RIT-D Final Project Assessment Report

Providing supply to the Badgerys Creek development area

11 December 2023

Endeavour Energy

POWER together

Contents

1.0 Executive summary

This Final Project Assessment Report (FPAR) was prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules (NER).

The purpose of this report is to demonstrate the basis for selection of the preferred option to provide supply to the Badgerys Creek development area.

The Western Sydney 'Aerotropolis' area is a greenfield development of a new city covering 11,000 hectares of land, which will spearhead Western Sydney's future urbanisation. The proposed development features a precinct-based land use and zoning approach that will require significant development of electricity infrastructure to meet the needs of the area over the long term.

This includes the Badgerys Creek development area, which is planned to be a hub for commercial and industrial developments. In particular, key infrastructure that the Badgerys Creek development area will need to support is electricity supply for the Elizabeth Enterprise Precinct business park, the Sydney Water Advanced Water Recycling Centre and the Badgerys Creek enterprise area south of Elizabeth Drive. In total, connections in this area are expected to require approximately 80MVA of electricity supply capacity by 2050.

The identified need for this investment is 'reliability corrective action' because investment is required to comply with our NER obligations to connect customers. The timing of the identified need for this RIT-D is determined by when the forecast customer demand requiring connection will exceed the existing network supply capacity. This is currently estimated to be in 2026, based on the connection requests received to date.

This FPAR follows publication of a Draft Project Assessment Report (DPAR) on 20 December 2022 which invited written submissions on the materials contained in the DPAR. On publication of the DPAR Endeavour Energy opened a six-week consultation period, during which time no submissions were received.

Four options were determined to be credible in addressing the network need and have been assessed in comparison to a "do nothing" (or no proactive intervention) base case. These are:

- Option 1 — establish Badgerys Creek zone substation with supply from the Western Sydney Airport Transmission Substation (WSA TS);
- Option 2A — establish Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X;
- Option 2B — stage Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X; and
- Option 2C — establish Badgerys Creek zone substation and stage 132kV supply from WSA TS and existing feeder 93X.

The 'do nothing' option is not considered credible because it will result in significant expected unserved energy in the development area which would prevent the connection of new customers and the curtailment of growth at sites that would be supplied by the limited existing supply capacity in the area.

Each of the credible options involve establishing a Badgerys Creek zone substation (connecting to the 132kV Aerotropolis foundation supply backbone feeder) with two 45 MVA transformers and two feeders. However, these options vary with the installation of the transformers and feeders being staged and whether both feeders connect to the same transmission substation, or, if one of them connects to another major feeder.

The economic assessment of the credible options is shown in Table 1. Under the NER, the preferred option is the credible option that maximises the present value of the net economic benefit to all those who produce, consume or transport electricity in the National Electricity Market (NEM). Applying this definition, Option 2A is the preferred option at this draft stage because it has the highest net market benefits.

However, we note that there is a less than one per cent difference between the net market benefits of each credible option. In light of this small difference, we consider that each of the credible options assessed are effectively equally ranked given the very large benefits via avoided unserved energy provided by all four of the network options and the accuracy in the estimates used in the analysis. Scenario and sensitivity analysis was

undertaken across a range of assumptions including forecast load growth, discount rate, value of customer reliability (VCR) and capital expenditure. Neither the scenario or sensitivity analysis results in one option becoming more favoured than another and, as such, we consider that they remain effectively equally ranked in the assessment.

Notwithstanding, we continue to view Option 2A as the preferred option because, in addition to having the highest net market benefits (based on weighting the scenarios considered), it has a number of practical advantages over the other credible options assessed. In particular, connecting to feeder 93X is advantageous because it has significant benefits in terms of diversifying the supply security and reliability of the Aerotropolis area by providing an alternative supply to the area in addition to the Aerotropolis backbone feeder (which will be the primary supply for Western Sydney Airport).

Connecting to feeder 93X also provides a future high-capacity connection to the future augmentation of Transgrid's Kemps Creek Bulk Supply Point (BSP) to provide 132kV supply to the Aerotropolis area, which is expected by 2030 (the timing of this investment is subject to TNSP and DNSP joint planning protocols). This option would therefore facilitate connection to Transgrid's Kemps Creek BSP as soon as it is available. It would also assist in avoiding potential delays associated with construction of the feeder in public roads and environmental and easement considerations for routes from underground to overhead in connecting to the Transgrid site.

Table 1 – Economic assessment of credible options (weighted results)

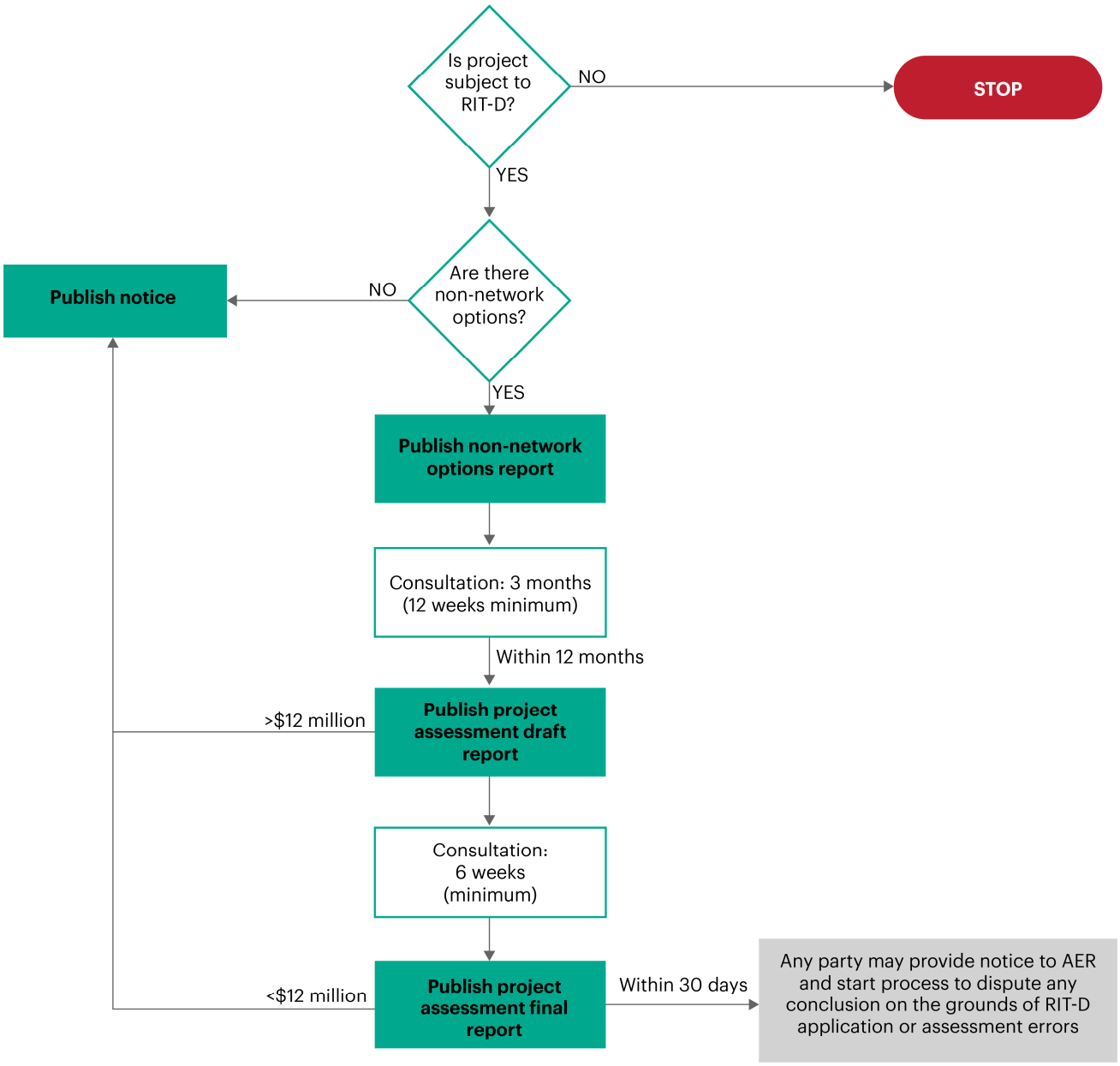
Option	Description	Project capex nominal ($M)	PV of market benefits ($M)	PV of costs ($M)	NPV ($M)	Rank
1	Establish Badgerys Creek zone substation with supply from the WSA TS	45.2	17,801.2	46.9[1]	17,754.3	2
2A	Establish Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X	52.4	17,804.5	48.7	17,755.8	1
2B	Stage Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X	53.7	17,802.5	49.2	17,753.3	3
2C	Establish Badgerys Creek zone substation and stage 132kV supply from WSA TS and existing feeder 93X	52.9	17,800.1	48.3	17,751.8	4

[1] The PV of costs for Option 1 includes future estimated costs of the connection works for the future Kemps Creek BSP. This provides an equal basis of comparison of the options in the economic evaluation for Badgerys Creek.

2.0 RIT-D process

This FPAR has been prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules. This report describes the application of the Regulatory Application Test – Distribution (RIT-D) for providing supply to the Badgerys Creek development area. The RIT-D process is summarised in Figure 1 below. We have previously applied the RIT-D to determine the most efficient means of providing the foundation supply to the Aerotropolis precinct – a 132kV backbone feeder.[1]

Figure 1 – Overview of the RIT-D process



[1] See: https://www.endeavourenergy.com.au/modern-grid/creating-the-modern-grid/network-planning/rit-d-projects.

