RIT-D Draft Project Assessment Report

Luddenham, Kemps Creek and Badgerys Creek 33kV Network Constraints

12 May 2022

Endeavour Energy

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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).

The purpose of this report is to demonstrate the basis for selection of the preferred option to address the network limitations in the Luddenham, Kemps Creek and Badgerys Creek 33kV network.

The Western Sydney Aerotropolis area is a greenfield development and is a Priority Growth Area for the NSW State Government. The region covers around 11,000 hectares around the planned Western Sydney International 'Nancy-Bird Walton' Airport (herein WSIA). The development will contribute towards 200,000 new jobs in the Western Parkland City in industries such as technology, logistics, science, creative industries and agribusiness. The NSW Department of Planning and Environment (DPE) estimates this region will be home for 1.1 million people by 2036.

The identified need for this investment is 'reliability corrective action' since 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 load requiring connection will exceed the existing network capacity. This is currently anticipated to be 2023/24, based on the connection enquiries received to date.

This report follows publication of a Screening Report which 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 area of study. This is due to the extent of forecast load in the area, the expected cost of non-network options and the capacity of the existing network to facilitate non-network technologies.

Four options were assessed and only three were determined to be credible in addressing the network need. The options assessed are listed below:

- Do Nothing : Base case;
- Option 1 : Establish 132/33kV transmission substation in two stages;
- Option 2 : Establish 132/33kV transmission substation with two 120MVA transformers upfront, and
- Option 3 : Augment existing 33kV network.

The 'Do Nothing' option is not considered credible as it will result in significant expected unserved energy in the development area which would prevent the connection of new loads.

Option 1 involves the establishment of a new 132/33kV transmission substation near the WSIA industrial load precinct in two stages. The first stage with one 120 MVA transformer to be commissioned in FY24. A second transformer will be established in FY27 for commissioning in FY28.

Option 2 involves the establishment of a new 132/33kV transmission substation near the WSIA industrial load precinct with two 120 MVA transformers upfront. Similar to Option 1, the site will be energised by cutting in and out of future 132kV Feeder 23R (Aerotropolis backbone feeder) to establish two transmission feeder connections.

Option 3 involves augmentation and expansion of the existing sub-transmission network ties from West Liverpool TS to increase network capacity.

The economic assessment of the credible options is shown in Table 1. Option 2 presents the greatest net present value (NPV) of the market benefits considered in the evaluation. The assessment period for calculating the NPV is 30 years. Market benefits are based predominantly on expected unserved energy (USE) which is monetised by using Value of Customer Reliability (VCR).

Table 1: Summary of Credible Options

Option	Description	Project capex nominal ($M)	PV of market benefits ($M)	PV of Costs ($M)	NPV ($M)	Rank
1	Establish 132/33kV transmission substation in two stages	42.6	296,227.0	-35.8	296,191.2	2
2	Establish 132/33kV transmission substation with two 120MVA transformers upfront	41.9	296,227.4	-35.7	296,191.7	1
3	Augment existing 33kV network	127.2	253,669.4	-104.6	253,564.8	3

Considering the capital cost, value of market benefits and NPV, the preferred option is Option 2.

Sensitivity analysis was undertaken across a range of assumptions including forecasted load growth, discount rate, VCR and Capex. In each scenario considered, Option 2 remained the preferred candidate, indicating there is a very high degree of confidence in this result.

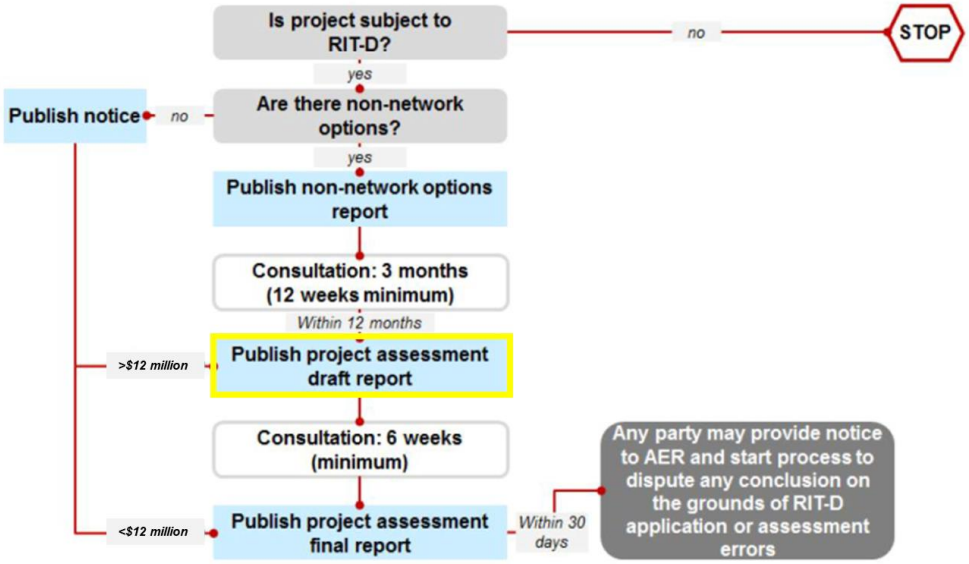
Endeavour Energy seeks written submissions from interested parties in relation to the preferred option outlined in this document. Submissions are due on or before 23rd June 2022. All submissions and enquiries should be directed to Endeavour Energy's Head of Portfolio Management Office at consultation@endeavourenergy.com.au.

2. RIT-D Process

This DPAR was 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 Investment Test – Distribution (RIT-D) for addressing network limitations in the areas of Luddenham, Kemps Creek and Badgerys Creek.

Endeavour Energy adopts a process of exploring feasible methods of supply in assessing the ability to supply development applications. 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 needs to balance timely investment with the ramping up of demand as the development progresses. This is required to mitigate the risks of stalling developments due to delayed supply of power to the area which has an adverse impact on the supply of land for housing, as well as commercial and employment needs.

Figure 1 – The RIT-D Process



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 23rd June 2022. 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 Head of Portfolio Management Office at consultation@endeavourenergy.com.au.

3. Context of the Project

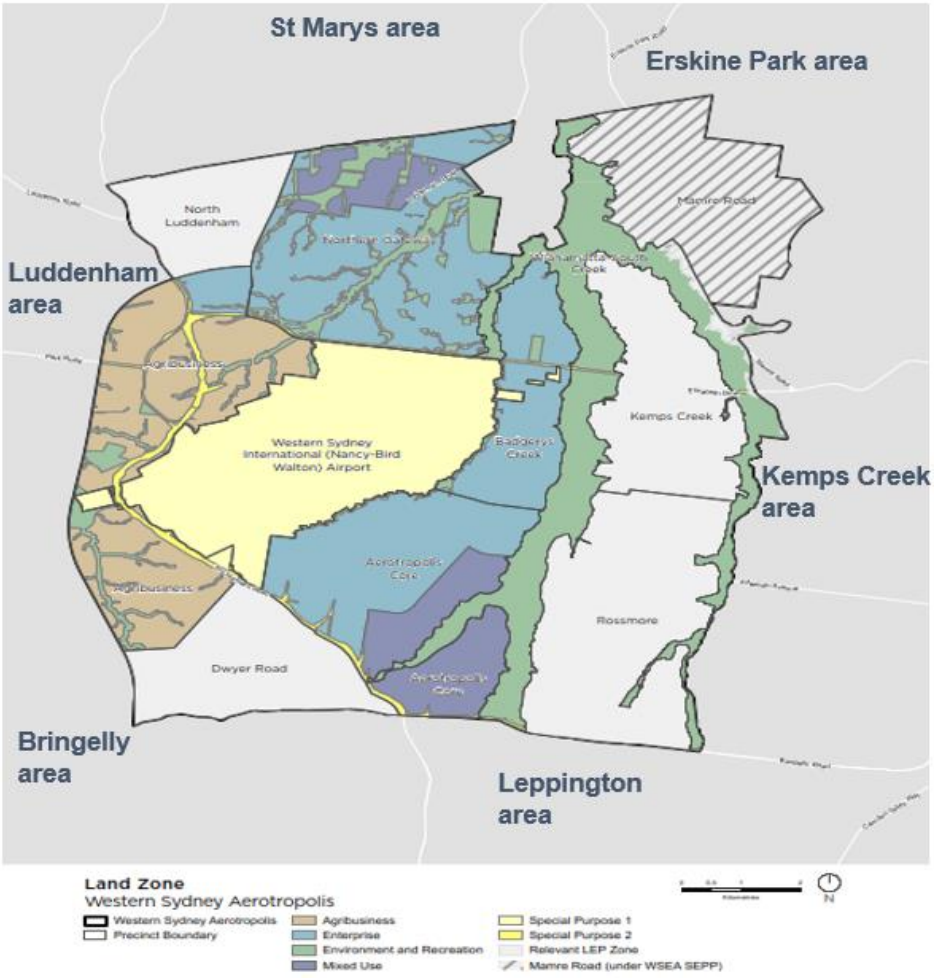
The Western Sydney Aerotropolis area is a greenfield development and is a Priority Growth Area for the NSW State Government. The region covers around 11,000 hectares around the planned Western Sydney International 'Nancy-Bird Walton' Airport (herein WSIA).

