Case For Investment (CFI): Capacity Increase for Aerotropolis Core Precinct

July 2022

Endeavour Energy

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Investment Title	**Capacity Increase for Aerotropolis Core Precinct**
<< project # / code >>	NPR-000078 (legacy project PR808)
Portfolio	Augex
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Pre RIT-D	☒
Final CFI	☐
Other	☐

1. Executive Summary

This Executive Summary sets out an overview of the proposed investment including the underlying need, a discussion of the key drivers, the options considered to address the need and our recommended solution. These aspects are covered in detail in the body of the Case for Investment (CFI).

1.1 Need/ Background

The Aerotropolis Core Precinct is planned for dense urban development centred around the proposed Aerotropolis Metro Station. This precinct forms the top priority of the NSW Government Aerotropolis Precinct Plan focusing on retail, services, and business activity. These developments are expected to require approximately 140MVA of capacity by 2041. The construction of large-scale infrastructure development in the Bradfield region has commenced in line with NSW Department of Planning and Environment (DPIE) plans.

The key drivers for this investment are the customer applications which Endeavour Energy have received, and are included in the Aerotropolis area plan. The area plan consists of the latest update of customer enquiries from the customer connections database and DPIE plans. All area plans are updated quarterly with the latest statistics on connections enquiries, coordination with utilities and department area plans. Key developments in this area include:

- The new CBD area within the Aerotropolis Core Precinct (which includes ENL4081) which is expected to grow to a maximum demand of 67MVA over a 30-year period from 2026;
- The residual Aerotropolis Core Precinct to the north of the proposed CBD is marked for general enterprise/industrial developments (which includes ENL4003). The total load of the residual land is estimated to be 97 MVA over a 30-year period from 2024.
- The southern portion of the Agribusiness Precinct, forecasted to require 73MVA from 2027 onwards.

The area is currently supplied by an 11kV distribution network from Bringelly zone substation (ZS), which has a limited firm capacity of 19 MVA and is set to be exceeded by 2025 based on current load forecasts and connection applications. From then, there will be a large amount of load at risk and ultimately sustained involuntary load shedding, resulting in considerable unserved energy. This will result in customers not being able to connect to the network, which contravenes Endeavour Energy's obligation to provide connection services. A project is required to service future customers in the Aerotropolis Core Precinct and surrounding areas and address the capacity constraints.

Figure 1 below describes the decision rule from Endeavour Energy's growth servicing strategy to determine the approach required to address the trigger and need. This decision rule considers both an action or decision to take now (Stage 1) and in the future as appropriate market conditions arise (Stage 2). Based on the decision rule, the identified need is such that it is sub-optimal for Endeavour Energy to do nothing because:

- Based on characteristics of growth, this investment is classified as **greenfield.**
- Identified need based on consequence of no action for the greenfield development is **reliability corrective action**[1].

[1] Refer Growth Servicing Strategy for definitions of greenfield and brownfield sites

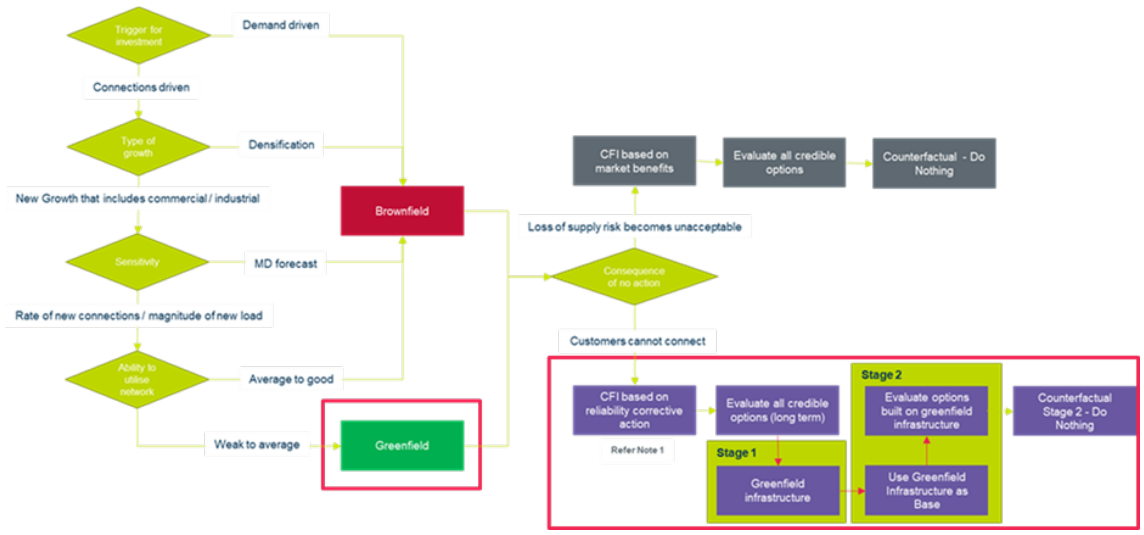

Figure 1: Decision Framework from Endeavour's Growth Service Strategy

1.2 Options Considered

1.2.1 Long Term Network Options

Increasing the capacity requires investment in infrastructure, which

- finds the right balance between short-term and long-term needs, and
- provides choices (network or non-network) of electricity infrastructure investment to cater for future growth scenarios.

To ensure that the long-term plan maximises net benefits to the community, Endeavour Energy specifically looked at both the location and staging of the investment. This CFI recommends the investment for the first stage only, but within the context of the overall long-term plan. Table 1 outlines the long-term options to address the identified need of supplying the new connections in this area. The Table 1 shows that Option 1 has the most significant economic benefit, Net Present Value (NPV) positive $27,022 million.

Table 1: List of Long-Term Network Options

Option	Stage 1 – Greenfield Infrastructure (Scope of CFI)	Stage 2 – Future Infrastructure built on Greenfield infrastructure	NPV [1] $M	Rank	Assessment Description
1	**Establish Bradfield North 45MVA (firm) zone substation in FY25, including 22kV upgrade**	**Augment Bringelly ZS augment in FY30 & FY 34 with 2x 45 MVA Transformers**	**27,022.9**	**1**	**Greatest Net Benefits, Preferred Long Term option**
2	Augment Bringelly zone substation 45MVA firm in FY25 including 22kV upgrade and additional feeders	Staged establishment of Bradfield North zone substation in FY27 and FY30 (1 x 45MVA TX in each stage)	27,021.6	2	Technically feasible, lower net benefits

Notes:
1: The NPV is based on the central scenario.

1.2.2 Phasing of the Preferred Network Option

To ensure that the proposed network option represents the minimum network infrastructure required to service the step change in new load, Endeavour Energy has considered Option 3, which phases the implementation of Bradfield North ZS, where the 2nd transformer is deferred to FY30.

Table 2 shows that Option 1 has the greatest economic benefit. Option 1 was also preferred because Option 3 has load at risk between FY25-29, limiting the number of future customers that could connect to the Aerotropolis Core precinct, and limiting future growth in the region.

Table 2: Option Summary Table

Option	Stage 1 – Greenfield Infrastructure	Stage 2 – Future Infrastructure built on Greenfield infrastructure	NPV [1] $M	Rank	Assessment Description
1	**Establish Bradfield North 45MVA (firm) zone substation in FY25 including 22kV upgrade**	**Augment Bringelly ZS augment in FY30 & FY 34 with 2x 45 MVA Transformers**	**27,022.9**	**1**	**Greatest Net Benefits, Preferred Long Term option**
3	Establish Bradfield North zone substation with 1x 45 MVA in FY25 including 22kV upgrade + 2nd Transformer at Bradfield North in FY30	Augment Bringelly ZS augment in FY30 & FY34 with 2x 45 MVA Transformers	27,018.0	2	Technically feasible, lower net benefits

Notes:
1: The NPV is based on the central scenario.

1.2.3 Non-Network Options

The New Technology Master Plan (NTMP) tool was used to evaluate credible non-network options against the constraints in the existing distribution network. The NTMP tool and the subsequent qualitative analysis found that non-network options are not feasible for the first stage of network infrastructure. Non-Network Options are discussed further in Section 3.8 and in the subsequent RIT-D screening report

1.3 Recommendation

This CFI recommends the investment for Stage 1 of the preferred option (Option 1), which is to establish Bradfield North ZS with two 45 MVA transformers with supporting 22kV distribution network. This CFI recommends the investment for the first stage only but within the context of the overall long-term plan. Figure 2 below shows the staging of the project:

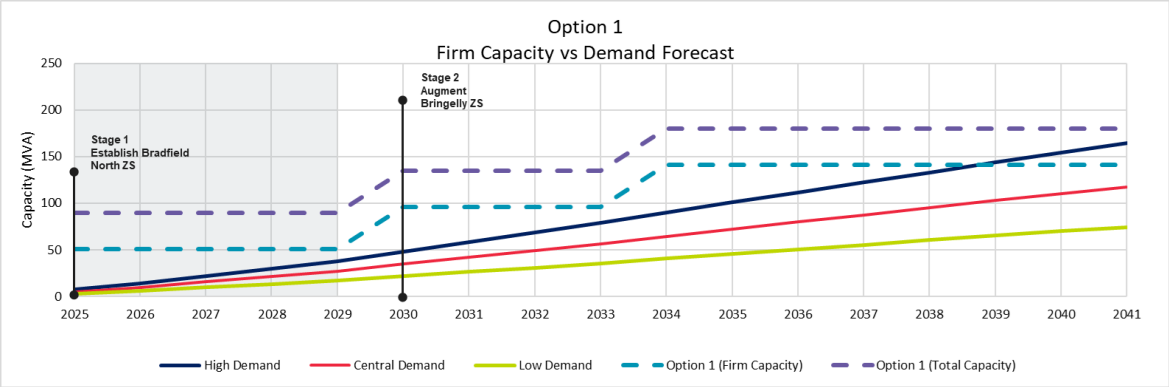

Figure 2 - Staging of Option 1

- **Stage 1 - Establish Greenfield Infrastructure:** The first stage includes the establishment of a new 45 MVA (firm) 132kV/22kV Bradfield North Zone Substation to facilitate the connections for the first 5 years. Non-network options are not feasible or credible for the essential headwork infrastructure. This essential infrastructure will facilitate the network and non-network options to service the growth beyond 2030.
- **Stage 2 - Build on Greenfield infrastructure:** The essential greenfield infrastructure installed in Stage 1 will provide a foundation upon which future infrastructure can be constructed. The future infrastructure can be either network or non-network (e.g. batteries). Stage 2 infrastructure will service the anticipated increase in maximum demand (MD) due to the forecast growth.

The CFI recommends that a project value of $38.8M with an additional 3.9M of contingency be approved for consideration in the FY22 Portfolio Investment Plan. This investment is expected to be spread over three years from FY23 to FY25.

The next steps for this project are:

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR) as per the Regulatory Investment Test-Distribution (RIT-D) process (Refer to Figure 3). This is because the identified need for this investment is a reliability correction action to meet Endeavour Energy's connection obligations in the National Electricity Rules (NER). Additionally, non-network options were not found to be feasible.
- The project proceeds to preliminary release for **Stage 1** of Option 1 which was the preferred option. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

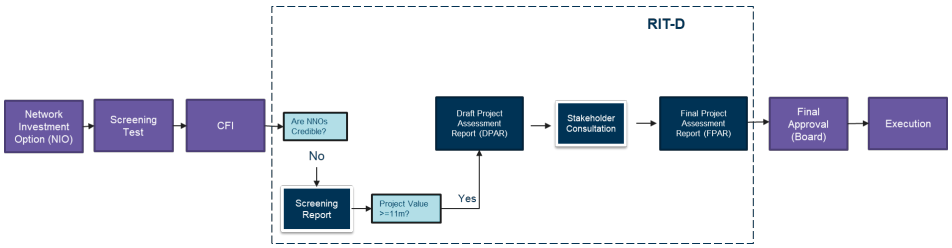

Figure 3 - Endeavour Energy's RIT-D Process for this Project

2. Project Proposal

2.1 Identified Need or Opportunity

The Aerotropolis Core Precinct is planned for dense urban development centred around the proposed Aerotropolis Metro Station. This precinct forms the top priority of the NSW Government Aerotropolis Precinct Plan focusing on retail, services and business activity. The precinct neighbours the Agribusiness Precinct to the west, and the Badgerys Creek Precinct to the north. The combined land use zoning of the area is shown in Figure 4. Further details on his precinct can be found in Endeavour Energy's area plan for the Aerotropolis area.

