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Investment Title	Capacity Increase for Menangle Park Development Areas
NPR-000044 (PR779)	Menangle Park Zone Substation Establishment
Portfolio	Augex
CFI Date	September 2022
Pre RIT-D	<input checked="" type="checkbox"/>
Final CFI	<input type="checkbox"/>
Other	<input type="checkbox"/>

1. Executive Summary

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

1.1 Need / Background

The planned developments are comprised of the Menangle Park Precinct, Mt Taurus Precinct, the residential and employment lands owned by Mirvac, all of which lie within the Southern portion of the Greater Macarthur Growth Area. These three precincts will ultimately account for approximately 10,000 new residential dwellings and ancillary loads consisting of town centres, schools, community facilities and future commercial spaces. These developments are expected to require approximately 70 MVA capacity by 2041. This growth in new demand forms the basis for this case of investment.

Initial capacity for the new growth in these three developments will be supplied from Menangle Park Mobile Zone Substation (ZS), which has a capacity of 15 MVA and will be commissioned in late 2022. The commissioning of this mobile substation results in the deferral of the network investment outlined in this CFI out of the current FY19-FY24 regulatory cycle.

Based on the demand forecast, the current network infrastructure will have load at risk from 2024 with the total capacity of Menangle Park Mobile ZS exceeded in 2027. 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 areas surrounding the temporary substation.

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. 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 is a **reliability corrective action**¹.

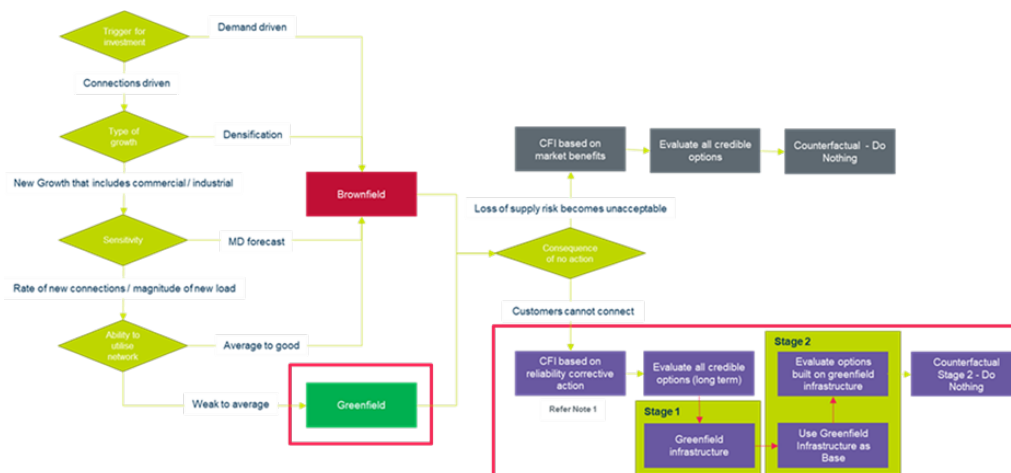


Figure 1 - Decision Rule from Endeavour Energy's Growth Servicing Strategy

¹ Refer to Growth Servicing Strategy document for definitions of greenfield and brownfield sites

1.2 Options Considered

1.2.1 Long Term Network Options

Table 1 outlines the long-term options to address the identified need of supplying the new connections in this area. The preferred ultimate option is **Option 2** as it has the greatest economic benefit being NPV positive **\$7,066 million**. This option also has the greatest reduction in unserved energy which will allow the greatest number of customers to connect.

Table 1 - List of Long-Term Network Options

Option	Description	Solution Type	NPV ¹ \$M	Rank	Comments
1	Establish Menangle Park ZS by FY27 (1x 35 MVA Transformer)	Network solution	6,604	3	Technically feasible, lower net benefits
2	Establish Menangle Park ZS by FY27 (2x 35 MVA Transformers)	Network solution	7,066	1	Greatest NPV, Preferred Long Term Network Option
4	Establish Hybrid ZS by retaining 15 MVA Mobile ZS and establishing Menangle Park Permanent ZS by FY27 (1x 35MVA Transformer)	Network solution	7,018	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 headwork infrastructure represents the minimum network infrastructure required to service the step-change in new load, Endeavour Energy compared Option 2 against Option 3, which defers the 2nd transformer by four years. Option 3 has a similar NPV (7,065.1 M) as Option 2 (7,066.2 M) over the study period (30 years). To compare the options, a comparative NPV analysis was completed, which baselines Option 3 against Option 2 (preferred long-term solution) and is outlined in Table 2.

Table 2 shows that Option 3 is NPV negative when baselined against Option 2, in which the benefits of deferring the 2nd transformer do not outweigh the quantified cost of unserved energy. **For these reasons, Option 2 is still the preferred network option.**

Table 2 - Comparative NPV Analysis of Option 3 against Option 2

Option	Description	Solution Type	Relative PV Cost ¹ \$M	Relative PV Benefits ²	Relative NPV ³ \$M	Comments
3	Establish staged Menangle Park ZS by FY30 (1x 35 MVA Transformers by FY27) 4-year deferral of 2 nd Transformer	Network solution	-1.73	+0.32	-1.41	Technically feasible, lower relative benefits compared to Option 2 (Long Term Network Solution)

Notes:

- 1: The PV cost relative to Option 2 (Highest NPV long term solution)
- 2: The PV benefits relative to Option 2 (Highest NPV long term solution)
- 3: The breakdown of PV is based on the central demand forecast 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. However, non-network may be feasible once the proposed network infrastructure has been commissioned to defer future network investment.

1.3 Recommendation and Next Steps

This CFI recommends the establishment of the new 66/11kV outdoor Menangle Park ZS with a firm capacity of 35 MVA to supply the development area (Option 2). This substation would be supplied by two underground 66kV feeders, which will loop into the proposed 66kV feeder 85J that will run adjacent to the substation. This option has the highest Net Present Value (NPV) (\$7,066.2 Million) with an estimated cost of \$18.8 million, which is expected to be spread over three years, from FY25 to FY27.

It is recommended that the project value of \$18.8 M be approved for consideration in the FY25-FY29 regulatory period.

Based on the Endeavour Energy's RIT-D process (Figure 2), it is recommended that:

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR). 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 with preferred **Option 2**, which recommends capital expenditure to build Menangle Park ZS with a firm capacity of 35 MVA by 2027, supplied by two underground 66kV feeder linkages looping into the future adjacent 66kV feeder 85J. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

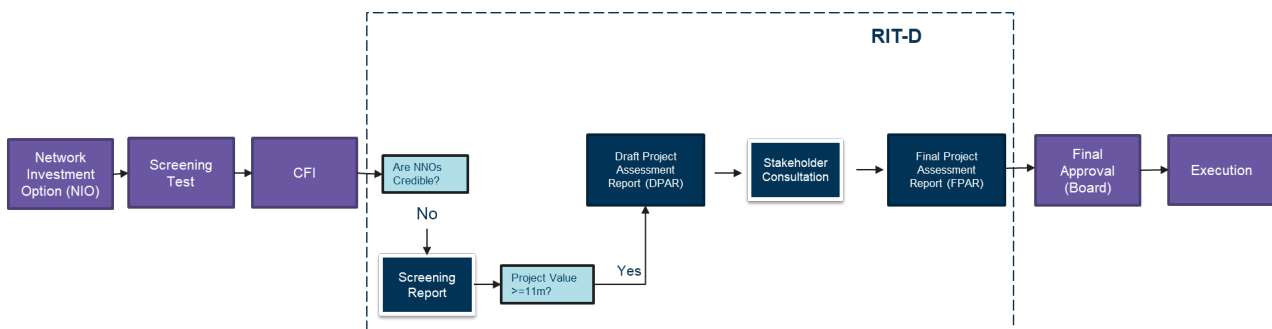


Figure 2 - Endeavour Energy's RIT-D Process for this Project

2. Project Proposal

2.1 Identified Need or Opportunity

This CFI addresses the planned developments of the Menangle Park Precinct, Mt Taurus Precinct and the residential and employment lands owned by Mirvac, all of which lie within the Southern portion of the Greater Macarthur Growth Area.

