RIT-D Draft Project Assessment Report

Providing supply to the Badgerys Creek development area

20 December 2022

Endeavour Energy

CONTACT

If you have any comments or enquiries regarding this report please send them to the **Portfolio Management Office** at**:**

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Contents

1. Executive summary

This draft project assessment report (DPAR) was prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules (NER). It represents the second stage in the Regulatory Investment Test – Distribution (RIT-D).

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' 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 60MVA of electricity supply capacity by 2050.

The identified need for this investment is 'reliability corrective action' because the 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 expected customer demand requiring connection will exceed the existing network capacity. This is currently expected to be in 2025/26, based on the connection enquiries received to date.

This report follows publication of an options screening notice that found that a non-network solution is unlikely to 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 is due to the level of the forecast demand for the Badgerys Creek development area, the expected cost of non-network options and the capacity of the existing network to facilitate non-network technologies. It also found that a SAPS solution could not contribute to meeting the identified need because the customer demand requirements of the greenfield development area are significant and therefore could not be supported by a network that is not part of the interconnected national electricity system with the ability to draw on grid-connected generation sources.

Four options were determined to be credible in addressing the network need and have been assessed against a do nothing 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 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.

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 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, 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.

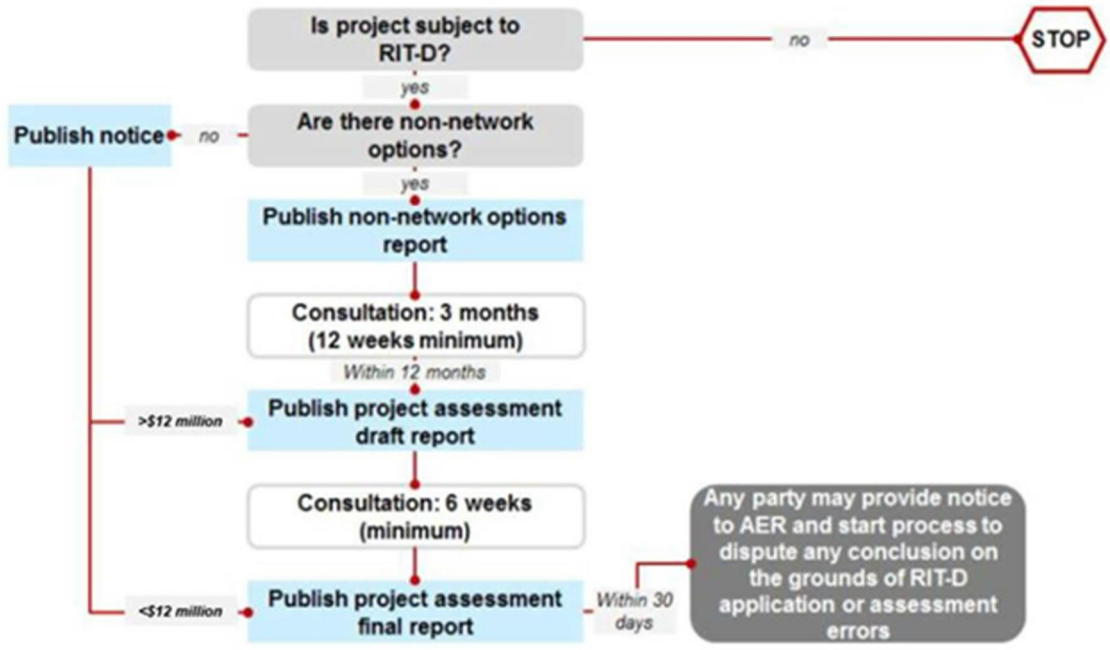
Endeavour Energy seeks written submissions from interested parties in relation to the preferred option outlined in this document. Submissions are due on or before [minimum six weeks after publication]. All submissions and enquiries should be directed to Endeavour Energy's Portfolio Management office at consultation@endeavourenergy.com.au.

2. RIT-D process

This DPAR has been prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the NER. We have already applied the RIT-D to determine the most efficient means of providing the foundation supply to the Aerotropolis precinct – a 132kV backbone feeder.[1] This DPAR represents the second step in the RIT-D process to determine the most efficient means of providing supply to the Badgerys Creek development area from the 132kV backbone. The RIT-D process is summarised in figure 1 below.

Endeavour Energy adopts a process of exploring feasible options in assessing the ability to supply new development areas in Western Sydney. However, for greenfield sites, Endeavour Energy needs to determine the length of time that the existing network will be able to sustain the prevailing precinct development rate. Endeavour Energy balances timely investment with the increase in demand as development progresses and our customers require connection to network.

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 Submissions requested to the DPAR

Endeavour Energy seeks written submissions from market participants and interested parties in relation to the preferred option outlined in this document. The consultation period is 6 weeks and submissions are due on or before **10 February 2023**. Submissions and any subsequent response by Endeavour Energy may be published.

2.2 Contact details

All submissions and enquiries regarding this DPAR should be directed to Endeavour Energy's Portfolio Management office at consultation@endeavourenergy.com.au.

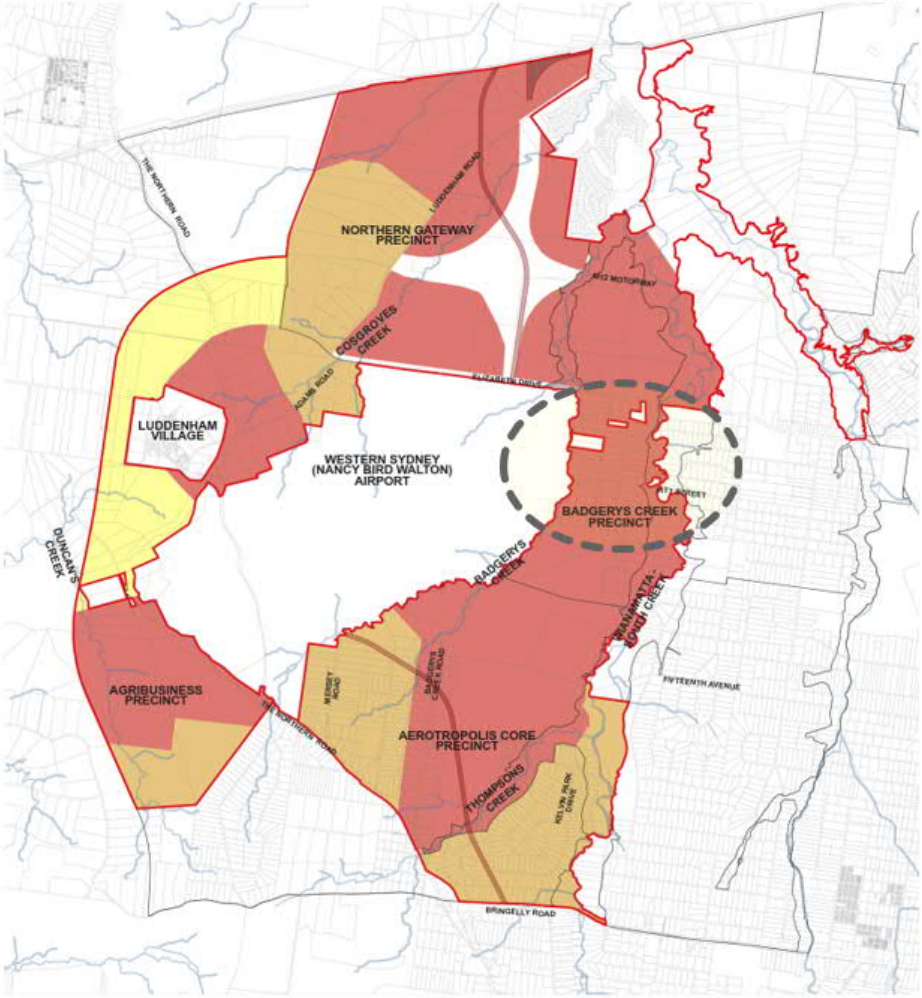
3. Key assumptions underpinning the 'identified need' for this RIT-D

This section sets out the key assumptions and methodologies that underpin the identified need for this RIT-D.