2.1 Completion of RIT-D Process

This FPAR represents the final stage of the consultation process in relation to the application of the RIT-D process undertaken by Endeavour Energy regarding providing supply to the Badgerys Creek development area. It follows publication of the options screening notice and DPAR, both of which were published on 20 December 2022.

Endeavour Energy invited written submissions on the materials contained in the DPAR (over a six-week consultation period) and no submissions were received.

2.2 Contact details

All enquiries regarding this FPAR should be directed to Endeavour Energy's Portfolio Management Office at consultation@endeavourenergy.com.au.

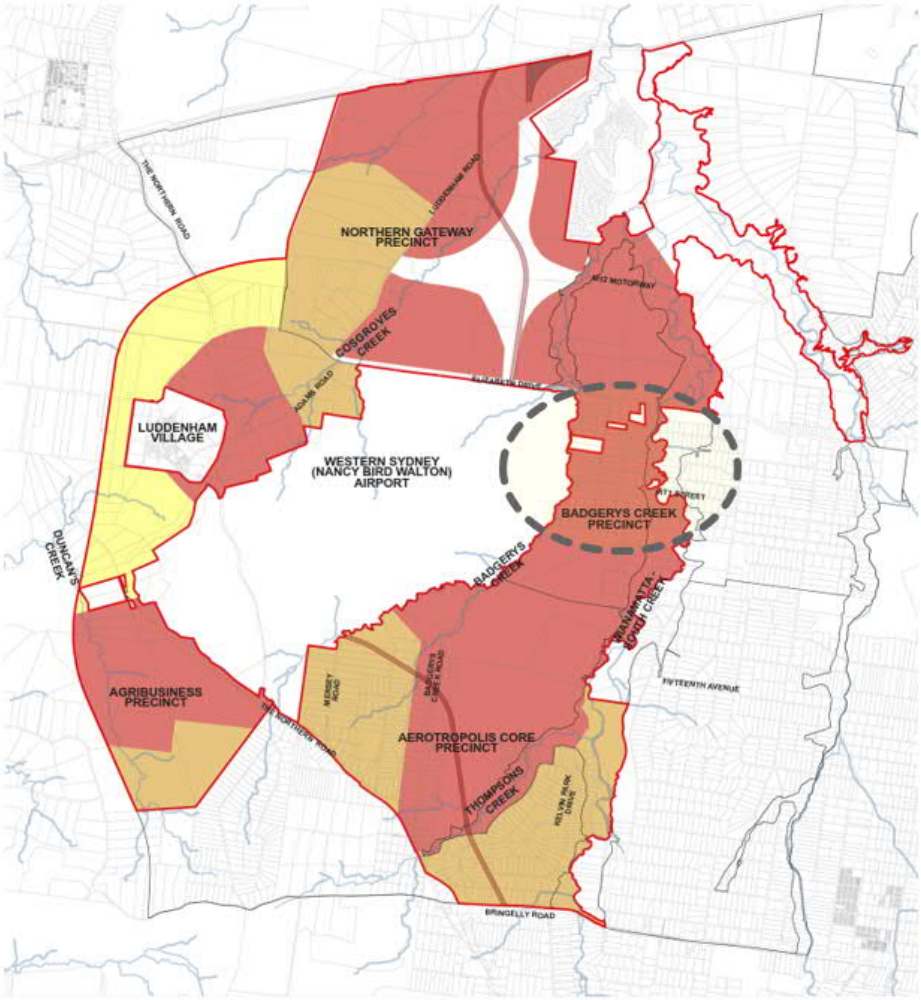
3.0 Context of the project

The Badgerys Creek Precinct is located within the Western Sydney Airport development area which is also referred to as the Western Sydney Aerotropolis. This area is defined in the Aerotropolis land use and zoning plan, however we have used the term 'Badgerys Creek development area' to include the area north of the Badgerys Creek Precinct to include key developments including a major water recycling facility and a business park located to the north of Elizabeth Drive.

The area is zoned for Enterprise land use and will feature transport, logistics and light industry and will not include any major residential development. The area is within close proximity to the airport (2kms from the airport boundary to the nearest part of the precinct) and will be an attractive location for businesses participating in the supply chain for goods transiting the airport. The area is currently supplied by a low capacity overhead electricity network that was originally designed and constructed prior to the development of the airport and is not capable of providing the supply capacity or the customer connection requirements of the developments planned for the area.

An overview of the Aerotropolis and the Badgerys Creek location is shown in Figure 2. The area is located to the east of the airport.

Figure 2 – Overview of the Aerotropolis and the Badgerys Creek Precinct in relation to the Western Sydney Airport



4.0 Network need

The Badgerys Creek development area will principally comprise enterprise, commercial and industrial customers and the electricity demand forecast for the area has been based on the land use zoning and the major developments proposed for the area. The network need of the Badgerys Creek development area includes the requirement to connect customers by providing a connection to the network as well as the ability to supply the required demand of the customers.

Key developments in the area include:

- The Elizabeth Enterprise Precinct (EEP), which is expected to grow to a maximum demand of 13 MVA by 2029 and 39 MVA by 2051;
- Sydney Water's Upper South Creek Advanced Water Recycling Centre (AWRC), which is expected to grow to a maximum demand of 5 MVA by 2029 and 17 MVA by 2051; and
- the Badgerys Creek Enterprise Area (south of Elizabeth Drive), which is expected to grow to a maximum demand of 2 MVA maximum load from 2029 and 27 MVA by 2051.

The location of these key developments in the area is illustrated in figure 3. In total, developments in this area are expected to require approximately 20 MVA of supply capacity by 2031 and 80 MVA by 2050.

Figure 3 – Location of key load developments in the Badgerys Creek development area

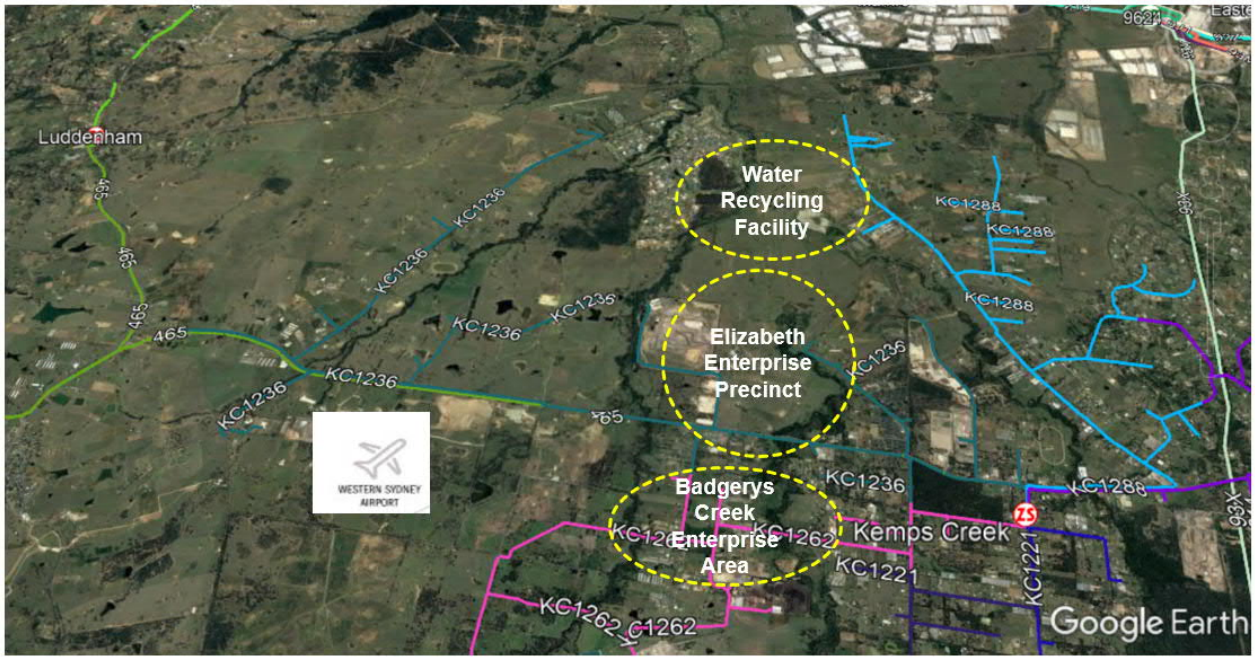
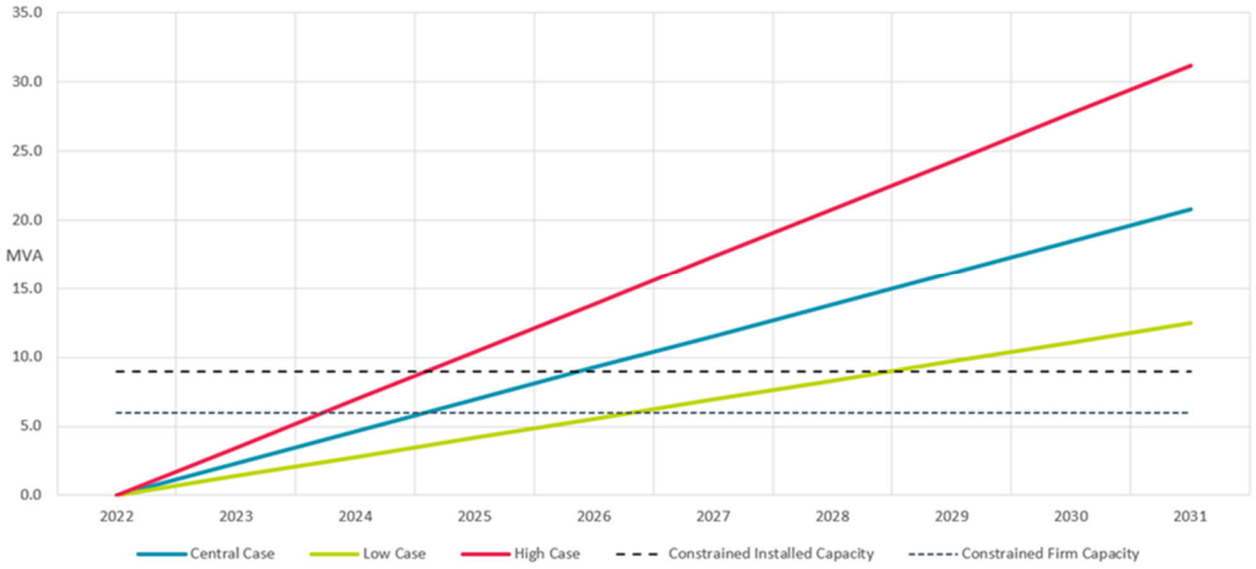


