield augmentation at Macquarie Park STS.
- Physical site restrictions also prohibit further 132/33kV transformers to be added at Macquarie Park STS to increase substation capacity.

Without the ability to increase substation capacity at Macquarie Park STS, the connection of major load in the Macquarie Park area will cause utilisation at Macquarie Park STS to exceed substation firm capacity (N-1) and eventually substation total capacity (N).

We have investigated how assuming different load forecasts going forward changes the expected net market benefits under the proposed options. In particular, we have investigated three future load forecasts – namely a central forecast that represents the load growth expected from the proposed loads, as well as a lower than-expected load forecast and a higher-than-expected forecast for these customers (reflecting different ramp up rates and ultimate load at full utilisation).

In particular, the three future load forecasts that have been investigated are:

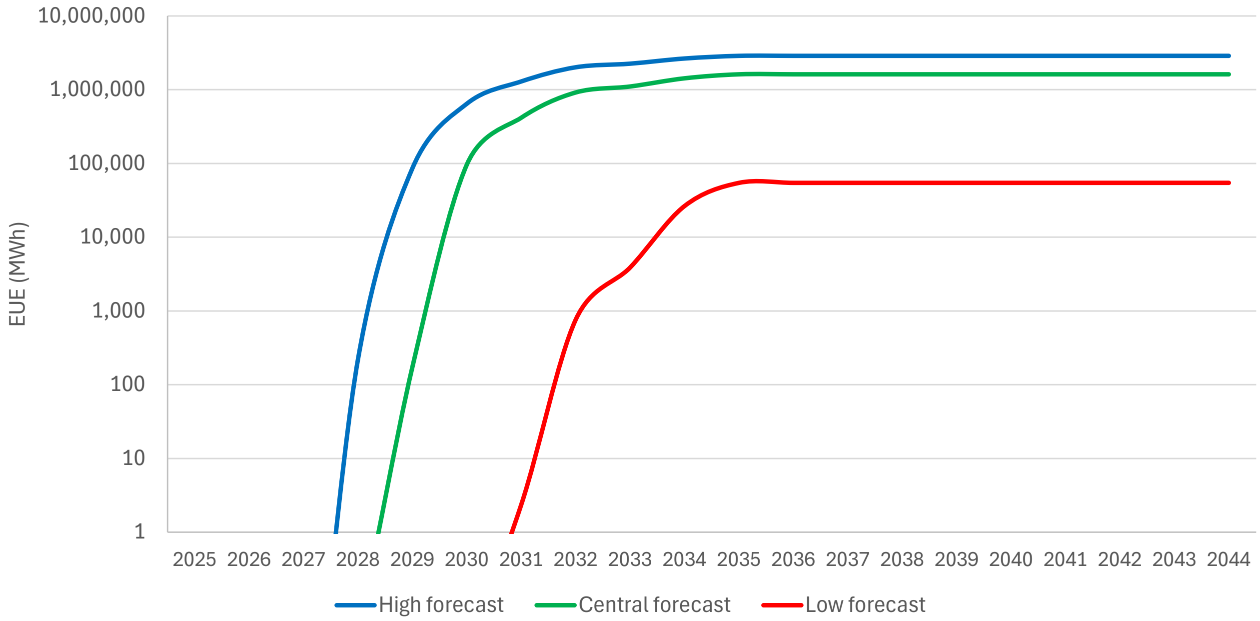
- A central forecast assuming 85% scaled load from the proposed major loads;
- A low demand forecast assuming 60% scaled load from the proposed major loads; and
- A high forecast assuming 100% scaled load from the proposed major loads.

The major loads have been scaled across the forecasts to account for uncertainty over the ramp up rate of customer demand in the future (i.e., the timing for these major loads to reach the total load requirements, as well as the size of their ultimate load). These percentages are reflective of ramp up rates experienced in recent years by similar customers in the network.

Figure 4 below shows the modelled levels of expected unserved energy (EUE), under each of the three underlying demand forecasts investigated, over the next twenty years. For clarity, this figure illustrates the MWh of EUE assumed under each load forecast if no credible option is commissioned (i.e. under the 'do nothing' base case for that load forecast).

Appendix D provides additional detail on the assumptions underpinning the identified need (i.e. the assumed load duration curve and how the probability of transformer failure has been modelled).

Figure 4 – Forecast EUE under each of the three demand forecasts (uncapped values)



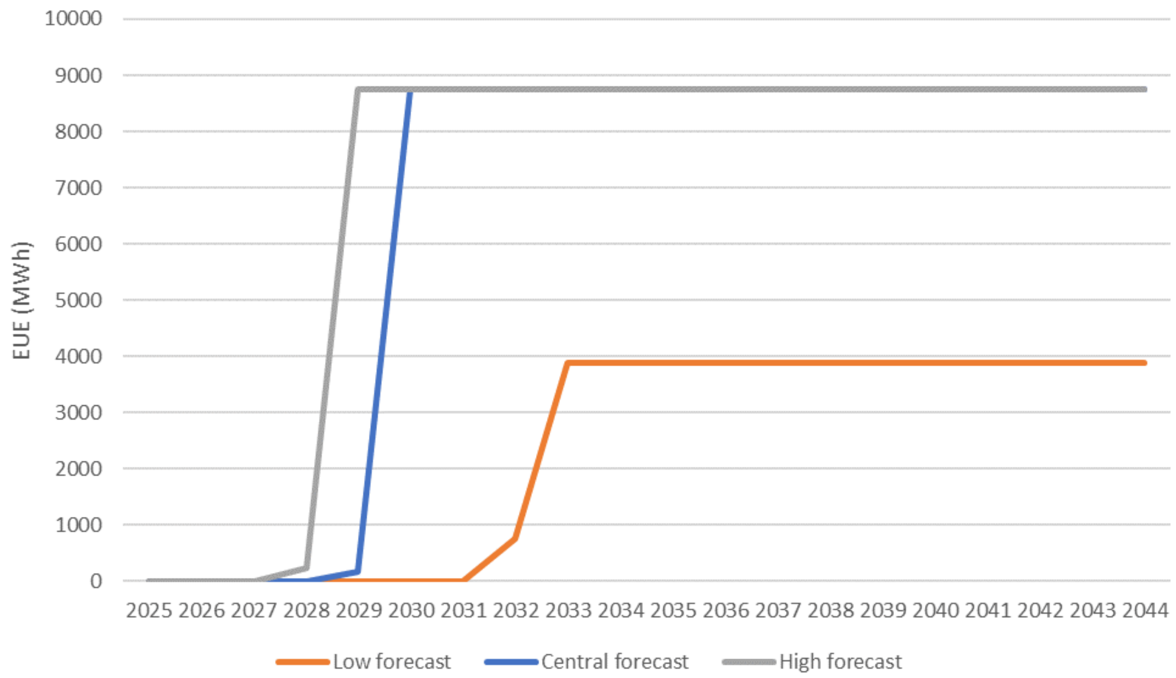
We have capped the level of EUE under all three demand forecasts in the NPV assessment. This cap is not reflected in the figure above (which shows the full EUE forecasts). Since the base case reflects a 'do nothing' approach with rapidly escalating EUE, we consider it appropriate to cap the level of EUE to avoid a situation where a significant increase in EUE skews the results (and we note that this approach does not affect the identification of the preferred option as all options avoid EUE equally)[7]. If uncapped, the EUE will increase exponentially because every MW of load will be unserved if corrective action is not taken.

The EUE under the three load forecasts above is shown to differ in terms of when it first appears (i.e. 2028 under the high forecast, 2029 for the central forecast and 2031 for the low forecast). This reflects the 'proportionate' approach we have taken to estimate EUE. While EUE will occur as soon as customers are requesting to connect in December 2028, we have modelled EUE using a top-down approach to consider the capacity in this area of our network (which factors in the small amount of capacity available at the existing Macquarie STS that cannot be accessed due to there being no free bays). We have not developed more refined EUE estimates (which would remove the assumed ability of the Macquarie STS to assist) given avoided EUE does not change the outcome of this RIT-D, as all options can avoid it equally.