Identified by Endeavour Energy, via correspondence from developers (Dahua Group, Mulpha and Mirvac), and in conjunction with council and NSW Department of Planning, Industry and Environment (DPIE) for future urban development, these precincts will ultimately account for approximately 10,000 new residential dwellings, as well as ancillary loads consisting of town centres, schools, community facilities and future commercial and industrial spaces, which is shown on Figure 3 below.



Figure 3 - Geographical representation of Southern Macarthur Growth Area showing precinct developments

2.2 Existing Infrastructure

2.2.1 Limitations of existing infrastructure

To service the initial growth, originally driven by the Menangle Park Precinct, PR258 was undertaken to deploy a 66/11kV 15 MVA mobile substation in the land of the Menangle Park ZS, instead of running new feeders from Ambarvale ZS. These feeders would present significant cost and voltage regulation issues. The mobile substation is connected to Macarthur Bulk Supply Point via a single 66kV feeder 85P. The commissioning of this mobile substation results in the deferral of the network investment outlined in this CFI out of the FY19-FY24 regulatory cycle. At a distribution level, this area is currently being serviced from Menangle Park Mobile ZS via two 11kV distribution feeders which extend into, or near, the three proposed developments and will be able to provide some capacity to service this area. Refer to the Figure 4 below for a simplified single line diagram (SLD) of the existing network infrastructure.

Since there is no 2nd transformer, the mobile substation only has N-0 security with a total capacity of 15 MVA with no firm capacity. If there is a failure of the 15 MVA transformer, or a failure on the 66kV transmission feeder 85P, there is only a firm backup capacity of 5.67 MVA from cross zone feeders NN1251 and T874. This is detailed in Table 3 below. The limited firm capacity of the mobile substation and associated distribution network is the primary constraint of supplying the new development area.

Table 3 - Firm Backup Capacity Available from Cross Zone Feeders

Zone Substation	Feeder	Backup Rating (MVA)	Spare Capacity (MVA)
Ambarvale	T874	5.62	3.36
Nepean	NN1251	6.10	2.31

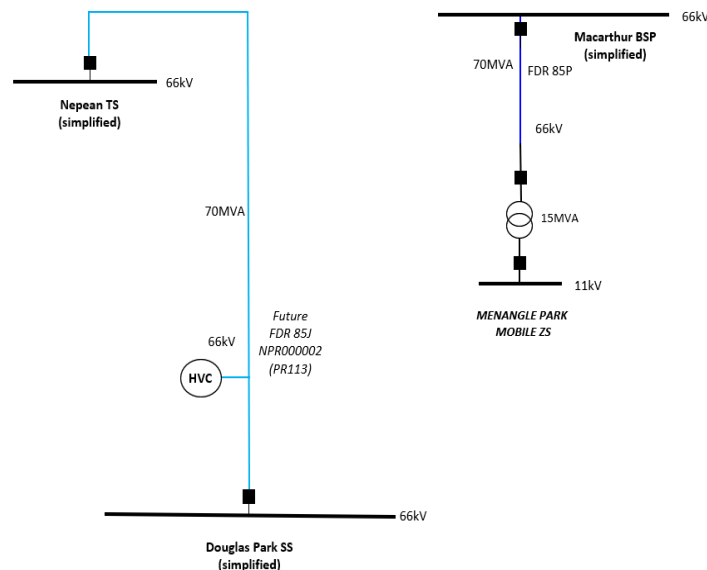


Figure 4 - High Level SLD of existing infrastructure

2.2.2 Load Growth

The breakdown of the new precinct loads is detailed below. The load forecast has been informed by correspondence from developers (Dahua Group, Mulpha and Mirvac), and in conjunction with council and DPIE for future urban development. This has been used to develop a residential lot forecast within development area.

- Menangle Park Precinct, developed by Dahua Group, is expected to accommodate approximately 5,360 new residential dwellings, a new school, town centre, community facilities, as well as employment lands.
- Mt Taurus, developed by Mulpha, is expected to accommodate approximately 2,000 new residential dwellings, a new school, town centre, tourism attractions, greenhouse space, as well as provide commercial and retail options.
- The Residential and Employment Lands owned by Mirvac, is expected to accommodate approximately 2,600 new residential dwellings, as well as providing 50 Hectares for commercial and industrial needs.
- Other commercial & industrial developments within these precincts.

These developments combined account for a demand of around 70 MVA by 2041 and form the basis for this case for investment. This is based on the following assumptions:

- Growth in line with delivery plan provided by developers and forecasts from DPIE.
- 0.5% Growth Rate following delivery of all these developments (2041-2051)
- 5.4kVA/lot for all residential lots
- 3.3kVA/lot for residential apartments

Table 4 below shows the status of the three important criteria to determine the timing. Based on the zoning, development and status of supporting infrastructure it is evident that investment is required.

Table 4 - 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

2.2.3 Demand Forecast

Considering the major new connections and network constraints listed above, the demand forecast for this development area is detailed in Figure 5 and presents a central, high and low forecast cases. The high forecast case represents 110% of central forecast case while low forecast case represents 90% of central forecast case. Based on the load forecast shown in Table 5 and Figure 5, the mobile substation will have load at risk from 2024 with the total capacity exceeded by 2027, which will result in unserved energy without additional electrical capacity investment in the area. This will result in customers not being able to connect to the network, which contravenes Endeavour Energy's obligation to provide connection services. An 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 5 - Menangle Park Precinct Load Forecast

Demand Forecast (MVA)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2036	2041
Dahua	0.2	0.6	1.8	2.3	3.2	4.9	6.6	9.1	12.1	21.8	26.2
Taurus	0.0	1.8	2.2	3.0	3.8	4.6	7.2	9.0	9.7	12.1	12.1
Mirvac	0.7	1.5	2.6	3.6	4.8	6.0	7.2	8.3	9.5	15.5	20.3
Total Load	2.9	6.0	8.6	10.8	13.7	17.5	22.9	28.5	33.4	51.4	60.7
Demand Forecast (MVA)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2036	2041
High Forecast	3.2	6.6	9.5	11.9	15.1	19.2	25.2	31.3	36.8	56.5	66.8
Central Forecast	2.9	6.0	8.6	10.8	13.7	17.5	22.9	28.5	33.4	51.4	60.7
Low Forecast	2.6	5.4	7.8	9.8	12.3	15.7	20.6	25.6	30.1	46.2	54.7
Capacity (MVA)	2023	2024	2025	2026	2027	2028	2029	2030	2031	2036	2041
Menangle Park Mobile ZS (Total Capacity)	15	15	15	15	15	15	15	15	15	15	15
Menangle Park Mobile ZS + Supporting 11kV Network (Firm Capacity)	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Load At Risk (MVA) (Central)	0.0	0.4	3.0	5.2	8.1	11.9	17.3	22.9	27.8	45.8	55.1