Figure 4 below shows our forecast maximum demand under a central, low and high demand scenario for the Badgerys Creek development area. It also shows the available supply capacity of the existing network assets in the area.

Figure 4 – Badgerys Creek development area maximum demand forecasts from 2022 to 2031



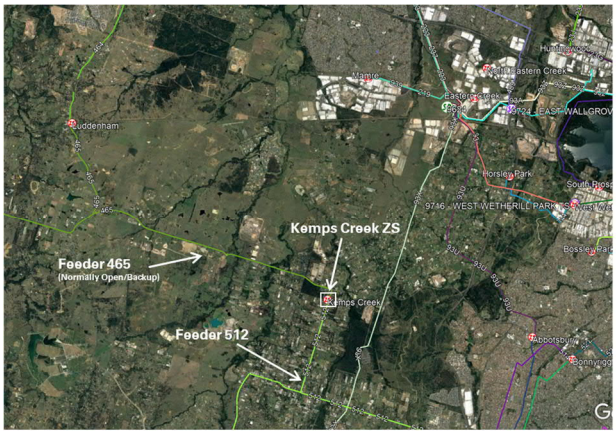
The demand forecasts have been developed to take into account the possible differences in timing of the major developments. In particular, the central scenario demand forecast represents the most likely level of demand expected in the Badgerys Creek development area based on the information provided by the proponents of the developments and their expected timeframes for development. This forecast is moderated and diversified to take into account our knowledge of similar developments in areas such as Erskine Park and Moorebank where there are similar developments of enterprise zoned areas in recent years. The high and low scenario demand forecasts represent respectively accelerated and delayed rates of development for the area.

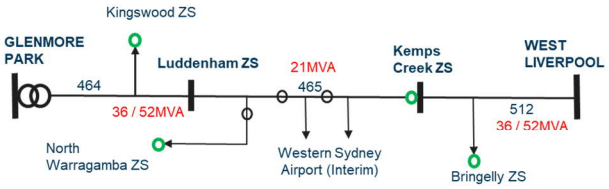
Existing Network is Constrained

The location of the Badgerys Creek development area is currently served by the Kemps Creek zone substation. The existing network is predominantly an overhead network and was constructed to meet the historical requirements of the area, which was sparsely populated with rural residential demand including agriculture.

Kemps Creek zone substation has two 25MVA transformers and supplies the surrounding area by 11kV feeders. Kemps Creek zone substation is in turn supplied at 33kV from two 33kV feeders. Figure 5 below shows the existing 33kV supply network in the area of Badgerys Creek and Kemps Creek.

Figure 5 – Existing 33kV supply network to the Kemps Creek area





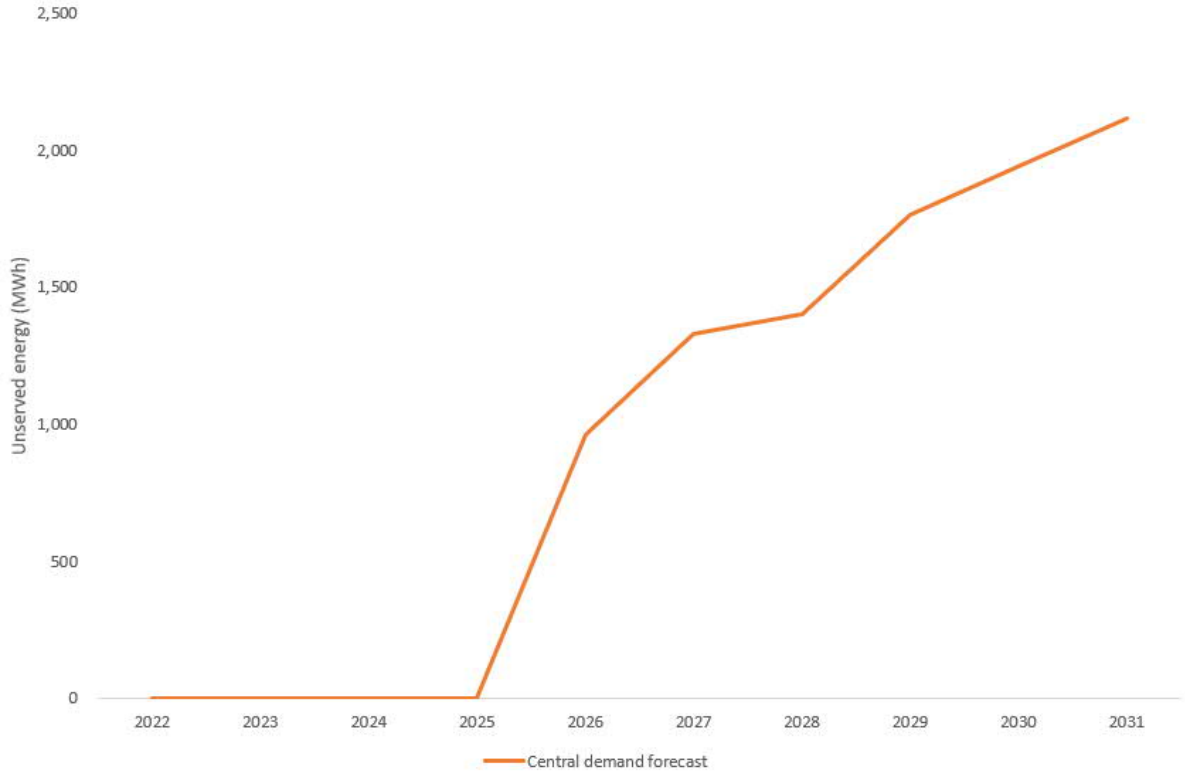
Importantly, the existing network in the area is not capable of servicing the growth in electricity demand. In particular, it is subject to a number of network constraints that inhibit the ability to supply the forecast demand based on the load growth from the major developments in the area. These network constraints are summarised in table 2 below.

Table 2 – Network constraints in the Badgerys Creek development area

Network Constraint	Description
Distribution network capacity from Kemps Creek ZS to the Badgerys Creek development area.	The Badgerys Creek development area is currently supplied from Kemps Creek ZS and the interim supplies for the Elizabeth Enterprise Precinct and the water recycling facility will be supplied by 11kV feeders from Kemps Creek ZS. The interim supplies will be insufficient by mid 2025 due to the lack of available 11kV feeder connections at Kemps Creek ZS and limitations on feeder egress from Kemps Creek ZS to the customer connection locations.
Kemps Creek ZS transformer firm capacity.	The Kemps Creek ZS firm transformer capacity will be exceeded by 2025. This is due to the load growth in the Kemps Creek area, Elizabeth Enterprise Precinct, the Sydney Water Facility, the Badgerys Creek area (south of Elizabeth Drive), the Austral areas, the provision of construction supplies for the WSA and Sydney Metro. Kemps Creek ZS has 2 x 25MVA transformers.
33kV Feeder 512 firm capacity.	The 33kV supply to Kemps Creek ZS will decrease its firm capacity as the demand on Feeder 464 from Glenmore Park ZS will increase due to load growth on Luddenham ZS and the interim supply to Western Sydney Airport. The establishment of the Western Sydney Airport TS in 2024 will provide a strong 33kV source of supply to the Feeder 465 and will alleviate this constraint in the period after 2024.

The initial customer demand from the development can be serviced by 8MVA of available capacity at Kemps Creek Zone Substation however this capacity is estimated to be exceeded by 2025/26. If network augmentation is not undertaken then there will be significant unserved energy in our network over the next decade –Figure 6.

Figure 6 – Forecast unserved energy for the Badgerys Creek development area central scenario



Although we expect that there will be significant market benefits associated with providing supply to the Badgerys Creek development area, we consider the need for this investment a 'reliability corrective action' due to our regulatory obligations to connect new customers. These regulatory obligations are set out in the box below.

'Identified need' for this Regulatory Investment Test for Distribution (RIT-D)

We have initiated this Regulatory Investment Test for Distribution (RIT-D) to investigate, and consult upon, how to most efficiently provide supply to new customers in the Badgerys Creek development area.