Figure 5 on the next page shows the capped levels of EUE for each of the three scenarios investigated. The cap is activated by the time EUE values reach the equivalent of 1MW of load unserved for a year.

[7] Ausgrid notes that this approach was commented on and supported by Dr Darryl Biggar in his review of the modelling undertaken for the Powering Sydney's Future RIT-T. See: Biggar, D., *An Assessment of the Modelling Conducted 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

Figure 5 – Forecast EUE under each of the three demand forecasts (capped values)



3 Four credible options have been assessed

This section provides details of the four credible options that Ausgrid has identified as part of its network planning activities. Each credible option has been developed following an assessment of the various potential dimensions for supply arrangements to connect the loads, including connection to the upstream network, substation configuration and physical location.

For continuity with the business case for this project submitted as part of our regulatory determination process for the current period, we have continued with the option numbering in this RIT-D, i.e., the four credible options assessed in this FPAR are 'Option 4' (which was included in the business case) through to 'Option 7' (noting that Options 5-7 were not included in the business case and have been developed as part of this RIT-D).

Fundamentally, the four credible options assessed differ by:

- Substation arrangement – Option 4 and Option 5 involve a new 132/33kV STS, while Option 6 and Option 7 also involve a new 132/33kV STS with an expanded 132kV busbar to facilitate possible future 132kV connections; and
- Location of the STS – Option 4 and Option 6 assume the same site, while Option 5 and Option 7 assume another site.

The specific locations of the sites have been redacted to not affect the subsequent procurement process and, instead, we only refer to 'site 1' (for Option 4 and Option 6) and 'site 2' (for Option 5 and Option 7). Both sites are in close proximity to where the customers are proposing to locate. Updated valuation assessments have been received for these two sites after the DPAR was published, and therefore such updates have been included in the cost of the options presented in this FPAR.

In addition, a contingency has been estimated and included in the capital costs of the four credible options following a risk assessment. The reasons and basis for this contingency allowance are outlined in section 3.5 below.

As stated in the DPAR, three of the four options presented in the contingent project business case submitted as part of our current regulatory determination process are no longer considered credible, primarily in light of a fundamental change in the value of the land required since the business case was submitted due to recent rezoning by the NSW Government. These options are discussed below as 'options considered but not progressed', along with all other options Ausgrid has considered to-date.

All options have an approximate 4.5 year construction time and Ausgrid assumes that the necessary construction would commence as soon as practicable after this RIT-D (and the subsequent contingent project application being approved by the AER). All credible options are expected to be commissioned in 2028/29.

All costs and benefits presented in this FPAR are in $2023/24, unless otherwise stated.

3.1 Option 4 – New 132/33kV STS at 'site 1' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J

Option 4 involves a new 132/33kV STS at site 1, connected via East Ryde Transition Point to feeders 92G and 92J. Option 4 was included in the contingent project business case as part of our current regulatory determination process.

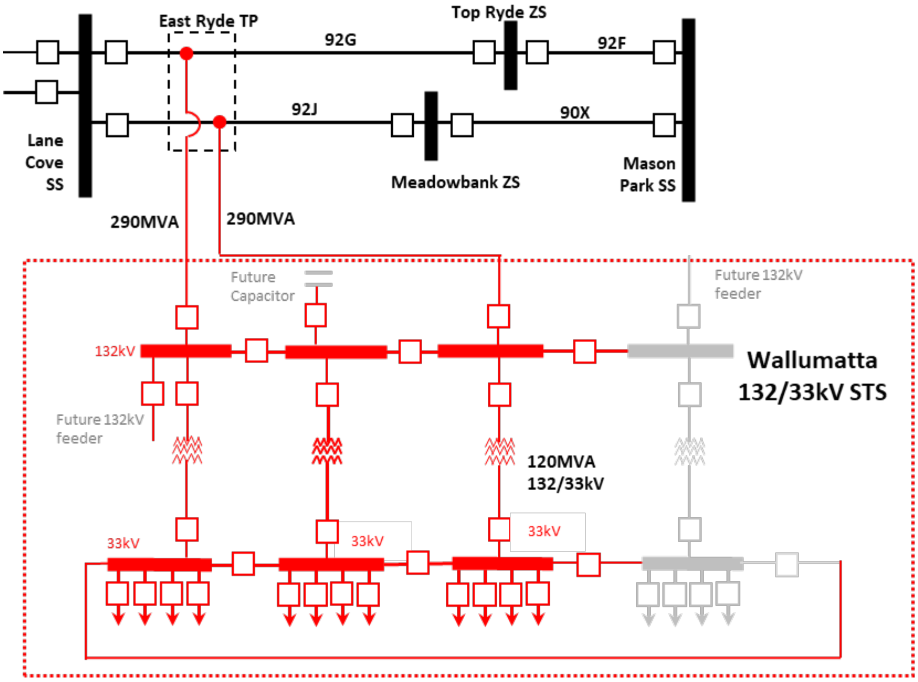
Specifically, the scope of this option includes the:

- Acquisition of property at site 1;
- Construction of the new Wallumatta 132/33kV STS, comprising:
  - 3 transformer units;
  - A new switchroom building; and
  - 28 indoor circuit breakers.
- Installation of two 132kV feeder connections to tee off from East Ryde Transition Point to Wallumatta STS, comprising:
  - Two pole structures to connect to East Ryde Transition Point;
  - The construction of ductline from the transition point to the substation site;
  - Construction of bore under major roads;
  - The installation of cables between East Ryde Transition Point and the substation site;
  - The installation of joint bays; and
  - Termination cable works at substation cable basement.

This option involves installation of long underground 132kV connections to tee off feeders 92G and 92J.

A schematic diagram of this option is presented in Figure 6 below, with the specific network elements shown in red.

Figure 6. Option 4 proposed network arrangement



The estimated network augmentation capital cost of this option is approximately $179 million. Table 4 shows the breakdown of the estimated capital costs for this option.

Table 4 – Breakdown of Option 4's expected network augmentation capital cost, $m

Component	Labour	Materials	Contracted Services	Contingency allowance	Total
Install a new 132/33kV STS (Wallumatta STS) with 3x120MVA transformers, 10x132kV and 18x33kV circuit breakers on site 1 + 132kV connections to tee off from Feeder 92G & 92J	**15.1**	**64.8**	**79.9**	**18.9**	**178.6**

The new Wallumatta 132/33kV STS will be constructed initially with three 120MVA 132/33kV transformer units, but capable to accommodate a future fourth transformer. The proposed configuration will be able to provide indoor 12x33kV feeder bays to connect large customers and will be able to expand to accommodate a fourth 33kV switchgroup.

The new STS will require 132kV supply connections by installing underground cables. Two circuits will be installed in a shared trench, connected to transmission feeders 92G & 92J, which link Lane Cove STSS to Mason Park STSS. The connection point will be the East Ryde Transition Point, which is closed to the Lane Cove River and Pittwater Road. From this point, the proposal is to construct approximately 6.4km of dual circuit 132kV ductline to reach the new Wallumatta STS site and install high-capacity cables using cross-linked polyethylene (XLPE) as insulation material.

Additional routine network operating costs under this option are expected to be around $138,000 per year (which is estimated at 0.2% of the new STS capital cost and 0.1% of the new cable capital costs, excluding land and contingency).

In addition, this option is estimated to involve an additional $28 million in contestable customer connection costs. The primary driver of this cost is the assumed distance between each customer location and the new STS (site 1 is approximately triple the assumed distance of site 2). The operating costs associated with the contestable customer connection costs are expected to be around $28,000 per year (which is estimated at 0.1% of the capex cost).

While we do not currently envisage that any of the options will need to be expanded beyond their initial capacity in the near future, all options offer this ability if required. Specifically, a fourth transformer can be accommodated under this option (as shown in grey in the schematic diagram above).

The total capital expenditure, including both network augmentation and customer connection costs, is $207 million.