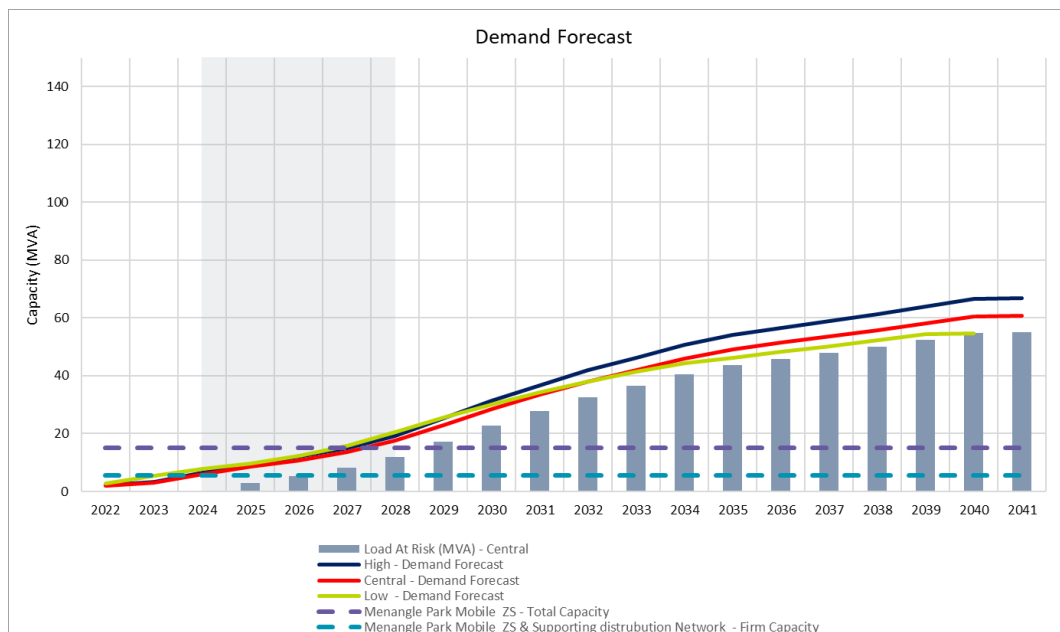


Figure 5 - Load Forecast for this Development Area

2.2.4 Related Projects

PR258 – Mobile Substation Menangle Park Supply Area is currently being commissioned and will supply the initial stages of all three developments.

NPR-000002 (PR113) – Supply to Southern Greater Macarthur Growth Area to build new 66kV feeder 85J from Nepean TS to Douglas Park SS prior to December 2024, as depicted in Figure 6 below.

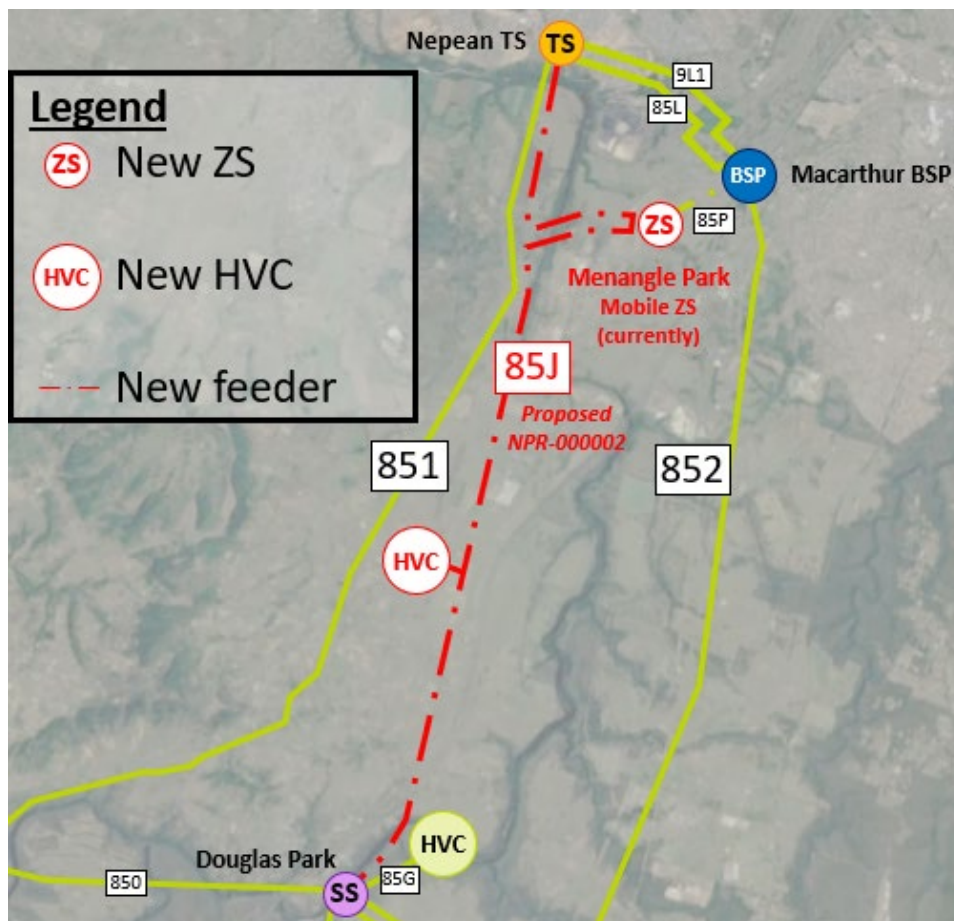


Figure 6 - NPR-000002 (PR113) New 66kV Feeder 85J from Nepean TS to Douglas Park SS

3. Options Considered

Based on the decision rule outlined in the Executive summary, the characteristics of the area are as follows:

- Investment is classified as **greenfield**.
- Identified need based on consequence of no action for the greenfield development is **reliability corrective action²**.

Figure 7 below (subset of the decision rule included in the Executive Summary) has been utilised to outline the options.

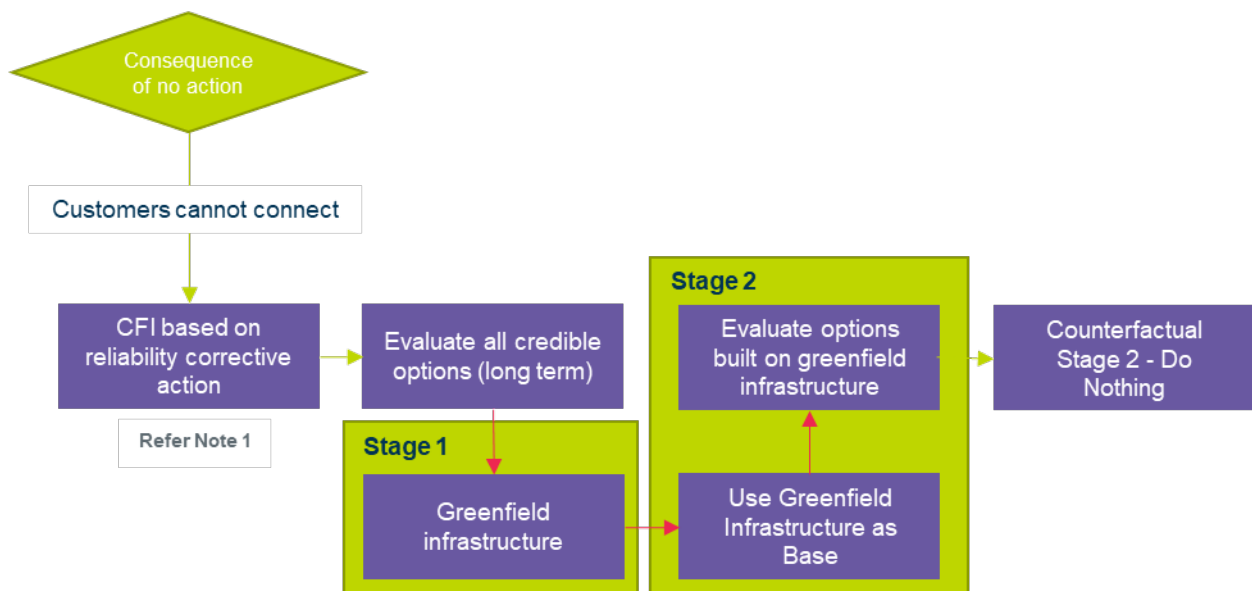


Figure 7 - Decision Rule from Endeavour Energy's Growth Servicing Strategy

3.1 BAU Base Case – “No Proactive Intervention”

The consequence of not proceeding with the investment in a network option for the development area results in significant unserved energy due to the existing supply network being constrained and incapable of supplying the forecast demand for the area. The option of ‘No proactive intervention’ will lead to the total capacity of Menangle Park Mobile ZS capacity being exceeded by 2027, resulting in significant unserved energy (Figure 8). There are also substantial reputational risks of negative media coverage and NSW Government dissatisfaction if Endeavour Energy cannot meet supply requirements for this 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. The VCR values used by Endeavour Energy in its modelling are the same as those published by AER. The AER endorsed this approach during the determination process.