The development will contribute towards 200,000 new jobs in the Western Parkland City in industries such as technology, logistics, science, creative industries and agribusiness. The NSW Department of Planning and Environment (DPE) estimates this region will be home for 1.1 million people by 2036.

To enable the region and facilitate efficient cross-utility planning, large areas of land were re-zoned, and Aerotropolis Precinct Plans prepared to support the priority release of land for development. The region under study covers the currently mainly rural/agricultural area that is bound by the existing established locations of Erskine Park, St Marys, Luddenham, Bringelly, Leppington and Kemps Creek.

Figure 2 shows the Land Use Zoning for the area and the boundary of the precincts within the Western Sydney Aerotropolis.

Figure 2 – Western Sydney Aerotropolis Precinct Land Zones



The establishment of WSIA as Sydney's second international airport at Badgerys Creek, is the catalyst for development in the Western Sydney Aerotropolis area and is a commitment of the Australian Commonwealth Government and the NSW Government. However, the strategic planning for the area also includes the establishment of Sydney's third city – the Western Parkland City.

While the total ultimate demand of the Western Sydney Aerotropolis area and the Western Parkland City will develop over the next 50 years, there are requirements for connection of major loads in the short to medium-term that require network augmentation. We are therefore initiating a Regulatory Investment Test for Distribution (RIT-D) to address the network constraints in the area.

4. Network Need

The existing network is a low capacity 33kV network that was originally designed to meet the existing and historical rural and residential load base. Existing loads in the area are supplied at 11kV from zone substations at Luddenham and Kemps Creek, that are supplied from a 33kV sub-transmission network between two bulk supply points, namely Liverpool BSP and Regentville BSP.

Due to a cross-bulk supply point arrangement, both Luddenham ZS and Kemps Creek ZS operate under a change-over configuration where an outage on any main supply feeder section results in a disconnection of customers until restored from the single alternate healthy 33kV feeder.

Initial connections within the central WSIA precinct have been made using direct tee connections to the existing network. However, there are no further options for high voltage connections in this region on the existing lines.

While the total ultimate demand of the Aerotropolis area and the Western Parkland City will develop over the next 50 years, there are requirements for connection of major loads in the short- to medium-term that require distribution network augmentation.

The region immediately surrounding the WSIA as shown in Figure 3 below, is zoned for industrial and commercial uses. Table 2 below lists some of the applications and enquiries Endeavour Energy has received to date in the region of study, including high voltage connections associated with WSIA to support 24-hour operations. The growth in the area is further supported by the extensive cross utility coordination, developer activity, and release of DPE precinct plans and Development Control Plans.

Table 2 – Sample of connections impacting the 33kV network capacity under study

Customer supplies through WSIA	Airport Terminal buildings (connection required 2024) Airport North Business Park (connection required 2024) Logistics, Freight and Agribusiness gateway (tendered connection required 2024) Sydney Metro Western Sydney Airport station and Business Park station Public transport electrification Western Sydney International Airport initial supply (DBL2631)
Luddenham region	Sydney Science Park (ENL3316) Chain of Ponds Residential Developments (ARP3834) Chain of Ponds Council Developments (ENL4226) DPIE Luddenham Village Discussion Paper and strategy
Kemps Creek region	Sydney Water Aerotropolis facility (ENL3685) Elizabeth Drive Industrial Park (NCL1653, UCL9988) Mamre Road Industrial development (DPIE rezoning and DCP 2021) Austral Residential expansion (DPIE rezoning and DCP 2021)

A number of these new loads are backed by Government commitments, for example:

- the Australian Commonwealth Government and the NSW Government have committed to the Western Sydney Airport, with commercial operations starting in 2026; and
- the NSW Government recently granted planning approval for the Sydney Metro – Western Sydney Airport line, with testing occurring one year prior to its commissioning in 2026. Sydney Metro have already started work on construction supplies, with significant load required for tunnel boring machines and other associated construction.
- In addition, the NSW Government has already rezoned all land around the Aerotropolis in preparation for these developments.

Figure 3 – Aerial view of precincts of the Western Sydney International Airport

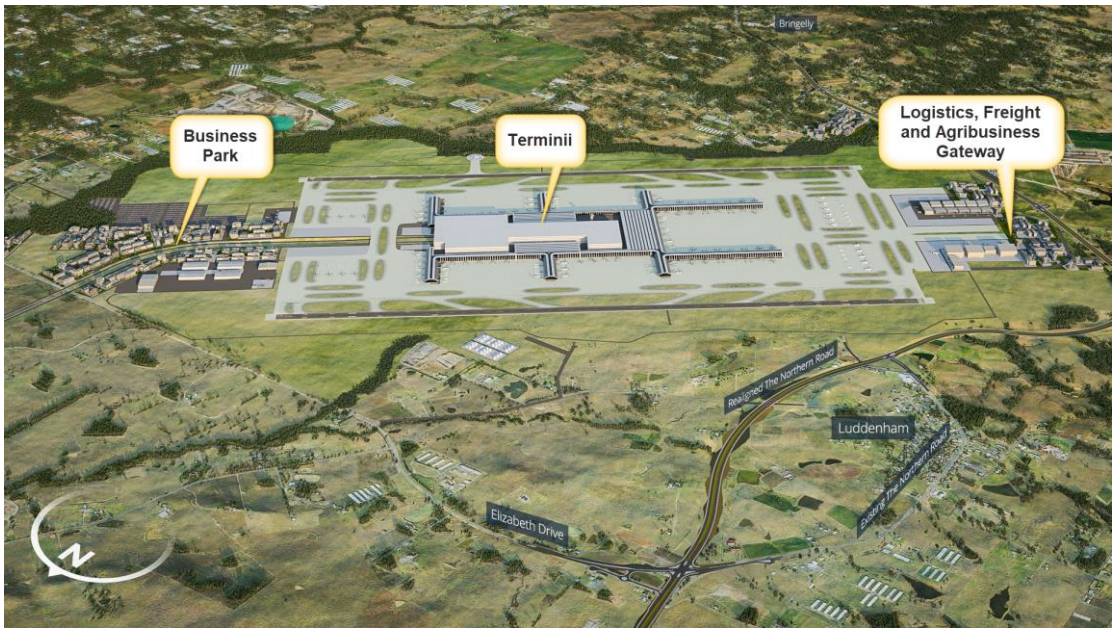
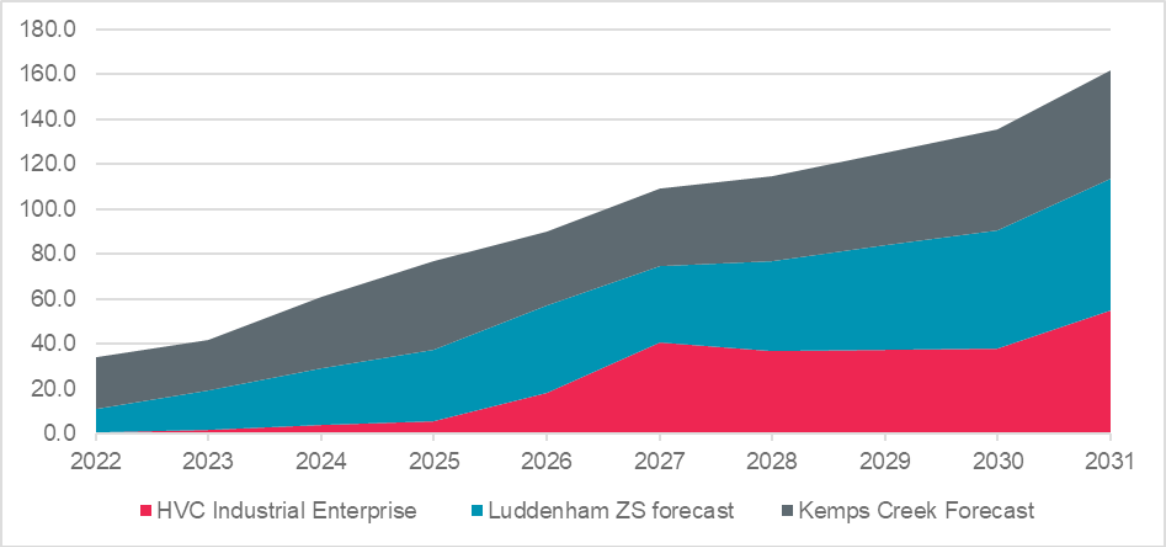


Table 3, Figure 4 and Figure 5 below shows the demand forecast and load at risk for Luddenham ZS, Kemps Creek ZS and the high voltage connections. These forecasts are underpinned by the number of applications already received and agreed to provide firm supply from both zone substations and key priority growth areas.