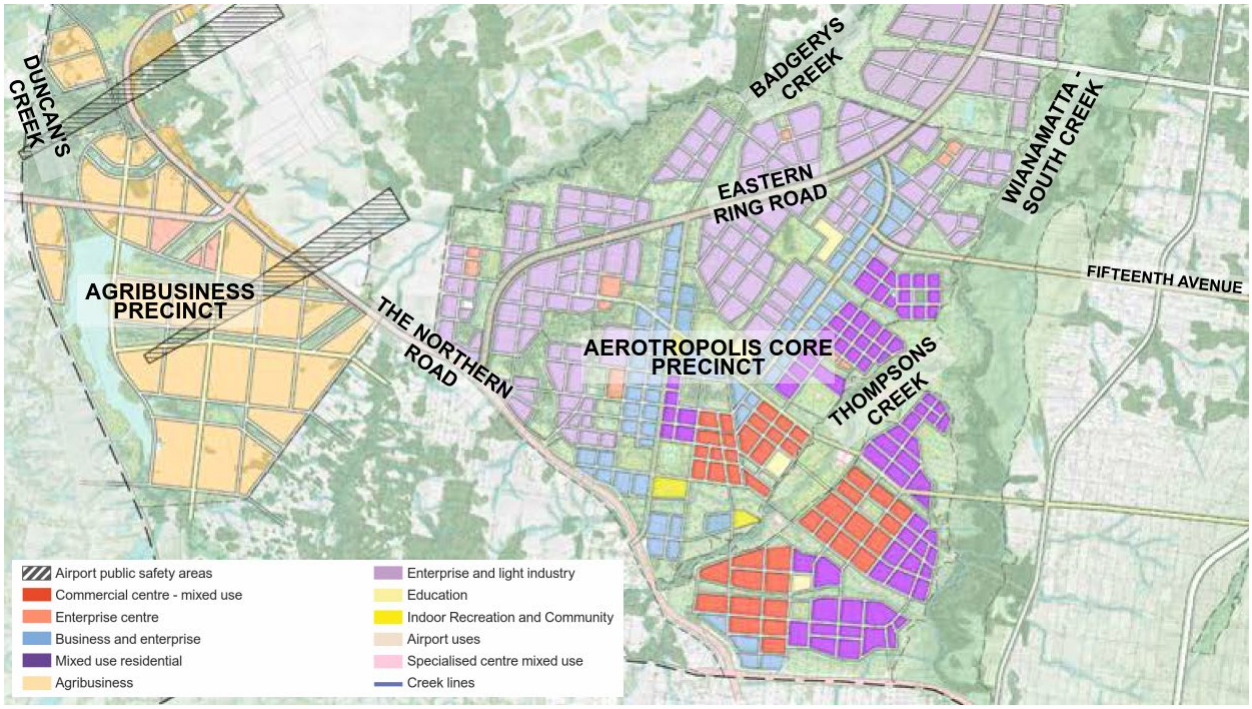

Figure 4 – Land use zoning of Aerotropolis Core Precinct and surrounding areas

2.2 Existing Infrastructure not capable to service the growth

2.2.1 Existing Infrastructure

This area is currently serviced via the 11kV low-capacity networks of Bringelly, Kemps Creek and Luddenham zone substations, established initially to service the rural residential load base. This network is predominately overhead and will require replacement or relocation due to road widening developments to cater for the increased transport requirements of the Aerotropolis. Ultimately, the greater area will be converted to 22kV supply through the gradual conversion of the existing 11kV network as 22kV capacity centres are established in line with the 22kV supply strategy for the area. The initial phases of development within the Aerotropolis Core Precinct are planned to be supplied via 11kV cable extensions from Kemps Creek and Bringelly zone substations, providing a total 12MVA of supply capacity. These feeder extensions will be included as part of the distribution works to establish supply to initial developments in the precinct.

Further 11kV network extensions beyond those already planned is not feasible due to capacity constraints at the surrounding zone substations and the prohibitively high cost and excessive voltage drop incurred by establishing 11kV supply from alternative sources. In addition, the cost to convert the area from 11kV to 22kV reticulation will increase over time in proportion to the number of distribution transformers installed, which will require replacement when the 22kV conversion is undertaken. For this reason, the 22kV conversion must occur as soon as 22kV capacity is available to the area.

2.2.2 Limitations of existing infrastructure

The main contingency that that will result in unserved energy due to the insufficient load transfer potential from neighbouring zone substations and feeders is the failure of a transformer at the existing 132/11kV Bringelly ZS. The substation has two transformers rated at 25 MVA and 19 MVA respectively. However, these transformers are supplied by different TransGrid Bulk Supply Points (BSPs). Operating both transformers in parallel can cause issues such as circulating currents. .This limits the total capacity of Bringelly ZS with 25 MVA with only 19 MVA firm (N-1) capacity with this contingency.

2.2.3 Load Growth

The capacity requirements of the area can be separated into the following developments:

- The new CBD area within the Aerotropolis Core Precinct (which includes ENL4081) which is expected to grow to a maximum demand of 67MVA over a 30-year period from 2026;
- The residual Aerotropolis Core Precinct to the north of the proposed CBD is marked for general enterprise/industrial developments (which includes ENL4003). The total load of the residual land is estimated to be 97 MVA over a 30-year period from 2024.
- The southern portion of the Agribusiness Precinct, forecasted to require 73MVA from 2027 onwards.

The developments are well progressed as shown in Table 3, which shows the status of the three important criteria to determine the timing of the investment. The table shows the moderate growth is likely in the short term which will require investment.

Table 3: Criteria for Investment Timing

Criteria	Low or later growth time frame	Moderate growth in medium term expected	High growth likely in shorter term
Zoning status	Not part of any official release area and not rezoned	Part of official release area but not rezoned yet	Yes rezoned
Development status	No current activity	First stages already planned /committed to	construction commenced for initial stages
Supporting infrastructure (water/sewer, roads, transport)	Lack of other infrastructure commitment	Planned/committed initial stages of other infrastructure	Significant progress on roads and transport and water/sewer infrastructure already

2.2.4 Demand Forecast

Considering the major new connections and network constraints listed above, the demand forecast for the Aerotropolis Core precinct is detailed in Figure 5 and presents a central, high and low forecast cases.

Based on the load forecast shown in Table 4 and Figure 5, the existing Bringelly ZS will have load at risk from 2024, which will result in customers not being able to connect to the network which contravenes Endeavour Energy's obligation to provide connection services. The investment into additional electrical capacity in this area is required to meet these requirements. Consequently, this investment is considered a reliability corrective action under Section 5.10 of the NER.

Table 4: BAU Aerotropolis Precinct Load Forecast

Demand Forecast (MVA)	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2036	2041
Agribusiness South	0.0	0.0	0.0	0.0	0.0	2.0	3.9	5.9	7.0	8.1	16.0	23.7
Enterprise Southwest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	4.9	17.2	29.5
Aerotropolis Core	0.0	0.0	3.2	6.5	9.7	12.9	16.2	19.4	22.7	25.9	42.1	58.3
Aerotropolis City (mixed commercial)	0.0	0.0	0.0	0.0	1.1	2.3	3.4	4.6	5.7	6.8	12.5	18.2
Aerotropolis City (mixed residential)	0.0	0.0	0.0	0.0	1.1	2.2	3.3	4.4	5.5	6.6	12.0	17.5
Total Demand (Undiversified)	0.0	0.0	3.2	6.5	11.9	19.4	26.8	34.2	43.3	52.3	99.9	147.2
Total Load (Diversified at 80%) (Central Forecast)	0.0	0.0	2.6	5.2	9.6	15.5	21.4	27.4	34.6	41.8	79.9	117.8
Existing Bringelly ZS Load Forecast	**2022**	**2023**	**2024**	2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2036**	**2041**
Nov 21 Summer Demand Forecast (SDF)	17.1	17.0	17.0	17.4	14.3	14.5	14.8	15.4	16.3	17.8	18.7	19.6
Total BAU Load Forecast (Aerotropolis & Existing Bringelly ZS)	**2022**	**2023**	**2024**	2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2036**	**2041**
High Forecast	17.1	17.0	20.9	25.2	28.4	36.6	44.9	53.4	64.5	76.2	130.2	184.0

Central Forecast	17.1	17.0	19.6	22.6	23.8	30.0	36.2	42.7	50.9	59.6	98.6	137.4
Low Forecast	17.1	17.0	18.6	20.5	20.0	24.1	28.3	32.7	38.1	44.2	69.2	94.1
	2022	**2023**	**2024**	2025	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2036**	**2041**
Bringelly ZS (Total Capacity)	25	25	25	25	25	25	25	25	25	25	25	25
Bringelly ZS (Firm Capacity)	19	19	19	19	19	19	19	19	19	19	19	19
Load At Risk (MVA) (Central)	0.0	0.0	0.6	3.6	4.8	11.0	17.2	23.7	31.9	40.6	79.6	118.4

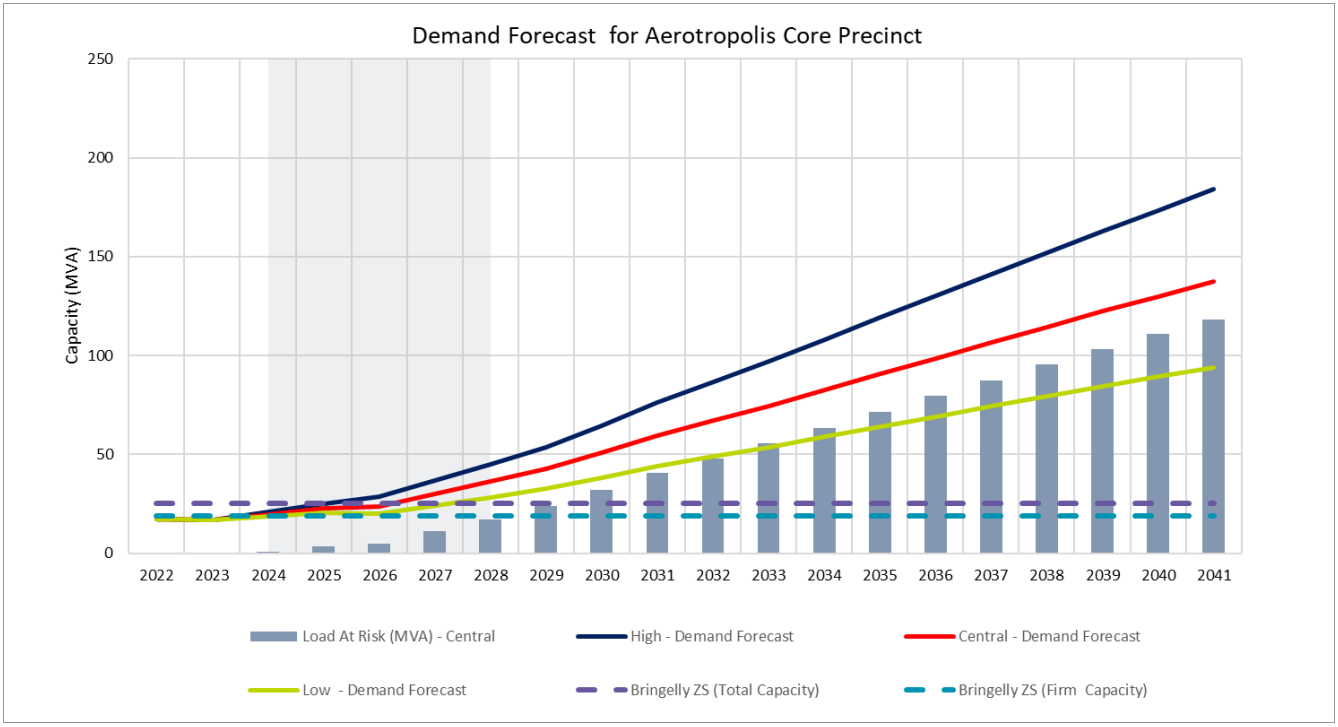

Figure 5 - Demand Forecast for the Aerotropolis Core Precinct

2.3 Related Projects

The CFI for the Aerotropolis Foundation Supply (PR741) was approved in October 2021. This project involves the establishment of the Aerotropolis backbone feeder, a 132kV 2745MVA feeder connecting South Erskine Park zone substation to Bringelly zone substation. In accordance with Endeavour Energy's 132kV servicing strategy for the area, this feeder will allow for the connection of several future zone substations in the greater area as shown in Figure 6 and is planned for completion in 2024.