3.2 Option 5 – New 132/33kV STS at 'site 2' tee connected at East Ryde Transition Point to 132kV Feeders 92G & 92J

Option 5 involves a new 132/33kV STS at site 2, connected via East Ryde Transition Point to feeders 92G and 92J.

The scope of this option involves the same components as Option 4 except that the assumed property acquired is at site 2 (as opposed to site 1). The proposed Wallumatta STS and network connection arrangement is therefore the same as that shown above for Option 4 and so a schematic diagram of this proposed option has not been re-presented here.

The only difference is that Option 5 requires slightly longer 132kV cable connections (i.e., 7.1km of dual circuit 132kV ductline). This is compensated by lower property acquisition costs of site 2[8] compared to the estimated value of site 1, which has been impacted by the proposal rezoning of the area and now is suitable for residential high-rise developments.

The estimated network augmentation capital cost of this option is approximately $162 million. Table 5 below shows the breakdown of the estimated capital costs for this option.

Table 5 – Breakdown of Option 5's expected network augmentation capital cost, $m

Component	Labour	Materials	Contracted Services	Contingency allowance	Total
Install a new 132/33kV STS (Wallumatta STS) with 3x120MVA transformers, 10x132kV and 18x33kV circuit breakers on site 2 + 132kV connections to tee off from Feeder 92G & 92J	**15.2**	**44.4**	**83.8**	**18.9**	**162.3**

Additional routine network operating costs under this option are expected to be around $143,000 per year (which is estimated at 0.2% of the new STS capital cost and 0.1% of the new cable capital costs, excluding land and contingency).

In addition, this option is estimated to involve an additional $12 million in contestable customer connection costs. The primary driver of this cost is the assumed distance between each customer location and the new STS. The operating costs associated with the contestable customer connection costs are expected to be around $12,000 per year (which is estimated at 0.1% of the capex cost).

Option 5 provides the same ability as Option 4 to expand in the future (if required) via a fourth transformer, noting that such expansion is not anticipated in the near future.

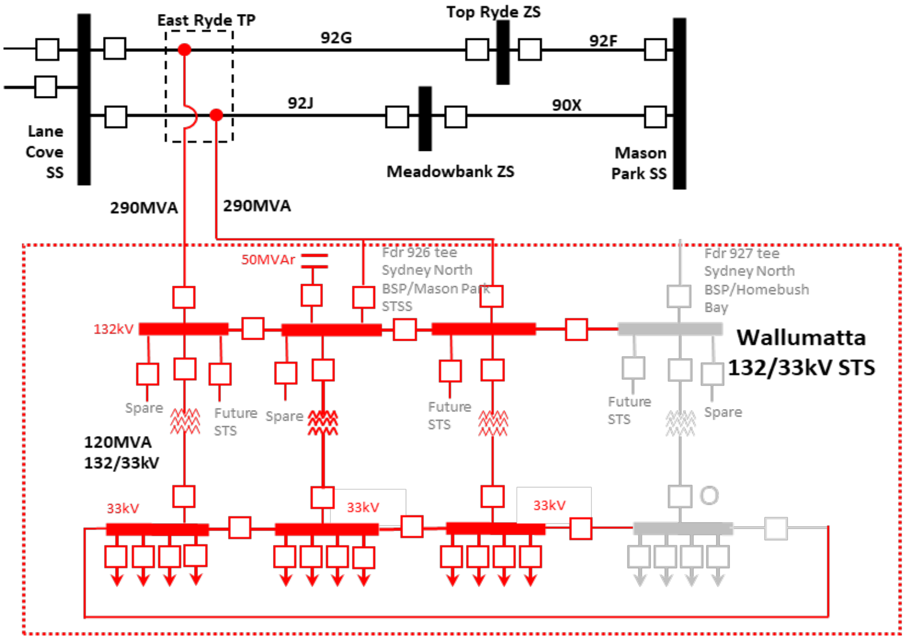
The total capital expenditure, including both network augmentation and customer connection costs, is $175 million.

[8] Consideration has been given in this analysis to repurpose part of the land available in Site 2, as it is anticipated that the new Wallumatta STS will use a portion of the site area.

3.3 Option 6 – New STS with expanded 132kV busbar at ‘site 1’ tee connected to 132kV Feeders 92G & 92J

Option 6 involves a new STS with an expanded 132kV busbar at site 1, connected via East Ryde Transition Point using tee connections to feeders 92G and 92J. This option is like Option 4, except that 32 circuit breakers are required at the STS (as opposed to 28 under Option 4). Figure 7 shows a diagram of this option, with network elements shown in red.

Figure 7. Option 6 proposed network arrangement



The estimated network augmentation capital cost of this option is approximately $186 million. Table 6 below shows the breakdown of the estimated capital costs for this option.

Table 6 – Breakdown of Option 6’s expected network augmentation capital cost, $m

Component	Labour	Materials	Contracted Services	Contingency allowance	Total
Install a new 132/33kV STS (Wallumatta STS) with 3x120MVA transformers, 14x132kV and 18x33kV circuit breakers on site 1 + 132kV connections to tee off from Feeder 92G & 92J	**15.7**	**65.6**	**85.9**	**18.9**	**186.1**

The new Wallumatta 132/33kV STS will be constructed initially with three 120MVA 132/33kV transformer units, but capable to accommodate a future fourth transformer. The proposed configuration will be able to provide 4x132kV feeder bays and 12x33kV feeder bays to connect large customers or additional substations and will be able to expand to accommodate two additional 132kV feeder bays and a fourth 33kV switchgroup.

Additional routine network operating costs under this option are expected to be around $146,000 per year (which is estimated at 0.2% of the new STS capital cost and 0.1% of the new cable capital costs, excluding land and contingency).

In addition, this option is estimated to involve an additional $28 million in contestable customer connection costs. This cost is the same as the one reported for Option 4 above. The operating costs associated with the contestable customer connection costs are expected to be around $28,000 per year (which is estimated at 0.1% of the capex cost).

While Option 6 provides the same ability as Option 4 and Option 5 to expand in the future via a fourth transformer (if required), as shown in grey in the schematic diagram above, the cost of doing so under this option is expected to be marginally greater than for Option 4 and Option 5. While the majority of the costs of this expansion are expected to be the same irrespective of the option (due to common design, labour, procurement and installation costs), Option 6 (and Option 7) involve additional bay work to expand and thus have slightly greater expected costs for future expansion – although, only in the order of approximately $1 million.

The total capital expenditure, including both network augmentation and customer connection costs, is $214 million.

3.4 Option 7 – New STS with expanded 132kV busbar at 'site 2' tee connected to 132kV Feeders 92G & 92J

Option 7 involves a new STS with an expanded 132kV busbar at site 2, connected via East Ryde Transition Point using tee connections to feeders 92G and 92J. The scope of this option involves the same components as Option 6 except that the assumed property acquired is at site 2 (as opposed to site 1). The network connection arrangement is therefore the same as that shown above for Option 6.

The estimated network augmentation capital cost of this option is approximately $170 million. Table 7 below shows the breakdown of the estimated capital costs for this option.

Table 7 – Breakdown of Option 7's expected network augmentation capital cost, $m

Component	Labour	Materials	Contracted Services	Contingency allowance	Total
Install a new 132/33kV STS (Wallumatta STS) with 3x120MVA transformers, 14x132kV and 18x33kV circuit breakers on site 2 + 132kV connections to tee off from Feeder 92G & 92J	**15.8**	**45.3**	**89.8**	**18.9**	**169.8**

Additional routine network operating costs under this option are expected to be around $150,000 per year (which is estimated at 0.2% of the new STS capital cost and 0.1% of the new cable capital costs, excluding land and contingency).

In addition, this option is estimated to involve an additional $12 million in contestable customer connection costs. The primary driver of this cost is the assumed distance between each customer location and the new STS. The associated routine operating costs are expected to be around $12,000 per year (which is estimated at 0.1% of the capex cost).

Option 7 provides the same ability (and cost) as Option 6 to expand in the future (if required) via a fourth transformer.