3.1 Relevant area of our network

The Badgerys Creek development area sits within the Western Sydney Aerotropolis and is planned to be a hub for commercial and industrial developments. It neighbours the Western Sydney Airport to the west, and the Aerotropolis Core Precinct to the south – figure 2.

Figure 2 – Overview of the location of the Badgerys Creek development area in our supply area



3.2 Load characteristics and demand forecast

The Badgerys Creek development area will principally comprise commercial and industrial customer demand. 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 capacity by 2031 and 60 MVA by 2050.

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

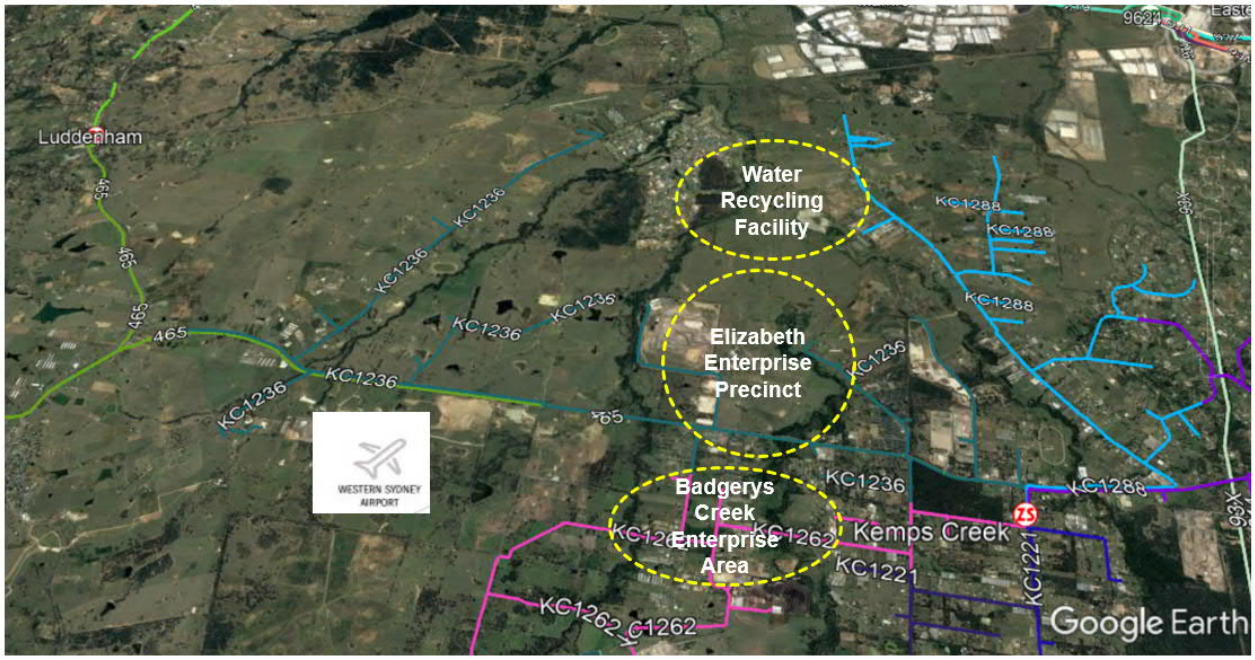
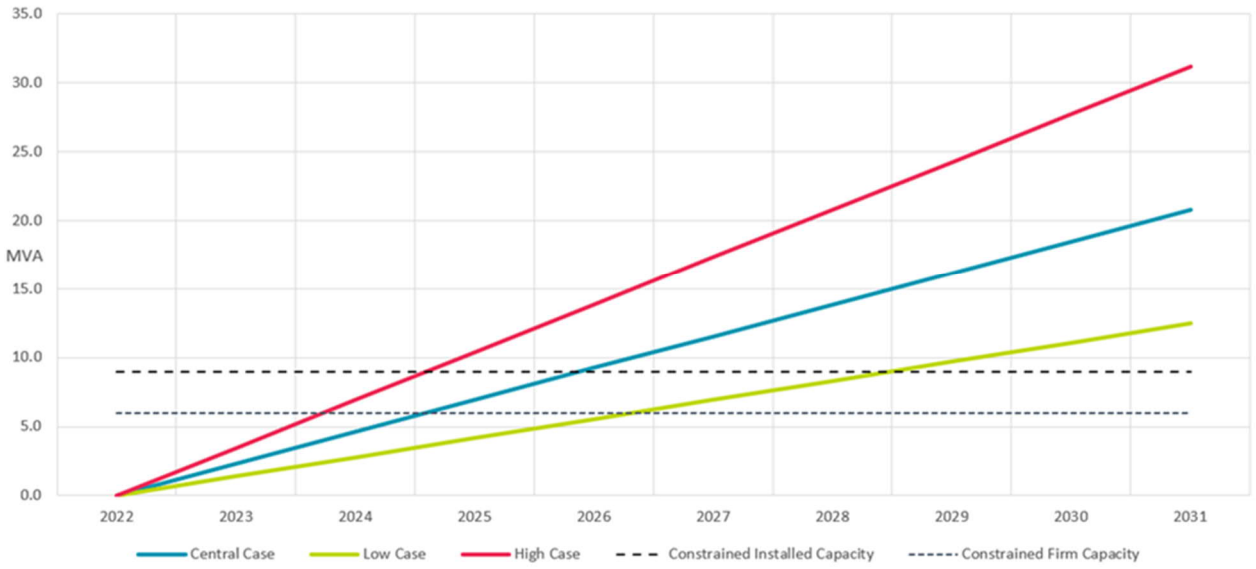


Figure 4 below shows our forecast maximum demand under a central, low and high demand scenario for the Badgerys Creek development area. It also shows the available supply capacity of the existing network infrastructure in the area (the existing network is described in greater detail in section 3.4).

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.

3.3 Expected pattern of use

Due to the fact that major customers have not yet connected to the network in this greenfield area, we have assessed the identified need using a representative demand profile, which assumes a representative load profile from an existing substation that we expect (at least initially), will have similar demand characteristics as the forecast load (i.e., capturing time and seasonal demand variations).

Specifically, the demand profile is based on the Moorebank zone substation load profile (an existing commercial/industrial area). The existing supply capacity to the Badgerys Creek development area has been included in our assessment of the identified need.