Endeavour Energy is required to connect customers under section 5.2.3(d) of the National Electricity Rules (NER), which state 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 timing of the identified need for this RIT-D, and so the required timing for credible options to address the need, is determined by when the expected customer connection requirement will exceed the existing network capacity. This is currently anticipated to be 2025/26, based on our demand forecasts which are further based on the requirement to connect new customers.

5.0 Preferred Option

The option that presents the highest net market benefit and is therefore considered as the preferred option is Option 2A. This option involves the establishment of a 132/22kV zone substation at Badgerys Creek in a location central to the major developments in the area. The zone substation will be supplied from two 132kV feeders with one from the Western Sydney Airport TS and one from the existing major feeder 93X. The substation will include two 45MVA power transformers and include distribution works to provide 22kV connection capability to major developments.

The total cost of this option is estimated to be $52.4 million in 2022/23 dollars and construction is expected to commence in 2023/24 with commissioning of the zone substation and distribution works to occur in 2025/26.

A detailed breakdown of the scope of this option is provided in **Section 6.0**.

6.0 Credible options considered

Four options were determined to be credible in addressing the network need and have been assessed in comparison to a “do nothing” (or no proactive intervention) base case. These are:

- Option 1 — establish Badgerys Creek zone substation with supply from the Western Sydney Airport Transmission Substation (WSA TS);
- Option 2A — establish Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X;
- Option 2B — stage Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X; and
- Option 2C — establish Badgerys Creek zone substation and stage 132kV supply from WSA TS and existing feeder 93X.

This section provides detailed information on the scope and cost of these options. It also discusses options that were considered but were not progressed further.

Each of the credible options involve establishing a Badgerys Creek zone substation with two 45 MVA transformers and two 132kV transmission mains feeders. However, these options vary by staging the installation of the transformers and the 132kV feeders. The options also include different sources of 132kV supply including from an existing feeder, 93X, which allows for a diversified 132kV supply to the entire Aerotropolis area, improving supply security and reliability across the wider network.

Figure 7 provides an overview of the broader Aerotropolis precinct electricity supply plan including the proposed Badgerys Creek ZS and Figure 8 provides an aerial view of the development area and proposed network infrastructure.

Figure 7 – Overview of Aerotropolis precinct with proposed and existing network infrastructure

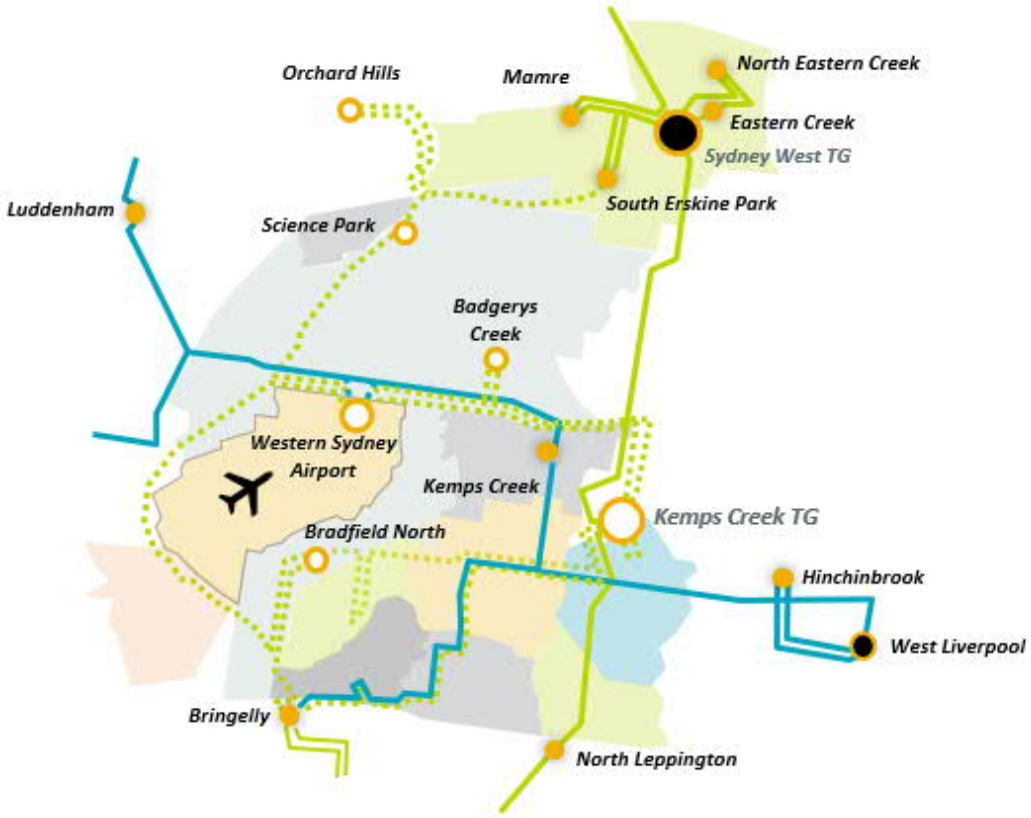
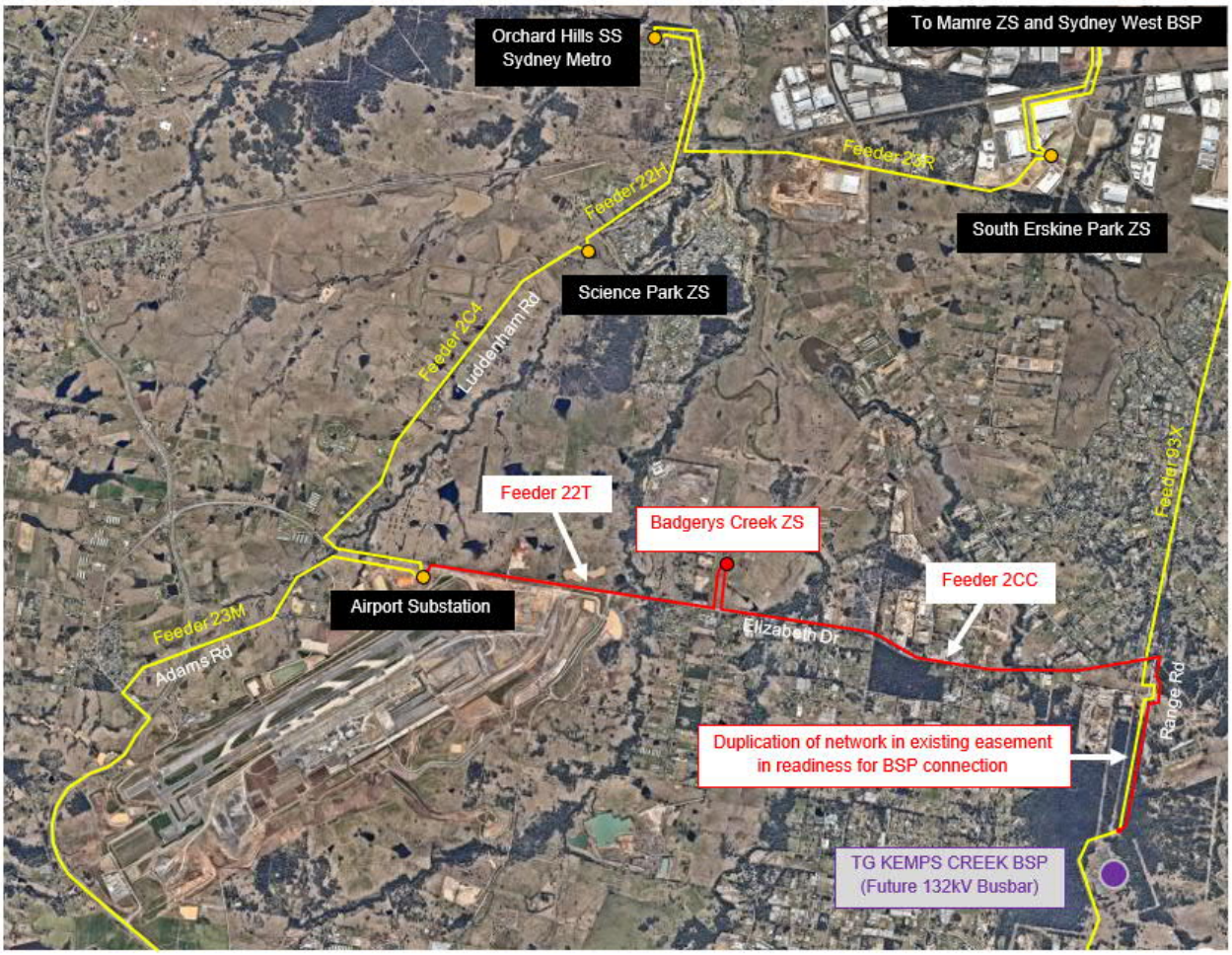


Figure 8 – Proposed Badgerys Creek ZS in relation to the existing and proposed 132kV supply.



The red lines show the proposed network assets to be installed under this RIT-D including the Badgerys Creek ZS. The red lines show the 132kV mains route proposed including a section catering for a high capacity connection to the future 132kV Bulk Supply Point at Kemps Creek. Feeder 22T and 2CC use the proposed feeder names for these mains.