The total capital expenditure, including both network augmentation and customer connection costs, is $182 million.

3.5 Inclusion of a Contingency Allowance

A number of risks have been identified, for which a risk cost allowance will be sought. Considering that all credible options require acquisition of land, installation of long-distance underground cables and construction of a new substation, it is assumed that identified risks and potential cost impacts should be similar across these network options.

A cost risk analysis was performed which involved multiplying the probability of an event occurring by the likely cost impact once an event occurs. The probability of an event or risk to occur is determined from the likelihood range established during risk workshops undertaken with subject matter experts. The cost impact may vary from an optimistic case (P10)[9], a likely outcome (P50)[10] to a pessimistic case (P90)[11] for each of the identified risks.

The identified risks, based on consultation with subject matter experts, are summarised and listed below (along with our estimated contingency allowance for each).

Table 8 – Summary of identified risks and corresponding cost allowances

Component	Cost rationale	Cost range (P10 to P90) ($ million)	Likely cost (P50) ($ million)	Probability	Contingency allowance ($ million)
Uncertain property costs due to failing to secure land at budgeted price	Property acquisition costs are highly variable and will most likely be determined on a negotiated basis.	**4.0 - 20.0**	**12.0**	**50%**	**6.0**
Uncertainty of site impact due to tenants with existing leases	Need to compensate tenants by paying out existing leases to enable timely initiation of works on site.	**1.5 - 5.0**	**2.0**	**75%**	**1.5**

[9] A positive outcome that 1 in 10 projects would achieve, or a 10% confidence that the project can be delivered to the amount or less.

[10] Expected outcome that 5 in 10 projects would achieve, or a 50% confidence that the project can be delivered to the amount or less.

[11] An adverse outcome that 1 in 10 projects would face, or a 90% confidence that the project can be delivered to the amount or less.

Component	Cost rationale	Cost range (P10 to P90) ($ million)	Likely cost (P50) ($ million)	Probability	Contingency allowance ($ million)
Uncertainty in securing resources with suitable capacity and capability	Difficulties to find resources with appropriate skills will be addressed by paying a premium over market rate. Assumes a 20% premium on labour costs budget of $15 million.	**1.5 – 4.6**	**3.1**	**50%**	**1.6**
Changes in design standards that the project must meet	Evolving industry requirements leading to use of non SF_6 132kV switchgear. Based on a cost of $4 million for standard 132kV equipment and assuming the cost will double for non SF_6 equipment.	**4.4 – 8.8**	**4.4**	**35%**	**1.5**
Uncertainty of project site due to demolition requirements not included in base estimates	Costs can vary according to building size. Assuming a unit rate of $200/m2 for a 3-level building, this could lead to demolition costs of up to $3 million	**1.0 – 3.0**	**2.0**	**75%**	**1.5**
Uncertainty in design and construction due to site topography and potential rezoning	Topography could have both time and cost impacts. Bulk earthworks costings of $75/m^3 could apply and retaining walls may be required. Additional rezoning plans could be announced, impacting land value or resulting in additional fire/noise requirements. Additional setback requirements add to the size of land required for substation.	**3.4 -16.0**	**8.5**	**40%**	**3.5**
Escalation of prices not included in base estimates	Pricing for 132kV cable procurement (around $20 million) based on existing supply arrangements, could increase up to 20% subject to exchange rate, commodity price and supply chain cost changes.	**1.4 – 3.9**	**2.9**	**40%**	**1.2**
Contractor cost uncertainties	Changes to contracted costs post award. The budget for contracted services is around $84 million, and variations/other claims could range between 2% and 10%	**1.7 – 8.4**	**4.2**	**20%**	**0.8**
Noise complaints arising from construction and/or installation work	Requirement to install noise and/or fire walls. Based on wall length of 10m height x 12m long costing $0.4 million. Up to 5 walls of this type could be required.	**0.4 – 2.0**	**1.2**	**60%**	**0.7**
Uncertainty in design and construction due cable egress issues	Longer cable runs may be required, leading to purchase of easements in neighbouring properties. Assumes 6m wide x 100 long easements at $4,250/m^2 rate.	**0.5 – 2.5**	**1.2**	**50%**	**0.6**

The aggregated value of the allowances listed above is $18.9 million and has been included in the assessment for each of the four options.

3.6 Options considered but not progressed

Ausgrid also considered several other options that have not been progressed because they were found to be technically or economically infeasible. The table below summarises Ausgrid's consideration and position on each of these options, which are grouped according to when they were considered. Note these costs do not include a contingency allowance.

Table 9 – Options considered but not progressed

Description	Reason why option was not progressed
Credible options from the business case ruled out in this RIT-D	
Option 1 – New 132/33kV STS at site 1 looped into 132kV Feeder 92B Sydney North BSP - Lane Cove STSS Option 2 – New 132/33kV STS at site 1 looped into 132kV Feeders 92A & 92B Sydney North BSP - Lane Cove STSS Option 3 – New 132kV STSS at 'site 3' and new 132/33kV STS at site 1 looped into 132kV Feeder 92B Sydney North BSP – Lane Cove STSS.	In 2023, the NSW Department of Planning, Housing and Infrastructure proposed to rezone land in the Macquarie Park area as being suitable for residential high rise. The expectation that this will occur has significantly increased the estimated value for all options involving site 1, compared to what was assumed at the time of preparing the contingent project business case. Due to the significant increase expected in property acquisition costs of site 1, Options 1-3 are between 27% and 68% more expensive than Option 5 in this FPAR (excluding contingency).[12] Given that Options 1-3 are not expected to provide any additional benefits (or avoided costs) they are therefore not considered economically feasible under the RIT-D. In addition, relative to Options 4-7, Options 1-3 have other drawbacks, including: • Rating constraints at Feeder 92A and/or Feeder 92B. • Expected overloading on tee connection 92A(2) to the Macquarie Park ZS under N-1 conditions (for Option 1). • Materially greater costs due to the need for twin cables to maintain network rating capacity in two different routes given the arrangement of 4 x 132kV feeders to the new STS (for Option 2) • Having to acquire a second property (i.e. site 3), which will require national park land clearing, leading to negative community impact and delays (Option 3).
Options ruled out as part of the business case and not considered further	
11kV connection for customers	As outlined in the business case,[13] the scale of requested loads means that 11kV connections would not be cost effective or efficient as extensive rearrangement work would be required to facilitate load transfers and the existing 11kV network is congested and near full capacity. In addition, there are technical limitations associated with installing multiple 11kV feeders to a single large load customer (such as multiple switching stations), complex protection schemes to manage the operation and separate metering points at 11kV. We therefore do not consider that 11kV connection is economically or technically feasible under the RIT-D.
Option variants utilising tee connections on Feeders 92A & 92B	These feeders have reached the maximum number of tee connections and adding a further tee connection is not feasible[14] (unlike for Feeders 92G & 92J under Options 4-7). Therefore, these variants are not technically feasible under the RIT-D.

[12] The total capital expenditure, including both network augmentation and customer connection costs, of options 1, 2 and 3 is estimated at $198m, $261m and $210m respectively, while the total capital expenditure of Option 5 is $156m, all excluding contingencies.

[13] Ausgrid, *Ausgrid's 2024-29 Revised Proposal, Attachment 5.6: New Wallumatta STS Business Case*, 30 November 2023, p 8.

[14] Such tee connection would require two multi-ended (four-ended) protection schemes for the 132kV network involving feeders 92A & 92B, Macquarie Park ZS, Macquarie STS and the new Wallumatta STS, between Sydney North BSP and Lane Cove STSS. This is not recommended as it will require three independent and redundant communication paths between all four ends, increasing the complexity of the communications network and switching operations, also noting that distance to fault measurements in relays and fault location information becomes inaccurate.