Figure 5 below presents the normalised load duration curve (LDC) assumed based on the representative demand profile, while figure 6 peak load profile for a summer day assumed for the demand expected from the customer connections associated with the Badgerys Creek development area based on the representative demand profile.

Figure 5 – Normalised LDC assumed for customer connections associated with the Badgerys Creek development area

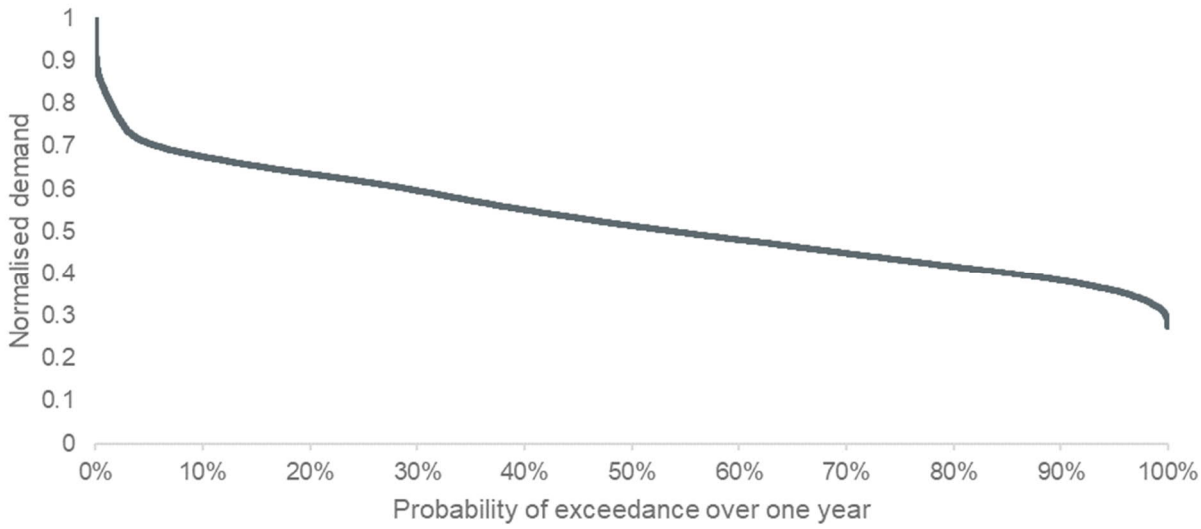
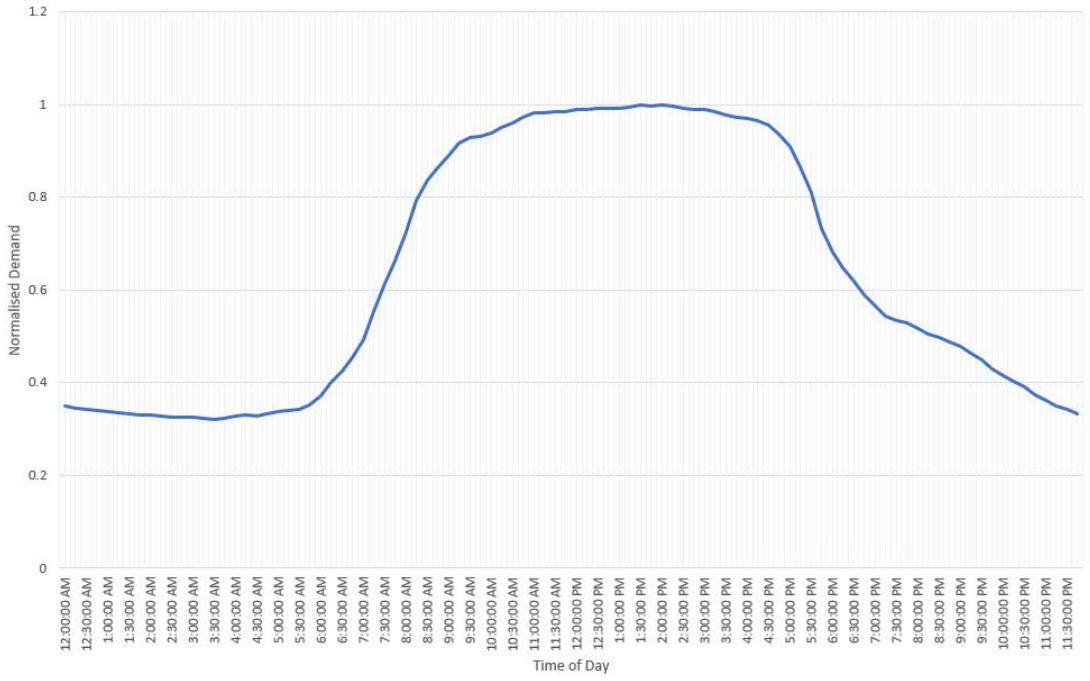


Figure 6 – Peak summer day profile for customer connections associated with the Badgerys Creek development area

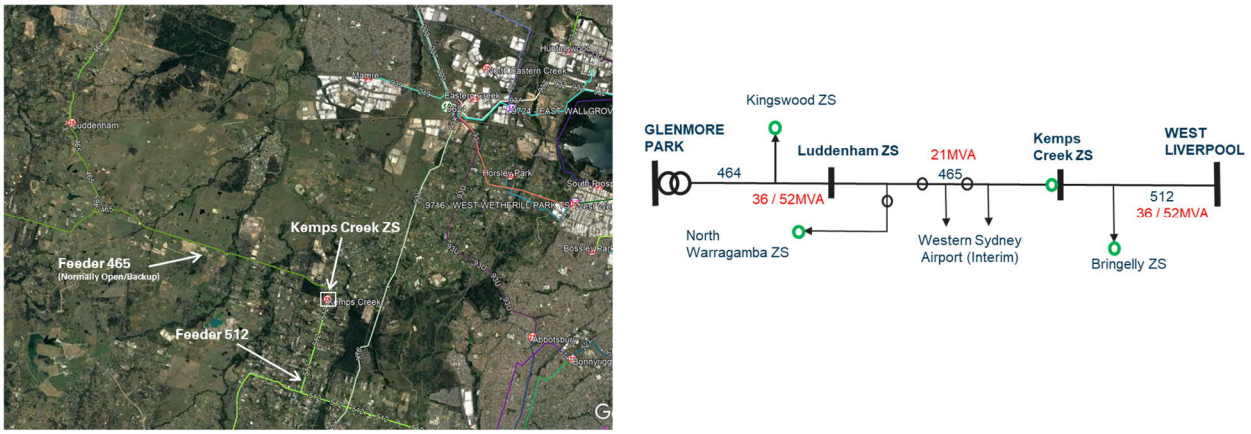


3.4 Existing network

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 7 below shows the existing 33kV supply network in the area of Badgerys Creek and Kemps Creek.