6.1 Option 1 – Establish Badgerys Creek ZS with supply from WSA TS

Option 1 involves establishing the Badgerys Creek zone substation in a single stage. The zone substation would comprise two 45MVA transformers with transmission supply provided by two 132kV feeders from the Western Sydney Airport transmission substation (WSA TS). It would also be designed to have provision for a third future transformer which, based on the current demand forecast, is expected to be required in the period 2035 to 2045.

The total cost of this option is estimated to be $45.2 million and the construction of the Badgerys Creek zone substation would commence in 2023/24 with commissioning in 2025/26.

Table 3 provides an overview of the scope of works and capital cost of works for Option 1 with operating costs estimated to be 0.4 per cent of total capital expenditure.

Table 3 – Scope of works and costs for Option 1

Scope	Description	Capital cost estimate ($M)

Zone Substation	Establishment of Badgerys Creek zone substation:
	• 132/22kV zone substation with two 45MVA transformers
	• Building(s) to house 22kV switchboards
	• Building(s) to house protection control equipment and amenities
	• Spatial provision for future:
	  o Third 45MVA transformer
	  o Third incoming 132kV feeder bay
	  o Additional 22kV switchboard
	  o Grid Battery Energy Storage System
		$21.3

Transmission Mains	Establishment of two 132kV feeders providing supply to Badgerys Creek zone substation: • Two feeders from WSA TS to Badgerys Creek zone substation (underground cables each with 3.6km route length and 275MVA capacity) • Associated protection works and communications fibre	$18.9
Distribution	Construction of seven 22kV distribution feeders: • 2 x 22kV feeders for the Elizabeth Enterprise Precinct. • 2 x 22kV feeders for the major water facility. • 1 x 22kV feeder heading westward towards the Northern Gateway area. • 2 x 22kV feeders and autotransformers for Kemps Creek ZS feeder ties with the location of the ties south of Elizabeth Drive (closer to the Kemps Creek ZS location to allow for beneficial load transfer). • 22kV conversion of network to be transferred to Badgerys Creek ZS. • Implement AFIC, time clock and/or smart meter conversions as required to support hot water heating service to residential areas south of Elizabeth Drive that may require back up supply.	$5.0
Total	Establishment of Badgerys Creek ZS including 132kV supply and distribution works.	$45.2

6.2 Option 2A – Establish Badgerys Creek ZS with supply from WSA TS and 93X

Option 2A involves establishing the Badgerys Creek zone substation in a single stage. The zone substation would comprise two 45MVA transformers with transmission supply provided by two 132kV feeders – one from the Western Sydney Airport TS and the other from a connection to the existing feeder 93X. It would also be designed to have provision for a third future transformer which, based on the current demand forecast, is expected to be required in the period 2035 to 2045.

The main difference between Option 1 and Option 2A is the 132kV supply to the zone substation being from two different sources – one source from the west (the WSA TS) and another from the east (feeder 93X). Connecting to feeder 93X is advantageous because it has significant benefits (included in the market benefits assessment) in terms of diversifying the supply security and reliability of the Aerotropolis area by providing an alternative supply to the area in addition to the Aerotropolis backbone feeder (which will be the primary supply for Western Sydney Airport).

Connecting to feeder 93X also provides a future high-capacity connection to the future augmentation of Transgrid's Kemps Creek Bulk Supply Point (BSP) to provide 132kV supply to the Aerotropolis area, which is expected by 2030 (subject to Joint Planning TNSP & DNSP). This option would therefore facilitate connection to Transgrid's Kemps Creek BSP as soon as it is available. It would also assist in avoiding potential delays associated with construction of the feeder in public roads and environmental and easement considerations for routes from underground to overhead in connecting to the Transgrid site.

The total cost of this option is estimated to be $52.4 million and the construction of the Badgerys Creek zone substation would commence in 2023/24 with commissioning in 2025/26. The higher cost relative to Option 1 reflects the increased length of feeder required to connect to feeder 93X. Table 4 provides an overview of the scope of works and capital cost of works for Option 2A with operating costs estimated to be 0.4 per cent of total capital expenditure.

Table 4 – Scope of works and costs for Option 2A

Scope	Description	Cost Estimate ($M)

Zone Substation	Establishment of Badgerys Creek zone substation:
	• 132/22kV zone substation with two 45MVA transformers
	• Building(s) to house 22kV switchboards
	• Building(s) to house protection control equipment and amenities
	• Spatial provision for future:
	  o Third 45MVA transformer
	  o Third incoming 132kV feeder bay
	  o Additional 22kV switchboard
	  o Grid Battery Energy Storage System
		$21.3

Transmission Mains	Establishment of two 132kV feeders providing supply to Badgerys Creek zone substation: • One feeder from WSA TS to Badgerys Creek zone substation (underground cable with 3.6km route length and 275MVA capacity) • One feeder from 93X to Badgerys Creek zone substation (underground cable with 6.0km and 275MVA capacity and 2.0km overhead route length in the 93X easement to the location of Transgrid's Kemps Creek BSP). • Associated protection works and communications fibre	$26.1
Distribution	Construction of seven 22kV distribution feeders: • 2 x 22kV feeders for the Elizabeth Enterprise Precinct. • 2 x 22kV feeders for the major water facility. • 1 x 22kV feeder heading westward towards the Northern Gateway area. • 2 x 22kV feeders and autotransformers for Kemps Creek ZS feeder ties with the location of the ties south of Elizabeth Drive (closer to the Kemps Creek ZS location to allow for beneficial load transfer). • 22kV conversion of network to be transferred to Badgerys Creek ZS. • Implement AFIC, time clock and/or smart meter conversions as required to support hot water heating service to residential areas south of Elizabeth Drive that may require back up supply.	$5.0
Total	Establishment of Badgerys Creek ZS including 132kV supply and distribution works.	$52.4

6.3 Option 2B – Stage Badgerys Creek ZS with supply from WSA TS and 93X

Option 2B involves establishing the Badgerys Creek zone substation in two stages. In particular, Badgerys Creek zone substation would be established with one 45MVA transformer and with transmission supply provided by two 132kV feeders – one from the WSA TS and other from a connection to the existing feeder 93X. It would also be designed to have provision for a third future transformer which, based on the current demand forecast, is expected to be required in the period 2035 to 2045.

The key advantages of this option are similar to those described in relation to Option 2A, reflecting its nature as the same technical solution (although with staging). In particular, connecting to feeder 93X has significant benefits in terms of diversifying the supply security and reliability of the Aerotropolis area by providing an alternative supply to the area in addition to the Aerotropolis backbone feeder (which will be the primary supply for Western Sydney Airport). Further, it facilitates connection to Transgrid's Kemps Creek BSP as soon as it is available and assists in avoiding potential delays associated with construction of the feeder in public roads and environmental and easement considerations for routes from underground to overhead in connecting to the Transgrid site.

However, this option would be associated with higher expected unserved energy during the period of the zone substation being supplied by the single transformer.

The total cost of this option is estimated to be $53.7 million and the construction of the Badgerys Creek zone substation (with a single transformer and supply from two 132kV feeders) would commence in 2023/24 with commissioning in 2025/26. Works to install the second transformer would commence in 2026/27 with commissioning in 2027/28. The increase in costs relative to option 2A reflect the need to demobilise and remobilise works on the site.

Table 5 provides an overview of the scope of works and capital cost of works for Option 2B with operating costs estimated to be 0.4 per cent of total capital expenditure.

Table 5 – Scope of works and costs for Option 2B

Scope	Description	Cost Estimate ($M)

Zone Substation	Establishment of Badgerys Creek zone substation:
	• 132/22kV zone substation with two 45MVA transformers (Staged for commissioning in FY26 and FY28 including demobilisation and remobilisation on the work site for the second transformer installation.)
	• Building(s) to house 22kV switchboards
	• Building(s) to house protection control equipment and amenities
	• Spatial provision for future:
	  o Third 45MVA transformer
	  o Third incoming 132kV feeder bay
	  o Additional 22kV switchboard
	  o Grid Battery Energy Storage System
		$22.6

Transmission Mains	Establishment of two 132kV feeders providing supply to Badgerys Creek zone substation: • One feeder from WSA TS to Badgerys Creek zone substation (underground cable with 3.6km route length and 275MVA capacity) • One feeder from 93X to Badgerys Creek zone substation (underground cable with 6.0km and 275MVA capacity and 2.0km overhead route length in the 93X easement to the location of Transgrid's Kemps Creek BSP). • Associated protection works and communications fibre	$26.1
Distribution	Construction of seven 22kV distribution feeders: • 2 x 22kV feeders for the Elizabeth Enterprise Precinct. • 2 x 22kV feeders for the major water facility. • 1 x 22kV feeder heading westward towards the Northern Gateway area. • 2 x 22kV feeders and autotransformers for Kemps Creek ZS feeder ties with the location of the ties south of Elizabeth Drive (closer to the Kemps Creek ZS location to allow for beneficial load transfer). • 22kV conversion of network to be transferred to Badgerys Creek ZS. • Implement AFIC, time clock and/or smart meter conversions as required to support hot water heating service to residential areas south of Elizabeth Drive that may require back up supply.)	$5.0
Total	Establishment of Badgerys Creek ZS including 132kV supply and distribution works.	$53.7

6.4 Option 2C – Establish Badgerys Creek ZS and stage 132kV supply

Option 2C involves establishing the Badgerys Creek zone substation in a single stage, but staging its 132kV supply. In particular, Badgerys Creek zone substation would be established with two 45MVA transformers and with transmission supply from a single 132kV feeder from WSA TS. A feeder that connects to the existing feeder 93X would subsequently be commissioned. The zone substation would also be designed to have provision for a third future transformer which, based on the current demand forecast, is expected to be required in the period 2035 to 2045.