Description	Reason why option was not progressed
New 132/66kV STS	The substation build costs for a 132/66kV STS is expected to be approximately 10% greater than for a 132/33kV STS without providing any additional benefits (or avoided costs). It is therefore not considered economically feasible under the RIT-D. In addition, and as stated in section 2.1 above, each of the customers have requested 33kV connection. If 66kV connection were the only supply option, this would result in additional costs to the customers. Therefore, a 132/66kV STS is not considered economically feasible under the RIT-D.
Direct supply at 132kV options considered further following the business case	
Option 8 – New 132kV STSS (expandable) at site 1 looped into 132kV Feeder 92B Option 9 - New 132kV STSS (expandable) at site 1 tee connected to 132kV Feeders 92G & 92J Option 10 - New 132kV STSS (expandable) at site 2 tee connected to 132kV Feeders 92G & 92J Option 11 - New 132kV STSS (expandable) at 'site 3' looped into 132kV Feeder 92B	Each customer would have to install switching equipment and substations onsite to reduce voltage to required internal levels for these options, which would occupy areas on their properties that otherwise could be used for their core business activities. While these options involve similar network augmentation capital costs to Options 4-7,[15] the additional connection costs required mean that they are overall materially higher cost options (between 54% and123% higher than Option 5 in this FPAR, excluding contingency).[16] Given that Options 8-11 are not expected to provide any additional benefits (or avoided costs) compared to Options 4-7, they are therefore not considered economically feasible under the RIT-D. In addition, relative to Options 4-7, Options 8-11 have a range of other drawbacks: • That customers have requested 33kV input supply. • Assets will be underutilised, as customers' requirements are well below the capacity that each 132kV feeder bay can provide (i.e., at least 286MVA). • Customer will have less space available at their sites to grow (i.e. add load). • Rating constraints at Feeder 92B (Option 8). • Under N-1 conditions, an overload will occur on tee connection 92A(2) to Macquarie Park Zone Substation (Option 8). • There are 132kV cable egress issues (Option 8, 9 and 10). • Site 3 is not suitable to accommodate a large switching station. Expansion of the site will require compulsory acquisition and national park land clearing, leading to a high risk of project delays (Option 11). • Customer connection costs would include long cable connections and excavation work under the motorway M2 (Option 11).
Non-network and SAPS options	
Using non-network solutions either in combination with, or in-place of, a network option.	Ausgrid has considered the ability of non-network solutions to meet the identified need. Specifically, we conducted analysis to consider how demand management could defer the timing of the network solution and whether the EUE could be cost effectively reduced. The assessment has shown that non-network alternatives would not be cost effective due to the magnitude of the load reduction required. This is detailed further in the Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.
Transferring and/or connecting customers to SAPS	The reduction in demand that SAPS could provide will not be sufficient to defer the network solution, given the magnitude and characteristics of the loads. This is detailed further in the Options Screening Notice released in accordance with clause 5.17.4(d) of the NER.

[15] Specifically, the network augmentation capital expenditure for these options (excluding contingency) is estimated at $160 million for Option 8, $150 million for Option 9, $134 million for Option 10 and $166 million for Option 11.

[16] The capital expenditure including network augmentation and customer connection costs of options 8, 9, 10 and 11 are $286m, $275m, $239m and $347m respectively, while combined network and customer connection cost of Option 5 is $156m, excluding contingencies.

4 How the options have been assessed

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

4.1 General overview of the assessment framework

All costs and benefits for each credible option have been measured against a 'business as usual' base case. Under this base case, Ausgrid will not be able to supply any of the customers' requested load with the existing Macquarie STS given the lack of spare bays. The base case is not a realistic state of the world, because of Ausgrid's obligation to process and facilitate customer connection requirements under Section 5.2.3 in the NER, and has instead only been defined and used to align with the RIT-D framework.

The RIT-D analysis has been undertaken over a 20-year period, from 2024-25 to 2043-44. Ausgrid considers that a 20-year period is appropriate as it 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.

Where the capital components of the credible options have asset lives greater than 20 years, Ausgrid has taken a terminal value approach to incorporate capital costs in the assessment, which ensures that the capital cost of long-lived options is appropriately captured in the 20-year assessment period. The terminal value has been calculated as the undepreciated value of capital costs at the end of the analysis period.

Ausgrid has adopted a real, pre-tax discount rate of 3.54% as the central assumption for the NPV analysis. This represents Ausgrid's 2024-25 opportunity cost for its capital investments as included in the AER's final decision for Ausgrid's current distribution determination.[17] As non-network or SAPS options have been found to be not viable, Ausgrid considers that the appropriate discount rate is the regulated cost of capital.

To test the results against variations in the discount rate, an upper value sensitivity of 10.5% has been adopted to align with the parameters prepared and consulted on by AEMO as part of preparing the 2023 Inputs, Assumptions and Scenarios Report.[18] For a lower value sensitivity for this RIT-D, this would ordinarily be aligned with the latest AER Final Decision for a Distribution Network Service Provider's (DNSP's) regulated weighted average cost of capital (WACC) at the time of preparing this FPAR; however, in this instance that regulated WACC is currently Ausgrid's.

4.2 Ausgrid's approach to estimating project costs

Ausgrid has estimated capital costs by considering the scope of works necessary under the credible options together with costing experience from previous projects of a similar nature, including the Macquarie STS project (and the current project adding a third transformer to it). Where possible, Ausgrid has also estimated capital costs using supplier quotes or other pricing information.

Ausgrid does not generally apply the Association for the Advancement of Cost Engineering (AACE) international cost estimate classification system to classify cost estimates. Doing so for this RIT-D would involve significant additional costs, which would not provide a corresponding increase in benefits compared with the use of our standard estimates and so this has not been undertaken.

A specific contingency allowance has been included as part of this FPAR. The basis on which this allowance has been calculated is set out in section 3.5 above. This allowance will also be included in the subsequent contingent project application.

We have considered sensitivity bounds in the range of -10% to +40% of the capital costs for this FPAR.

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

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

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

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

4.3 Market benefits are expected from avoided unserved energy

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

The approach Ausgrid has adopted to estimate the financial impact in eliminated unserved energy are outlined in section 4.3.1 below. Further details on the assumptions and methodology considered are presented in Appendix D.

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

4.3.1 Avoided unserved energy

EUE is the amount of energy that customers request to utilise but cannot be supplied due to a network capacity limitation. A reduction of the unserved energy expected from the credible option, relative to the base case, results in a positive contribution to market benefits.

EUE under the base case has been estimated using the amount of load requested in the customer connection applications multiplied by the duration of the load not being supplied considering the characteristic of the typical load profile of the customer type.

The 'market benefit' under the RIT-D from avoiding EUE is estimated by multiplying the unserved energy by the Value of Customer Reliability (VCR). The VCR is measured in dollars per kWh 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 $52.024/kWh reflecting the NSW state-wide VCR estimated by the AER in its December 2019 VCR Final Report, adjusted by the Consumer Price Index (CPI) to be in 2023/24 dollars.[19] We have also tested the VCR as a sensitivity with values that are 30% lower and 30% higher than the central rate, consistent with the AER's specified +/- 30% confidence interval.[20]

While we have also investigated how assuming different load forecasts going forward changes the EUE under the proposed options, as discussed in section 2.3 above, this is not considered material to the assessment as all options avoid the same amount of EUE (and from the same point in time).

4.4 Three different demand scenarios have been modelled to address uncertainty

RIT-D assessments are required to be based on cost-benefit analysis that includes an assessment of 'reasonable scenarios', which are designed to test alternate sets of key assumptions and whether they affect identification of the preferred option. Ausgrid has assessed three alternative future load demand scenarios – namely:

- A central forecast assuming 85% scaled load from the proposed major loads;
- A low demand forecast assuming 60% scaled load from the proposed major loads; and
- A high forecast assuming 100% scaled load from the proposed major loads.

The scenarios only differ by the demand forecasts given this is the key parameter that may affect the ranking of the credible options. How the results are affected by changes to other variables (i.e. the discount rate and capital costs) have been investigated in the sensitivity analysis.