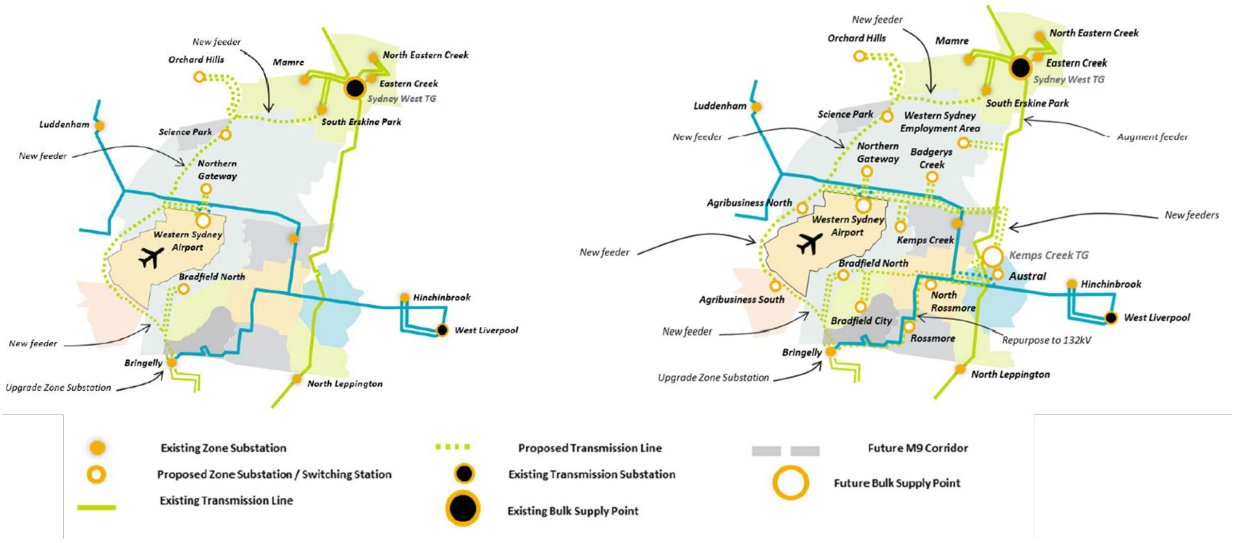

Figure 6 – Aerotropolis Area Plan[2] overview (Left: Near Term Configuration, Right: Long Term Network Configuration)

The CFI for PR741 also discussed an option to install additional supply capacity at Bringelly zone substation in addition to the feeder augmentation works required to establish the new 132kV feeder. This would include the installation of 2 x 132kV/22kV 45MVA power transformers as well as the associated switchboards and the installation of 4 x 22kV feeders. The analysis suggested that this option would develop 22kV capacity ahead of the network need for the area and could be deferred to a separate Bringelly zone substation 22kV augmentation project according to the optimal timing of the network need. It is now apparent that the network capacity will be required prior to 2025, however, the preferred option to satisfy the network need in the area is yet to be determined.

A site is currently being investigated to purchase under project PR775 with the purpose of establishing a 132kV/22kV zone substation. The site is located within the northern area of the Aerotropolis Core Precinct near the corner of Badgerys Creek Road and the proposed Eastern Ring Road, which will be the North Bradfield zone substation site.

[2] Endeavour Energy, Western Sydney Aerotropolis Area Plan, June 2022

3. Options Considered

Based on the decision rule outlined in the Growth Servicing Strategy, the following are the characteristics of the area:

- Investment is classified as **greenfield.**
- Identified need based on consequence of no action for the greenfield development is **reliability corrective action**[3].

Figure 7 below (subset of the decision rule included in the Growth Servicing Strategy) has been utilised to outline the options.

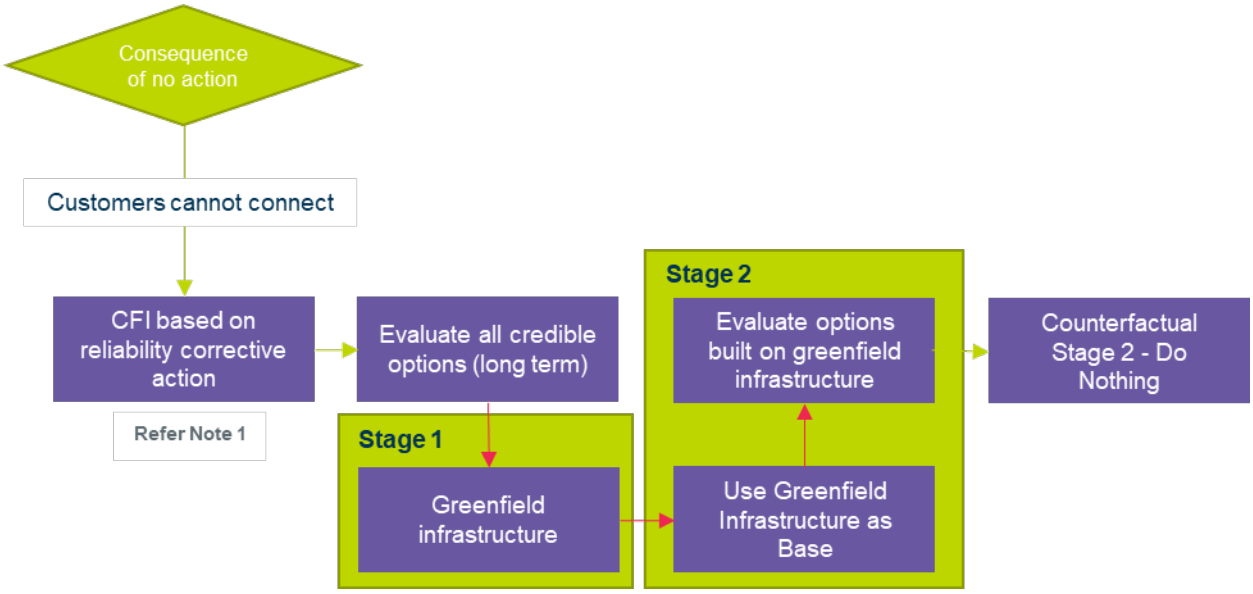

Figure 7 - Decision Rule from Endeavour Energy's Growth Servicing Strategy

[3] Refer Growth Servicing Strategy for definitions of greenfield and brownfield sites

3.1 BAU Base Case - 'No proactive intervention'

This section examines the risks and benefits of undertaking a non-proactive intervention (i.e. BAU). The consequence of not proceeding with any investment in a network option for the Aerotropolis Core Precinct will result in significant unserved energy due to the existing supply network being constrained and incapable of supplying the forecast demand and customers for the area.

In terms of Risk Cost assessment, the "No Proactive Intervention" option provides a base case where the risks are valued by applying a Value of Customer Reliability (VCR) to the forecast expected unserved energy. A composite VCR of $43,540 for the Aerotropolis Core Precinct was used based on 55% commercial, 21% industrial and 24% residential load.

Without proactive intervention, a risk of unserved energy will remain as shown on Figure 8 and Table 5, and Endeavour Energy may be unable to provide supply security for future developments in the growth area.

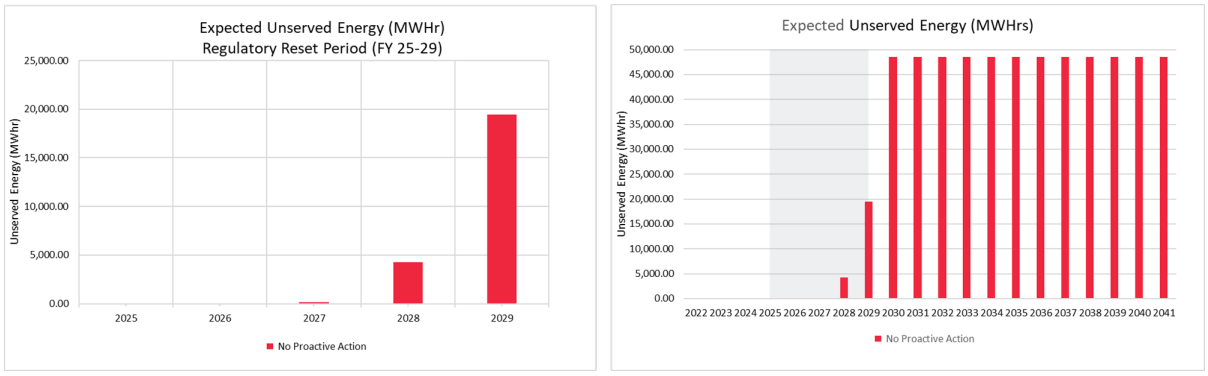

Figure 8 - Expected Unserved Energy as a result of "no proactive intervention"

Table 5: Value of Expected Unserved Energy as a result of "no proactive intervention"

	2025	2026	2027	2028	2029	2030	2031	2036	2041
Expected Unserved Energy (MWh)	0.10	0.32	157.84	4,295.38	19,467.31	48,559.32	48,559.32	48,559.32	48,559.32
Value of Unserved Energy ($M)	0.00	0.01	6.87	187.02	847.61	2,114.27	2,114.27	2,114.27	2,114.27

Notes

1. The value of unserved energy for the base case has been capped to the level five years after commissioning the proposed options (2025) in Section 3.2.

3.2 Credible Network Options (Long Term)

The National Electricity Objectives (NEO) require Endeavour Energy to operate the networks in the long-term interests of consumers. The options table below sets out the **long-term *credible options*** considered together with the option: "*no proactive intervention"* to assist the overall comparison. While the "no proactive intervention" in the face of ongoing load growth results in what appears to be unrealistically high volumes of expected unserved energy, it provides a clear reference point for comparing the performance of different credible options.

- addresses the identified need
- is (or are) commercially and technically feasible
- can be implemented in sufficient time to meet the identified need

Each credible option is further elaborated in the subsequent chapter.

3.2.1 Demand Forecast for Network Options

The network options listed in this section involve establishing a 132/22kV substation in 2025. This will sectionalise the existing Bringelly ZS and supporting 11kV network. All future Aerotropolis load was assumed to be shifted to the new substation in 2025. The load forecast that was used for the technical and economic assessment of the network options is listed in Table 6. This is the same forecast as Table 4; however it excludes the existing Bringelly ZS load forecast from the November 2021 Summer Demand Foreacst (SDF).

Table 6: Aerotropolis Precinct Load Forecast for Network Options

Demand Forecast (MVA)	2025	2026	2027	2028	2029	2030	2031	2036	2041
Agribusiness South	0.0	0.0	2.0	3.9	5.9	7.0	8.1	16.0	23.7
Enterprise Southwest	0.0	0.0	0.0	0.0	0.0	2.5	4.9	17.2	29.5
Aerotropolis Core	6.5	9.7	12.9	16.2	19.4	22.7	25.9	42.1	58.3
Aerotropolis City (mixed commercial)	0.0	1.1	2.3	3.4	4.6	5.7	6.8	12.5	18.2
Aerotropolis City (mixed residential)	0.0	1.1	2.2	3.3	4.4	5.5	6.6	12.0	17.5
Total Demand (Undiversified)	6.5	11.9	19.4	26.8	34.2	43.3	52.3	99.9	147.2
Total Load (Diversified at 80%) (Central Forecast)	5.2	9.6	15.5	21.4	27.4	34.6	41.8	79.9	117.8
Total Load Forecast for Network Options	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2036**	**2041**
High Forecast	7.8	14.2	22.1	30.1	38.0	48.3	58.5	111.5	164.4
Central Forecast	5.2	9.6	15.5	21.4	27.4	34.6	41.8	79.9	117.8
Low Forecast	3.1	5.7	9.6	13.5	17.4	21.9	26.4	50.5	74.5

Note

1. Before 2025, the load forecast in the same as Table 4

3.2.2 Option 1 – Establish Bradfield North Zone Substation (FY25) and augmentation of Bringelly Zone Substation (FY30 & FY34)

3.2.2.1 Stage 1 – Greenfield Infrastructure

This option proposes to stage the network infrastructure in line with the Growth Servicing Strategy. Based on credible growth information included in the area plans, there is a definite need for increased capacity in the region to connect future customers. Increasing the capacity requires investment in infrastructure, which

- finds the right balance between short-term and long-term needs, and
- provides the choices (network or non-network) for future growth of electricity infrastructure investment is not constrained.