For a 30-year review period, no proactive intervention equates to a PV cost of \$7,082 M, which is a very high and unacceptable high-risk position and is therefore non-preferred.

² Refer Growth Servicing Strategy for definitions of greenfield and brownfield sites

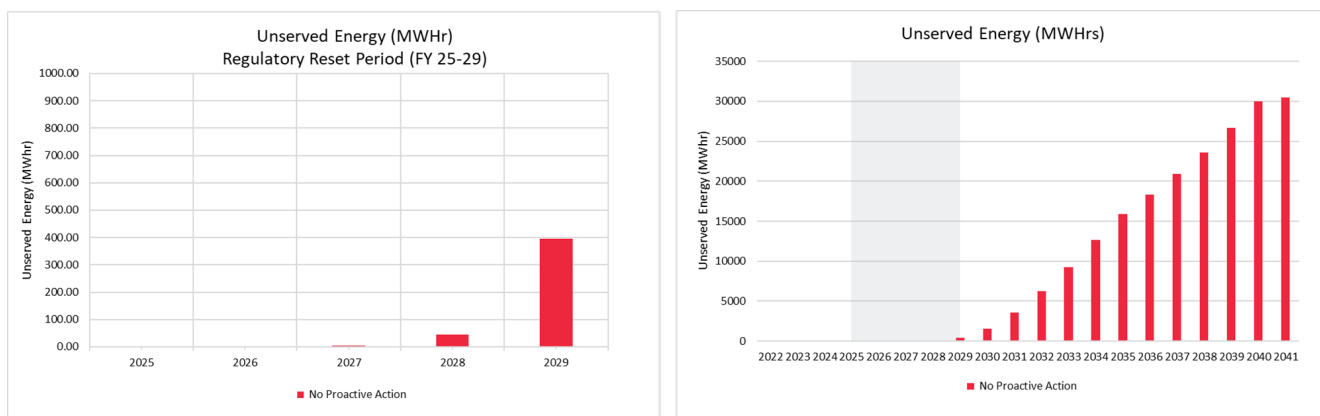


Figure 8 - Expected Unserved Energy as a result of “no proactive intervention” based on Central Demand

Table 6 - 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	1	5	44	395	1,537	3,602	18,317	30,459
Value of Unserved Energy (\$M)	0	0	0.1	1.2	10	40	94	477	792

3.2 Credible Network Options

The National Electricity Objectives (NEO) as stated in the National Electricity Law (NEL) require Endeavour Energy to operate the networks in the long-term interests of consumers. The options in this section sets out the **credible options** that were considered, together with a counterfactual option: “*no proactive intervention*” to assist the overall comparison. These include all substantially differing commercially and technically credible options, including non-network solutions. Credible options (or a group of options) are those that meet the following criteria:

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

Each credible network option is further elaborated in the subsequent chapter.

3.2.1 Option 1 – Menangle Park ZS by FY27 (1x 35 MVA Transformer)

3.2.1.1 Scope

Option 1 proposes establishment of a 66kV/11kV 35 MVA zone substation at Menangle Park by 2027, and decommissioning of the existing 15 MVA mobile substation, which is currently onsite.

Supply would be established to the new substation from the existing 66kV feeder, 85P from Macarthur BSP. The existing 66kV feeder 85P, from Macarthur BSP will also be transferred across from the 15 MVA mobile substation which is currently onsite. The mobile substation will then be decommissioned.

It is expected that this zone substation’s load will be supplied via Macarthur BSP. Further, the new substation will also be looped into the future 66kV feeder 85J, which will be built outside the site under NPR-000002 (PR113) prior to 2027. Two short underground feeder connections to Menangle Park zone substation will achieve this.

Using the new standard substation layouts, which makes use of modular buildings and provides the base design for a 66kV/11kV, 1 x 35MVA, indoor substation on an 8280sqm site, this Option’s scopes of works are as follows:

Zone Substation:

- 66/11kV 1 x 35 MVA transformer
- 2 x Transmission Feeder bays
- 2 x 66kV busbars
- 1 x 11kV busbar with 6 x 11kV circuit breakers

Transmission Lines:

- Establish two underground 66kV feeder linkages ringing into the future adjacent 66kV feeder 85J via two new 66kV UGOHs.
- Disconnect existing 66kV feeder 85P from mobile substation and terminate into new Menangle Park zone substation.

Mobile Substation

- Decommission existing mobile zone substation which is currently onsite.

This option involves the establishment of the Menangle Park ZS with 1 x 35MVA transformers commissioned in 2027. Figure 9 presents how this option will reduce the unserved energy when compared to the base case ("no proactive intervention"). This option does not have N-1 security and only has 5.6 MVA backup firm capacity from the existing distribution network. The total substation capacity can only meet the forecasted central demand until 2031. While this option reduces the unserved energy when compared to the base case, unserved energy is still expected from 2027 onwards. A high level SLD of this option can be found on Figure 10.

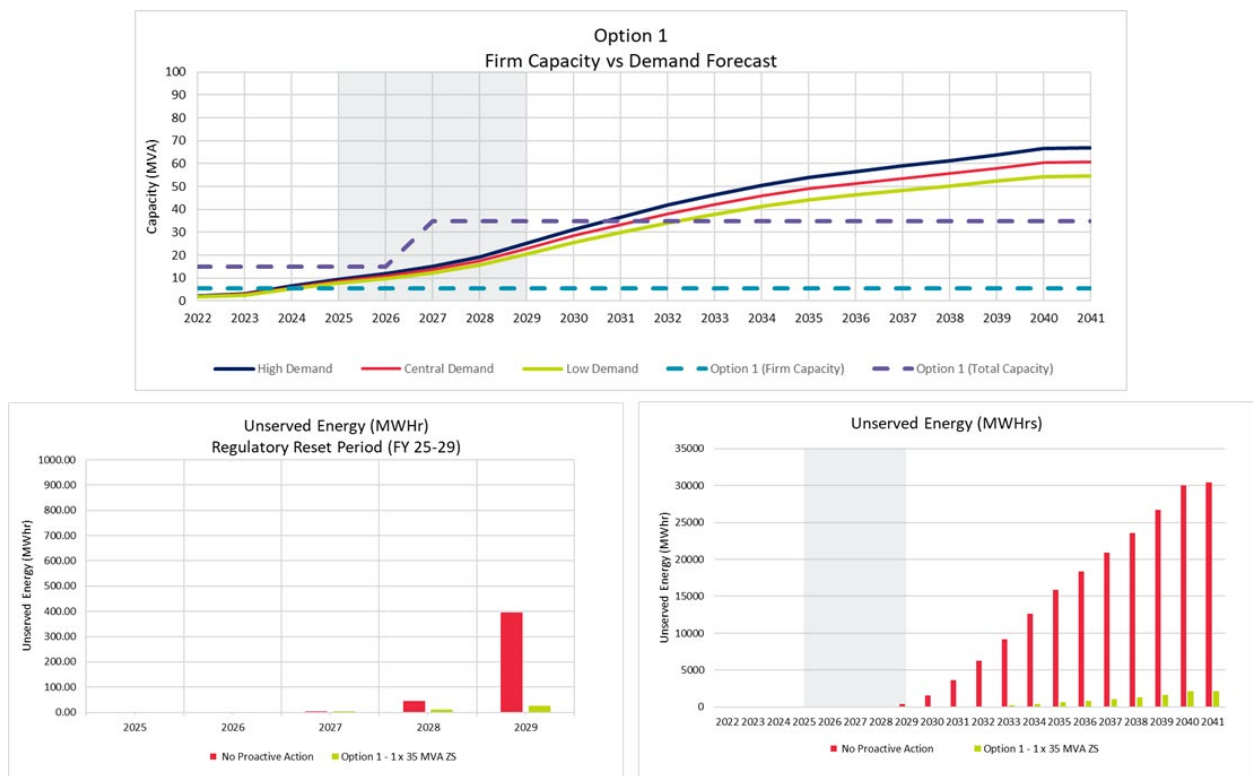


Figure 9 - Summary of Option 1 - Expected Unserved Energy based on central case demand forecast

Table 8 - Summary of Option 1 based on central case demand forecast

Option	PV "Market Benefits" (\$M)	PV Costs (\$M)	NPV (\$M)
1	\$6,615	\$10	\$6,604

3.2.2 Establish Menangle Park ZS by FY27 (2x 35 MVA Transformers)

3.2.2.1 Scope

Option 2 would establish a 66kV/11kV 70 MVA zone substation at Menangle Park by 2027, and decommission the existing 15 MVA mobile substation, which is currently onsite.