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

Table 10 – Summary of the three scenarios investigated

Variable	Scenario 1 – central demand scenario	Scenario 2 – low demand scenario	Scenario 3 – high demand scenario
Demand	Central forecast	Low forecast	High forecast
VCR	$52.024/kWh across all scenarios		
Discount Rate	3.54% across all scenarios		

Ausgrid has weighted each of the demand scenarios equally in the NPV assessment. However, Option 5 is preferred (and the NPV outcome is positive) across all scenarios and so the weightings do not influence the RIT-D outcome.

[19] AER, Values of Customer Reliability – Final report on VCR values, December 2019, pp 71 and 87-88. The NSW state-wide VCR has been inflated to $2023/24 using the Australian Bureau of Statistics CPI weighted average of eight capital cities (series ID: A2325846C).
[20] AER, *Values of Customer Reliability – Final Report on VCR values*, December 2019, p. 84.

5 Assessment of the credible options

This section outlines the NPV assessment of credible options compared against the base case 'do nothing' option.

5.1 Gross market benefits estimated for the credible options

The table below summarises the gross market benefit of the credible options relative to the base case in present value terms. The gross market benefit has been calculated for each of the three scenarios outlined in the section above and is also provided on a weighted basis. For each scenario, the estimated gross market benefits are the same for all options for this RIT-D as they all avoid the same EUE (and this is the only expected source of market benefit).

Table 11 – Present value of gross benefits of credible options relative to the base case, $m

Option / scenario	Central demand	High demand	Low demand	Weighted benefits
Scenario weighting	1/3	1/3	1/3	–
Option 4	1,413.1	1,788.3	177.4	1,126.3
Option 5	1,413.1	1,788.3	177.4	1,126.3
Option 6	1,413.1	1,788.3	177.4	1,126.3
Option 7	1,413.1	1,788.3	177.4	1,126.3

5.2 Estimated costs for the credible options

The table below summarises the cost of the options in present value terms. Option costs comprise capital costs and ongoing operating and maintenance costs. The capital cost of each option does not vary across the three scenarios. Variations in the capital costs have been tested as part of the sensitivity analysis.

Table 12 – Present value of costs of the credible options relative to the base case, PV $m

Option / scenario	Central demand	High demand	Low demand	Weighted costs
Scenario weighting	1/3	1/3	1/3	
Option 4	-99.2	-99.2	-99.2	-99.2
Option 5	-83.6	-83.6	-83.6	-83.6
Option 6	-103.4	-103.4	-103.4	-103.4
Option 7	-98.1	-98.1	-98.1	-98.1

5.3 Net present value assessment outcomes

The table below summarises the net market benefit in NPV terms for the credible options under each scenario. The net market benefit is the gross benefit (as set out in Table 5-1) minus the cost of the option (as set out in Table 5-2), all in present value terms. Option 5 has the greatest estimated net market benefits of all options across each of the scenarios investigated. The differences in net economic benefits are driven solely by the cost differences across the options.

Table 13 – Present value of net benefits relative to the base case by scenario and weighted, NPV $m

Option / scenario	Central demand	High demand	Low demand	Weighted	Rank
Scenario weighting	1/3	1/3	1/3		
Option 4	1,313.9	1,689.1	78.2	1,027.1	3
Option 5	**1,329.5**	**1,704.8**	**93.8**	**1,042.7**	**1**
Option 6	1,309.7	1,684.9	74.0	1,022.9	4
Option 7	1,315.0	1,690.3	79.3	1,028.2	2

Consideration has been given in the NPV analysis to repurpose part of the land available in Site 2, as it is anticipated that the new Wallumatta STS will use a portion of the site area. This is only applicable to Options 5 and 7.

5.4 Sensitivity analysis results

Ausgrid has undertaken a sensitivity testing exercise to understand the robustness of the RIT-D assessment to underlying assumptions about key variables. Specifically, we have investigated the following sensitivities:

- A 40% increase in the assumed network capital costs;
- A 10% decrease in assumed network capital costs;
- A 25% increase/decrease in the assumed planned maintenance costs;
- A 30% lower VCR ($36.42/kWh) and a higher VCR ($67.63/kWh); and
- A higher discount rate assumption.

We have not investigated sensitivity tests to determine the optimal timing for the new STS since the timing is determined by customers' requirement in their connection applications, and Ausgrid must facilitate the customers' connection.

The results of the sensitivity tests are presented in the table below and show that Option 5 remains the top-ranked option and has positive net market benefits across all the sensitivities modelled.

Table 14 – NPV results from sensitivity tests, weighted across demand scenarios ($2023/24, million)

Sensitivity	Option 4	Option 5	Option 6	Option 7
Core weighted results	1,027.1	**1,042.7**	1,022.9	1,028.2
High capital costs (+40%)	988.1	**1,009.9**	982.2	989.6
Low capital costs (-10%)	1,036.8	**1,050.9**	1,033.0	1,037.8
High planned maintenance costs (+25%)	1,026.7	**1,042.3**	1,022.4	1,027.8
Low planned maintenance costs (-25%)	1,027.5	**1,043.1**	1,023.3	1,028.6
High VCR ($67.63/kWh)	1,364.9	**1,380.6**	1,360.7	1,366.0
Low VCR ($36.42/kWh)	689.2	**704.8**	685.0	690.3
High discount rate (10.5%)	582.4	**604.1**	577.6	587.8

We have not investigated boundary values for these variables as they will not change the conclusion that Option 5 is the preferred option. This is driven by the fact that:

- Option 5 is the lowest cost of all four options; and
- All options avoid the same EUE (and do not provide any other market benefits or avoided costs).

In addition, we have not investigated sensitivity testing on the demand forecasts since they too will not affect the finding that Option 5 is the preferred option, given that:

- If three customers are connected instead of four, we would build Wallumatta STS with no scope changes; and
- Any demand over 345MVA[21] would trigger additional investment outside the scope of this RIT-D, thus requiring a separate RIT-D assessment.

If only two customers connected (instead of four), Ausgrid would build Wallumatta STS with a marginally reduced scope. Specifically, the initial number of transformers and 33kV switchgroups to be installed would be reduced from three to two and would result in an approximate 3.5% reduction in overall capital costs[22]. Notwithstanding, this is not considered a material change, and Option 5 will remain as the option with the highest net benefit of all options.

If one customer proceeds to connect, a shared asset is no longer required, and the customer will fund the entire network augmentation. If no customer is connected, Option 5 would not be preferred, and the investment would not proceed. No construction will commence until material components of connection agreement contracts have been executed.

[21] The connection applications have combined "N-1" requirements (345MVA) that will exceed the rating capacity of Wallumatta STS (282MVA under N-1). They will require additional network augmentation even if no other customers require additional demand.
[22] The 132kV cable connection scope will remain unchanged, and changes in mobilisation of equipment, project management, design and installation costs of the substation are not material. The impact is limited to the procurement of the equipment not required initially.

Finally, we have not investigated boundary values for the assumed difference in property acquisition costs between site 1 and site 2 since only site 1 has been impacted by the rezoning of the area and, as a result, it is unlikely that the cost difference among the two sites would be reduced sufficiently to make Option 4 (or Option 6) preferred. Moreover, the two options involving site 1 (Option 4 and Option 6) also involve significantly greater contestable customer connection costs than Option 5 – $28 million compared to $12 million – meaning that the assumed property acquisition costs for these options would need to fall *below* those for site 2 in order for these options to be preferred (all else held constant).

6 Proposed preferred option

Ausgrid considers that Option 5 is the preferred option that satisfies the RIT-D. It involves a new 132/33kV STS at site 2, connected via East Ryde Transition Point to feeders 92G and 92J.

The scope of this option includes the:

- Acquisition of property at site 2;
- Construction of the new Wallumatta 132/33kV STS, comprising:
  - 3 transformer units;
  - A new switchroom building; and
  - 28 indoor circuit breakers; and
- Installation of two 132kV feeder connections to tee off from East Ryde Transition Point to Wallumatta STS, comprising:
  - Two pole structures to connect to East Ryde Transition Point;
  - The construction of ductline from the transition point to the substation site;
  - Construction of bore under major roads;
  - The installation of cables between East Ryde Transition Point and the substation site;
  - The installation of joint bays; and
  - Termination cable works at substation cable basement.