Table 3 – Central scenario demand forecast and load at risk (MVA)

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Kemps Creek ZS	22.7	22.5	32.2	39.7	32.5	34.6	37.5	41.0	44.9	48.6
Luddenham ZS	10.4	17.9	25.2	31.5	39.3	33.9	40.4	46.8	52.9	58.6
HVC Industrial Enterprise	0.8	1.6	3.7	5.9	18.1	40.7	36.7	37.4	37.9	54.9
Load at Risk	-	-	10.4	25.9	36.3	51.1	57.4	67.7	78.1	101.1

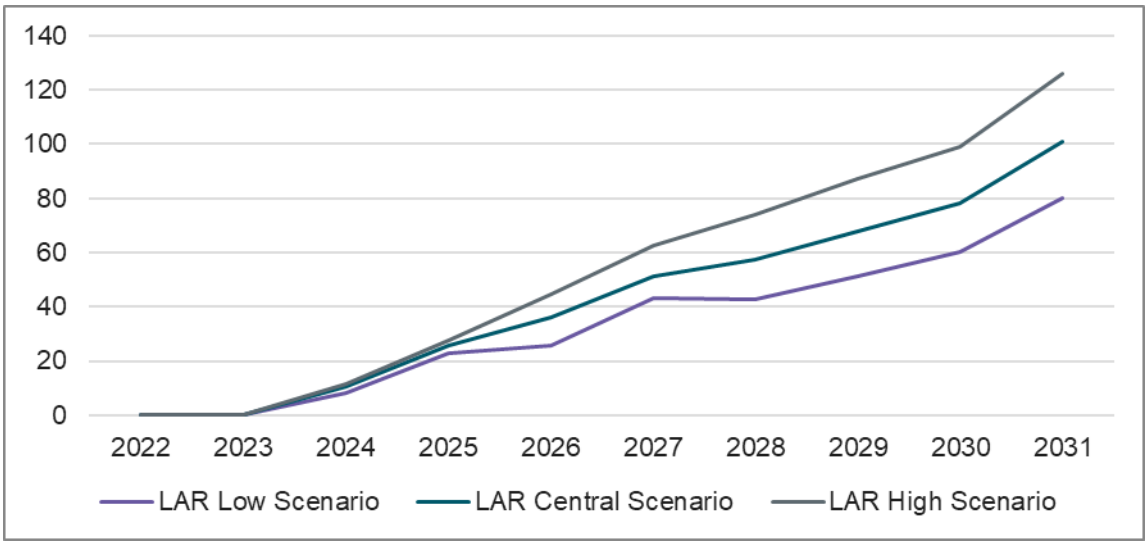
Figure 4 – Demand Forecast (Central load forecasting scenario)



The existing 33kV feeder network has a total capacity of between 21MVA and 50MVA (section dependent) and is insufficient to meet the needs of the zone substations and customers in the area from 2023/24.

It should be noted that the load at risk presented in Table 3 is not simply a numerical summation of the load forecasts against the rating of an individual asset. Since the loads are geographically dispersed, interconnected by feeders of different ratings, and is supported by a network that changes-over between two bulk-supply-points, the load at risk is a function of the different load centres and the combination of elements that can be tripped. The load at risk presented is the maximum of the scenarios.

Figure 5 – Load at Risk (LAR) in MVA for Low, Central and High forecasting scenarios



'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 facilitate the connection of the new major loads in the regions of Luddenham, Kemps Creek and Badgerys Creek.

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 load requiring connection will exceed the existing network capacity. This is currently anticipated to be 2023/24, based on the connection enquiries received to date.

Importantly, no construction on new distribution investments will commence until there is a high degree of certainty that the anticipated loads will be seeking connection to our network at the timing indicated.

The transmission network augmentation to support the growth in the regions of Luddenham, Kemps Creek and Badgerys Creek was included as part of our regulatory proposal to the Australian Energy Regulator (AER) for the current regulatory control period and also discussed in our most recent Distribution Annual Planning Report (DAPR).

Endeavour notes that the proposed transmission substation will be a shared network asset which will become part of Endeavour's Regulatory Asset Base. As initially these prospective customers are expected to utilise a high majority of the asset, specific tariff arrangements will be established to recover the majority of the cost of the augmentation from the beneficiaries (i.e. the new customers). These customers will be charged a cost reflective network price, determined specifically from this network augmentation investment. This will ensure no cross subsidy from existing customers, but can be adjusted such that as a larger number of customers benefit from the asset, the costs can be shared accordingly.

A non-network screening notice has been published in accordance with NER clause 5.17.4(c), and found that there is unlikely to be a non-network option that could form a potential credible option on a standalone basis, or that could form a significant part of a potential credible option. This notice is available online. This DPAR represents the next formal stage of the RIT-D process and provides information and outcomes from economic assessment of network-based options for the regions of Luddenham, Kemps Creek and Badgerys Creek.

5. Preferred option

The option that presents the greatest net market benefit and thus considered as the preferred option, is Option 2. This option is the establishment of a new 132/33kV transmission substation with two 120 MVA transformers upfront near the WSIA industrial load precinct along Elizabeth Drive. The site will be energised by cutting in and out of the future 132kV Aerotropolis foundation supply. The substation will meet the connection and load growth requirements across the load centres of Luddenham zone substation, Kemps Creek zone substation and high voltage connections associated with the WSIA.

The preferred option has the highest market benefits and highest net present value (NPV) of all the three credible network options. This option has a lower initial cost compared to Option 1 since the

establishment of two transformers upfront does not incur additional re-mobilisation costs, and despite both options ultimately have similar value of market benefits, this option has higher net economic benefits.

In comparison to Option 3, the preferred option presents lower delivery risk due to the shortening and reduction of the number of required transmission routes, higher operational flexibility and additional future options.

The total cost of the preferred option is estimated to be $41.9 million. Construction could start in 2021/22 and be completed in 2023/24, with commissioning of the feeder in the same year as construction is complete. The scope of work and costs for this option are shown in Table 6.

6. Credible options considered

There were several options considered in the evaluation, of which three network-based options were determined to be credible. Non-network options were considered as part the screening report but were not considered to be credible due to the large greenfield development requirements. The credible options are listed below, and details are further discussed in this section.

- Do Nothing : Base case;
- Option 1 : Establish 132/33kV transmission substation in two stages;
- Option 2 : Establish 132/33kV transmission substation with two 120MVA transformers upfront, and
- Option 3 : Augment existing 33kV network.

6.1 Base Case ('Do Nothing' option)

A baseline risk position has been established based on a 'Do Nothing' option. The project involves the extension of supply into a greenfield development area which will ultimately supply significant major connections as highlighted in Section 4 .

The 'Do Nothing' approach will result in significant expected unserved energy in the development area from 2024 onwards. As this region is nationally significant, this also carries a significant reputational risk of negative media coverage and both Federal and NSW Government dissatisfaction if Endeavour Energy is unable to meet supply requirements for this area.

In terms of risk cost assessment, the 'Do Nothing' option provides a base case where the risks are valued by applying a Value of Customer Reliability (VCR) to the forecast expected unserved energy. The VCR used by Endeavour Energy in its modelling is based on values published by the AER on its Values of Customer Reliability Report in December 2019. This approach was endorsed by the AER during the determination process. Table 4 shows the annualised risk cost of no proactive intervention.