Figure 7 – 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

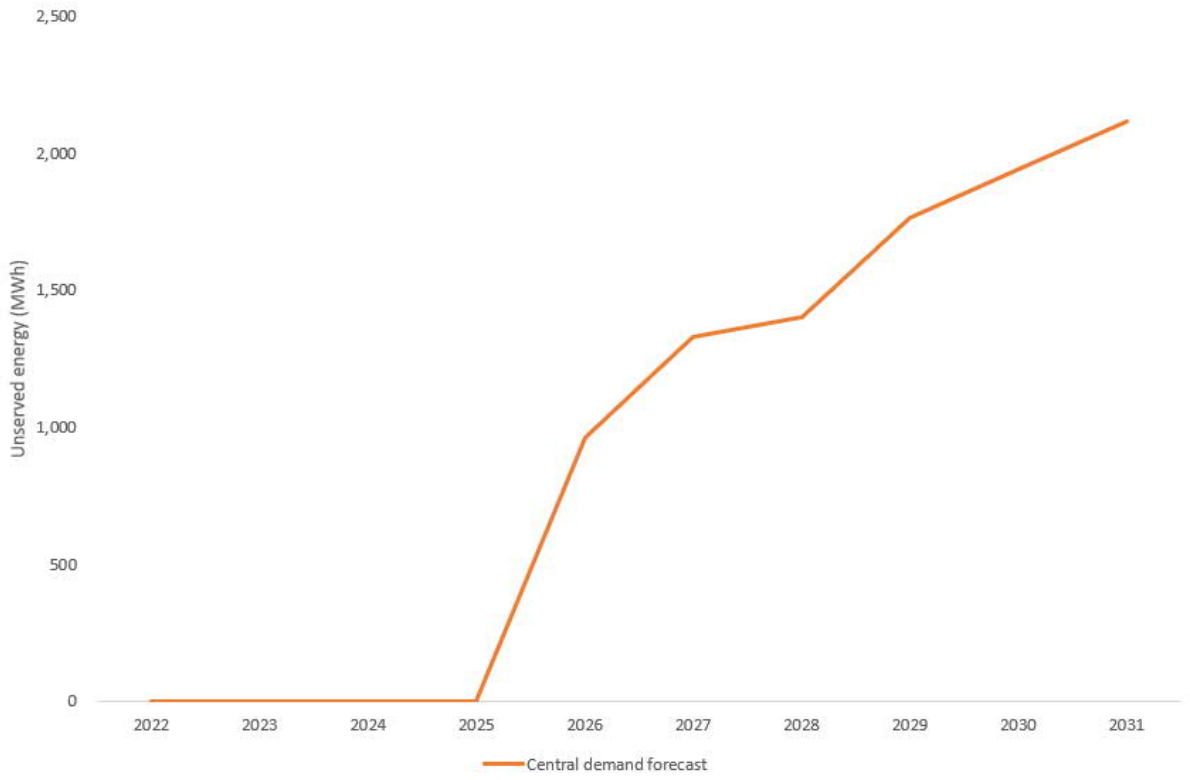
Network Constraint	Description
Distribution network capacity from Kemps Creek ZS to the Badgerys Creek development area.	The Badgerys Creek development area is currently supplied from Kemps Creek ZS and the interim supplies for the Elizabeth Enterprise Precinct and the water recycling facility will be 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.

Figure 4 above illustrates that this existing distribution network is insufficient to meet the supply needs of the Badgerys Creek development area from 2025/26.

3.5 Expected unserved energy if action is not taken

If network augmentation is not undertaken, there will be significant unserved energy in our network over the next decade with available capacity being exceeded from 2025/26. Figure 8 presents the estimated USE if no action is taken.

Figure 8 – Forecast unserved energy for the Badgerys Creek development area based on the central scenario



Although we expect there to 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 load. These regulatory obligations are set out in the box below.

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

We have initiated a Regulatory Investment Test for Distribution (RIT-D) to investigate, and consult on, how to most efficiently provide supply to major new customer connections 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 demand requiring connection will exceed the existing network capacity. This is currently anticipated to be 2025/26, based on the firm connection enquiries received to date.

4. Proposed network options to meet the identified need

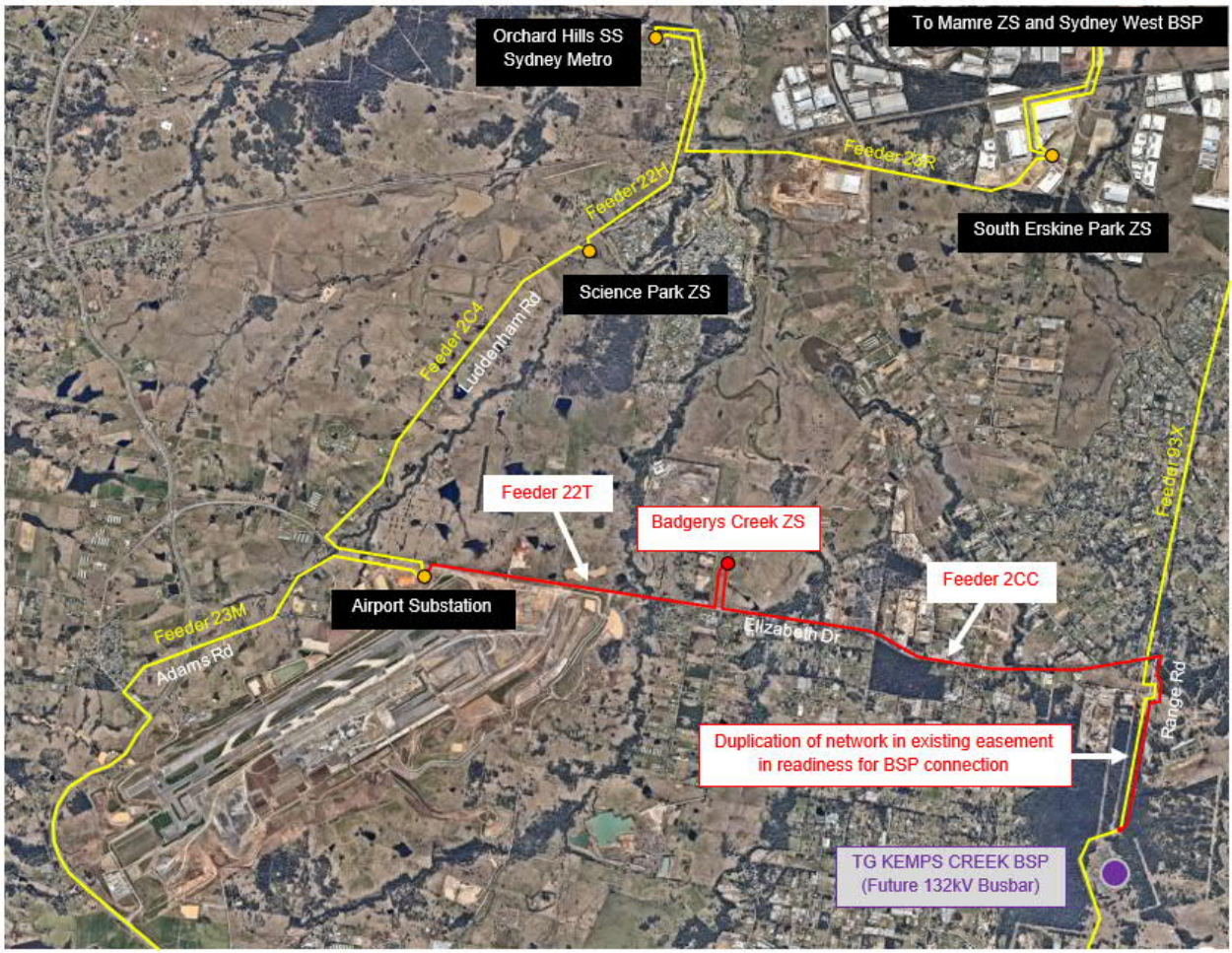
We have identified four credible network options to meet the identified need. This section provides more information on the scope and cost of these options. It also outlines options considered but not progressed to this DPAR.