Stage 1 Greenfield infrastructure is the minimum network infrastructure required to service the step change in new load for the short term. Providing this minimum network infrastructure is considered credible base case option[4] because “No proactive intervention” will contravene the obligation to provide connection services.

For this option, Stage 1 infrastructure is establishing a permanent 45MVA firm 132kV/22kV Bradfield North zone substation towards the north of the Aerotropolis Core Precinct to be commissioned by 2025. Supply would be established to the substation via two 132kV 2.8km feeder extensions along Badgerys Creek Road from the existing Aerotropolis feeder along the Northern Road (to be established under PR741). The new substation would be cut-in to the feeder, with one feeder terminating at Bringelly zone substation and the other feeder terminating at WSA TS. These feeders will be underground construction due to the planned urban development of the precinct.

This option proposes the following equipment to be installed:

- Two (2) 132kV indoor switchgear modular type buildings; each with:
  - One (1) 132kV transformer circuit breaker (CB)
  - One (1) 132kV feeder CB
  - One (1) 132kV bus section/coupler CB
- Three (3) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler CB
- One (1) modular type control building.
- One (1) modular type amenities building.
- Two (2) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.
- 132kV and 22kV cables associated with the two power transformers.
- One (1) auxiliary transformer.
- A 10m landscaped zone surrounding the substation.

[4] Section 3.3 characterising the base case. Application guidelines, Regulatory Investment Test for Distribution (RIT-D)

- Yard area provided for the installation of a future BESS and distribution ducting.
- Two (2) 132kV feeders cut in and out from the Aerotropolis feeder from Bringelly ZS to WSA TS along The Northern North (approx. 2800m south)
- Distribution Work Program (DWP) items including:
  - The 22kV conversion of the Aerotropolis Core Precinct area
  - 4 x 11kV/22kV auto-transformers
  - Installation of time clocks

Figure **9** shows that this stage provides a substation with 45 MVA of firm capacity and an additional 6 MVA of backup capacity from the four autotransformers planned for the initial growth. This meets the short to medium network capacity needs till 2032 under the central scenario and 2030 under the high scenario.

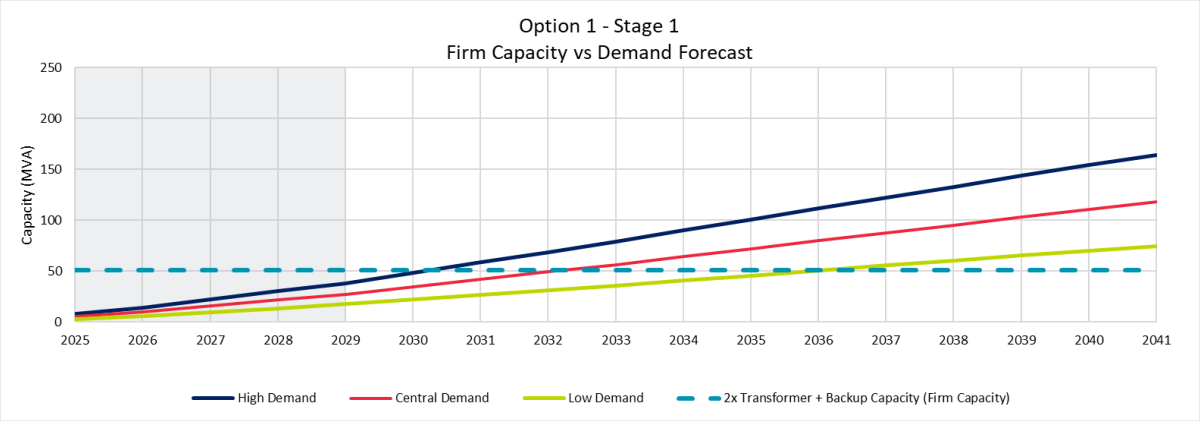

Figure 9 **- Firm Capacity of Stage 1 Infrastructure for Option 1**

3.2.2.2 Stage 2 – Future Infrastructure built on Greenfield infrastructure

Figure **9** shows that by 2032 the predicted load will exceed the installed firm capacity leading to additional load at risk. To service this growth, Endeavour Energy is proposing to a staged augmentation of Bringelly ZS to be commissioned 2030 and 2034. These dates were chosen to align with the Growth Servicing Strategy in which network investment for greenfield development is delivered using “Just in advance” principles. “Just in advance” is the process of delivering the electrical infrastructure in readiness to facilitate growth.

This option proposes the following equipment to be installed for this stage:

Augment Bringelly ZS (Phase A) – FY30 Commissioning

- Extension of the yard 60m to the south including:
  - Relocation of an existing water pipe.
  - Installation of a new stormwater drain.
  - Filling-in an existing dam and benching the extended yard area.
  - An additional 10m landscape zone along the southern boundary.
- Relocate security fence and extend yard approximately 10m to property boundary on the northern side to provide space for new 22kV switchroom buildings.
- Outdoor 132kV equipment work including:
  - Extension of the 132kV busbar and installation of 1 x bus section CBs

- Relocation of 1 x 132kV feeders bays
- Installation of 1 x 132kV transformer bays
- Removal of redundant 132kV OH and UG mains

- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls

Augment Bringelly ZS (Phase B) – FY34 Commissioning

- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls
- Installation of 1 x bus section CB
- Installation of 1 x 132kV transformer bays

3.2.2.3 Scope Summary

This option proposes to establish Bradfield North ZS with 2x 45 MVA transformers as the base greenfield infrastructure, providing a firm substation capacity (N-1) of 45 MVA by FY25 with a total firm capacity of 51 MVA. To service future growth, Bringelly ZS will be augmented with 2x 45 MVA transformers, which will provide an additional firm capacity of 90 MVA by FY34, resulting in a total firm capacity of 96 MVA by FY30 and 141 MVA by FY34. Figure 10 presents how this option will reduce the unserved energy when compared to the BAU base case ("no proactive intervention"). This option can meet the forecasted central demand of the development area with N-1 capacity until 2041, resulting in minimal expected unserved energy to 2041. This is achieved by staging the proposed network investment "Just in advance" of forecasted growth.

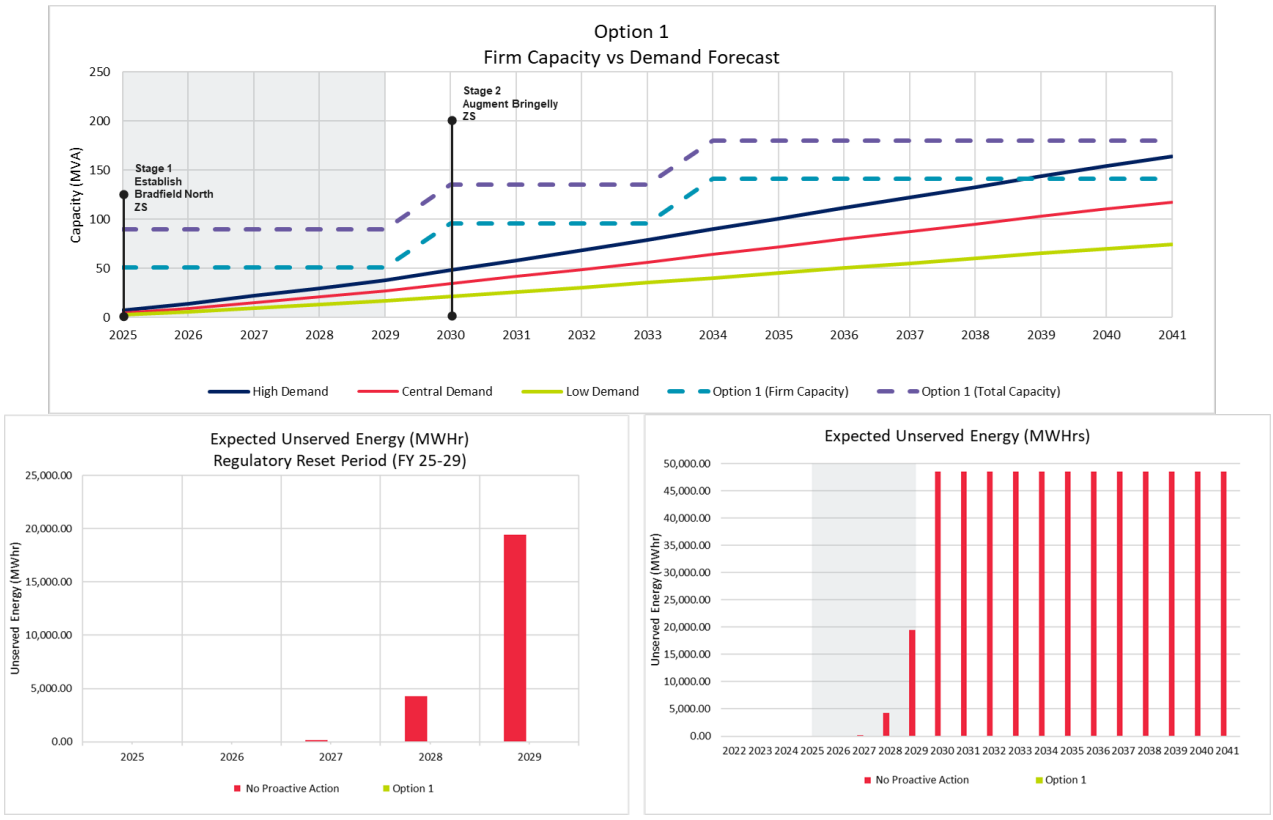

Figure 10 - Summary of Option 1. Expected Unserved Energy based on central case demand forecast

Assumptions

Below is a list of assumptions specific to this option:

- Project PR741 will be completed prior to 2025 to facilitate the 132kV feeder connection and provide the opportunity for connection of new power transformers to the 132kV busbar at Bringelly zone substation.
- The installation of new 132kV feeders along Badgerys Creek Road is feasible prior to 2025.
- The initial stages of the southern portion of the Agribusiness Precinct can be supplied via 22kV feeder extensions from Bradfield North zone substation prior to 2027.

3.2.2.4 Cost

The total estimated capital cost of Option 1 is $56.8M. The cost is spread over multiple years to align with the different construction timelines and stages, based on estimates provided by Endeavour Energy's estimating team. Table 7 provides a summary of the capital cost.

Table 7: Option 1 - Capital cost summary

Stage	2023	2024	2025	2029	2030	2034
Stage 1 – Establish Bradfield North ZS	$5.82M	$17.46M	$15.52M			
Stage 2 (Phase A) – Augment Bringelly ZS with 1x 45 MVA Transformer				$7.35M	$7.35M	
Stage 2 (Phase B) – Augment Bringelly ZS with 2nd Transformer						$3.3M

3.2.2.5 Benefits & NPV

The NER states that quantifiable economic market benefits (needs) include changes in involuntary load shedding. The costs and benefits analysis described in the following section included this benefit in determining the best option. Endeavour Energy's Unserved Energy Template was used to estimate the involuntary load shedding that can be prevented as a result of proactive action. The HK model utilised the involuntary load shedding along with a Value of Customer Reliability to calculate a market benefit. There were no other identified risks that were included in the costs and benefits analysis.

The assumptions used in the HK model are stated below, and the NPV summary is provided in Table 8 below.

- A study period of 30 years;
- The commercial discount rate was set to 3.26% based on the pre-tax real WACC for the 2025-29 determination period and ±1.04% for low and high sensitivities.
- A composite VCR of $43,540 for the Aerotropolis Core Precinct was used based on 55% commercial, 21% industrial and 24% residential load

- A maintenance cost estimate based on 0.4% of the project cost, commencing the year after commissioning; and
- The benefits of options are based on the avoided unserved energy.
- NPV stated below is based on the central scenario

The benefits of avoided unserved energy have been capped to the level, five years after commissioning of the options.