Supply would be established to the new substation from the existing 66kV feeder, 85P from Macarthur BSP. The existing 66kV feeder 85P, from Macarthur BSP will also be transferred across from the 15 MVA mobile substation which is currently onsite. The mobile substation will then be decommissioned.

It is expected that this zone substation's load will be supplied via Macarthur BSP. Further, the new substation will also be looped into the future 66kV feeder 85J, which will be built outside the site under NPR-000002 (PR113) prior to 2027. This will be achieved via two short underground feeder connections to Menangle Park zone substation.

Using the new standard substation layouts, which makes use of modular buildings and provides the base design for a 66kV/11kV, 2 x 35MVA, indoor substation on an 8280sqm site, this Option's scopes of works are as follows:

Zone Substation:

- 66/11kV 2 x 35 MVA transformer
- 3 x Transmission Feeder bays
- 3 x 66kV busbars
- 2 x 11kV busbar each with 6 x 11kV circuit breakers

Transmission Lines:

- Establish two underground 66kV feeder linkages looping into the future adjacent 66kV feeder 85J via two new 66kV UGOHs.
- Disconnect existing 66kV feeder 85P from mobile substation and terminate into new Menangle Park zone substation.

Mobile Substation

- Decommission existing mobile zone substation which is currently onsite.

This option involves the establishment of the Menangle Park ZS with 2 x 35MVA transformers commissioned in 2027. Figure 11 presents how this option will reduce the unserved energy when compared to the base case ("no proactive intervention"). This option results in a firm capacity of 35 MVA by 2027. This option can meet the forecasted central demand of the development with N-1 capacity until 2031 and N-0 capacity until 2040. While the N-1 firm capacity is less than the forecasted load from FY31 onwards, there is minimal expected unserved energy to 2041 with the central scenario. A high level SLD can be found on Figure 12.

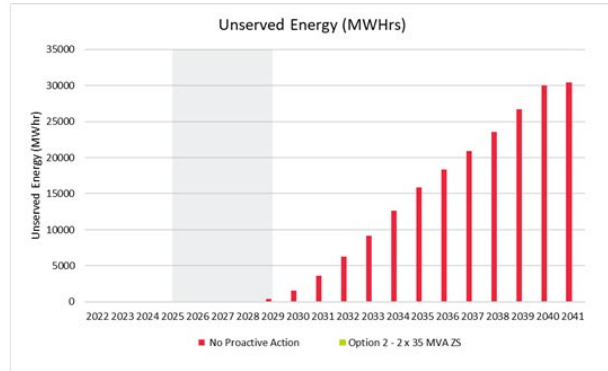
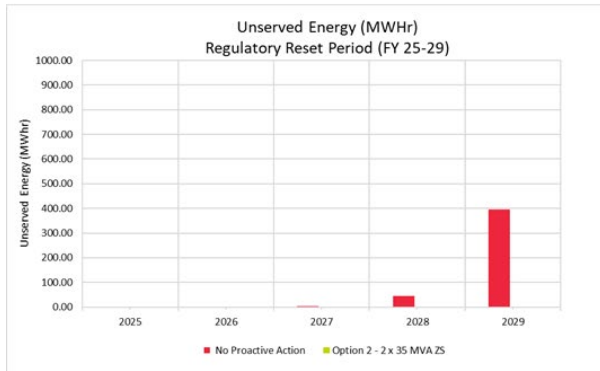
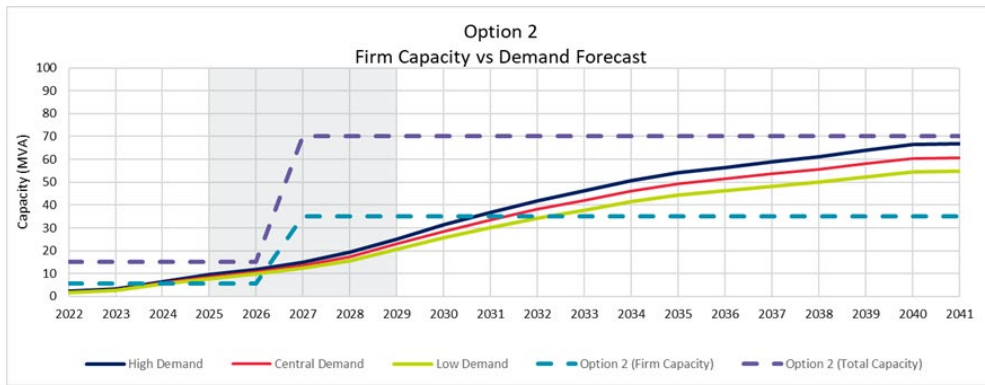


Figure 11 - Summary of Option 2. Expected Unserved Energy based on central case demand forecast

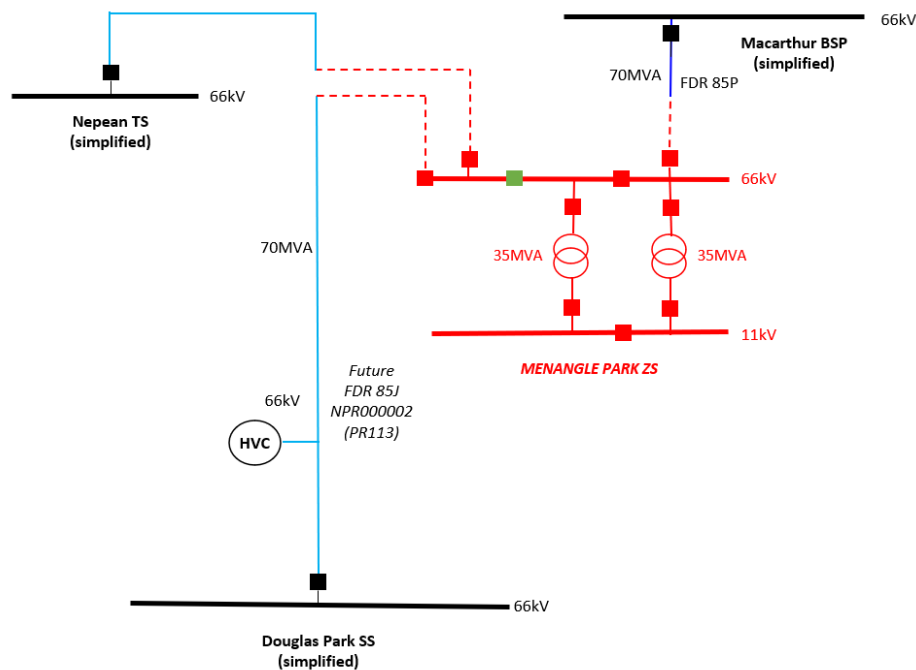


Figure 12 - High Level SLD (Left) for Option 2

3.2.2.2 Cost

Total estimated capital cost of Option 2 is **\$18.8 M**. The cost is spread over three years to align with construction timelines, and it is based on estimates provided by Endeavour Energy's estimating team. Commissioning of the substation is planned for **FY27**. A summary of the capital cost can be found in Table 9.

The total present value of costs for Option 2 is \$13.8M.