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 as whether both feeders connect to the same transmission substation, or, if one of them connects to another major feeder.

Figure 9 provides an overview of how the proposed Badgerys Creek and existing Kemps Creek zone substations fit into the Aerotropolis structure plan, while figure 10 provides an aerial view of the development area and proposed network infrastructure.

Figure 9 – Overview of the Aerotropolis precinct proposed and existing network infrastructure

Figure 10 – Development area and proposed network infrastructure for the Badgerys Creek development area



For the pre RIT-D planning for the Badgerys Creek development area, we have used planning asset identifying numbers for feeders, however these will not be finalised until the RIT-D process has completed and consultation with TNSP on the proposed feeder identifiers has been completed. We also note that any augmentation of the existing Kemps Creek BSP is subject to joint planning protocols between TNSP and DNSP.

4.1 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 2022/23 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 assumed to be 0.4 per cent of total capital expenditure.

Table 3 – Scope of works and costs for Option 1

Scope	Description	Cost Estimate ($M)
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

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

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**

4.2 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 expected to be $52.4 million and the construction of the Badgerys Creek zone substation would commence in 2022/23 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 assumed 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)
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
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
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**

4.3 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 expected 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 2022/23 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 assumed 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)
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
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
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**

4.4 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 expected 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 2022/23 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 assumed 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)
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
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
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**

4.5 Options considered but not progressed

Endeavour Energy considered a number of options that we have not progressed to this DPAR. 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.

5. Assessment framework

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

5.1 Overview of the assessment framework

All costs and benefits for each credible option have been assessed against a do nothing, business-as-usual base case. Under this base case, Endeavour Energy would utilise the existing Kemps Creek zone substation to service the growing demand in the Badgerys Creek development area. The consequence of not proceeding with any investment is significant USE due to the existing supply network being constrained and incapable of supplying the forecast demand from new customers in the area.

The RIT-D analysis has been undertaken over a 30-year period, from 2021/22 to 2050/51. We consider that this assessment period takes into account the size, complexity and expected life of the relevant credible options to provide a reasonable indication of the market benefits and costs of the option. Further, the Badgerys Creek development area is expected to mature over a 30-year period and so the assessment period incorporates the expected demand growth development period. While the capital components of the credible options have asset lives greater than 30 years, we have taken a terminal value approach to incorporated capital costs in the assessment, which ensures that the capital costs of long-lived options is appropriately captured in the 30-year assessment period.

We have adopted a central real, pre-tax discount rate of 3.26 per cent as the central assumption for the NPV analysis presented in this DPAR. We have also tested the sensitivity of the results to changes in this discount rate assumption with a lower bound real, pre-tax discount rate of 2.22 per cent and an upper bound discount rate of 4.30 per cent (i.e., a symmetrical upwards adjustment).

5.2 Market benefits are expected from reduced involuntary load shedding

We expect that the only relevant categories of market benefits prescribed under the NER for this RIT-D relate to changes in involuntary load shedding and differences in the timing of expenditure. Our approach to valuing these market benefits are outlined below.

5.2.1 Reduced involuntary load shedding

Endeavour Energy has valued reduced involuntary load shedding by reference to our estimate of energy at risk, which is derived from the annual peak demand forecasts and load duration curves set out in section 3.

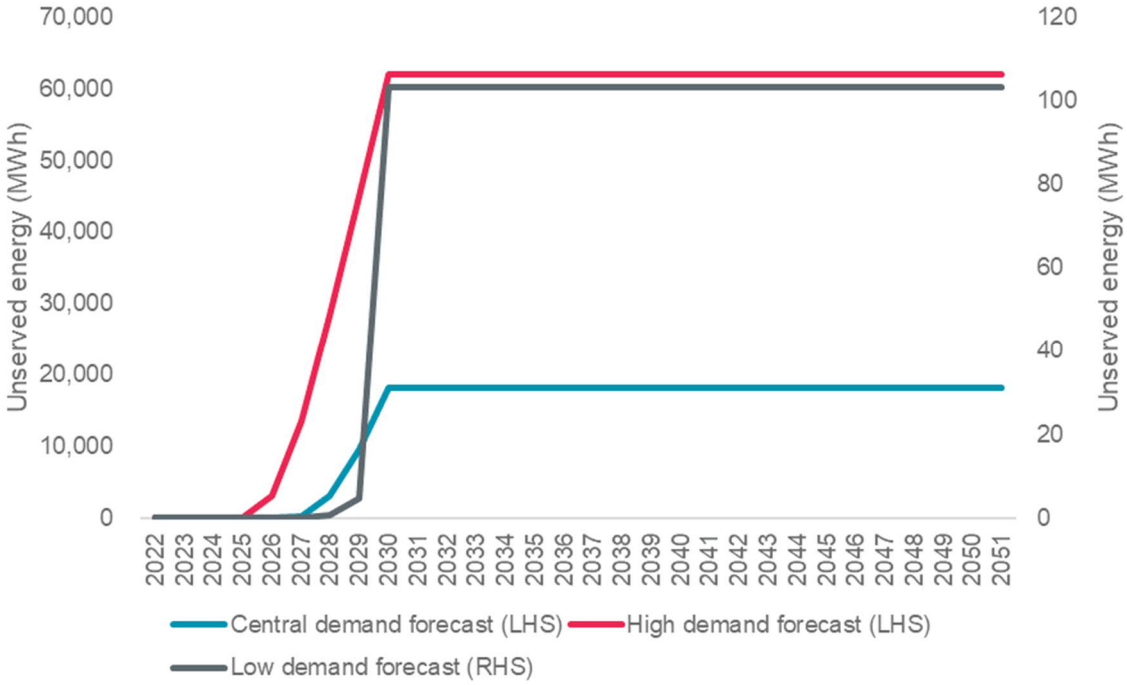
We have capped the expected future USE, in MWh, as part of the DPAR NPV assessment, because the uncapped value of USE will otherwise become unrealistically high (since, in reality, we would undertake investment to avoid widespread customer outages). Using the very large uncapped USE values has the potential to distort the comparison of net market benefits between credible options. The approach of capping USE in the base case is in-line with other RIT-Ds (and RIT-Ts) and does not affect the ranking of the overall options.[2,3]

[2] We note that this is also consistent with the approach proposed by Dr Biggar in his review of 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, p. 27). While Dr Biggar suggests capping the 'congestion cost' (calculated as the unserved energy valued at the VCR) in such assessments, we consider it more intuitive to cap the underlying unserved energy, in MWh, and continue to value it at the appropriate VCR. This is the approach that has been adopted by other DNSPs and is effectively equivalent to the approach proposed by Dr Biggar.

[3] See for example: Ausgrid, *Ensuring reliable supply for the Sydney Airport network area*, Final Project Assessment Report, 6 March 2020, p. 15.