Table 8: Summary of Option 2A

Option	PV "Market Benefits" ($M)	PV Costs ($M)	NPV ($M)
1	$27,065.3	$42.45	$27,022.9

3.2.3 Option 2 – Augment Bringelly Zone Substation (FY25) and staged establishment of Bradfield North Zone Substation (FY30 & FY34)

3.2.3.1 Stage 1 – Greenfield Infrastructure

Similar to Option 1, this option proposes to stage the network infrastructure in line with the Growth Servicing Strategy.

Stage 1 infrastructure is the augmentation of Bringelly ZS with 2x 45 MVA 132kV/22kV transformers which will provide 45 MVA of additional firm capacity to the substation. The following equipment is proposed to be installed:

- Extension of the yard 60m to the south including:
  - Relocation of an existing water pipe.
  - Installation of a new stormwater drain.
  - Filling-in an existing dam and benching the extended yard area.
  - An additional 10m landscape zone along the southern boundary.
- Relocate security fence and extend yard approximately 10m to property boundary on the northern side to provide space for new 22kV switchroom buildings.
- Outdoor 132kV equipment work including:
  - Extension of the 132kV busbar and installation of 2 x bus section CBs
  - Relocation of 2 x 132kV feeders bays
  - Installation of 2 x 132kV transformer bays
  - Removal of redundant 132kV OH and UG mains
- Two (2) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler
- Two (2) 45MVA 132kV/22kV transformers and associated bunds.
- One large firewall along western side of substation.
- 22kV cables associated with the two transformers.

- Distribution ducting along eastern side of substation and restoration of driveway
- Distribution Work Program (DWP) items including:
  - The 22kV conversion of the Aerotropolis Core Precinct area
  - 4 x 11kV/22kV auto-transformers
  - 2 x 22kV feeders from Bringelly ZS to Ingham's Industrial Precinct
  - 2 x 22kV feeders from Badgerys Creek ZS to Ingham's Industrial Precinct
  - Installation of time clocks

Figure 11 shows that this stage provides a substation with 45 MVA of firm capacity and an additional 6 MVA of backup capacity from the four autotransformers planned for the initial growth. This meets the short to medium network capacity needs till 2032 under the central scenario and 2030 under the high scenario.

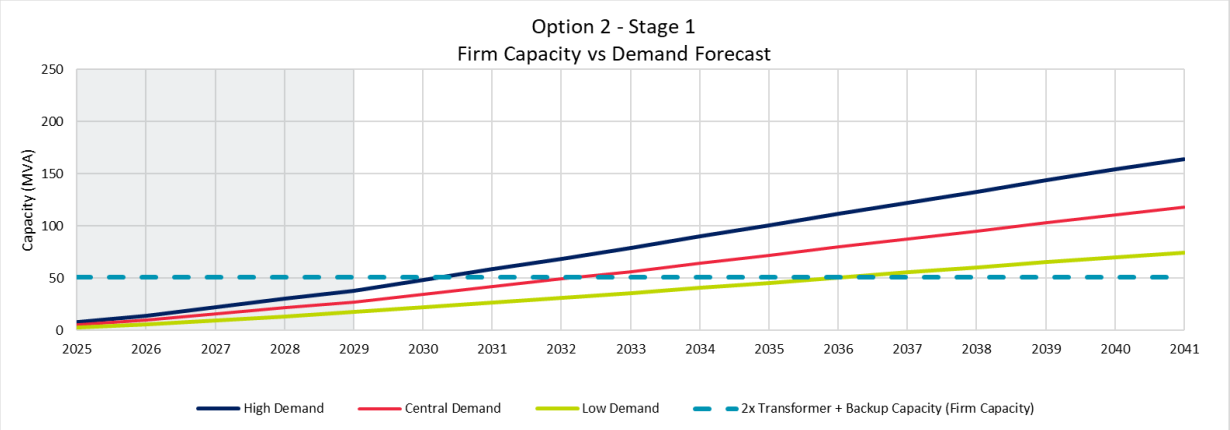

Figure 11 - Firm Capacity of Stage 1 Infrastructure for Option 2

3.2.3.2 Stage 2 – Future Infrastructure built on Greenfield infrastructure

Figure 11 shows that by 2032 the predicted load will exceed the installed firm capacity leading to additional load at risk. To service this growth, Endeavour Energy is proposing to a staged establishment of Bradfield North ZS to be commissioned 2030 and 2034. These dates were chosen to align with the Growth Servicing Strategy in which network investment for greenfield development is delivered using "Just in advance" principles. "Just in advance" is the process of delivery of the electrical infrastructure in readiness to facilitate growth.

This option proposes the following equipment to be installed for this stage:

Establish Bradfield North ZS (Phase A) – FY30 Commissioning

- Two (2) 132kV indoor switchgear modular type buildings; each with:
  - One (1) 132kV transformer CB
  - One (1) 132kV feeder CB
  - One (1) 132kV bus section/coupler CB
- Two (2) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs

    - One (1) 22kV bus section/coupler CB
- One (1) modular type control building.
- One (1) modular type amenities building.
- One (1) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.
- 132kV and 22kV cables associated with the two power transformers.
- One (1) auxiliary transformer.
- A 10m landscaped zone surrounding the substation.
- Yard area provided for the installation of a future BESS and distribution ducting.
- Two (2) 132kV feeders cut in and out from the Aerotropolis feeder from Bringelly ZS to WSA TS along The Northern North (approx. 2800m south)

Establish Bradfield North ZS (Phase B) – FY34 Commissioning

- One (1) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.
- One (1) 22kV indoor switchgear modular type buildings; each with:
    - One (1) 22kV transformer CB
    - Five (5) 22kV feeder CBs
    - One (1) 22kV bus section/coupler CB

3.2.3.3 Scope Summary

This option proposes to augment Bringelly ZS with 2x 45 MVA transformers as the base greenfield infrastructure, providing a firm substation capacity (N-1) of 45 MVA by FY25 with a total firm capacity of 51 MVA. To service future growth, Bradfield North will be established in phases with 2x 45 MVA transformers, which will provide an additional firm capacity of 90 MVA by FY34, resulting in a total firm capacity of 96 MVA by FY30 and 141 MVA by FY34. Figure 10 presents how this option will reduce the unserved energy compared to the base case (“no proactive intervention”). This option can meet the forecasted central demand of the development with N-1 capacity until 2041, resulting in minimal expected unserved energy to 2041. This is achieved by staging the proposed network investment “Just in advance” of forecasted growth.

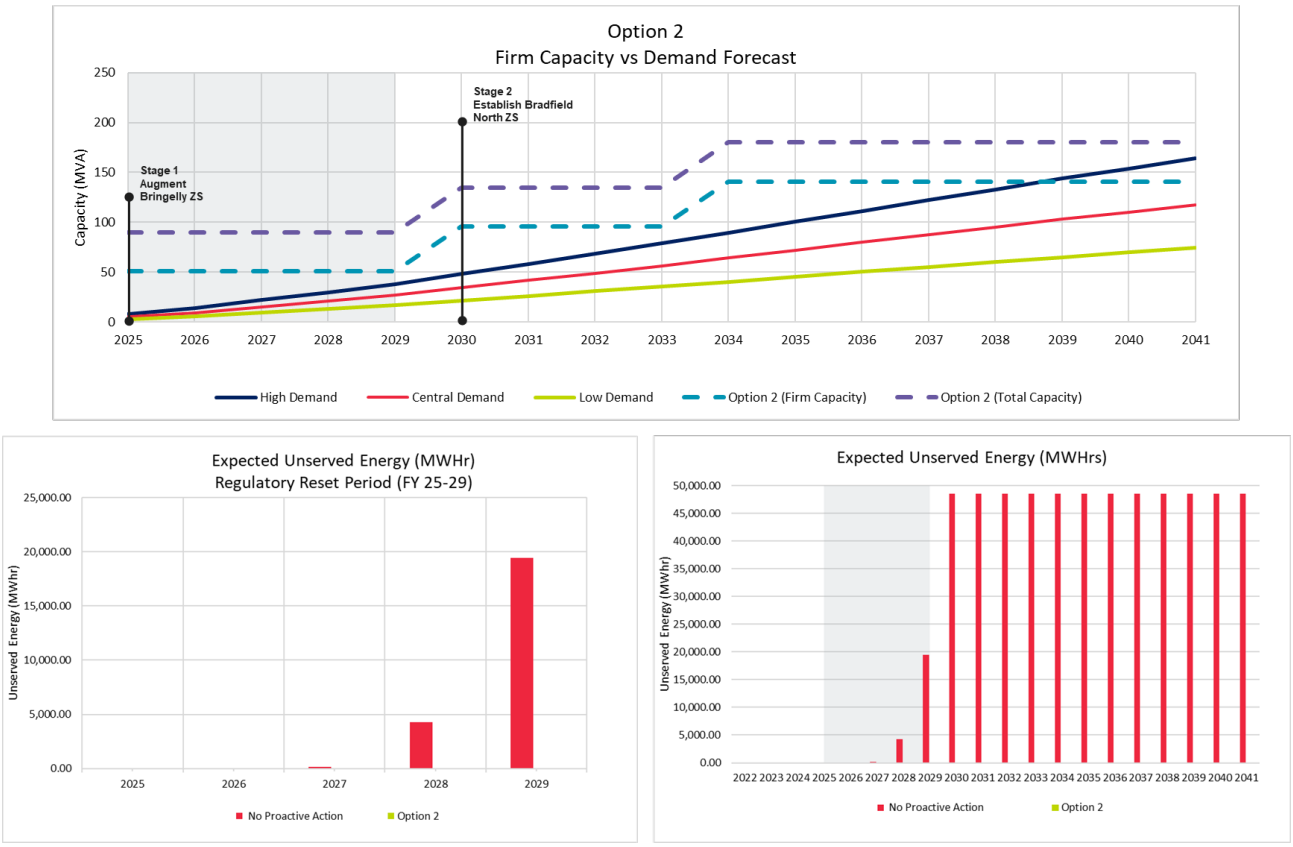

Figure 12 - Summary of Option 2. Expected Unserved Energy based on central case demand forecast

3.2.3.4 Cost

The total estimated capital cost of Option 2 is $62.7M. The cost is spread over multiple years to align with the different construction timelines and stages, based on estimates provided by Endeavour Energy's estimating team. Table 9 provides a summary of the capital cost.

Table 9: Option 2 - Capital cost summary

Stage	2023	2024	2025	2029	2030	2034
Stage 1 – Augment Bringelly ZS	$4.16M	$12.5M	$11.1M			
Stage 2 (Phase A) – Establish Bradfield ZS with 1x 45 MVA Transformer				$15.7M	$15.7M	
Stage 2 (Phase B) – Install 2nd Transformer at Bradfield North ZS						$3.7M

3.2.3.5 Benefits & NPV

The NER states that quantifiable economic market benefits (needs) include changes in involuntary load shedding. The costs and benefits analysis described in the following section included this benefit in determining the best option. Endeavour Energy's Unserved Energy Template was used to estimate the involuntary load shedding that can be prevented as a result of proactive action. The HK model utilised the involuntary load shedding along with a Value of Customer Reliability to calculate a market benefit. There were no other identified risks that were included in the costs and benefits analysis.

The assumptions used in the HK model are stated in Section 3.2.2.5. The NPV summary is provided in the in Table 10 below.