The key advantages of this option are similar to those described in relation to Option 2A and 2B, reflecting its nature as the same technical solution (although with a different type of staging). In particular, connecting to feeder 93X has significant benefits in terms of diversifying the supply security and reliability of the Aerotropolis area by providing an alternative supply to the area in addition to the Aerotropolis backbone feeder (which will be the primary supply for Western Sydney Airport). Further, it facilitates connection to Transgrid's Kemps Creek BSP as soon as it is available and assists in avoiding potential delays associated with construction of the feeder in public roads and environmental and easement considerations for routes from underground to overhead in connecting to the Transgrid site.

However, this option would incur higher expected unserved energy during the period of the zone substation being supplied by the single 132kV feeder. Although the single feeder from the WSA TS would have sufficient capacity to supply the zone substation, it would result in a higher level of reliability and security of supply risk due to the dependence on the single transmission feeder. If there were a fault on the single feeder there would be a long duration outage to customers.

The total cost of this option is estimated to be $52.9 million and the construction of the Badgerys Creek zone substation (with two transformers and a single 132kV supply feeder) would commence in 2023/24 with commissioning in 2025/26. Works to construct the second feeder connecting to feeder 93X would commence in 2025/26 with commissioning in 2027/28.

Table 6 provides an overview of the scope of works and capital cost of works for Option 2C with operating costs estimated to be 0.4 per cent of total capital expenditure.

Table 6 – Scope of works and costs for Option 2C

Scope	Description	Cost Estimate ($M)

Zone Substation	Establishment of Badgerys Creek zone substation:
	• 132/22kV zone substation with two 45MVA transformers
	• Building(s) to house 22kV switchboards
	• Building(s) to house protection control equipment and amenities
	• Spatial provision for future:
	  o Third 45MVA transformer
	  o Third incoming 132kV feeder bay
	  o Additional 22kV switchboard
	  o Grid Battery Energy Storage System
		$21.3

Transmission Mains	Establishment of two 132kV feeders providing supply to Badgerys Creek zone substation: • FY2026 :- One feeder from WSA TS to Badgerys Creek zone substation (underground cable with 3.6km route length and 275MVA capacity) • FY2028 :- One feeder from 93X to Badgerys Creek zone substation (underground cable with 6.0km and 275MVA capacity and 2.0km overhead route length in the 93X easement to the location of Transgrid's Kemps Creek BSP). • Associated protection works and communications fibre	$26.6
Distribution	Construction of seven 22kV distribution feeders: • 2 x 22kV feeders for the Elizabeth Enterprise Precinct. • 2 x 22kV feeders for the major water facility. • 1 x 22kV feeder heading westward towards the Northern Gateway area. • 2 x 22kV feeders and autotransformers for Kemps Creek ZS feeder ties with the location of the ties south of Elizabeth Drive (closer to the Kemps Creek ZS location to allow for beneficial load transfer). • 22kV conversion of network to be transferred to Badgerys Creek ZS. • Implement AFIC, time clock and/or smart meter conversions as required to support hot water heating service to residential areas south of Elizabeth Drive that may require back up supply.)	$5.0
Total	Establishment of Badgerys Creek ZS including 132kV supply and distribution works.	$52.9

6.5 Options considered but not progressed

Endeavour Energy considered a number of options that we have not progressed to the DPAR and FPAR stage. These options, and our reasoning for not progressing them, are summarised in table 7.

Table 7 – Options considered but not progressed

Option	Reason not progressed
Augmentation of existing Kemps Creek zone substation	Possible network options considered were adding a third transformer and augmenting the existing transformers to 35MVA (from 25MVA) and conversion of the Kemps Creek zone substation to 132kV. However, both of these options would require long duration planned outages to the Kemps Creek zone substation during the construction works period to the detriment of customers supplied by the zone substation.
Establish Badgerys Creek zone substation with single transformer and single 132kV supply from WSA TS	This option would be associated with a lack of firm capacity supply from a single transformer and single transmission supply. There would also be insufficient back up capacity from the distribution network to support this option. The Badgerys Creek development area will be a 22kV distribution network and initially there will be no backup at 22kV and will therefore rely on autotransformers to the adjacent 11kV networks. It is estimated that there will not be a widespread 22kV network in adjacent areas until 2030.
Establish Badgerys Creek zone substation with single transformer and single 132kV supply from feeder 93X	This option would be associated with a lack of firm capacity supply from a single transformer and single transmission supply. There would also be insufficient back up capacity from the distribution network to support this option. The Badgerys Creek development area will be a 22kV distribution network and initially there will be no backup at 22kV and will therefore rely on autotransformers to the adjacent 11kV networks. It is estimated that there will not be a widespread 22kV network in adjacent areas until 2030.
Stage Badgerys Creek zone substation with two 132kV feeders from WSA TS	This is a staged variant of Option 1. However, we do not propose to progress staging of this option further because it would not provide full alignment to the Aerotropolis growth servicing strategy that utilises the new Transgrid BSP for the area.

7.0 Modelling & Assumptions

7.1 Assumptions

The RIT-D states that the preferred option is the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM.

The market benefit of a credible option is calculated by comparing the credible option in place with the state of the system in the base case. The emphasis in this situation is differences in the risks of involuntary load shedding.

The market benefits that can be considered under the National Electricity Rules are:

- Changes in voluntary load curtailment (considered a negative benefit);
- Changes in involuntary load shedding and customer interruptions caused by network outages;
- Changes in costs to other parties (timing of new plant, capital costs, operating and maintenance costs);
- Differences in timing of expenditure;
- Changes in load transfer capacity and the capacity of embedded generators to take up load;
- Option value;
- Changes in electrical energy losses; and
- Any other class of market benefit determined to be relevant by the AER.

The time period chosen for the NPV analysis was 30 years.

7.1.1 Energy at risk and expected unserved energy

A core justification for this project is based on the load at risk and energy not able to be supplied to customers waiting to connect to the network. This is different to the situation where existing connected customers risk losing supply by a fault on the network. The same VCR value has been applied as a default position to the energy at risk values established from the connection requests received. For a greenfield development such as this, where the forecast demand rapidly exceeds the available capacity in the network, the VCR benefits to be captured from implementing a project to address network constraints can rapidly rise to extremely large amounts. The Energy at Risk (EAR) has been estimated from the annual peak demand forecasts and load duration curves. EAR was capped at a constant value based on 2029/30 levels.

7.1.2 Load profile characteristics

Due to the fact that the area will not be fully developed for a few years we have assessed the identified need using a representative demand profile to capture time of day and seasonal variations in demand.

Specifically, the demand profile is based on the Moorebank Zone Substation load profile, an existing commercial, industrial and light enterprise area.

Figure 9 below presents the normalised load duration curve (LDC) and Figure 10 presents the peak load profile for a summer day assumed for the customer connections associated with the Badgerys Creek development area.

Figure 9 – Normalised LDC assumed for customer connections expected within the Badgerys Creek development area