The estimated network augmentation capital cost of this option is approximately $162 million, comprising:

- $80.0 million for commissioning a new 132/33kV STS with 3x120MVA transformers and 3x33kV switchgroups;
- $63.4 million for the associated 132kV connections to tee off from Feeder 92G & 92J; and
- $18.9 million as a contingency allowance.

Additional routine network operating costs under this option are expected to be around $143,000 per year.

In addition, Option 5 is estimated to involve an additional $12 million in contestable customer connection costs.

Overall, Option 5 is the lowest cost of all four credible options assessed in this FPAR.

Ausgrid assumes that the necessary construction would commence as soon as practicable after this RIT-D, and the subsequent contingent project application being approved by the AER, and end in 2028/29 ahead of when customers are expected to connect (in December 2028).

Ausgrid considers that this FPAR, and the accompanying detailed analysis, identify Option 5 as the preferred option and that this satisfies the RIT-D. Ausgrid is the proponent for Option 5.

'Re-opening triggers' for this RIT-D

Under the updated Rules relating to a Material Change in Circumstance (MCC), Ausgrid is required to set out in the DPAR (for consultation) and the FPAR (for confirmation) re-opening triggers for this RIT-D. No submissions were received on the proposed re-opening triggers.

We consider that there is only one re-opener trigger for this RIT-D associated with less load requesting to connect. In particular:

- If two large customers are connected (instead of four), Ausgrid would need to build the new Wallumatta STS with a reduced network arrangement initially. We note that this would only marginally reduce the expected capital costs overall (in the order of 3.5%).

To be clear, should this occur, Ausgrid would prepare a letter to the AER confirming that, as a consequence, Ausgrid would reduce the initial number of transformers and 33kV switchgroups to be installed from three to two and that Option 5 remains the preferred option (consistent with this RIT-D). A new RIT-D would not be commenced (which would require significant time to complete and jeopardise Ausgrid's ability to facilitate the timely connection of the large customers). Instead, Ausgrid would refer back to this RIT-D to confirm that the action Ausgrid is proposing to take is considered optimal.

We do not consider there are any further re-opener triggers for this RIT-D associated with more or less load requesting to connect. In particular:

- If three large customers are connected (instead of four), we would build Wallumatta STS with no scope changes;
- If only one customer is connected, a shared network asset is no longer required, and the customer will fund the entire connection cost.
- If no customer is connected, Option 5 would not be preferred. However, under these circumstances, the investment would not proceed, importantly, and no construction will commence until material components of connection agreement contracts have been executed.
- Any demand over 345MVA would trigger additional investment outside of the scope of that contemplated by this RIT-D and would thus require a separate RIT-D to be undertaken.

In addition, based on the sensitivity assessment included in this FPAR Ausgrid does not consider the following will constitute re-opening triggers for this RIT-D either:

- Real cost increases compared to those used in the RIT-D analysis;
- The assumed difference in property acquisition costs between site 1 and site 2;
- Variations to the AER estimated VCR; or
- Credible changes to the commercial discount rate.

Specifically, the finding that Option 5 is the preferred option is not found to be sensitive to changes in these variables.

Appendix A – Checklist of compliance clauses

This table below sets out a compliance checklist that demonstrates the compliance of this FPAR with the requirements of clause 5.17.4(r) of the NER version 216.

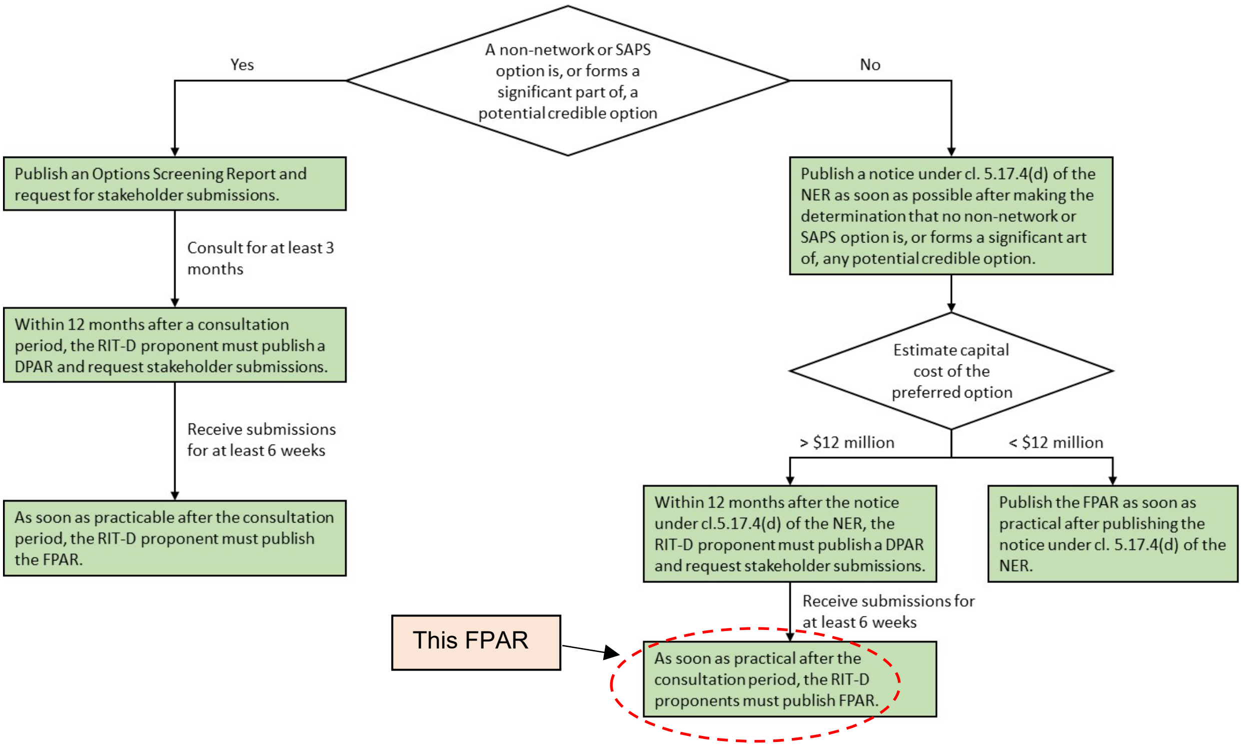
Clause	Summary of requirements	Section in the FPAR
5.17.4(r)	The matters specified as requirements for the DPAR, as outlined below in clause 5.17.4(j).	See below
	A summary of any submissions received on the DPAR and the RIT-D proponent's response to each such submission	NA
5.17.4(j)	(1) a description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

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

Guidelines section	Summary of requirements	Section in the FPAR
3.5A.1	Where the estimated capital costs of the preferred option exceeds $100 million (as varied in accordance with a cost threshold determination), a RIT–D proponent must, in a RIT-D application: • outline the process it has applied, or intends to apply, to ensure that the estimated costs are accurate to the extent practicable having regard to the purpose of that stage of the RIT-D • for all credible options (including the preferred option), either o apply the cost estimate classification system published by the AACE, or o if it does not apply the AACE cost estimate classification system, identify the alternative cost estimation system or cost estimation arrangements it intends to apply, and provide reasons to explain why applying that alternative system or arrangements is more appropriate or suitable than applying the AACE cost estimate classification system in producing an accurate cost estimate	4.2
3.5A.2	For each credible option, a RIT-D proponent must specify, to the extent practicable and in a manner which is fit for purpose for that stage of the RIT-D: • all key inputs and assumptions adopted in deriving the cost estimate • a breakdown of the main components of the cost estimate • the methodologies and processes applied in deriving the cost estimate (e.g. market testing, unit costs from recent projects, and engineering-based cost estimates) • the reasons in support of the key inputs and assumptions adopted and methodologies and processes applied • the level of any contingency allowance that have been included in the cost estimate, and the reasons for that level of contingency allowance	3 & 4.2
3.8.1	Where the estimated capital cost of the preferred option exceeds $100 million (as varied in accordance with an applicable cost threshold determination), a RIT-D proponent must undertake sensitivity analysis on all credible options, by varying one or more inputs and/or assumptions.	5.4
3.9.4	If a contingency allowance is included in a cost estimate for a credible option, the RIT-D proponent must explain: • the reasons and basis for the contingency allowance, including the particular costs that the contingency allowance may relate to, and • how the level or quantum of the contingency allowance was determined.	3.5

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 material

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

- Changes in the timing of unrelated expenditure;
- Changes in voluntary load curtailment;
- Changes in costs to other parties;
- Changes in load transfer capability and capacity of embedded generators to take up load;
- Option value;
- Changes in electrical energy losses; and
- Changes in Australia's greenhouse gas emissions.