Table 10: Summary of Option 2

Option	PV "Market Benefits" ($M)	PV Costs ($M)	NPV ($M)
2	$27,065.3	$43.74	$27,021.6

3.3 Recommended Long-term option

The options table below sets out the **long-term *credible options*** considered together with the option: *BAU Base Case* - "*no proactive intervention"* to assist the overall comparison. Table 11 shows that Option 1 represents the highest value (economic benefit), being NPV positive of $25,902 Million compared to other options, even with the sensitivity & scenarios considered in Section 3.6. This option is also the least cost and technically feasible option, allowing Endeavour Energy to connect customers in the long term. **Hence, Option 1 is the preferred long-term network configuration for the project's overall scope.**

Table 11: Summary of credible options

Option	Description	Solution Type	PV residual risk[1] $M	PV Cost[2] $M	PV Benefits[3]	NPV [4][5] $M	Rank	Assessment Description
BAU	BAU - No proactive intervention	Base case / counterfactual	-27,065.3	-	-	-	3	Non-preferred as will lead to unacceptable risk or higher cost for customers if opportunity not captured
1	**Establish Bradfield North 45MVA (firm) zone substation in FY25 including 22kV upgrade** **+ Augment Bringelly ZS in FY27 and FY30 (1 x 45MVA TX in each stage)**	**Network solution**	**-**	**42.4**	**27,065.3**	**27,022.9**	**1**	**Greatest Net Benefits, Preferred Long Term option**
2	Augment Bringelly zone substation 45MVA firm in FY25 including 22kV upgrade and additional feeders +Staged establishment of Bradfield North zone substation in FY27 and FY30 (1 x 45MVA TX in each stage)	Network Solution	-	43.7	27,065.3	**27,021.6**	2	Technically feasible, lower net benefits

Notes:
1: PV residual risk cost (or savings for opportunities) post the investment..
2: PV of total costs, both Capex and Opex. See Appendix A for further details on cost
3: PV of total quantified benefits, both risk mitigated and any forecast decrease in Capex or Opex arising as a result of undertaking the investment (opportunities).
4: PV Benefits less PV Investment Costs
5. The breakdown of PV is based on the central demand forecast scenario

3.4 Phasing of the Preferred Long Term Network Option

Based on Option 1 in Section 3.2.2 and the consequence of no proactive intervention detailed in Section 3.1, it is likely that the servicing the future growth in the area will require the initial establishment of Bradfield North ZS with a firm capacity of 45 MVA followed by a staged augmentation of Bringelly ZS.

To ensure that the proposed solution represents the minimum network infrastructure required to service the step change in new load, Endeavour Energy has considered the following option which phases the implementation of Bradfield North ZS (Stage 1 - Greenfield Infrastructure) where the 2nd transformer is deferred to the next regulatory cycle in FY30.

3.4.1 Option 3 – Establish Bradfield North Zone Substation as a staged 45 MVA substation (FY25 & FY30) and augment of Bringelly Zone Substation (FY30 & FY34)

3.4.1.1 Stage 1 – Greenfield Infrastructure

For this option, Stage 1 infrastructure is the establishment of a staged 45MVA firm 132kV/22kV Bradfield North zone substation towards the north of the Aerotropolis Core Precinct with the first transformer installed in FY25 and the 2nd transformer installed in FY30. The proposed equipment to be installed is the same as Option 1 (Section 3.2.2.1), with the following items proposed in FY30 rather than FY25.

Establish Bradfield North ZS - FY30 Commissioning

- One (1) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.
- One (1) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler CB

Figure 13 shows that between FY25 and FY30, the substation does not have firm capacity and relies on the 6 MVA of backup firm capacity from the 22kV distribution works planned for the initial growth. This firm capacity cannot meet the central demand from FY26 onwards leading to load at risk until the 2nd transformer is installed in FY30.

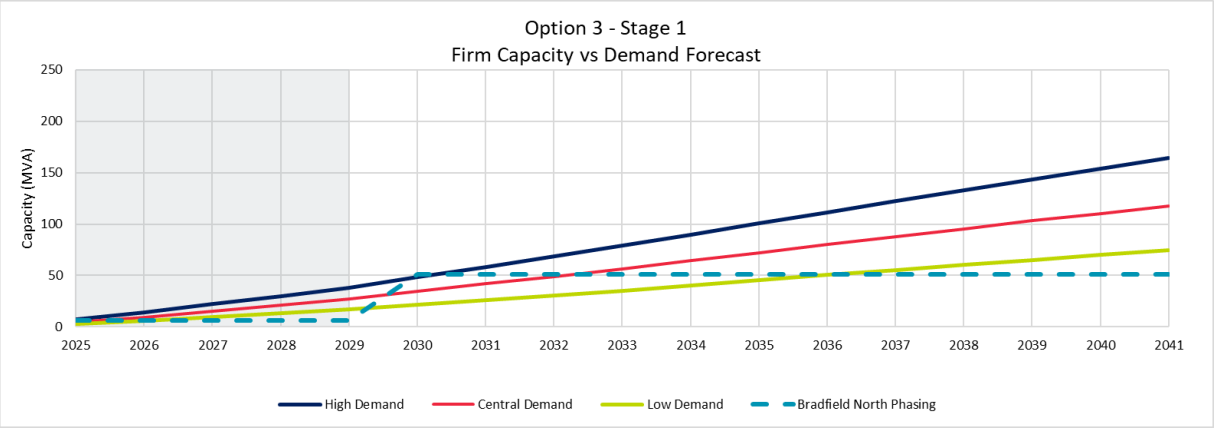

Figure 13 - Firm Capacity of Stage 1 Infrastructure for Option 3

3.4.1.2 Stage 2 – Future Infrastructure built on Greenfield infrastructure

Stage 2 for this option is the same as Option 1, which is a staged augmentation of Bringelly ZS to be commissioned 2030 and 2034. Refer to Section 3.2.2.2 for further details.

3.4.1.3 Scope Summary

This option proposes to stage the establishment of Bradfield North ZS with one 45 MVA transformer commissioned in FY25 and the 2nd transformer deferred by five years and commissioned in FY30 (next regulatory cycle). From FY25-FY29, the substation has no firm capacity and relies on 6 MVA of backup firm capacity from autotransformers until the 2nd transformer is installed in FY30 which provides a firm resulting in a total firm capacity of 51 MVA by FY30.

To service future growth, Bringelly ZS will be augmented with 2x 45 MVA transformers which will provide an additional firm capacity of 90 MVA by FY34, resulting in a total firm capacity of 141 MVA.

Figure 14 presents how this option will reduce the unserved energy compared to the base case ("no proactive intervention"), and Table 12 compares the unserved energy with both the base case and Option 1 from FY25 to FY30. While this option reduces the expected unserved energy when compared to the base case, unserved energy is still expected between 2025-2029 when compared to Option 1.

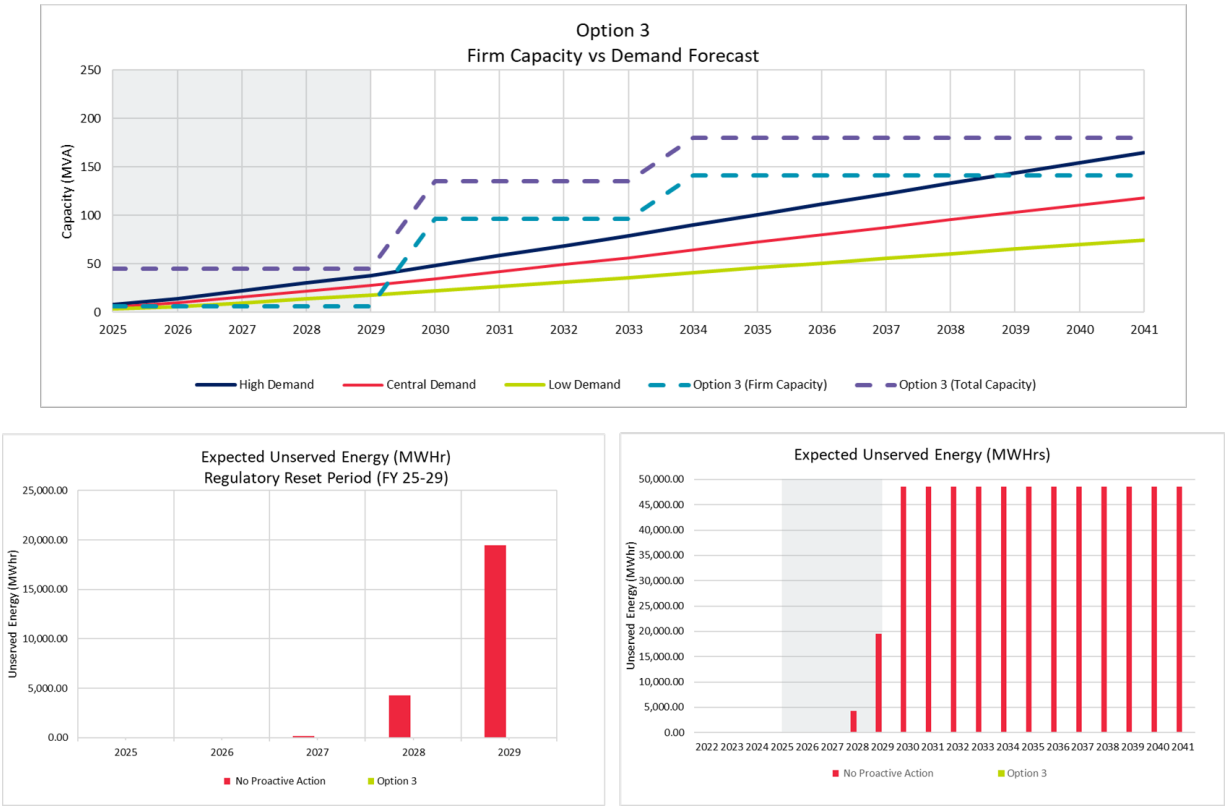

Figure 14 - Summary of Option 3. Expected Unserved Energy based on central case demand forecast

Table 12: Value of Expected Unserved Energy (MWhr) between 2025-2030

Option	2025	2026	2027	2028	2029
Option 1	0.0	0.0	0.0	0.0	0.0
Option 3	0.00	2.3	22.2	46.9	72.0

3.4.1.4 Cost

The total estimated capital cost of Option 3 is $56.8M. The cost is spread over multiple years to align with the different construction timelines and stages, based on estimates provided by Endeavour Energy's estimating team. Table 7 provides a summary of the capital cost.

Table 13: Option 1 - Capital cost summary

Stage	2023	2024	2025	2029	2030	2034
Stage 1 – Establish Bradfield North ZS with 1x 45 MVA Transformer	$5.27M	$14.04M	15.80M			
Stage 1 - Install 2nd 45 MVA Transformer at Bradfield North ZS				$3.7M		
Stage 2 (Phase A) – Augment Bringelly ZS with 1x 45 MVA Transformer				$7.35M	$7.35M	
Stage 2 (Phase B) – Augment Bringelly ZS with 2nd Transformer						$3.3M

3.4.1.5 Benefits & NPV

The NER states that quantifiable economic market benefits (needs) include changes in involuntary load shedding. The costs and benefits analysis described in the following section included this benefit in determining the best option. Endeavour Energy's Unserved Energy Template was used to estimate the involuntary load shedding that can be prevented as a result of proactive action. The HK model utilised the involuntary load shedding along with a Value of Customer Reliability to calculate a market benefit. There were no other identified risks that were included in the costs and benefits analysis.

The assumptions used in the HK model are stated in Section 3.2.2.5. The NPV summary is provided in the in Table 14 below.

Table 14: Summary of Option 3

Option	PV "Market Benefits" ($M)	PV Costs ($M)	NPV ($M)
3	$27,060.2	$42.19	$27,018

3.5 Recommended Network Option

Table 15 below compares Option 3 with Option 1 which defers part of the network investment against Option 1 which was the recommended long-term network option. Table 15 shows that Option 1 is the option with the highest value (economic benefit), being NPV positive of $27,023 Million compared to Option 3 ($ 27,018 million) for the central scenario. Additionally, Option 3 has load at risk between FY25-29, limiting the number of future customers that could connect to the Aerotropolis Core precinct, limiting future growth in the region. **For these reasons, Option 1 is the preferred network option.**

Table 15: Options' Summary Table

Option	Description	Solution Type	PV residual risk[1] $M	PV Cost[2] $M	PV Benefits[3]	NPV [45] $M	Rank	Comments
1	**Establish Bradfield North 45MVA (firm) zone substation in FY25 including 22kV upgrade** **+ Bringelly zone substation augment in FY25 (2 x 45MVA TX)**	**Network solution**	**-**	**42.4**	**27,065.3**	**27,022.9**	**1**	**Greatest Net Benefits, Preferred Long Term option**
3	**Establish Bradfield North zone substation with 1x 45 MVA in FY25 including 22kV upgrade** **+ 2nd Transformer at Bradfield North in FY30** **+ Bringelly zone substation augment in FY25 (2 x 45MVA TX)**	Network Solution	-	42.2	27,060.2	27,018	2	Technically feasible, lower net benefits,

Notes:
1: PV residual risk cost (or savings for opportunities) post the investment.
2: PV of total costs, both Capex and Opex. See Appendix A for further details on cost.
3: PV of total quantified benefits, both risk mitigated and any forecast decrease in Capex or Opex arising as a result of undertaking the investment (opportunities).
4: PV Benefits less PV Investment Costs.
5: The breakdown of PV is based on the central scenario.