Figure 11 illustrates the USE profile under the base case used in the NPV analysis, with USE values capped at the 2029/30 forecast level.

Figure 11 – Base case USE profile in NPV analysis



The value of unserved energy is calculated using the VCR. This represents an estimate of the value electricity consumers place on reliable electricity supply. The VCR value (in dollars per MWh) is applied to the difference in the MWh of USE calculated between the because case and each credible option.

We used a composite VCR value of $45,000 per MWh in the evaluation. This is based on the 2021 VCR values provided by the AER,[4] weighted in accordance with the forecast composition of the commercial, industrial and residential within the Badgerys Creek development area. The Badgerys Creek precinct land use zoning is based on enterprise use, however our existing Kemps Creek zone substation supplies some residential customers in the area south of Elizabeth Drive. At this stage, the commissioning of the proposed Badgerys Creek ZS will result in a load transfer from Kemps Creek ZS and it is likely that some residential load base maybe transferred. Under planned and unplanned outage conditions, there maybe a higher degree of residential load base supplied by the proposed Badgerys Creek ZS.

The assumption on the composition of the VCR is conservative and lower than we expect, particularly in view of the water recycling facility which is planned to be supplied from the proposed Badgerys Creek ZS. The composite VCR is aligned to the assumption used for our other RIT-D project economic evaluations in the Western Sydney Aerotropolis area.

A breakdown of this calculation is provided in the table below.

[4] AER, *2021 VCR annual adjustment,* December 2021.

Table 8 – Composite VCR used in evaluation

Parameter	Commercial	Industrial	Residential
Demand composition of the Badgerys Creek development area	30%	40%	30%
AER VCR	$44,830	$64,230	$21,290
Demand weighted VCR			**$45,528**

5.2.2 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.

In this context, Transgrid plans to commission a new 132kV BSP in the Aerotropolis area in 2030. Based on joint planning discussions between Endeavour Energy and Transgrid, we understand that the intended approach is for Transgrid to provide 132kV supply from their existing Kemps Creek substation (500/330kV). Currently, Endeavour Energy is not supplied from this substation.

The new 132kV BSP would require enabling works by Endeavour Energy to provide high-capacity connection of the new BSP to customers in the Aerotropolis area and to the south west area of Sydney. The credible options assessed in this DPAR differ in their scope regarding facilitating connection to the new BSP. In particular, those options that involve connection to feeder 93X provide future lower cost and timely connection to the new BSP relative to those that do not. This benefit has been captured by discounting the incremental costs associated with connecting to the new BSP under each option.

5.3 No other categories of market benefit are expected to be material

This section provides a brief overview of why Endeavour Energy considers the categories of market benefit (other than reduced involuntary load shedding) are not material for this RIT-D. These are:

- changes in voluntary load curtailment;
- option value;
- changes in load transfer capability;
- changes in costs to other parties; and
- changes in electrical losses.

5.3.1 Changes in voluntary load curtailment

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

Endeavour Energy has not estimated any market benefits associated with changes in voluntary load curtailment. Although customers are now more broadly capable of providing greater levels of voluntary

load curtailment, the greenfield nature of this investment is such that the area does not have the capacity to deliver sufficient voluntary demand reduction.

5.3.2 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.

Although we have not explicitly quantified option value for this assessment, it is implicitly captured in the structure of our credible options (each of which have flexibility for future investment).

5.3.3 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 as 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 Badgerys Creek development area. Since the areas in and around the Badgerys Creek development area are mostly serviced by remote rural 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.

5.3.4 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.

5.3.5 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. Since the majority of customers to be connected will be general customers (rather than site specific), 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 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.

5.4 Three different 'scenarios' have been modelled to address uncertainty

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

We have assessed three alternative future scenarios as part of the DPAR 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/framework used for each scenario is provided in table 9 below.

Table 9 – Scenarios used in RIT-D NPV assessment

Parameter/ scenario	Central scenario	High benefits	Low benefits
Capex	Central estimates	-25%	+25%
Demand	Central demand forecast (see section 3.2)	High demand forecast (see section 3.2)	Low demand forecast (see section 3.2)
VCR	Load-weighted AER VCR	+30%	-30%
Discount rate	3.26%	2.22%	4.30%
Maintenance costs	Central estimates	-25%	+25%

The above scenarios have been developed to comprehensively test the range of net benefits that can be expected from the credible options. We consider that this approach allows for a more robust test of the preferred option compared with adopting individual sensitivity tests because multiple inputs are changed together.

Endeavour Energy considers that the central scenario is most likely because it is based primarily on a set of expected/central assumptions. 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.

6. Assessment of credible options

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

6.1 Gross market benefits estimated for each credible option

The table below summarises the gross market benefit of each credible option relative to the base case in present value terms. The gross market benefit has been calculated for each of the scenarios outlined in the previous section.

Table 10 – Present value of gross economic benefits of each credible option relative to the base case ($m)

Option	Central scenario	High benefits	Low benefits	Weighted
Scenario weighting	50%	25%	25%	
Option 1	10,434.0	50,178.9	-29.9	17,754.3
Option 2A	10,432.8	50,190.0	-32.2	17,755.8
Option 2B	10,430.6	50,185.1	-32.9	17,753.3
Option 2C	10,428.6	50,182.0	-31.9	17,751.8

6.2 Estimated costs for each credible option

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

The cost of each option has been calculated for each of the three reasonable scenarios described above.

Table 11 – Present value of costs of each credible option relative to the base case ($M)

Option	Central scenario	High benefits	Low benefits	Weighted
Scenario weighting	50%	25%	25%	
Option 1	-47.0	-31.2	-59.4	-46.2
Option 2A	-48.7	-32.3	-61.7	-47.8
Option 2B	-49.3	-32.7	-62.3	-48.4
Option 2C	-48.4	-32.1	-61.1	-47.5

6.3 Net present value assessment outcomes

The table below summarises the net market benefit in NPV terms for each credible option under each scenario. The net market benefit is the gross market benefit (as set out in table 10) minus the cost of each option (as set out in table 11).

Table 12 – Present value of net market benefit of each credible option relative to the base case ($M)

Option	Central scenario	High benefits	Low benefits	Weighted	Rank
Scenario weighting	50%	25%	25%		
Option 1	10,434.0	50,178.9	-29.9	17,754.3	2
Option 2A	10,432.8	50,190.0	-32.2	17,755.8	1
Option 2B	10,430.6	50,185.1	-32.9	17,753.3	3
Option 2C	10,428.6	50,182.0	-31.9	17,751.8	4

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 accuracy in the estimates used in the analysis. Notwithstanding, we continue to view Option 2A as the preferred option because, in addition to having the highest net market benefits, 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. 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 following section demonstrates that the sensitivity analysis we have undertaken does not result in one option becoming more favoured than another – reinforcing our view that Option 2A is preferred at this draft stage.

6.4 Sensitivity analysis results

We have undertaken a thorough sensitivity testing exercise to understand the robustness of the RIT-D assessment to underlying assumptions about key variables. Our sensitivity analysis has focused on testing the sensitivity of the total NPV benefit associated with the investment proceeding consistent with the timeframes described in section 4. We have not sought to determine the optimal timing because the investment is driven by reliability corrective action and future load will exceed capacity from 2024/25.