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

Market benefits	Reason for excluding from this RIT-D
Timing of unrelated expenditure	While a new Wallumatta STS would be designed to supply large customers in the area, it will free up capacity on the existing zone substations to supply residential and smaller commercial loads. In addition, it is expected that a new STS will release capacity on the 11kV network to supply the load growth expected from the rezoned Macquarie Park area for around ten years (meaning that only minor network augmentations are expected to be required). These impacts have not been quantified in the RIT-D assessment as they are not considered material as each of the four options for the new STS will have the same impact. The options are also not expected to affect the timing or amount of any other expenditure for unrelated needs.
Changes in voluntary load curtailment	The level of voluntary load curtailment currently present in the National Electricity Market 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. None of the options in this RIT-D are not expected to affect the pool price and so there is not expected to be any changes in voluntary load curtailment.
Costs to other parties	This category of market benefit typically relates to impacts on generation investment from the options. The options in this RIT-D will not affect the wholesale market and so we have not estimated this category of market benefit.
Changes in load transfer capacity and embedded generators	Load transfer capacity between substations is predominantly limited by the high voltage feeders that connect substations. The options under consideration do not affect high voltage feeders and therefore are unlikely to materially change load transfer capacity. Further, the options are unlikely to enable embedded generators in Ausgrid's network to be able to take up load given the size and profile of the load serviced by network assets considered. Consequently, Ausgrid has not attempted to estimate any benefits from changes in load transfer capacity and embedded generators.
Option value	Option values arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change, and the credible options considered have sufficiently flexible to respond to that change. The credible options assessed do not involve stages or any other flexibility and so we do not consider that option value is relevant.

Changes in electrical energy losses	Ausgrid does not expect that the credible options considered will lead to significant changes in network losses and so have not estimated this category of market benefits.
Changes in Australia's greenhouse gas emissions	None of the options are expected to result in materially different levels of greenhouse gas emissions (including sulphur hexafluoride (SF6) emissions), as they do not affect either the pattern of generator dispatch in the wholesale market or the level of expected SF6 leakages from network assets.

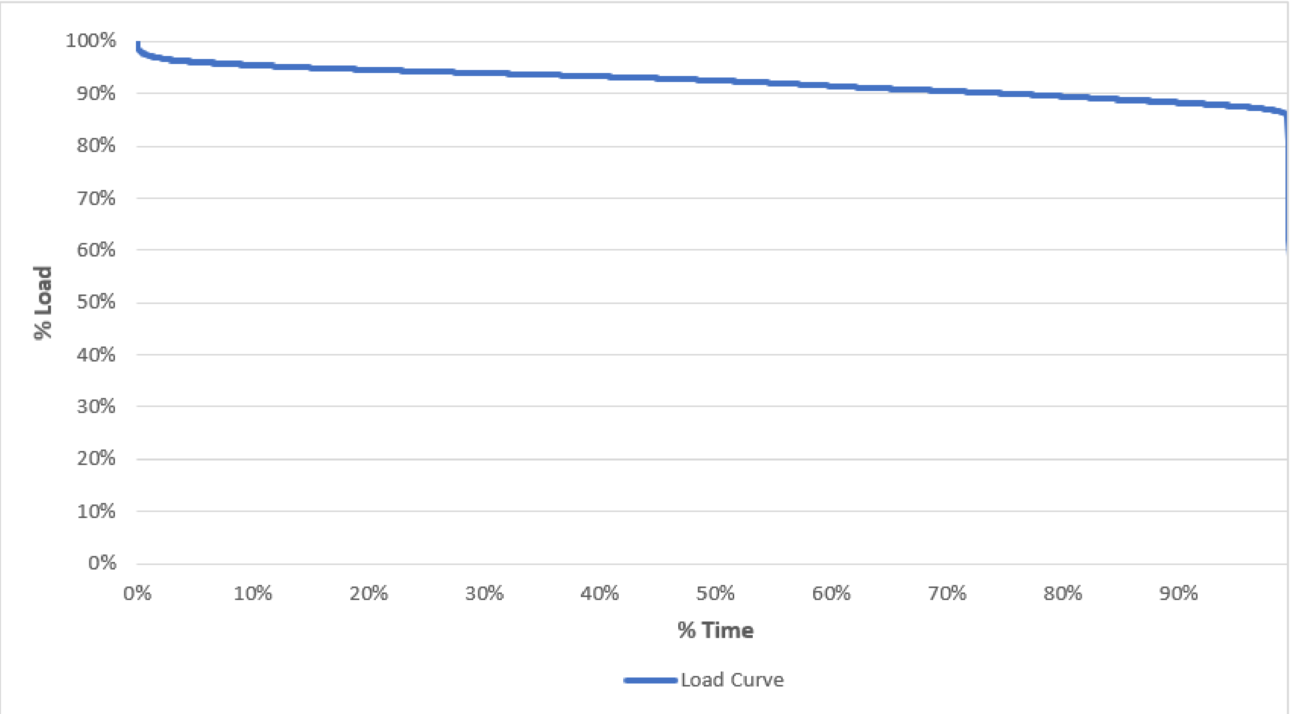
Appendix D – Additional detail on the assessment methodology and assumptions

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

D.1 Characteristic load duration curve

The load duration curve used in the analysis is presented in the figure below. It is assumed that the load types supplied will not change substantially into the future and therefore the load duration curve will maintain its characteristic shape.

Figure D.1 – Load duration curve



D.2 Probability of failure

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

Table D.16 – Summary of failure probability models used to estimate failure probability.

Network asset type	Failure probability model	Key parameters
Subtransmission substation transformer	Weibull distribution function	Transformer failure rate Age of transformer at failure in years Repair time

Transformers

The failure rate of transformers is expressed in terms of the Weibull distribution with sets of parameters for different transformer types.

Table D.17 – Subtransmission Substation transformer parameters

Transformer	Type	Year of commissioning	μ factor	Q factor	MTTR (Weeks)*
Transformer No.1	132kV Bushing Type	2021	160.8	2.33	6
Transformer No.2	132kV Bushing Type	2021	160.8	2.33	6
Transformer No.3 (project in progress)	132kV Bushing Type	2025	160.8	2.33	6

* Mean Time To Repair

The following equation is used to calculate the yearly major failure rates based on the Weibull parameters related to the subtransmission substation transformer.

Equation 1

$$f = \left(\frac{\beta}{\mu}\right) \times \left(\frac{t}{\mu}\right)^{(\beta-1)}$$

Where:

f is the failure rate

t is the age (in years)

β is the shape parameter

μ is the scale parameter

Equation 2 shows how the failure rate is used to calculate unavailability for failures.

Equation 2

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

Unavailability of each network element is calculated for pre switching and post switching scenarios, by using Equations 3 and 4.

Equation 3

$$Pre - switching\ unavailability = \frac{8760 \times \lambda \times r_s}{f \times r_r + 8760}$$

Equation 4

$$Post - switching\ unavailability = \frac{8760 \times \lambda \times (r_r - r_s)}{f \times r_r + 8760}$$

Where:

f is the failure rate

r_s is the switching time (in hours)

r_r is the repair time (in hours)

Ausgrid