Table 4 – Risk cost of 'no proactive intervention'

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Risk Cost ($M)	0	0	0.18	15.0	1,074	3,003	3,612	4,960	6,312	10,372

6.2 Option 1 – Establish 132/33kV transmission substation in two stages

This option is to establish a 132/33kV transmission substation near the WSIA industrial load precinct along Elizabeth Drive. Under this option, a single 132/33kV transformer with 120MVA capacity will be

established for commissioning in FY24 to form part of Stage 1, with supply secured from the existing 33kV network ties. For Stage 2, a second transformer will be established in FY27 for commissioning in FY28 to address the annual and cumulative risk costs related to unserved energy due to increasing demand.

The site will be energised by cutting in and out of future 132kV Feeder 23R (Aerotropolis backbone feeder) to establish two transmission feeder connections. The proposed underground feeder route traverses 1km to the west of the WSIA.

The costs and benefits for Stage 1 and Stage 2 were considered in the economic evaluation. The scope of work and costs for this option are shown in Table 5.

Figure 6 – Option 1 simplified transmission single line diagram (first stage)

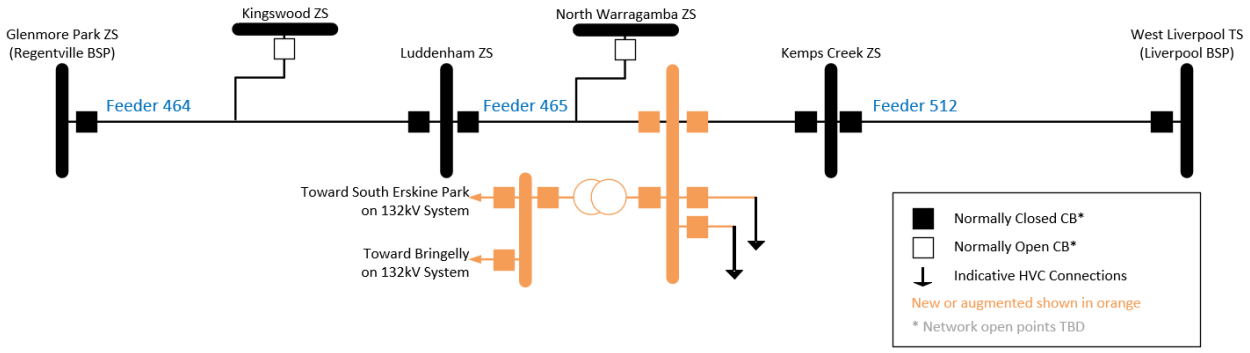


Figure 7 – Option 1 simplified substation single line diagram (first stage)

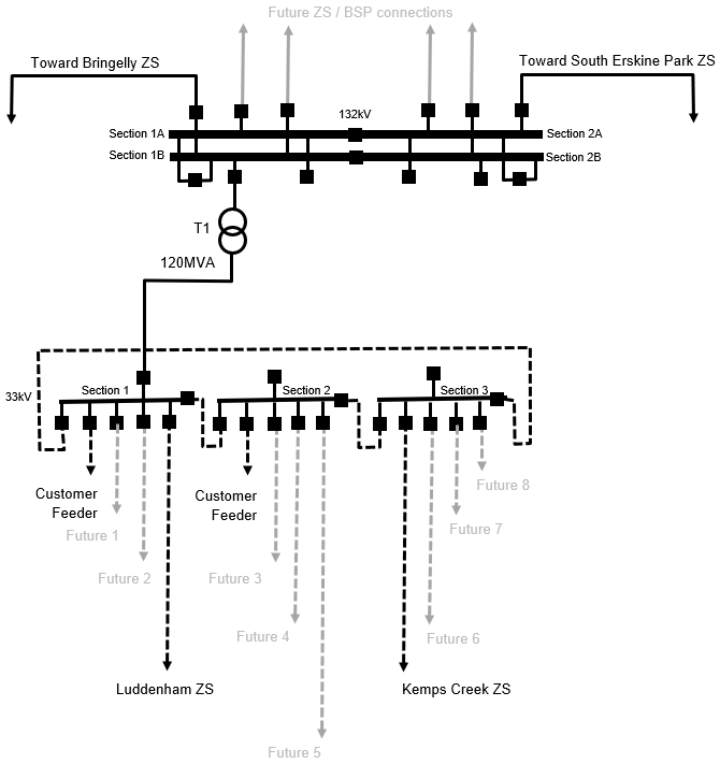


Table 5 – Scope of works and costs for Option 1

Scope	Description	Cost Estimate ($M)

Mains	Establish 132kV and 33kV mains connections
	• 2x 132kV sub-transmission connections
	  ○ Cut in and out from the Aerotropolis backbone feeder;
	  ○ Approximately 1,100m of 132kV feeder route from Adams Road and Elizbeth Drive intersection
	  ○ Utilise existing cable ducts along Elizabeth Drive West line route
	  ○ Associated protection and communication fibre
	  ○ Reimbursement of Sydney Water for increased depth of burial of water mains along Elizabeth Drive.
	• 4x 33kV sub-transmission connections
	  ○ Cut in and out from Feeder 465: Luddenham tee to Kemps Creek ZS by UG cable connection
	  ○ Relocate 2x existing high voltage customer tee connections from Feeder 465 to 33kV switchboard by UG cable and associated protection and communication fibre.
		12.5

Substations	Establish 132/33kV Transmission Substation • Acquire suitable land holding • 132kV busbar with modular construction of 6x feeder bays, 4x transformer bays; and 4x 132kV bus couplers. • One 120MVA 132/33kV transformer and associated bunds and firewalls in FY24 (Stage 1) • Second 120MVA transformer and associated bunds and firewalls in FY27 (Stage 2) • 33kV busbar with modular construction of three bus sections with 12x feeder CB's, 3x transformer CBs, and 3x bus couplers • 2x Auxiliary transformers • Modular type amenities building • Land acquisitions, related due diligence and legal costs	30.1
Total	Establish 132/33kV substation in two stages	**42.6**

6.3 Option 2 – Establish 132/33kV transmission substation with two 120MVA transformers upfront

This option is to establish a 132/33kV transmission substation with two 120MVA transformers upfront, near the WSIA industrial load precinct along Elizabeth Drive. Similar to Option 1, the site is to be energised by cutting in and out of future 132kV Feeder 23R (Aerotropolis backbone feeder) to establish two transmission feeder connections. The proposed underground feeder route traverses 1km to the west of the industrial load precinct.

The scope of work and costs for this option are shown in Table 6.