Rather, we have assessed the sensitivity of the net benefits of each option to:

- changes in the discount rate;
- changes in the capital costs; and
- changes in the VCR.

The figures below demonstrate that these sensitivities do not result in one option becoming more favoured than another – reaffirming our view that they are effectively equally ranked in the assessment.

Figure 12 – Impact of varying the discount rate on the net market benefits of each credible option

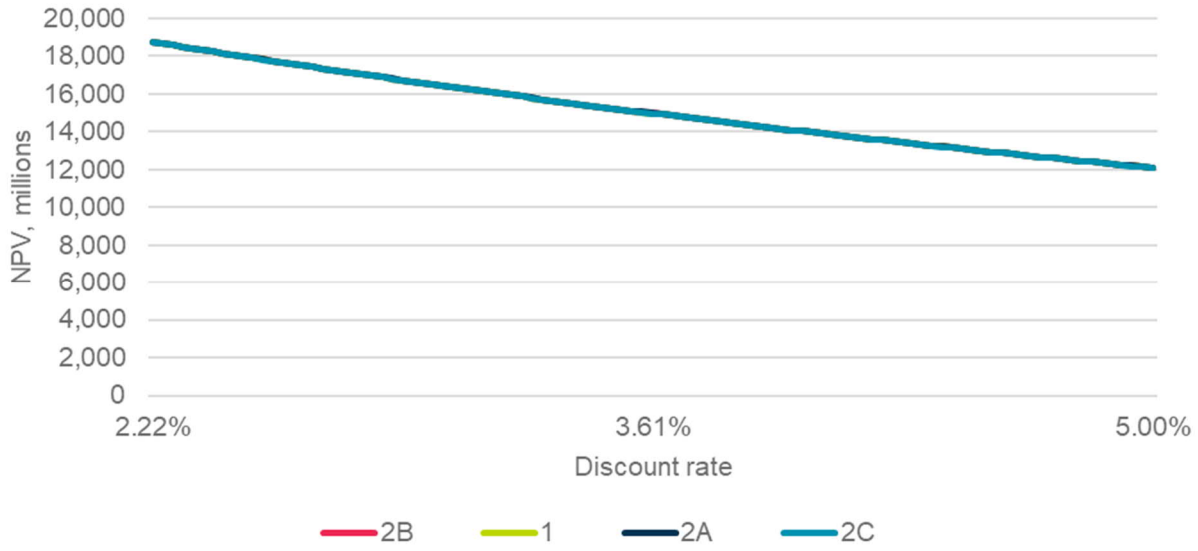


Figure 13 – Impact of varying capital costs on the net market benefits of each credible option

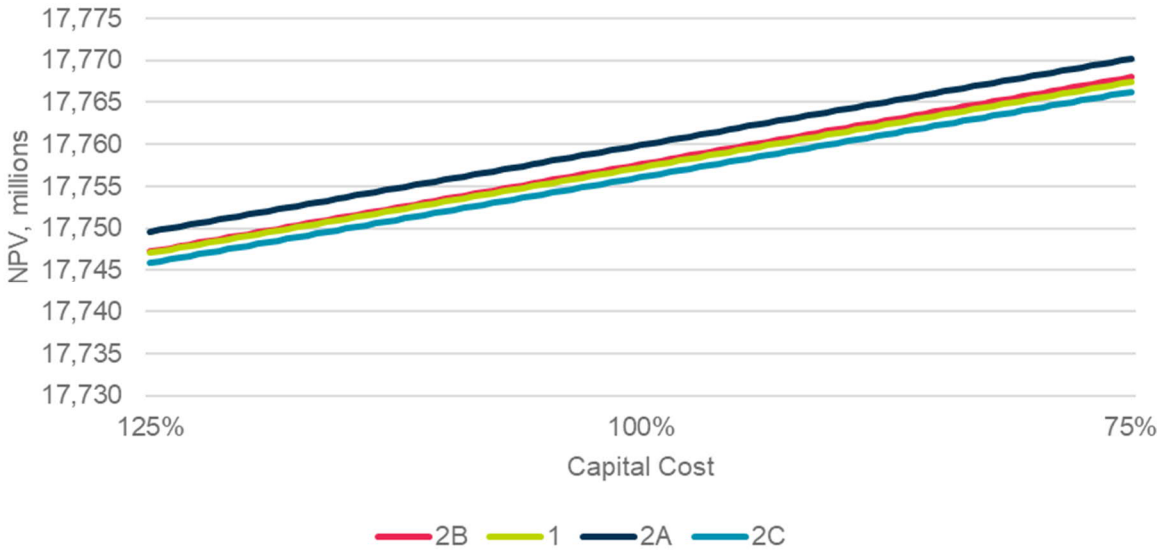
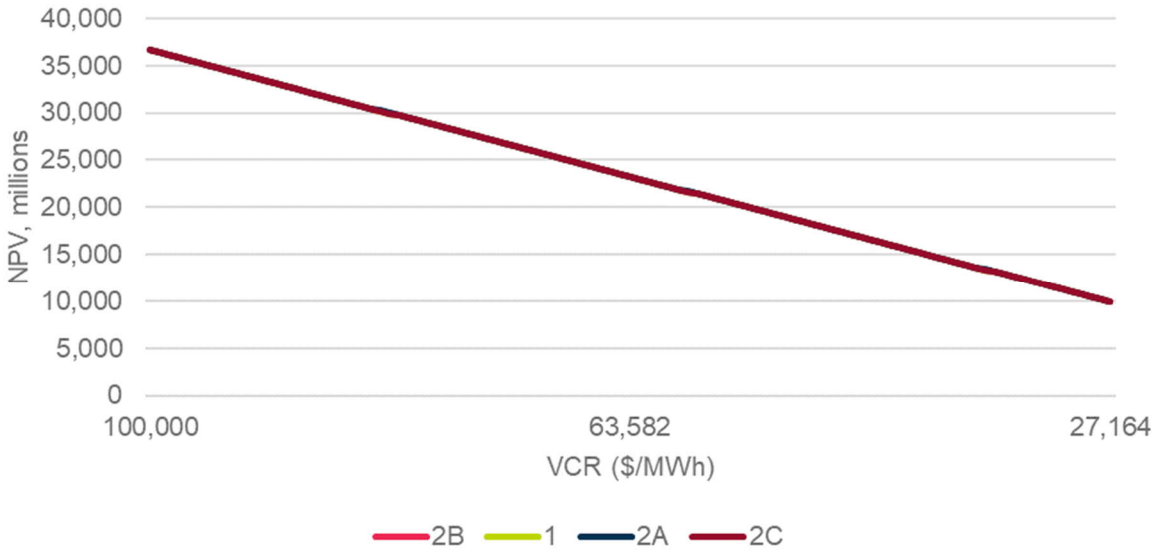


Figure 14 – Impact of varying the VCR on the net market benefits of each credible option



7. Conclusion

The Badgerys Creek development area sits within the Western Sydney Aerotropolis area and is planned to be a hub for commercial and industrial developments. Significant customer connection growth owing to the connection of the Badgerys Creek development area requires the establishment of additional connection and capacity capability to the network in the region.

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 DPAR 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 the same, 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 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 2022/23 with commissioning in 2025/26.