3.6 Sensitivity and Scenario Analysis

3.6.1 Sensitivity Analysis

Sensitivity and threshold testing were conducted for the three variables used in the HK model for this economic evaluation: discount rate, capital cost and VCR.

Option 1 has the largest NPV for the tested standard ranges of sensitivities and there was no tipping point found between the options. Details of the sensitivity analysis for various parameters are presented in the Figure 15 and Figure 16 below.

Figure 15 – Sensitivity testing completed using the HK model.

Thresholds and tipping points

Rank	Option	Weighted NPV
1	Option 1	37,516,495,600
2	Option 2	37,515,254,257

Goal seek values

Parameters	Units	Value	Notes
Discount rate	Percent	3.26%	Users should provide the seed values for goal seek values, which can be the same value from the central scenario. Using extreme seed values may cause issues with the model.
Capital cost	Factor	1.0000	
VCR	$/MWh	43,540	
Risk costs	Factor	1.0000	

Rank 1 Option 1 for zero NPV

Parameters	Units	Value	Notes
Discount rate	Percent	177.53%	No reasonable discount rate can achieve zero NPV
Capital cost	Factor	946.3500	No reasonable capital costs can achieve zero NPV
VCR	$/MWh	57	
Risk costs	Factor	-335,543.3200	No reasonable risk costs can achieve zero NPV

Rank 2 Option 2 for zero NPV

Parameters	Units	Value	Notes
Discount rate	Percent	166.79%	No reasonable discount rate can achieve zero NPV
Capital cost	Factor	942.2100	No reasonable capital costs can achieve zero NPV
VCR	$/MWh	57	
Risk costs	Factor	###########	No reasonable risk costs can achieve zero NPV

Tipping points for Rank 1 to Rank 2

Parameters	Units	Value	Notes
Discount rate	Percent	#N/A	No tipping points were identified
Capital cost	Factor	#N/A	No tipping points were identified
VCR	$/MWh	#N/A	No tipping points were identified
Risk costs	Factor	#N/A	No tipping points were identified

Figure 16 – Summary of Sensitivity Analysis

3.6.2 Scenario Analysis: Weighted NPV Scenarios

The model has carried out scenario analysis considering the parameters below.

Parameters		S1	S2	S3	S4	
General parameters	**Unit**	**Central**	**High**	**Low**	**[Extra]**	**Notes**
Commercial discount rate	Percent	3.26%	2.22%	4.30%	3.26%	
VCR for involuntary load shedding	$/MWh	43,540	56,602	30,478	43,540	
VCR for voluntary load curtailment	$/MWh	43,540	56,602	30,478	43,540	
Cost parameters	**Unit**	**Central**	**High**	**Low**	**[Extra]**	**Notes**
Capital cost	Factor	1.00	0.75	1.25	1.00	
Planned routine maintenance and refurbishment	Factor	1.00	0.75	1.25	1.00	
Unplanned corrective maintenance	Factor	1.00	1.25	0.75	1.00	
Decommissioning costs	Factor	1.00	1.25	0.75	1.00	
NNO proponent charges	Factor	1.00	0.75	1.25	1.00	
Cost X	Factor	1.00	1.00	1.00	1.00	
Risk cost parameters	**Unit**	**Central**	**High**	**Low**	**[Extra]**	**Notes**
Reliability and security risk costs	Factor	1.00	1.30	0.70	1.00	
Safety and health risk costs	Factor	1.00	1.30	0.70	1.00	
Environmental risk costs	Factor	1.00	1.30	0.70	1.00	
Legal/regulatory compliance risk costs	Factor	1.00	1.30	0.70	1.00	
Financial risk costs	Factor	1.00	1.30	0.70	1.00	
Benefit parameters	**Unit**	**Central**	**High**	**Low**	**[Extra]**	**Notes**
Avoided involuntary load shedding	Factor	1.00	1.00	1.00	1.00	
Avoided voluntary load curtailment	Factor	1.00	1.00	1.00	1.00	
Avoided costs for non-RIT-D proponent parties	Factor	1.00	1.00	1.00	1.00	
Differences in the timing of unrelated network expenditure	Factor	1.00	1.00	1.00	1.00	
Changes in load transfer capacity	Factor	1.00	1.00	1.00	1.00	
Additional option value	Factor	1.00	1.00	1.00	1.00	
Changes in electrical energy losses	Factor	1.00	1.00	1.00	1.00	
Scenario weightings	**Unit**	**Central**	**High**	**Low**	**[Extra]**	**Notes**
Weightings	%	0.50	0.25	0.25	0.00	

Figure 17 - Houston Kemp model scenario parameters

Table 16: Scenarios

Variable	Scenario 1 - baseline	Scenario 2 – low benefits	Scenario 3 – high benefits
Capital cost	Estimated network capital costs	25% increase in the estimated network capital costs	25% decrease in the estimated network capital costs
Value of customer reliability (VCR)	$43,540/MWh	$30,478/MWh 30% lower than baseline	$56,602/MWh 30% higher than baseline
Discount rate	3.26% (WACC)	2.22%	4.33
Scenario weighting	50%	25%	25%

The scenarios have been weighted as 50% for Scenario 1 being the most likely with Scenarios 1 and 2 being given a weighting of 25%. The weighted NPV for each option is shown below, showing that Option 1 is still the preferred option with the highest weighted NPV.

Table 17: Weighted net present value of options

Option	Scenario 1 NPV ($M)	Scenario 2 NPV ($M)	Scenario 3 NPV ($M)	Weighted NPV ($M)	Option ranking
Option 1	27,023	93,607	2,413	37,516	1
Option 2	27,022	93,606	2,412	37,515	2
Option 3	27,018	93,594	2,413	37,511	3

3.7 Proposed Investment Timing

The optimal timing where the value of unserved energy from the 'No Proactive Intervention' scenario exceeds investment costs for Option 1 is 2027 as per Figure 18.

However, the proposed timing for the establishment of Bradfield North zone substation is 2025. The identified need for this investment is a reliability correction action to meet expected future load. The data released by the NSW Government over the past 12 months indicates that this correction action is required from 2024 onwards. The proposed timing of commissioning of 2025 is the earliest feasible date that this

project could be delivered. Endeavour Energy adopts a “just in advance” principle to design and deliver the infrastructure to meet the growth needs of those areas identified for greenfield development.

Subsequent stages of augmentation at Bringelly zone substation are expected in 2030 and 2034, however, the optimal timing of these projects can be determined closer to the required timing, according to the rate of load growth in the area.

Annualised cost and optimal commissioning year for Op		
Option name	Annualised cost	Optimal year
Option 1	2,423,911	2027

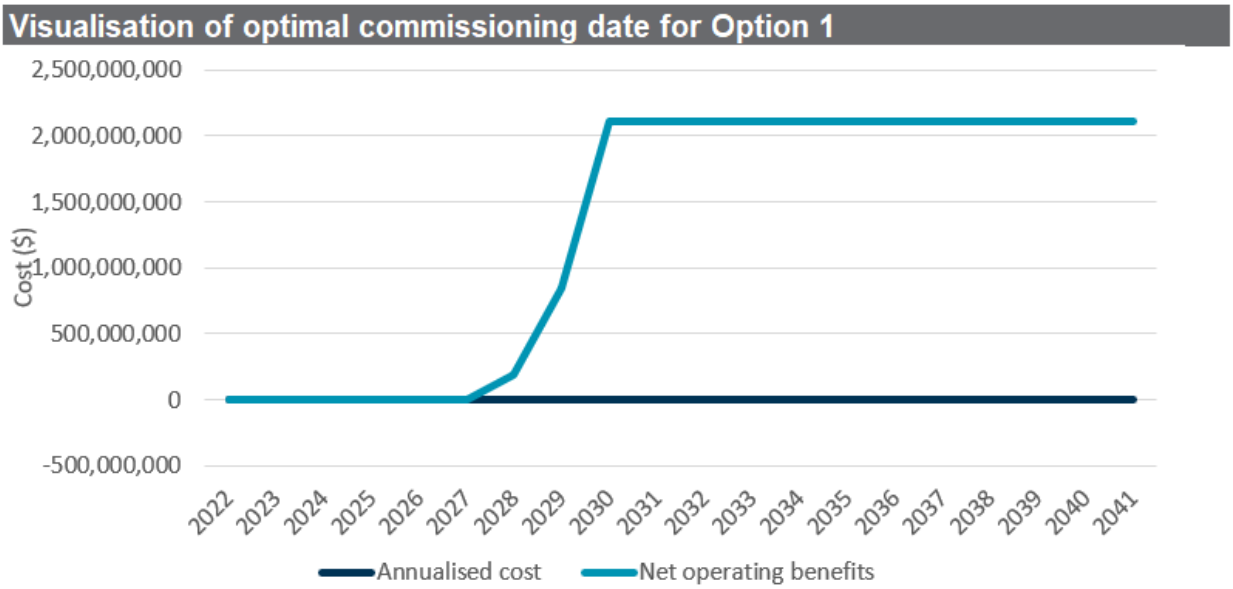

Figure 18 - Houston Kemp optimal timing output for Option 1

3.8 Non-network Options to Defer Network Investment

3.8.1 Scope

Electricity Distributors in NSW operate under the licence requirement (under the NSW Electricity Supply Act 1995) to investigate non-network alternatives to network augmentation for specific capital expenditure projects. The National Electricity Rules (NER) require Distribution Network Service Providers (DNSP) to investigate non-network options by utilising a consultation process as part of planning for major network augmentations.

The New Technology Master Plan (NTMP) tool was used to evaluate credible non-network options with the constraint of the existing Bringelly ZS. Figure 19 shows the comparison of non-network solutions and network solutions against the base case (“no proactive intervention”), while Figure 20 compares non-network solutions against the network solution.

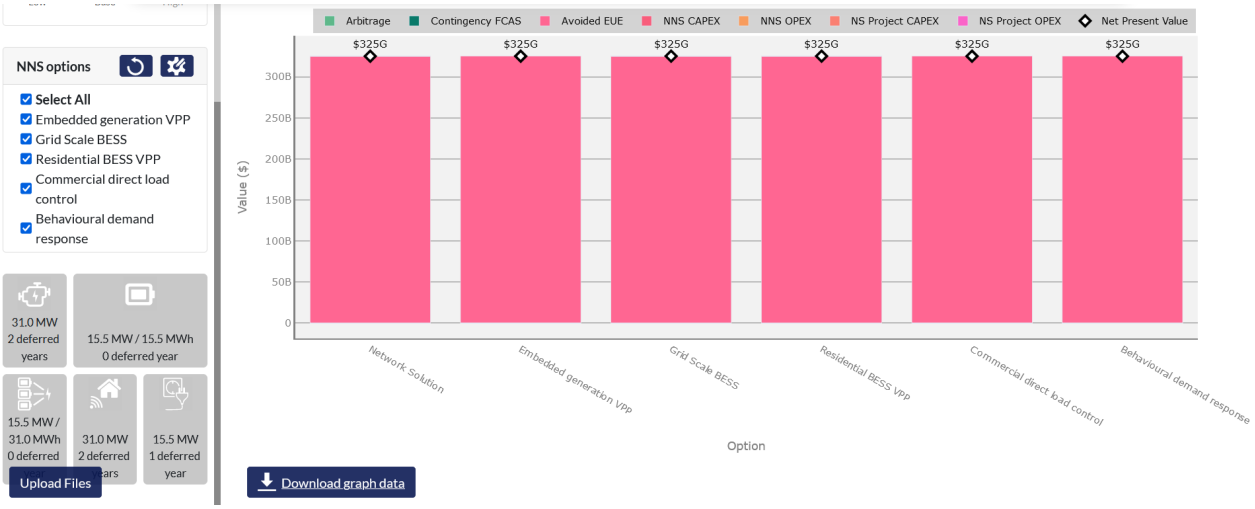

Figure 19 - NTMP Output for Non-Network Options when compared to the Base Case (“no proactive intervention”)