Figure 8 – Option 2 simplified transmission single line diagram

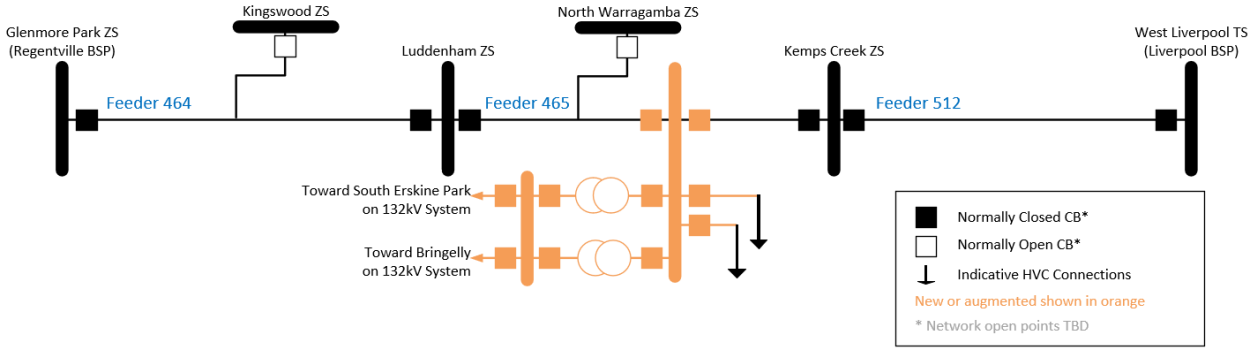


Figure 9 – Option 2 simplified substation single line diagram

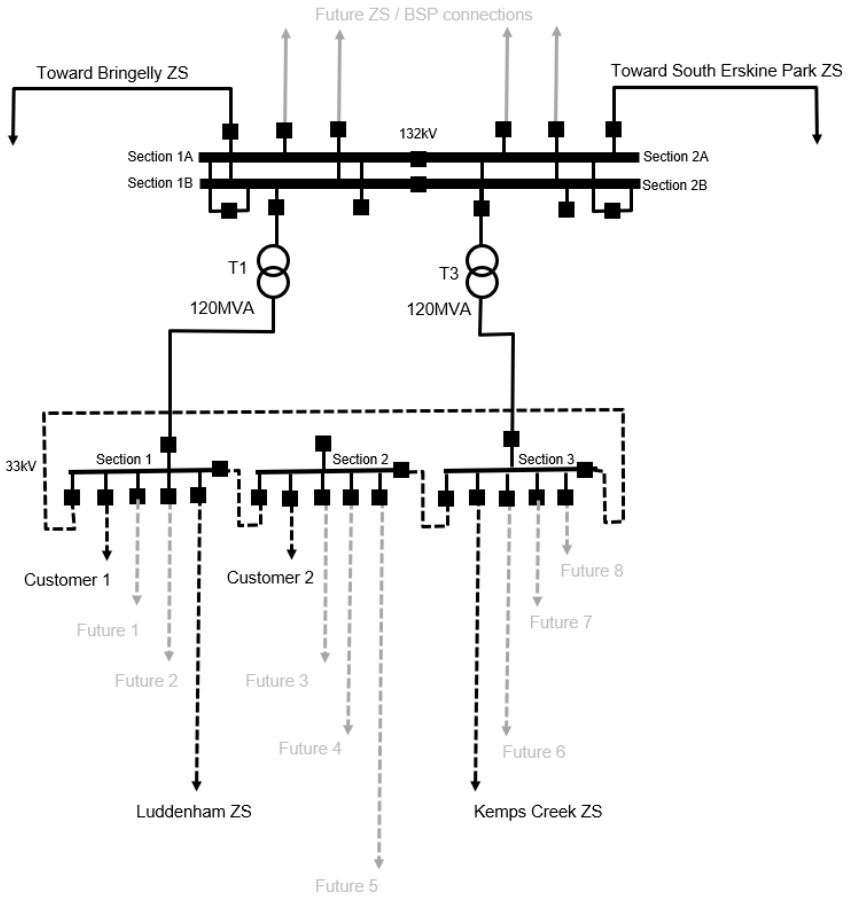


Table 6 – Scope of works and costs for Option 2

Scope	Description	Cost Estimate ($M)

Mains	Establish 132kV and 33kV mains connections
	• 2x 132kV sub-transmission connections
	  ○ Cut in and out from the Aerotropolis backbone feeder;
	  ○ Approximately 1,100m of 132kV feeder route from Adams Road and Elizbeth Drive intersection
	  ○ Utilise existing cable ducts along Elizabeth Drive West line route
	  ○ Associated protection and communication fibre
	  ○ Reimbursement of Sydney Water for increased depth of burial of water mains along Elizabeth Drive.
	• 4x 33kV sub-transmission connections
	  ○ Cut in and out from Feeder 465: Luddenham tee to Kemps Creek ZS by UG cable connection
	  ○ Relocate 2x existing high voltage customer tee connections from Feeder 465 to 33kV switchboard by UG cable and associated protection and communication fibre.
		12.5

Substations	Establish 132/33kV Transmission Substation • Acquire suitable land holding • 132kV busbar with modular construction of 6x feeder bays, 4x transformer bays; and 4x 132kV bus couplers. • Two 120MVA 132/33kV transformers and associated bunds and firewalls. • 33kV busbar with modular construction of three bus sections with 12x feeder CB's, 3x transformer CBs, and 3x bus couplers • 2x Auxiliary transformers • Modular type amenities building • Land acquisitions, related due diligence and legal costs	29.4
Total	Establish 132/33kV Substation with two 120MVA transformers upfront	**41.9**

6.4 Option 3 – Augment existing 33kV network

This option increases network capacity through augmentation and expansion of the existing sub-transmission network ties from West Liverpool TS. Under this option, three new 33kV feeders from West Liverpool TS will be established towards the load centre to provide additional network capacity.

As the load at risk is separated across two bulk supply points and to maximise operational flexibility, a new 33kV switching station will be established with initial capacity for nine 33kV feeder circuits.

The scope of work and costs for this option are shown in Table 7.

Table 7 – Scope of works and costs for Option 3

Scope	Description	Cost Estimate ($M)
Mains	Establish 3x 33kV Feeders from West Liverpool TS. • Each feeder of approximately 20.1 km route length via either Hoxton Park or Kurrajong Roads, Fifteenth Avenue and Elizabeth Drive. • Using existing cable ducts where available in road reserves or trenching as required. • Associated protection and communications fibre.	115.2
Substation	Establish 33kV Switching Station Facility with 9x 33kV feeder bays • Cut in and out existing Feeder 465 and relabel feeder section to Kemps Creek ZS. • Connect 3x new 33kV feeders to new switching station. • Cut over existing HV customer tee connections to dedicated CB's • 2x Auxiliary transformers • Circuit Breaker and Secondary systems (CTs/VTs, SCADA) • Land acquisitions and related due diligence and legal costs	7.0
	West Liverpool TS connection works: • Extend 33kV busbar. • Connect new feeders and relocate two existing feeders to achieve busbar diversity of the new feeders. • Installation of additional Secondary Systems equipment	5.5
Total	Augment existing 33kV network	**127.2**

6.5 Options not considered

As highlighted in the screening report it is not considered feasible that a non-network solution will form a potential credible option on a standalone basis, or form a significant part of a potential credible option for this project. This is due to the extent of forecast load for the area, the expected cost of network options and the capacity of the existing network to facilitate non-network technologies (refer to Section 3.4 and 4 of the Screening Report). The screening report also explains why the option of extending the 33kV network from Regentville BSP was not progress to the DPAR.

7. Modelling & 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 state of the system with 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.

Endeavour Energy is currently seeking further engagement with the AER on matters to support new technology solutions under the RIT-D framework. Particularly, we are seeking advice to consider new classes of market benefits and guidance on the method to quantify these benefits.

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 load at risk and energy not able to be supplied to customers waiting to connect. This is different to a situation where already connected customers risk losing supply. The same VCR value has been applied as a default position to the energy at risk values established from the proposals 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 quickly rise to extremely large amounts.

The Energy at Risk (EAR) has been estimated from the annual peak demand forecasts and load duration curves.

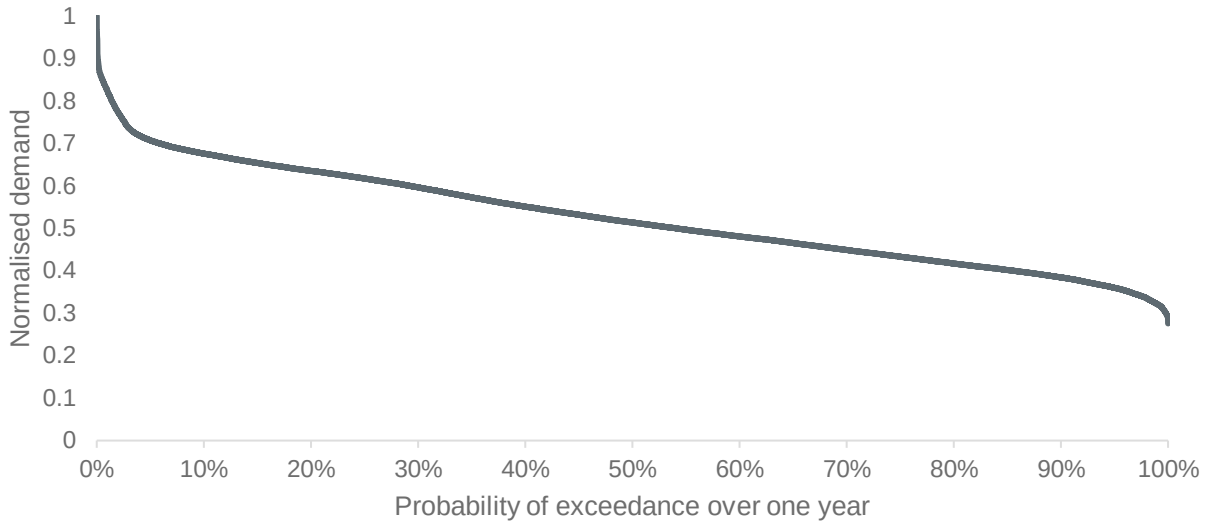
7.1.2 Load profile characteristics

Since the forecast loads are yet to connect, we have assessed the identified need using a composite demand profile, created by scaling load profiles from other areas, that we expect will have similar demand characteristics as the forecast load (i.e. capturing time and seasonal demand variations).