Table 9 - Option 2 - Capital cost summary

Option	2025	2026	2027
2	\$2.82M	\$8.46M	\$7.52M

3.2.2.3 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 3.2.1.3. The NPV summary is provided in the Table 10 below.

Table 10 - NPV Summary - Option 2 (Central Scenario)

Option	PV "Market Benefits" (\$M)	PV Costs (\$M)	NPV (\$M)
2	\$7,080	\$13.8	\$7,066

3.2.3 Option 4 - Establish Hybrid ZS by retaining 15 MVA Mobile ZS and establishing Menangle Park Permanent ZS by FY27 (1x 35MVA Transformer) n

3.2.3.1 Scope

Option 4 proposes a hybrid network solution. This option will establish a 66kV/11kV 35 MVA zone substation at Menangle Park by 2027, and retain the existing 15 MVA mobile substation, which is currently onsite.

Supply would be established to the new substation from Nepean TS by looping into the future 66kV feeder 85J, which will be built outside the site under NPR-000002 (PR113) prior to 2027. The mobile substation will be supplied by the existing 66kV feeder, 85P from Macarthur BSP

Using the new standard substation layouts, which makes use of modular buildings and provides the base design for a 66kV/11kV, 1 x 35MVA, indoor substation on an 8280sqm site, this Option's scopes of works are as follows:

Zone Substation:

- 66/11kV 1 x 35 MVA transformer
- 2 x Transmission Feeder bays
- 2 x 66kV busbars
- 1 x 11kV busbar with 6 x 11kV circuit breakers

Transmission Lines:

- Establish two underground 66kV feeder linkages ringing into the future adjacent 66kV feeder 85J via two new 66kV UGOHs.

Mobile Substation

- Retain existing mobile zone substation which is currently onsite and supplied by 66kV feeder 85P.

This option involves the establishment of the hybrid network solution consisting of Menangle Park ZS with 1 x 35MVA transformers (commissioned in 2027) and a 15 MVA mobile substation set to be commissioned in late 2022. The hybrid solution has a total capacity of 50 MVA with a firm capacity of 15 MVA. Figure 9 presents how this option will reduce the unserved energy when compared to the base case ("no proactive intervention"). Table 11 compares the expected unserved energy between Option 2 and

Option 4. The total substation capacity can only meet the forecasted central demand until 2035. While this option reduces the unserved energy when compared to the base case, significant unserved energy is still expected from 2031 onwards. A high level SLD of this option can be found on Figure 10.

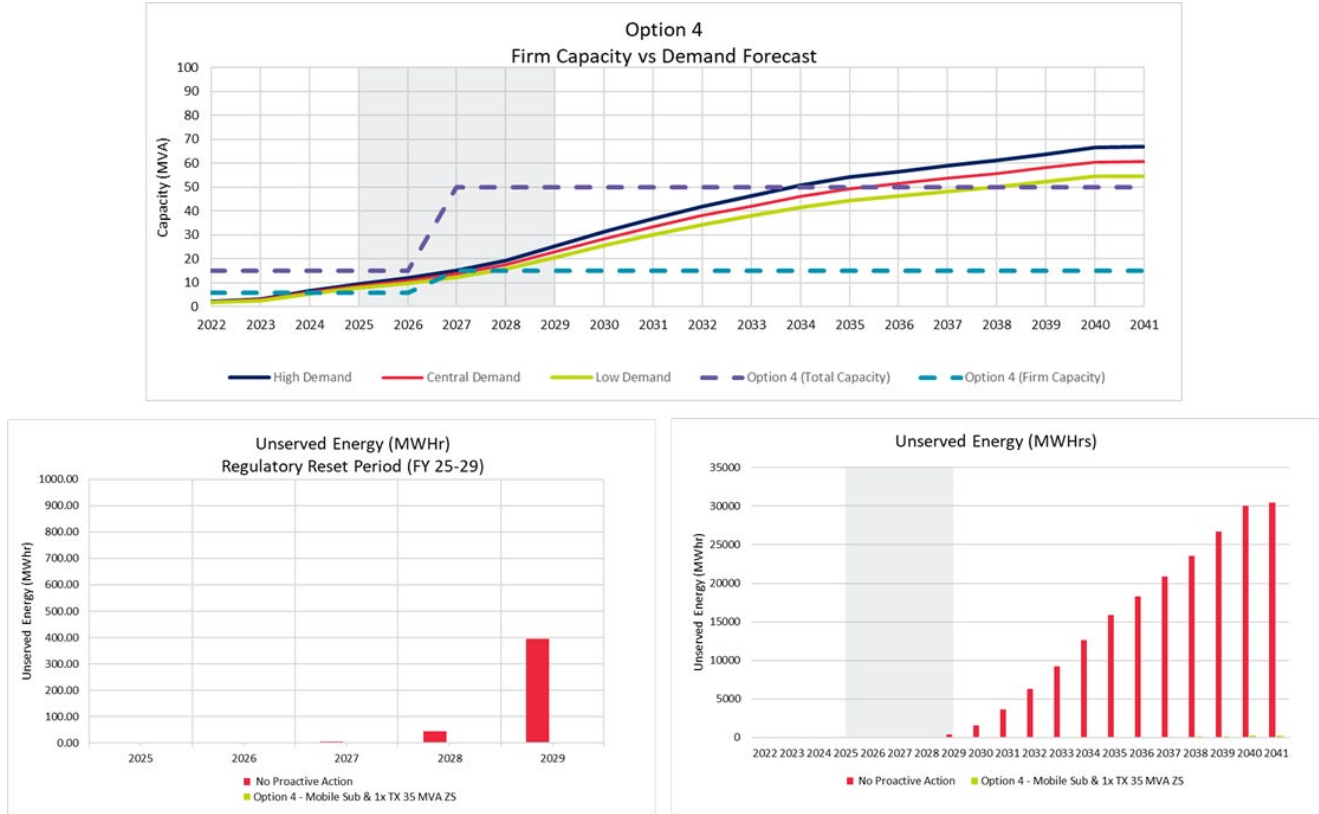


Figure 13 - Summary of Option 4 - Expected Unserved Energy based on central case demand forecast

Table 11 – Comparison of Unserved Energy between Option 2 & 4

Unserved Energy	2025	2026	2027	2028	2029	2030	2031	2036	2041
Option 1	0.34	1.49	0.00	0.00	0.00	0.00	0.00	2.83	8.58
Option 4	0.34	1.49	0.34	0.07	0.79	3.22	7.65	42.8	252.2

3.3 Recommended Long Term Network 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 14 shows that Option 2 represents the highest value (economic benefit), being NPV positive of \$7,066.2 Million compared to Option 4 even with the sensitivity & scenarios considered in Section 3.6. Additionally, it has the greatest reduction in unserved energy which will allow the greatest number of customers to connect. Hence, **Option 2** is the preferred long-term credible network configuration for the project's overall scope.

Table 14 – Options’ summary table

Option	Description	Solution Type	PV residual risk ¹ \$M	PV Cost ² \$M	PV Benefits ³	NPV ⁴⁵ \$M	Rank	Assessment Description
N/A	BAU Base Case - No proactive intervention	Base case / counterfactual	7,082	-	-	-	4	Non-preferred as will lead to unacceptable risk or higher cost for customers if opportunity not captured
1	Establish Menangle Park ZS by FY27 (1x 35 MVA Transformers)	Network solution	-	10	6,614.6	6,604.6	3	Technically feasible, lower net benefits
2	Establish Menangle Park ZS by FY27 (2x 35 MVA Transformers)	Network solution	-	13.8	7,080.0	7,066.2	1	Greatest Net Benefits, Preferred Long Term option
4	Establish Hybrid ZS by retaining 15 MVA Mobile ZS and establishing Menangle Park Permanent ZS by FY27 (1x 35MVA Transformer)	Network solution	-	11.4	7,028.9	7,017.5	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 4 for further details.