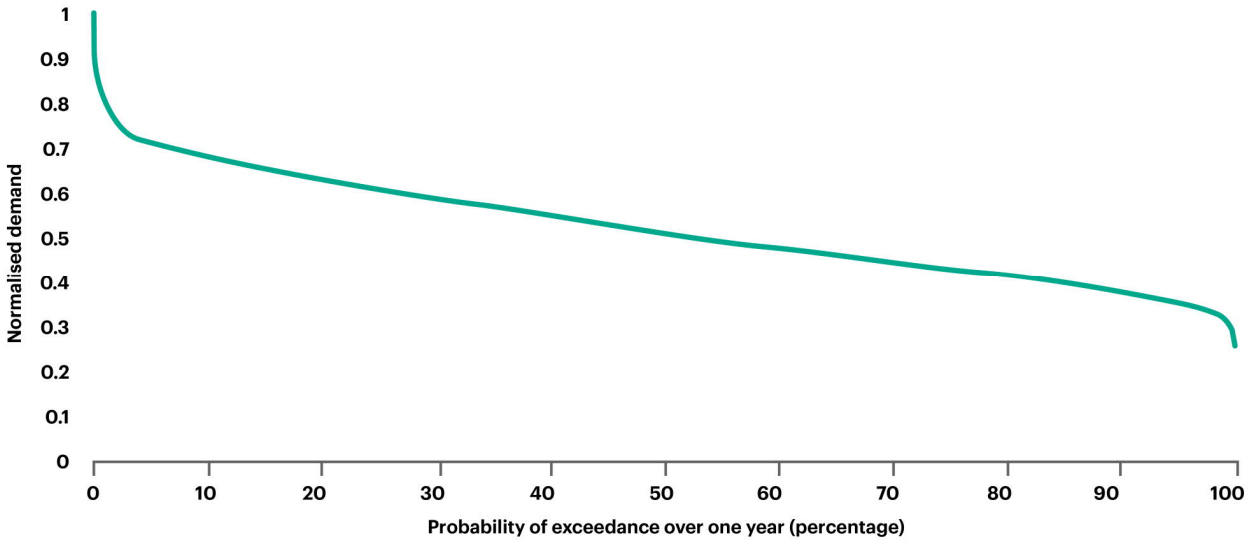
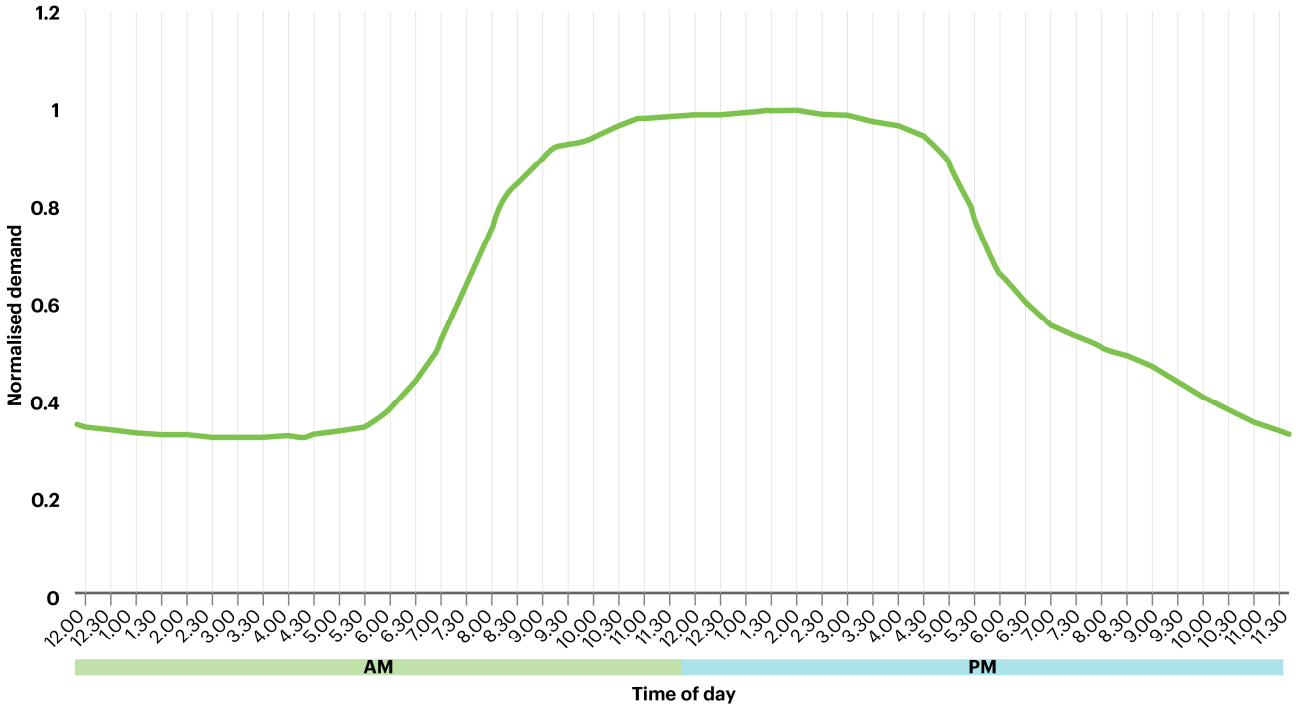


Figure 10 – Peak summer day profile for customer connections expected within the Badgerys Creek development area



7.1.3 Value of customer reliability

The value of unserved energy is calculated using the Value of Customer Reliability (VCR). This represents an estimate of the value electricity consumers place on a reliable electricity supply. Endeavour Energy used a VCR of $44,582 per MWhr in the evaluation which is based on the VCR values provided by the AER, weighted in accordance with the composition of the commercial, industrial and residential demand within the Aerotropolis Area. Although the Badgerys Creek development area is zoned for enterprise land use and with no major new residential development, we have used an average load composition for the Aerotropolis area reflecting the requirement of predominantly enterprise zoned areas to provide backup supply to adjacent residential areas. This approach is conservative and leads to a lower VCR value. A breakdown of this calculation is provided in Table 8 below.

Table 8 – Composite VCR used in the evaluation

Parameter	Commercial	Industrial	Residential
Demand composition of the Aerotropolis Area including the Badgerys Creek development area	30%	40%	30%
AER VCR	$44,830	$64,230	$21,290
Demand weighted VCR ($/MWhr)			**$44,582**

7.2 Classes of market benefit considered

7.2.1 Changes in involuntary load shedding

Changes in involuntary load shedding and the associated customer interruptions caused by network outages are the sole market benefits that are considered material and have been quantified in this RIT-D assessment.

Increasing the supply capability in the Badgerys Creek development area increases the supply available to meet the growth in demand within these areas. This will provide greater reliability for this area by reducing potential supply interruptions and consequent risk of involuntary load shedding. The present rules only allow for consideration of changes in involuntary load shedding for connected customers. The establishment of supply in a greenfield area where potential customers would otherwise not have supply is therefore captured using changes in involuntary load shedding.

7.3 Classes of market benefit not considered to be material

The classes of market benefits that are not considered material include:

- Differences in timing of expenditure;
- Changes in voluntary load curtailment;
- Option value;
- Changes in load transfer capacity;
- Changes in costs to other parties; and
- Changes in electrical losses.

These are further detailed below.

7.3.1 Differences in timing of expenditure

Differences in the timing of expenditure relates to the potential for a credible option to change the timing (or configuration) of other future investments to be made by or for the RIT-D proponent. Importantly, this relates to distribution investments that address identified needs other than those addressed by the credible option.

Given that this investment is concerned with establishing supply in the greenfield area of the Badgerys Creek development area, we do not consider differences in the timing of expenditure to be material for this RIT-D.

7.3.2 Changes in voluntary load curtailment

Voluntary load curtailment is when customers agree to reduce their demand to address a network limitation in return for a payment. A credible demand side option to enlist such customers to voluntarily reduce demand could lead to a reduction in involuntary load shedding.

Endeavour Energy has not estimated any market benefits associated with changes in voluntary load curtailment as there is insufficient capacity in the existing customer base to deliver sufficient voluntary demand reduction.

7.3.3 Option value

Endeavour Energy notes that the AER's view is that option value is likely to 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 by the RIT-D proponent are sufficiently flexible to respond to that change.

Due to the certainty of the Badgerys Creek development area being developed, there is little doubt about the need and use of the infrastructure investment and each option is considered equivalent in that respect. Option value has therefore not been considered in the economic analysis.

7.3.4 Changes in load transfer capability

Distribution investments can improve load transfer capacity where a credible option allows end users to gain access to a back-up power supply. This is a market benefit because backed-up power supplies can service end-users in the event of power failure. The primary objective of this project is to facilitate connection of new customers in the area. Because the areas in and around the precinct are currently mainly serviced by historical rural and residential standard distribution networks, load transfers to other parts of the network cannot be meaningfully considered until adjacent areas are further developed in the future. Immediate changes to load transfer capacity are therefore not considered material for this RIT-D.

7.3.5 Changes in costs to other parties

In this instance, Endeavour Energy has not identified any changes in costs to other parties from developing the credible options identified in this document.

7.3.6 Changes in electrical losses

Endeavour Energy recognises that there would be small changes in the loss profiles for customers across the network due to changes in the network proposed by this project requirement. The impact of the small change in loss profile for these customers is unlikely to have significant impact on the network wide distribution loss factors that will be applicable to these and other customers. These changes are captured as part of the complex annual review of distribution loss factors when more information about customer usage patterns is available. Changes in electrical losses have therefore not been modelled for this RIT-D.

7.4 Scenarios and sensitivities

The central scenario parameters and relevant references in the FPAR are summarised in Table 9.

Table 9 – Central Scenario Parameters and references in the FPAR

Parameter	Central scenario
Maximum demand forecasts	Three demand forecast scenarios provided in Section 4.0.
Capital costs	Cost Estimates provided in Section 6.
Operating & Maintenance costs	0.4 per cent of capital expenditure.
Value of customer reliability	Section 7.1.3

7.4.1 Demand forecasts

The maximum demand forecasts have been derived from a projection of the customer connection applications and enquiries and the time series forecast is presented in Section 4.0.

The central scenario has been developed from analysis of the customer connection request information. It is based on:

- An ultimate load forecast for the precinct based on surface area analysis;
- A timeframe to reach that ultimate load (the estimated time for this precinct to reach maturity is 30 years); and
- A load ramp up rate assumption (which is linear in this instance).

Probabilistic 'load realisation' factors have been applied to the development derived forecast, which in turn is calibrated by the actual connections applications that we receive over time. This load realisation factor is what differentiates the demand scenarios. In particular, the low scenario uses a lower load realisation factor than the central scenario, while the high scenario has been developed assuming a 100 per cent load realisation factor – suggesting that the full developer derived forecast will be realised in the expected timeframe.

Our demand forecast for the Badgerys Creek development area includes several large spot loads that we consider to be committed and foundational to the requirement for this investment.

7.4.2 Capital costs

Capital cost estimates have been based on the scope of work presented for each option and are based on current market pricing for materials, labour and third party contracting. The cost estimates in the FPAR have been updated from the DPAR to reflect an uplift in costs observed in materials including copper cable and also in the cost of civil and building works, particularly civil works required for placement of underground cables.

For sensitivity analysis, these estimates have been varied by ± 25%.

7.4.3 Value of customer reliability

Our analysis adopts the value of customer reliability values published by the AER to calculate the expected unserved energy. The ratio of load types has been estimated and used to calculate the weighted aggregate VCR value and then applied to the energy at risk. Based on the estimated load composition of the subject area, a demand composition weighted VCR value of $44.58 per kWh has been derived and used in the RIT-D analysis. A variation of ±25% has been used for sensitivity testing in accordance with AER guidelines.