Specifically, the composite demand profile is based on the Aerotropolis load profile, which incorporates Wetherill Park zone substation load profile (an existing commercial/industrial site). The existing supply capacity to the area has been included in our assessment of the identified need.

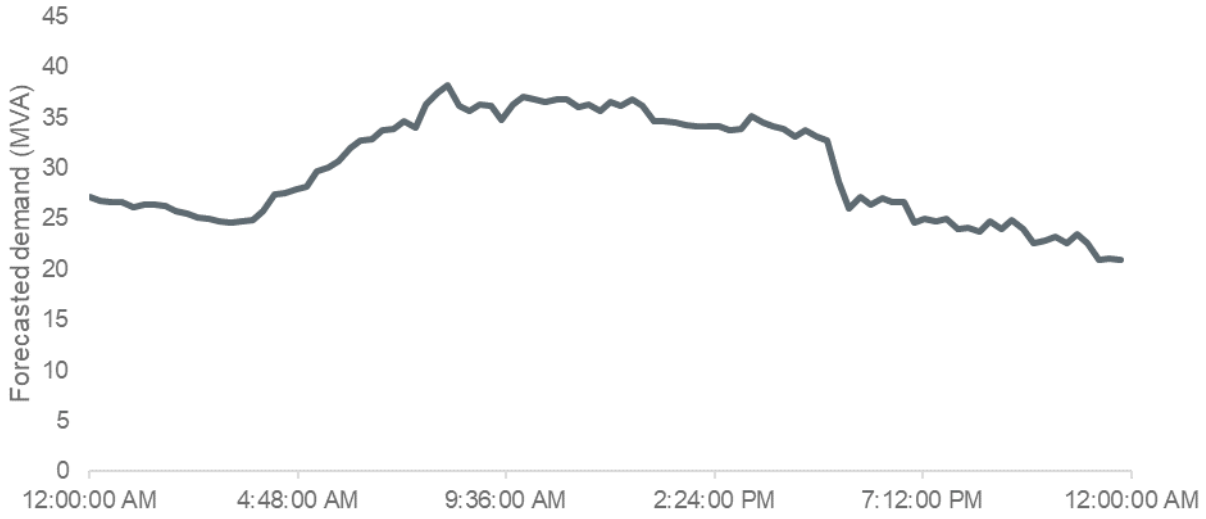
Figure 10 presents the normalised Load Duration Curve (LDC) assumed based on the composite demand profile.

Figure 10 – Normalised LDC assumed for high voltage connections associated with WSIA



Similarly, Figure 11 presents the peak load profile for summer assumed load based on the composite demand profile.

Figure 11 – Peak summer day profile assumed for high voltage connections associated with WSIA



7.1.3 Plant failure rates

To understand the comparison between overhead and underground, the analysis considered the failure rate of the 132kV feeders. The failure rate assumptions shown in Table 8 are based on Endeavour Energy's operational experience.

As the feeders will be operating as ring mains the duration of the outages is expected to be relatively short and equivalent between the two options.

Table 8 – 132kV Feeder Failure Rates

	Overhead	Underground
132kV Feeder Failure Rate (faults/km/annum)	0.002	0.001
Duration of outage	1 Hour	1 Hour

7.1.4 Plant Ratings

Endeavour Energy's standard ratings have been employed for the purposes of this evaluation.

7.1.5 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 $45.90 per kWh in the evaluation which is based on the 2021 VCR values provided by the AER, weighted in accordance with the composition of the commercial, industrial and residential load within the constituent connections.

This reflects a high level of commercial and industrial loads that will be served in the development area. A breakdown of these assumptions is provided in Table 9:

Table 9 – Forecasted load types for the major connection points

Connection Points	Commercial	Industrial	Residential
Sydney Science Park	80%		20%
Northern Gateway & USyd Employment Lands	80%	20%	
Adams Rd Precinct	40%	60%	
Western Sydney Airport	100%		
Sydney Metro	100%		

Using this composition, a VCR was then calculated based on each load component parts and weighted based on the forecast contribution of each load point. This is shown in Table 10.

Table 10 – VCR Weightings and Derivation

Connection Points	Forecast MVA	VCR
Sydney Science Park	75	40,142
Northern Gateway & USyd Employment Lands	90	48,710
Adams Rd Precinct	25	56,470
Western Sydney International Airport	34	44,830
Sydney Metro	46	44,830
Weighted Average		**45,899**

7.2 Classes of market benefit considered

The classes of market benefits that are considered material and have been quantified in this RIT-D assessment are:

- Changes in involuntary load shedding and customer interruptions caused by network outages; and
- Differences in the timing of expenditure

7.2.1 Changes in involuntary load shedding

Increasing the supply capability in the areas of Luddenham, Kemps Creek and Badgerys Creek increases the supply available to meet the growth in demand within these areas. This will provide greater reliability for this region 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 development area where potential customers would otherwise have to go without supply is therefore captured using changes in involuntary load shedding.

7.2.2 Differences in timing of expenditure

The difference in the timing of expenditure for the options considered is shown in Table 11 below. Option 1 has a larger upfront component over the build period, relative to total costs. Note there are no major differences in project staging between the options.

Table 11 - Comparison of Option Capital Cost Schedules

Option	Description	2022 ($M)	2023 ($M)	2024 ($M)	2025 ($M)	2027 ($M)
1	Establish 132/33kV transmission substation in two stages	5.9	17.6	15.6	0	3.5
2	Establish 132/33kV transmission substation with two 120MVA transformers upfront	6.3	18.8	16.7	0	0
3	Augment existing 33kV network	0	36.9	50.9	38.1	0

7.3 Classes of market benefit not considered to be material

The classes of market benefits that are not considered material are listed below:

- Changes in voluntary load curtailment
- Option value
- Changes in load transfer capacity.
- Changes in costs to other parties
- Changes in electrical losses.

7.3.1 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 could lead to a reduction in involuntary load shedding, that is, increase in voluntary load reduction.

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 (predominantly residential) to deliver sufficient voluntary demand reduction.

7.3.2 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.

Due to the committed connections there is little uncertainty about the need and use of the assets and each option is considered equivalent in that respect. Option Value has therefore not been considered in the economic analysis.

7.3.3 Changes in load transfer capability

Each of the Options 1, 2 and 3 allows for alternate supply from both ends of the feeder to ensure secure and reliable supply. This alternate supply from both ends of the feeders common to all 3 options identified provides operational flexibility for Endeavour Energy. They each also support the future growth of the area with high reliability and will make connection of additional Endeavour Energy and customer funded substations both economic and timely. The operational flexibility provided by alternate supply from either end of the proposed feeders also enhances the ability of the network to accept embedded generation within the area, particularly large-scale PV solar farms and other renewable energy projects that may develop in the area based on stated intentions of connecting customers to pursue net zero and potentially carbon negative solutions.

As these benefits were considered broadly equivalent between each of the options, this was not considered to be material aspect of comparison.

7.3.4 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.

7.3.5 Changes in electrical losses

Endeavour Energy recognises that there would be small changes in the loss profile for customers serviced out via the options considered but given they are all 132kV feeders that these are negligibly small in each case. Changes in electrical losses have not been modelled.

7.4 Scenarios and sensitivities

The capital and operating cost assumptions for each credible option are summarised in Table 12.

Table 12 – Base Case Capital and Operating Cost Assumptions

Variables	Values
Maximum demand forecasts	Base (expected) growth scenario presented in Section 4
Capital costs	Estimates provided in Section 1
O&M costs	0.4% of capital spend unless otherwise stated.
Value of customer reliability	Base estimates provided in Section 7.1.5

7.4.1 Demand forecasts

The maximum demand forecasts have been derived from a projection of the connection and growth of new loads. Notionally, this is on an approximate 50% probability of exceedance basis. For sensitivity

analysis, the base forecast has been varied by ± 20% and included variable customer growth rate assumptions, as shown in the earlier table.

7.4.2 Capital costs

Capital cost estimates have been based on standard planning cost estimates of the detailed scope of work including a high-level scope of work. For sensitivity analysis, these estimates have been varied by ± 25%.