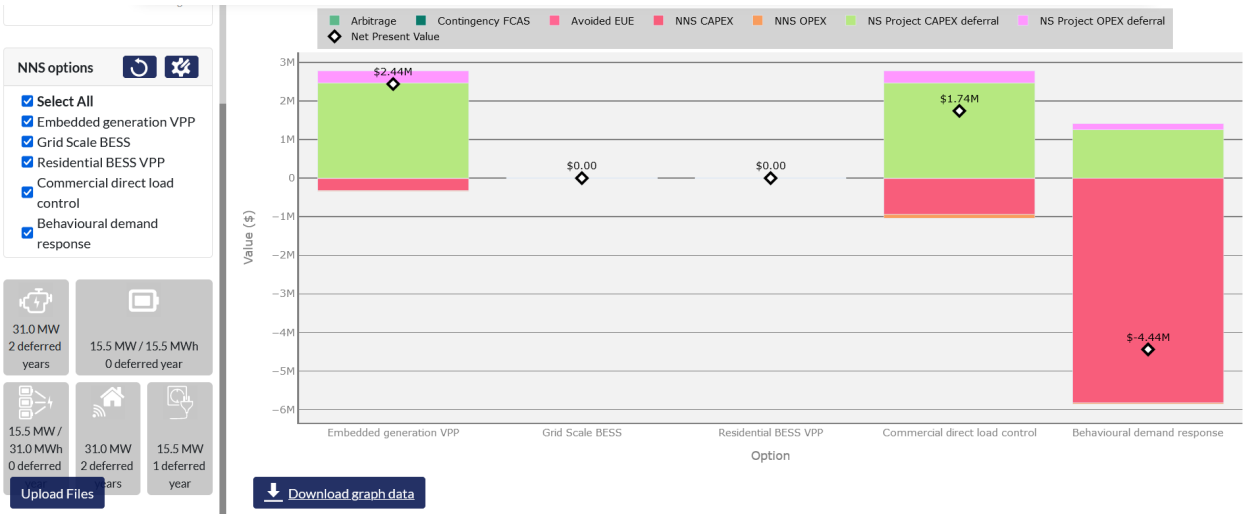

Figure 20 - NTMP Output for Non-Network Options when compared to the Network Solution

Table 18 provides an overview of the outputs from the NTMP tool and overlays with qualitative assessment.

Table 18: Non-Network / New Technology Options

Non-Network Options	Outcomes	Qualitative Assessment	Comments
Grid-Scale Storage (15.5MW /15.5 MWh)	Does not defer network investment	✕	Not a feasible option as it does not defer network investment.
VPP (31.0 MW)	Potentially defer the network investment by 2 years	✕	Not a feasible option as this is a new development. Additionally, the proposed capacity is large for a new technology. This uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure
Residential BESS VPP 15.5MW /30 MWh)	Does not defer network investment	✕	Not a feasible option as it does not defer network investment and requires customers to connect to the network, which cannot be completed with existing infrastructure.
Commercial Direct Load Control (31.0 MW)	Potentially defer the network investment by 2 years	✕	Not a feasible option as this is a new development. Additionally, the proposed capacity is large for new technology and this uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure
Behavioural Demand Response (15.5 MW)	Potentially defer the network investment by 1 years	✕	Not a feasible option as this is a new development. Additionally, the proposed capacity is large for new technology and this uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure

3.8.2 Summary

The NTMP tool and the subsequent qualitative analysis found no feasible non-network option for this project due to the lack of network capacity in this development area. As part of the RIT-D process, Endeavour Energy will issue a screening report before progressing with the Draft Project Assessment Report (DPAR). However, non-networks may be feasible once the first stage of greenfield network infrastructure has been commissioned to defer future network investment.

4. Detailed description and costs of preferred option

The preferred option is to initially establish a new 45MVA firm 132kV/22kV zone substation in Bradfield North involves the following:

- Two (2) 132kV indoor switchgear modular type buildings; each with:
  - One (1) 132kV transformer CB
  - One (1) 132kV feeder CB
  - One (1) 132kV bus section/coupler CB
- Three (3) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler CB
- One (1) modular type control building.
- One (1) modular type amenities building.
- Two (2) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.
- 132kV and 22kV cables associated with the two power transformers.
- One (1) auxiliary transformer.
- A 10m landscaped zone surrounding the substation.
- Yard area provided for the installation of a future BESS and distribution ducting.
- Two (2) 132kV feeders cut in and out from the Aerotropolis feeder from Bringelly ZS to WSA TS along The Northern North (approx. 2800m south)
- Distribution Work Program (DWP) items including:
  - The 22kV conversion of the Aerotropolis Core Precinct area
  - 4 x 11kV/22kV auto-transformers
  - Installation of smart meters and/or time clocks, and streetlight control points that will allow the connection of these assets to this substation without Audio Frequency Injection Cell facilities.

The total cost of the above works is estimated to be $38.8M with 3.9M contingency. Further details can be found in Appendix A.

5. Recommendations and Next Steps

The following is recommended:

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR) as per the RIT-D process (Refer to Figure 21). This is because the identified need for this investment is a reliability correction action to meet Endeavour Energy's connection obligations in the NER. Additionally, non-network options were not found to be feasible.
- The project proceeds to preliminary release for **Stage 1** of Option 1 which was the preferred option. Stage 1 (Greenfield infrastructure) is the minimum network infrastructure required to service the step change in new load for the short term. For Option 1, this is the establishment of a new 45MVA 132kV/22kV Bradfield North Zone Substation to facilitate the connections for the first 5 years. This essential infrastructure will facilitate the network and non-network options to service the growth beyond 2030. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

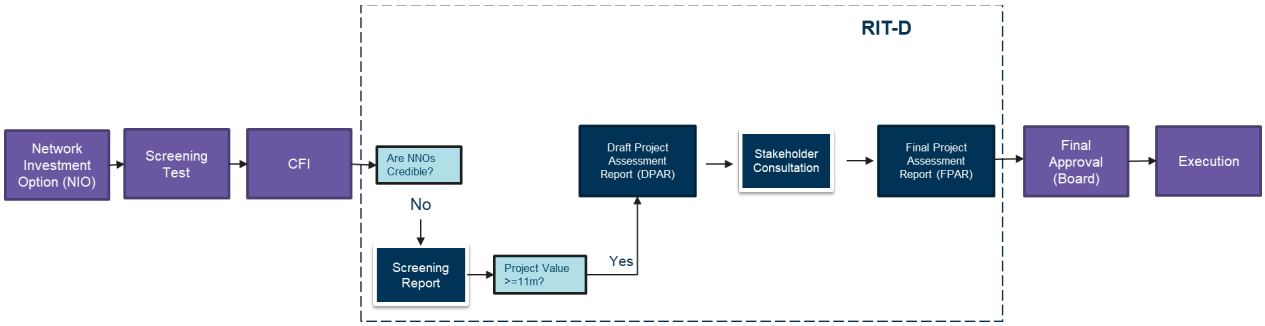

Figure 21 - Endeavour Energy's RIT-D Process for this Project

Appendices

A. Detailed Cost Estimate for Options

PROJECT SUMAMRY			
Project ID:	PR808	**Sites:**	Bradfield North ZS / Bringelly ZS
Revision No:	1	**Date:**	03/05/2022

PROJECT DESCRIPTION

Two (2) estimates have been prepared for the options provided by Capacity Planning for the proposed zone substation works to supply the Aerotropolis Core Precinct and surrounding areas at 22kV.

The two options have also been separated into subsequent stages, assuming one complete option is established first, providing 90MVA total capacity (45MVA firm). Further works then provide an additional 45MVA capacity in each of two subsequent stages. The initial DWP works including the conversion of the area to 22kV is only included in the complete options.

Option No.1 – Establish Bradfield North ZS

The estimate is based on the following:

- Two (2) 132kV indoor switchgear modular type buildings; each with:
  - One (1) 132kV transformer CB
  - One (1) 132kV feeder CB
  - One (1) 132kV bus section/coupler CB

- Three (3) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler CB

- One (1) modular type control building.

- One (1) modular type amenities building.

- Two (2) 45MVA 132kV/22kV power transformers and associated bunds and fire walls.

- 132kV and 22kV cables associated with the two power transformers.

- One (1) auxiliary transformer.

- A 10m landscaped zone surrounding the substation.

- Yard area provided for the installation of a future BESS and distribution ducting.

- Two (2) 132kV feeders cut in and out from the Aerotropolis feeder from Bringelly ZS to WSA TS along The Northern North (approx. 2800m south).

- Distribution Work Program (DWP) items including:
  - The 22kV conversion of the Aerotropolis Core Precinct area
  - 4 x 11kV/22kV auto-transformers
  - Installation of time clocks

Option No.2 – Augment Bringelly ZS

The estimate is based on the following:

- Extension of the yard 60m to the south including:
  - Relocation of an existing water pipe.
  - Installation of a new stormwater drain.
  - Filling-in an existing dam and benching the extended yard area.
  - An additional 10m landscape zone along the southern boundary.

- Relocate security fence and extend yard approximately 10m to property boundary on the northern side to provide space for new 22kV switchroom buildings.

- Outdoor 132kV equipment work including:
  - Extension of the 132kV busbar and installation of 2 x bus section CBs
  - Relocation of 2 x 132kV feeders bays
  - Installation of 2 x 132kV transformer bays
  - Removal of redundant 132kV OH and UG mains

- Two (2) 22kV indoor switchgear modular type buildings; each with:
  - One (1) 22kV transformer CB
  - Five (5) 22kV feeder CBs
  - One (1) 22kV bus section/coupler CB

- Two (2) 45MVA 132kV/22kV transformers and associated bunds.

- One large firewall along western side of substation.

- 22kV cables associated with the two transformers.

- Distribution ducting along eastern side of substation and restoration of driveway.

- Distribution Work Program (DWP) items including:
  - The 22kV conversion of the Aerotropolis Core Precinct area
  - 4 x 11kV/22kV auto-transformers
  - 2 x 22kV feeders from Bringelly ZS to Ingham's Industrial Precinct
  - 2 x 22kV feeders from Badgerys Creek ZS to Ingham's Industrial Precinct
  - Installation of time clocks

Staging Breakdown

Establish Bradfield North ZS Stage 1

As per Option No.1 above with only:

- Two (2) 22kV indoor switchgear modular type buildings
- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls
- No DWP items

Establish Bradfield North ZS Stage 2

Additional works including:

- One (1) 22kV indoor switchgear modular type buildings
- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls

Augment Bringelly ZS Stage 1

As per Option No.2 above with only:

- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls
- Installation of 1 x bus section CB
- Installation of 1 x 132kV transformer bays
- No DWP items

Augment Bringelly ZS Stage 2

Additional works including:

- One (1) 45MVA 132kV/22kV power transformer and associated bunds and fire walls
- Installation of 1 x bus section CB
- Installation of 1 x 132kV transformer bays

EXCLUSIONS

- BESS not included

ASSUMPTIONS

- Land i.e. easements are free
- All costs are in FY22 dollars, staging of future works will be subject to change over time such as CPI etc.

COST ESTIMATE

Substation	Estimate	Contingency	Total
Bradfield North ZS	**$38,800,000**	**$3,900,000**	**$42,700,000**
Bringelly ZS	**$27,700,000**	**$3,000,000**	**$30,700,000**

STAGING BREAKDOWN

Substation	Estimate	Contingency	Total
Bradfield North ZS – Stage 1	**$31,300,000**	**$3,100,000**	**$34,400,000**
Bradfield North ZS – Stage 2	**$3,700,000**	**$300,000**	**$4,000,000**
Bringelly ZS – Stage 1	**$14,700,000**	**$1,700,000**	**$16,400,000**
Bringelly ZS – Stage 2	**$3,300,000**	**$300,000**	**$3,600,000**

Completed by:	Blake Christian		
Signature:		**Date:**	03/05/2022
ENDORSED			
Endorsed by:	Mitch Adair		
Signature:		**Date**:	03/05/2022
COMMENTS			

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