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 Network Option

Based on Option 2 from 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 ultimate establishment of Menangle Park ZS with a firm capacity of 35 MVA. To ensure that the proposed headwork infrastructure represents the minimum network infrastructure required to service the step change in new load, Endeavour Energy has considered the following:

- Option 3 Deferred 2nd Transformer
 - Two staged implementation of Menangle Park ZS where the 2nd Transformer is deferred by four years (FY30)

This option is detailed in the following section.

3.4.1 Option 3 – Establish staged Menangle Park ZS by FY30 (1x 35 MVA Transformers by FY27)

3.4.1.1 Scope

Option 3 would establish a staged 66kV/11kV 70 MVA zone substation at Menangle Park and decommission the existing 15 MVA mobile substation in 2027, which is currently onsite.

Under Stage 1, the scope of works is the same as Option 1. Under Stage 2, to be undertaken 4 years later, an additional 66/11kV 35 MVA transformer, 66kV bus bar, 66kV transmission feeder bay and 11kV busbar with another 6 x 11kV circuit breakers would be installed.

Supply would be established to the new substation from the existing 66kV feeder, 85P from Macarthur BSP. The existing 66kV feeder 85P, from Macarthur BSP will also be transferred across from the 15 MVA mobile substation which is currently onsite. The mobile substation will then be decommissioned.

It is expected that this zone substation's load will be supplied via Macarthur BSP. Further, the new substation will also be rung into the future 66kV feeder 85J, which will be built outside the site under NPR-000002 (PR113) prior to 2025. This will be achieved via two short underground feeder connections to Menangle Park zone substation.

Using the new standard substation layouts, which makes use of modular buildings and provides the base design for a 66kV/11kV, 2 x 35MVA, indoor substation on an 8280sqm site, this Option's scopes of works are as follows:

Stage 1:

Zone Substation:

- 66/11kV 1 x 35 MVA transformer
- 2 x Transmission Feeder bays
- 2 x 66kV busbars
- 1 x 11kV busbar with 6 x 11kV circuit breakers

Transmission Lines:

- Establish two underground 66kV feeder linkages ringing into the future adjacent 66kV feeder 85J via two new 66kV UG OHs.
- Disconnect existing 66kV feeder 85P from mobile substation and terminate into new Menangle Park zone substation.

Mobile Substation

- Decommission existing mobile zone substation which is currently onsite.

Stage 2:

Zone Substation:

- 66/11kV 1 x 35 MVA transformer

- 1 x Transmission Feeder bays
- 1 x 66kV busbars
- 1 x 11kV busbar with 6 x 11kV circuit breakers

This option results in a total capacity of 35 MVA and 5.6 MVA firm capacity from 2027 to 2031. From 2031 onwards, Menangle Park ZS has a total capacity of 70 MVA with 35 MVA firm capacity. The expected unserved energy (EUE) between 2027 to 2031 is the same as Option 1. From 2031 onwards, the EUE is the same as Option 2 and there is minimal expected unserved energy to 2041 with the central scenario. Table 15 compares the EUE between Option 2 and Option 3 from 2027 to 2031 (deferral period of the 2nd transformer) and a high level SLD can be found on Figure 16 below.

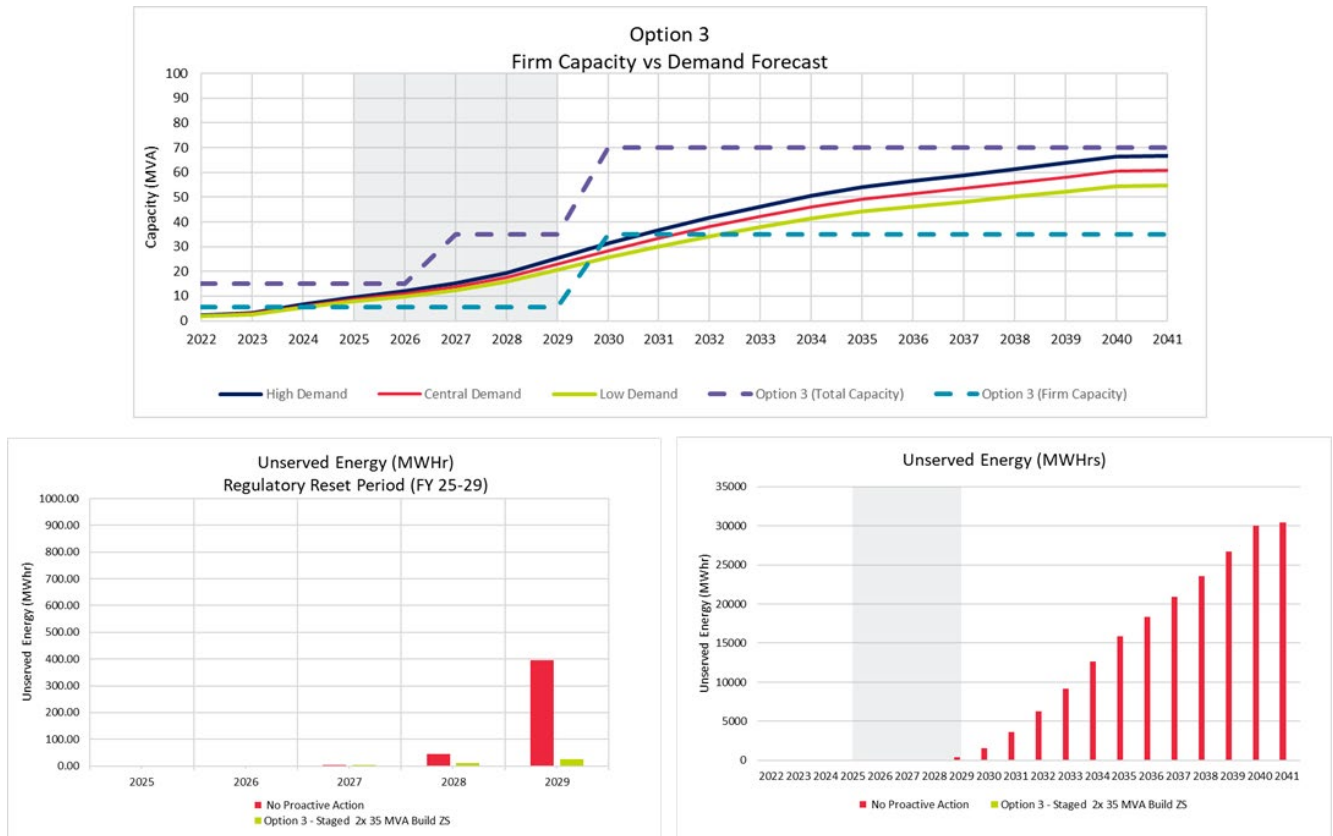


Figure 15 - Summary of Option 3 - Expected Unserved Energy based on central case demand forecast

Table 15 – Comparison of Expected Unserved Energy between Option 2 and Option 3

Expected Unserved Energy (MWh)	2027	2028	2029	2030	2031
Option 2	0.0	0.0	0.0	0.0	0.0
Option 3	4.2	11	27	45	0.0