7.4.3 Value of customer reliability

This analysis adopts the value of customer reliability values published by 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 volume weighted VCR value of $45.90 per kWh has been derived and used in the RIT-D analysis. A variation of ±30% has been used for sensitivity testing in accordance with AER guidelines.

7.4.4 Discount Rate

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

Table 13 below describes the variations in input parameters used for the purpose of defining various scenarios.

Table 13 – Variables for Sensitivity Testing

Parameter/ scenario	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%

8. Results of analysis

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

8.1 Central case results

The economic analysis of the options under the Central case scenario is shown in Table 14. This shows Option 2 has the highest NPV of all the credible options, thus considered the preferred option.

Table 14 – Central case results

Option	Description	Project capex nominal ($M)	PV of market benefits ($M)	PV of Costs ($M)	NPV ($M)	Rank
1	Establish 132/33kV transmission substation in two stages	42.6	296,227.0	-35.8	296,191.2	2
2	Establish 132/33kV transmission substation with two 120MVA transformers upfront	41.9	296,227.4	-35.7	296,191.7	1
3	Augment existing 33kV network	127.2	253,669.4	-104.6	253,564.8	3

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 changes in relation to:

- Forecast demand, and hence quantity of involuntary load shedding
- Investment costs
- Discount Rate

Detailed in Figure 12 are the scenarios used in sensitivity testing and their relative weightings.

Figure 12 – Summary of Scenarios used in sensitivity testing

Scenarios	
Scenario selection	
Scenario	Scenario 1

Scenario weighting			
	Scenario 1	cenario	Scenario 3
Weighting	0.50	0.25	0.25

General inputs							
General	Unit	Value	Selection	Scenario 1	cenario	Scenario 3	User defined
Commercial discount rate	Percent	3.26%	Central	Central	High	Low	Central

Cost inputs							
Cost	Unit	Value	Selection	Scenario 1	cenario	Scenario 3	User defined
Capital cost	Percent	100%	Central	Central	High	Low	Central
Planned routine maintenance and refurbishment	Percent	100%	Central	Central	High	Low	Central
Unplanned corrective maintenance	Percent	100%	Central	Central	High	Low	Central
Decommissioning costs	Percent	100%	Central	Central	Central	Central	Central
Non-network option provider costs	Percent	100%	Central	Central	High	Low	Central

Benefit inputs							
Market benefits	Unit	Value	Selection	Scenario 1	Scenari	Scenario 3	User defined
Involuntary load shedding - VCR	$/MWh	45,900	Central	Central	Low	High	Central
Involuntary load shedding - MWh	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Percent	100%	Central	Central	Low	High	Central
Voluntary load curtailment - VCR	$/MWh	45,900	Central	Central	Low	High	Central
Voluntary load curtailment - MWh	Scenario	NA	Central	Central	Low	High	Central
Costs for non RIT-D proponent parties	Percent	100%	Central	Central	Central	Central	Central
Electricity energy losses	$/MWh	100	Central	Central	Central	Central	Central
Change in load transfer capacity and the capacity for embedded generators to tak	Percent	100%	Central	Central	Central	Central	Central
Other classes of market benefits	Percent	100%	Central	Central	Central	Central	Central

Detailed in Table 15 are the results of the sensitivity analysis.

Table 15 Sensitivity and Scenario Assessment

Option	Description	Scenario 1 Rank	Scenario 2 Rank	Scenario 3 Rank	Weighted Scenario Rank
1	Establish 132/33kV transmission substation in two stages	2	2	2	2
2	Establish 132/33kV transmission substation with two 120MVA transformers upfront	1	1	1	1
3	Augment existing 33kV network	3	3	3	3

The results show that Option 2 maximises the net market benefit in the base case as well as the weighted scenarios considered for sensitivity analysis.

8.3 Economic timing

The economic timing of the proposed preferred option may be taken to be the point where network capacity is insufficient to connect new customers.

The 33kV network in the areas of Luddenham, Kemps Creek and Badgerys Creek requires connection capacity to be made available as soon as the existing available capacity in the network is exhausted. Based on current demand forecast, this is expected to occur in FY24. Consequently, this date is seen as the economic timing for this project.

9. Conclusion

The establishment of WSIA as Sydney's second international airport at Badgerys Creek, is the catalyst for development in the Western Sydney Aerotropolis area. WSIA and the associated high voltage connections is forecast to add significantly to electricity demand in Endeavour Energy's distribution network in the short to medium-term. A number of connection applications and enquiries have already been received and incorporated into the demand forecast for the area.

The demand for Luddenham zone substation, Kemps Creek zone substation and new high voltage connections (including the Airport Terminal buildings, Airport North Business Park and Logistics, Freight and Agribusiness gateway) is expected to grow from 61 MVA in 2023/24 to over 160 MVA by 2030/31.

As outlined in the Screening Report, it is not considered feasible that a non-network solution will form a potential credible option on a standalone basis, or form a significant part of a potential credible option for the Luddenham, Kemps Creek and Badgerys Creek 33kV supply area.

This DPAR has identified three credible network-based options that can technically meet the required network demand. Two of the options involve establishing a new 132/33kV transmission substation, one with two transformers upfront and the other in two stages with one transformer initially. The third option involves augmenting the existing 33kV network. An economic evaluation was conducted on all credible options and the option that presented the greatest net market benefit and thus considered as the preferred option is Option 2. This option is the establishment of a new 132/33kV transmission substation with two 120 MVA transformers upfront near the WSIA industrial load precinct. It has a lower initial cost compared to Option 1 since the establishment of two transformers upfront does not incur additional re-mobilisation costs, and despite both options ultimately have similar value of market benefits, this option has higher net economic benefits. Option 3 has the highest cost and lowest market benefits and was therefore ranked last in the economic evaluation.

The new transmission substation will meet the connection and load growth requirements across the load centres of Luddenham zone substation, Kemps Creek zone substation and high voltage connections associated with the WSIA. The total cost of the preferred option is estimated to be $41.9 million. Construction could start in 2021/22 and be completed in 2023/24, with commissioning of the feeder in the same year as construction is complete.

Endeavour notes that the proposed transmission substation will be a shared network asset which will become part of Endeavour's Regulatory Asset Base. As initially these prospective customers are expected to utilise a high majority of the asset, specific tariff arrangements will be established to recover the majority of the cost of the augmentation from the beneficiaries (i.e. the new customers). These customers will be charged a cost reflective network price, determined specifically from this network augmentation investment. This will ensure no cross subsidy from existing customers, but can be adjusted such that as a larger number of customers benefit from the asset, the costs can be shared accordingly.

10. Appendix – Further Details on Network need

10.1 Existing Network Overview

The existing network in the region of interest is insufficient to meet the supply needs of the Luddenham, Kemps Creek and Badgerys Creek area from 2023/24.

The electricity supply network in the region was originally provided to meet the historical setting of rural and low-density residential loads. Existing loads in the area are supplied at 11kV from zone substations at Luddenham and Kemps Creek, that are supplied from a 33kV sub-transmission network between two bulk supply points, namely Liverpool BSP and Regentville BSP. Geographic overlay and simplified single line diagrams of the existing transmission network infrastructure are shown in Figure 13, Figure 14 and Figure 15

Figure 13– Geographic location with 33kV feeders, major substations, and indicative high voltage customer locations

Both Luddenham Zone Substation and the High Voltage connections are supplied on 33kV Feeders 464 and 465. These feeders are a radial supply originating from Regentville BSP through a single 132/33kV step down transformer at Glenmore Park ZS.

Kemps Creek ZS is normally supplied by Feeder 512 from Liverpool BSP (via West Liverpool TS). Feeder 464 and 465 service as backup supplies to Kingswood ZS (on Penrith TS system) and North Warragamba ZS (Regentville TG 132kV system). A necessary normally-open point between the Bulk Supply Points exists at the Kemps Creek ZS end of Feeder 465. Feeder 464 and Feeder 512 are rated at 50MVA. Feeder 465 is rated at 21 MVA (near term augment to 29MVA).

Due to a cross-bulk supply point arrangement, both Luddenham ZS and Kemps Creek ZS operate under a change-over configuration where an outage on any main supply feeder section (464, 465, 512) results in a disconnection of customers until restored from the single alternate healthy 33kV feeder.