7.4.4 Discount rates

The discount rate used in the financial analysis will impact the estimated present value of net market benefits and may affect the ranking of credible options. Endeavour Energy has employed a real, pre-tax discount rate

based on the latest AER determination as the low case. For sensitivity analysis, a symmetrical application was used to determine the high case.

7.4.5 Summary of sensitivities and scenarios

We have assessed three alternative future scenarios as part of the NPV assessment, namely:

- a **central scenario** – consisting of assumptions that reflect a central set of variable estimates, which, in our opinion, provides the most likely scenario;
- a **high benefit scenario** – reflecting an optimistic set of assumptions which have been selected to investigate an upper bound on reasonably expected market benefits; and
- a **low benefit scenario** – reflecting a number of assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world.

A summary of the key variables and framework used for each scenario is provided in Table 10 below.

Table 10 – Scenarios used in the Badgerys Creek development area NPV assessment

Parameter	Central scenario	High benefits	Low benefits
Capex	Central estimates	-25%	+25%
Demand	Central demand forecast	High demand forecast	Low demand forecast
VCR	Load-weighted AER VCR	+30%	-30%
Discount rate	3.26%	2.22%	4.30%
Maintenance costs	Central estimates	-25%	+25%

Endeavour Energy is aware of the recent AER determination on a RIT-T dispute which provided guidance on the selection of scenarios for economic assessment under the RIT-T and RIT-D. We have continued using the scenarios defined in the DPAR for this project and carried these through to the FPAR. Based on our interpretation of the recent determination, we will modify our selection of scenarios and the conduct of sensitivity analysis on future projects to ensure alignment to the principles. The DPAR for this RIT-D was published prior to the AER's determination on the recent RIT-T and we consider it unnecessary to rework the scenarios previously published in the DPAR based on a simple benefits test.

Endeavour Energy considers that the central scenario is most likely because it is based primarily on a set of expected central assumptions with regards to the key variables. We have therefore assigned this scenario a weighting of 50 per cent, with the other two scenarios being equally weighted with 25 per cent each.

8.0 Results of analysis

This section describes the results of the economic assessment for each of the credible options considered in this RIT-D.

8.1 Central case results

Table 11 presents the economic analysis of the options under the central case scenario including the present value of the benefits and costs.

The central case results show that Option 1 is preferred in comparison to Option 2A, which is preferred in the weighted case.

We reviewed these results carefully and considered the merits of Option 1 and Option 2A.

Option 1 has a lower project nominal capex due to its 132kV supply being from WSA TS and a shorter feeder route length, however the additional cost of the future 132kV connection to the expected bulk supply point at Kemps Creek has been included in the PV of costs. This provides an equal basis for comparison between the options with respect to the future connection costs to the new BSP.

Option 2A has additional benefits in comparison to Option 1 due to the 132kV supply being from diversified sources and providing increased supply security and reliability to the entire Aerotropolis area. The connection to 132kV feeder 93X will provide an east side connection and a diversification from the 132kV supply of Option 1, which is dependent upon the 132kV Aerotropolis Backbone feeder from South Erskine Park ZS to Bringelly ZS.

Option 2A would also provide an early implementation of the feeder required to enable connection of the new BSP at Transgrid's Kemps Creek substation. Option 2A would have the feeder in place by 2028, in comparison to Option 1 which would not have a new 132kV feeder in place and may restrict the full benefits of the new BSP.

Also, construction of the feeder required would involve disruption to major roads potentially after completion of major road upgrades and have a high community cost.

After careful consideration of the high benefits available from Option 2A, many of which are not fully quantified in the economic analysis required under NER, and a comparison to the relatively small difference in the NPV between Option 1 and Option 2A, we prefer Option 2A, the preferred option in the weighted scenario analysis.

The difference in the NPV is $1.2M.

Table 11 – Central case results

Option	Description	Project capex nominal ($m)	PV of market benefits ($m)	PV of costs ($m)	NPV ($m)	Rank
1	Establish Badgerys Creek zone substation with supply from the WSA TS	45.2	10,480.9	46.9[1]	10,434.0	1
2A	Establish Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X	52.4	10,481.5	48.7	10,432.8	2
2B	Stage Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X	53.7	10,479.8	49.2	10,430.6	3
2C	Establish Badgerys Creek zone substation and stage 132kV supply from WSA TS and existing feeder 93X	52.9	10,476.9	48.3	10,428.6	4

[1] The PV of costs for Option 1 includes future estimated costs of the connection works for the future Kemps Creek BSP. This provides an equal basis of comparison of the options in the economic evaluation for Badgerys Creek.

8.2 Sensitivity and scenario assessment

Endeavour Energy has carried out sensitivity analysis in the RIT-D assessment based on variations of key parameters. Specifically, Endeavour Energy has investigated as part of the scenarios changes in relation to the:

- Forecast demand, and hence quantity of involuntary load shedding;
- Value of customer reliability;
- Investment costs; and
- Discount rate.

Option 1 is the preferred option under the central case and Option 2A is the preferred option under our weighted scenario. We note the small difference in the NPV for Options 1 and 2A and note the higher non-quantified benefits of Option 2A, including the increase in supply security and reliability for the entire Aerotropolis area and the advanced preparedness for the expected new Bulk Supply Point at Transgrid's Kemps Creek.

8.3 Economic timing

The economic timing of the preferred option is the point in time when the existing network capacity is insufficient to supply new customers.

The supply to the Badgerys Creek development area requires connection capacity to be made available as soon as the existing available capacity in the network is exhausted. Based on the current demand forecast, this is expected to occur in 2026. Consequently, this date is taken to be the economic timing for this project.

Endeavour Energy is constantly monitoring customer demand in this precinct via customer network connection requests and direct discussions with major customers and other utilities. Any material delays in the development of the Badgerys Creek development area would require a reassessment of the economic timing.

9.0 Conclusion

The Badgerys Creek development area is located within the Western Sydney Aerotropolis area and is planned to be a hub for commercial and industrial developments.

Key developments in the area include:

- The Elizabeth Enterprise Precinct (EEP), which is expected to grow to a maximum demand of 13 MVA by 2029 and 39 MVA by 2051;
- Sydney Water's Upper South Creek Advanced Water Recycling Centre (AWRC), which is expected to grow to a maximum demand of 5 MVA by 2029 and 17 MVA by 2051; and
- the Badgerys Creek Enterprise Area (south of Elizabeth Drive), which is expected to grow to a maximum demand of 2 MVA maximum load from 2029 and 27 MVA by 2051.

Although the existing network capacity is able to service the initial customer connections, as demand continues to grow it will exceed the existing supply capacity of the network. In particular, the Badgerys Creek development area is expected to have demand of 20MVA by 2029 and 80MVA by 2050, while the existing available firm supply capacity is less than 10MVA from our existing constrained Kemps Creek ZS.

As outlined in the options screening notice, it is not considered feasible that a non-network solution, or SAPS solution, will form a potential credible option on a standalone basis, or form a significant part of a potential credible option for the Badgerys Creek development area RIT-D.

This RIT-D has identified four credible network-based options that can technically meet the required network demand. Each of the credible options involve establishing a Badgerys Creek zone substation (connecting to the 132kV Aerotropolis backbone feeder) with two 45 MVA transformers and two feeders. However, these options vary by whether the installation of the transformers and feeders is staged, as well whether both feeders connect to the same transmission substation, or, if one of them connects to another major feeder. In particular, the options are:

- Option 1 — establish Badgerys Creek zone substation with supply from the Western Sydney Airport Transmission Substation (WSA TS);
- Option 2A — establish Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X;
- Option 2B — stage Badgerys Creek zone substation with supply from WSA TS and existing feeder 93X; and
- Option 2C — establish Badgerys Creek zone substation and stage 132kV supply from WSA TS and existing feeder 93X.

Each of these options were considered in an economic evaluation, and Option 2A was selected as the preferred option. Although the outcome of the assessment is that each of the options were effectively ranked equal (within 1% NPV terms), there are a number of practical reasons Option 2A is preferred. Specifically, connecting to feeder 93X is advantageous because it has significant benefits in terms of diversifying the supply security and reliability of the Aerotropolis area by providing an alternative supply to the area in addition to the Aerotropolis backbone feeder (which will be the primary supply for Western Sydney Airport).

Connecting to feeder 93X also provides a future high-capacity connection to the future augmentation of Transgrid's Kemps Creek Bulk Supply Point (BSP) to provide 132kV supply to the Aerotropolis area, which is expected by 2030. This option would therefore facilitate connection to Transgrid's Kemps Creek BSP as soon as it is available. It would also assist in avoiding potential delays associated with construction of the feeder in public roads and environmental and easement considerations for routes from underground to overhead in connecting to the proposed Transgrid site.

The total cost of this option is estimated to be **$52.4 million** and the construction of the Badgerys Creek zone substation would commence in 2023/24 with commissioning in 2025/26.

Endeavour Energy will apply a suitable contingency to the cost estimate.

Cost Estimate (Option 2A – Preferred Option)	Value ($M)
Central estimate based on cost outcomes for similar recent project work including major equipment.	**52.4**
Guidance estimate including likely contingency for project delivery.	**60.0**

CONTACT

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Endeavour Energy

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