Single Line Diagram of the Proposed Badgerys Creek Zone Substation

Figure 15 below shows the proposed single line diagram for the proposed Badgerys Creek ZS. The diagram shows the future provisions for a third transformer and a third 132kV supply. Based on the current demand forecast for the Badgerys Creek development area these are likely to be required in the period 2035 to 2045.

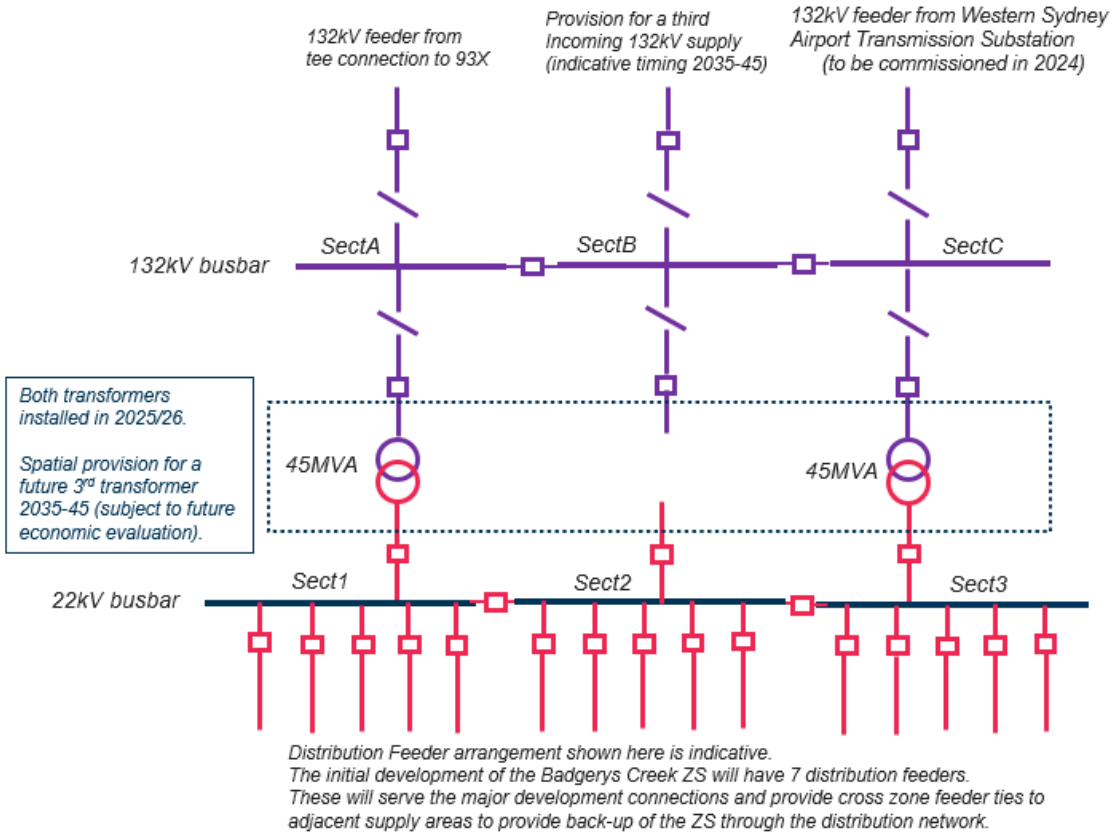
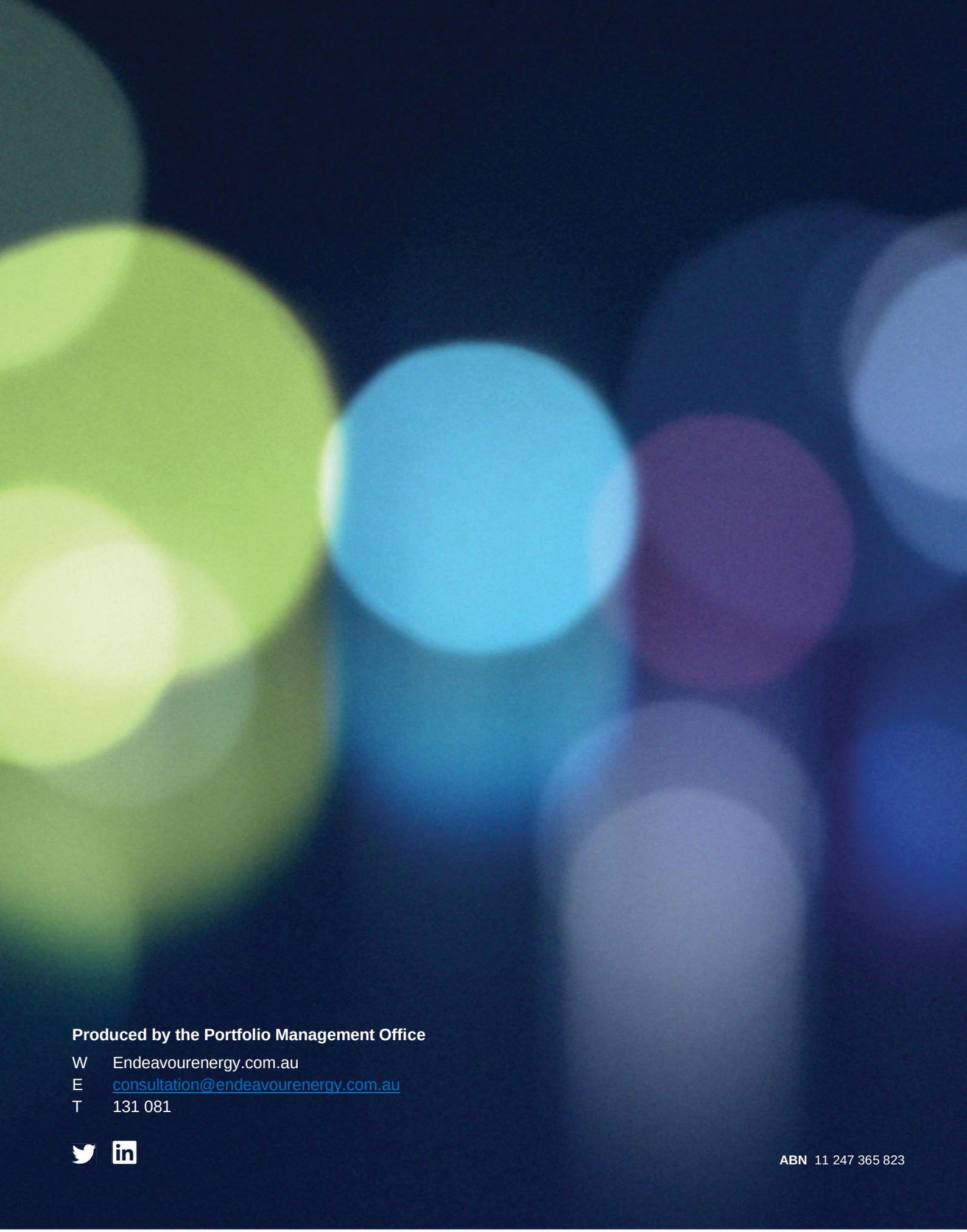


Figure 15: Single Line Diagram for the proposed Badgerys Creek Zone Substation.



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