Figure 14 – Simplified single line diagram of existing transmission network

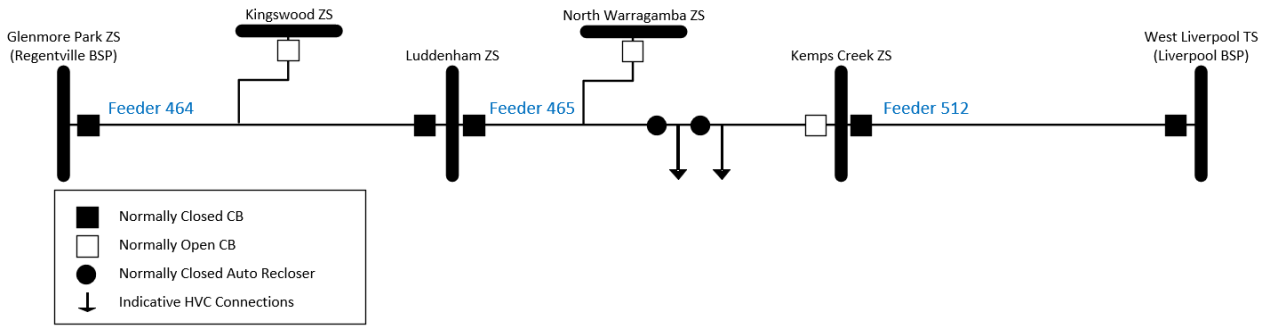
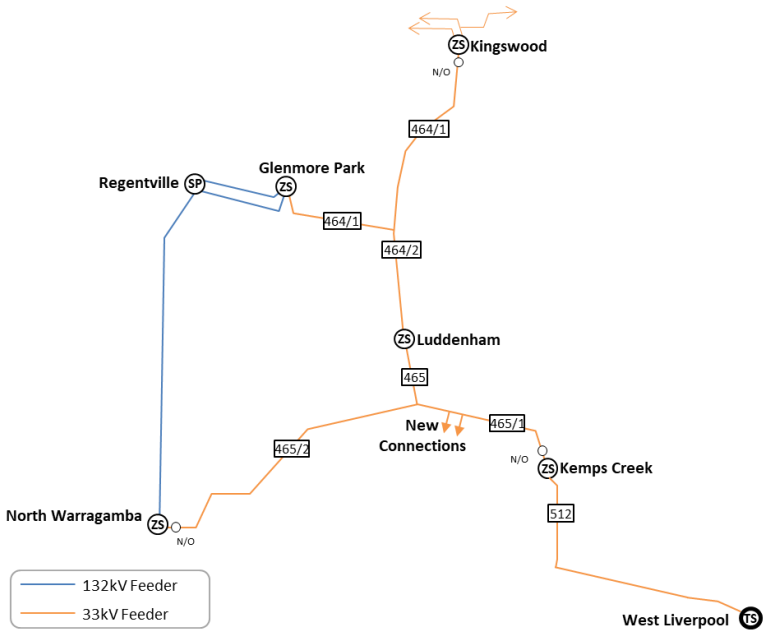


Figure 15 – Geographic single line diagram of transmission network



10.2 Load forecast

In the body of the report, Figure 5 shows the load at risk under a central, low and high demand scenario.

Each scenario reflects different assumptions regarding the timing and quantity assumed for future load connections. In particular, we have considered different growth rates and different eventual load requirements for the seven key loads:

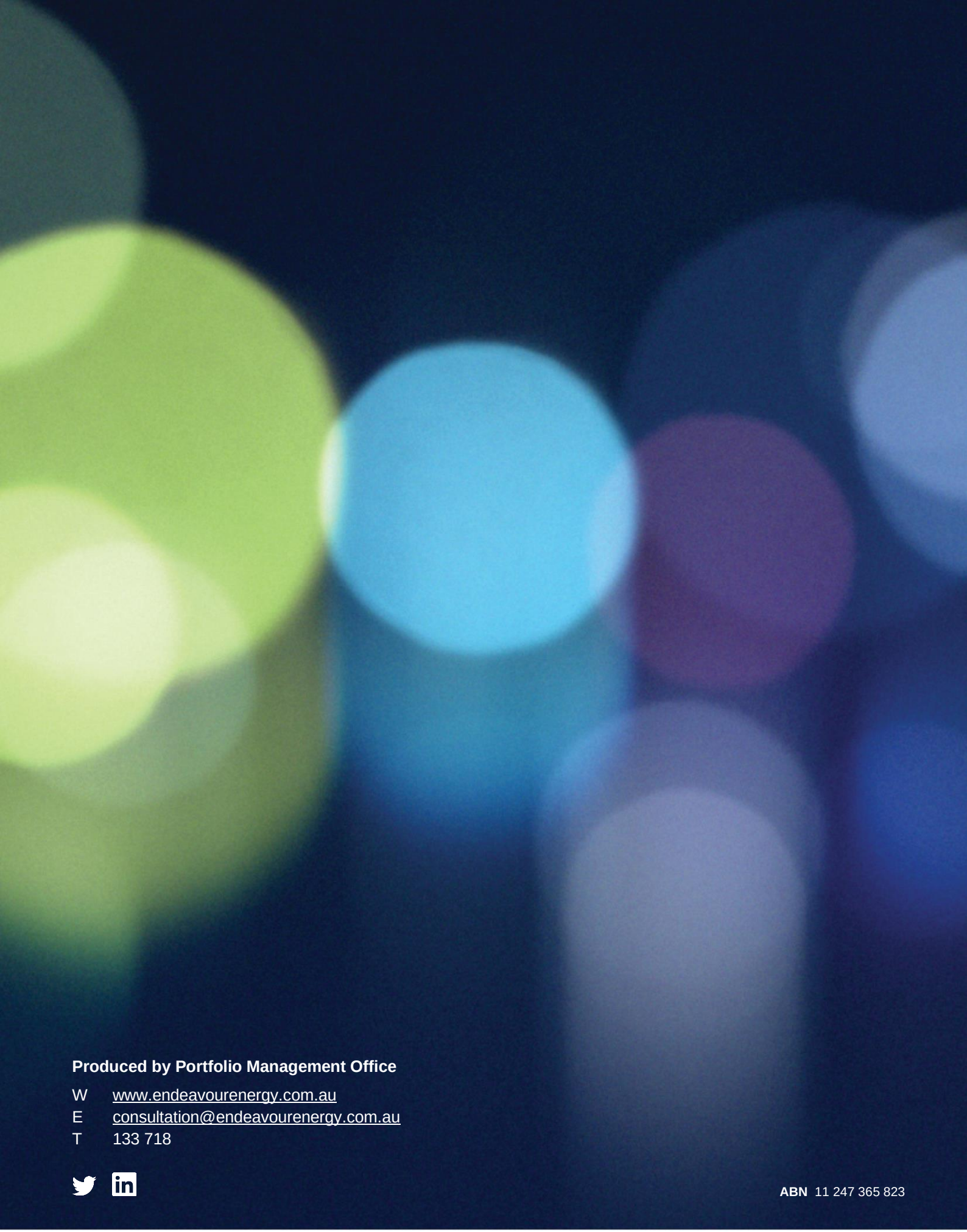
- Western Sydney International Airport
- BHL & Sydney University Employment Lands (residual)
- Initial BHL (Northern Gateway)

- BHL Northern Gateway Estate Stage 1
- Agribusiness North (excluding Adams Rd)
- UIL5931 - Adams Rd (Luddenham)
- UIL5931 - Adams Rd (Kemps Creek)

The demand forecast across the three scenarios can be summarised as follows:

- the central scenario assumes that these key customer connections eventually total 102.5 MVA in 2030/31 with a modest generation capacity estimate from WSIA;
- the low scenario assumes the same key customer connections as under the central scenario, albeit at lower growth rates and high generation capacity estimate from WSIA (ie, under the low scenario, demand reaches 81.3 MVA in 2030/31); and
- the high scenario assumes the same key customer connections as under the central scenario, albeit at higher growth rates and low generation capacity estimate from WSIA (ie, under the high scenario, demand reaches 127.6 MVA in 2030/31).

Due to the confidentiality of these forecast loads, we are not able to present a further breakdown of the composition of demand under each scenario. The combined demand forecasts shown above are based on currently available information derived from the plans of NSW government planning groups, infrastructure providers and private developers. There is a degree of uncertainty with regards to the demand requirements, as they are dependent upon individual commercial decisions of the development proponents, which has been reflected in the different load scenarios shown above.



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