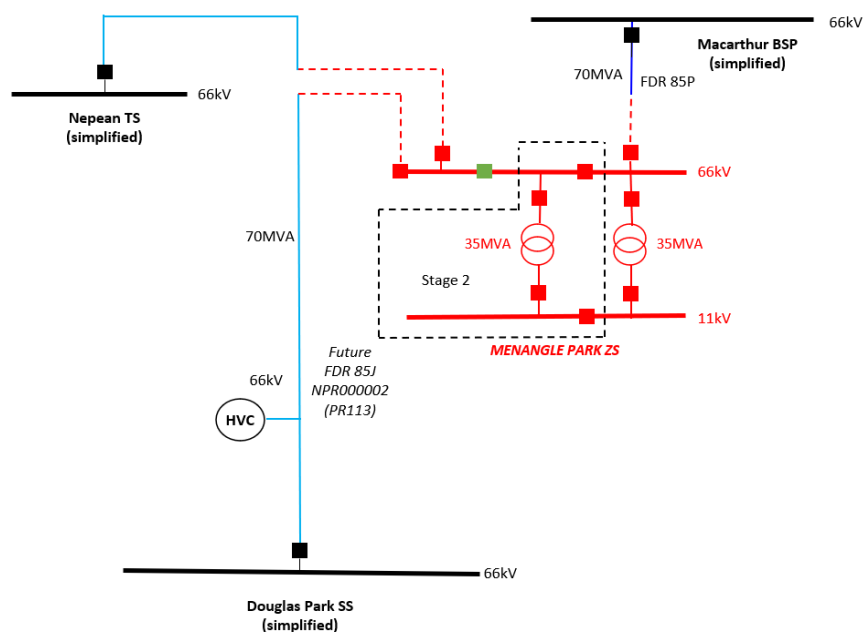


Figure 16 - High Level SLD (Left) for Option 3

3.4.1.2 Cost

The total estimated capital cost for the first phase of Option 3 is \$13.6M and \$5.7M for the 2nd stage. The cost is based on estimates provided by Endeavour Energy's estimating team. Commissioning of new equipment from Stage 1 is planned for FY27 while commissioning of new equipment from Stage 2 is planned for FY31. A summary of the capital cost can be found in Table 16.

The total present value of costs for Option 3 (both stages combined) is \$13.2M.

Table 16 - Option 3 - Capital cost summary

Option 3	2024	2025	2026	2030
Stage 1	\$2.04M	\$6.12M	\$5.44M	-
Stage 2	-	-	-	\$5.7M

3.4.2 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. No other identified risks were included in the costs and benefits analysis.

The assumptions used in the HK model are stated in Section 3.2.1.3. The NPV summary is provided in the Table 17 below.

Table 17 - NPV Summary - Option 3 (Central Scenario)

Option	PV "Market Benefits" (\$M)	PV Costs (\$M)	NPV (\$M)
3	\$7,078	\$13.2	\$7,065.1

3.5 Recommended Network Option

Option 3 which defers part of the network investment, has a similar NPV (7,065.1 M) as Option 2 (7,066.2.8 M) over the study period (30 years), even with the sensitivity & scenarios considered in Section 3.6. This is because Option 3 is a subset of Option 2, with the only change being between 2027-31, where the second transformer is deferred in Option 3.

A comparative NPV analysis was completed to compare these options, which baselines Option 3 against Option 2 (preferred long-term solution). The comparative NPV analysis was based on the following inputs and assumptions and is summarised in Table 18.

- A study period of 9 years (2022-2031)
 - After 2031, both Option 2 & Option 3 are the same
- The commercial discount rate was set to 3.26% and a composite VCR of \$26,008/MWh was used
 - Same inputs defined in Section 3.2.1.3
- Comparative PV Costs
 - The relative cost for deferring the 2nd transformer in Option 3 is the increase in expected unserved energy from only having one transformer relative to Option 2
- Comparative PV Benefits
 - The relative benefits of deferring the 2nd transformer for Option 3 are:
 - Deferred capital expenditure of the 2nd transformer
 - Reduced maintenance cost by only having one transformer compared to two transformers in Option 2.

Table 18 shows that Option 3 is NPV negative when baselined against Option 2, in which the benefits of deferring the 2nd transformer do not outweigh the quantified cost of unserved energy. **Hence, Option 2 is the preferred network option.**

Table 18 – Comparative NPV Analysis of Option 3 against Option 2

Option	Description	Solution Type	Relative PV Cost ¹ \$M	Relative PV Benefits ²	Relative NPV ³⁴ \$M	Comments
3	Establish staged Menangle Park ZS by FY30 (1x 35 MVA Transformers by FY27) 4-year deferral of 2 nd Transformer	Network solution	-1.73	+0.32	-1.41	Technically feasible, lower relative benefits compared to Option 2 (Long Term Network Solution)

Notes:

- 1: The PV cost relative to Option 2 (Highest NPV long term solution)
- 2: The PV benefits relative to Option 2 (Highest NPV long term solution)
- 3: PV Benefits less PV Investment Costs.
- 4: The breakdown of PV is based on the central demand forecast scenario

3.6 Sensitivity and Scenario Analysis

3.6.1 Sensitivity Analysis

Sensitivity tests and analysis have been applied to the economic evaluation in the Houston Kemp model and results are shown below.

To confirm the robustness of the economic evaluation and to demonstrate the results over a range of variation in some of the key variables, the sensitivity analysis was conducted on all of the credible network options.

The key variables included in the sensitivity analysis and shown below in Figure 17 were:

- Discount rate used for the discounted cashflow in the evaluation.
- Capital cost estimates.
- Value of customer reliability
- Risk costs, for this project, essentially the value of the expected unserved energy.

The output demonstrates that Option 2 remains the most favourable option in all sensitivity tests as no tipping point was found between the options as shown in Figure 18.



Figure 17 - Sensitivity analysis

Thresholds and tipping points

Rank	Option	Weighted NPV
1	Option 2	6,909,312,631
2	Option 3	6,908,249,817

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	26,008	
Risk costs	Factor	1.0000	

Rank 1 Option 2 for zero NPV

Parameters	Units	Value	Notes
Discount rate	Percent	101.75%	No reasonable discount rate can achieve zero NPV
Capital cost	Factor	709.1640	No reasonable capital costs can achieve zero NPV
VCR	\$/MWh	40	
Risk costs	Factor	-335,543.3200	No reasonable risk costs can achieve zero NPV

Rank 2 Option 3 for zero NPV

Parameters	Units	Value	Notes
Discount rate	Percent	101.55%	No reasonable discount rate can achieve zero NPV
Capital cost	Factor	657.6496	No reasonable capital costs can achieve zero NPV
VCR	\$/MWh	43	
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 18: Summary of Sensitivity Analysis & Tipping Point

3.6.2 Scenario Analysis: Weighted NPV

Scenario analysis has been carried out by the HK model. The parameters of the scenario analysis are presented on Figure 19 below.

Parameters		S1	S2	S3	S4
General parameters		Central	High	Low	[Extra]
Commercial discount rate	Percent	3.26%	2.22%	4.30%	3.26%
VCR for involuntary load shedding	\$/MWh	26,008	33,810	18,206	26,008
VCR for voluntary load curtailment	\$/MWh	26,008	50,447	27,164	26,008
Cost parameters		Central	High	Low	[Extra]
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		Central	High	Low	[Extra]
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		Central	High	Low	[Extra]
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		Central	High	Low	[Extra]
Weightings	%	0.50	0.25	0.25	0.00

Figure 19 - Houston Kemp model scenario parameters

Table 19 - Summary of scenarios investigated

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)	\$26/kWh (from AER VCR report)	\$18.2/kWh 30% lower than baseline	\$33.8/kWh 30% higher than baseline
Discount rate	3.26% (WACC)	2.22%	4.3%
Maintenance costs	Estimated network maintenance costs	25% decrease in the estimated network maintenance costs	25% increase in the estimated network maintenance costs
Scenario weighting	50%	25%	25%

The scenarios have been weighted as 50% for Scenario 1 being the most likely with Scenarios 2 and 3 being given a weighting of 25%. The weighted NPV for each option is shown in Table 18 below. The scenario assessment shows that Option 2 remains the preferred option with the highest weighted NPV.

Table 11 – 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	6,605	7,759	4,894	6,466	4
Option 2	7,066	8,156	5,349	6,909	1
Option 3	7,065	8,155	5,348	6,908	2
Option 4	7,017	8,128	5,290	6,863	3

3.7 Proposed Investment Timing

The optimal timing where the value of unserved energy from the 'No Proactive Intervention' scenario exceeds investment costs is 2028 as per Figure 20. However, the identified need for this investment is a reliability correction action to meet the expected future load. 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. This is achieved by the proposed timing of Option 2 where the infrastructure is established by 2028.

Annualised cost and optimal commissioning year for Option 2		
Option name	Annualised cost	Optimal year
Option 2	766,875	2028

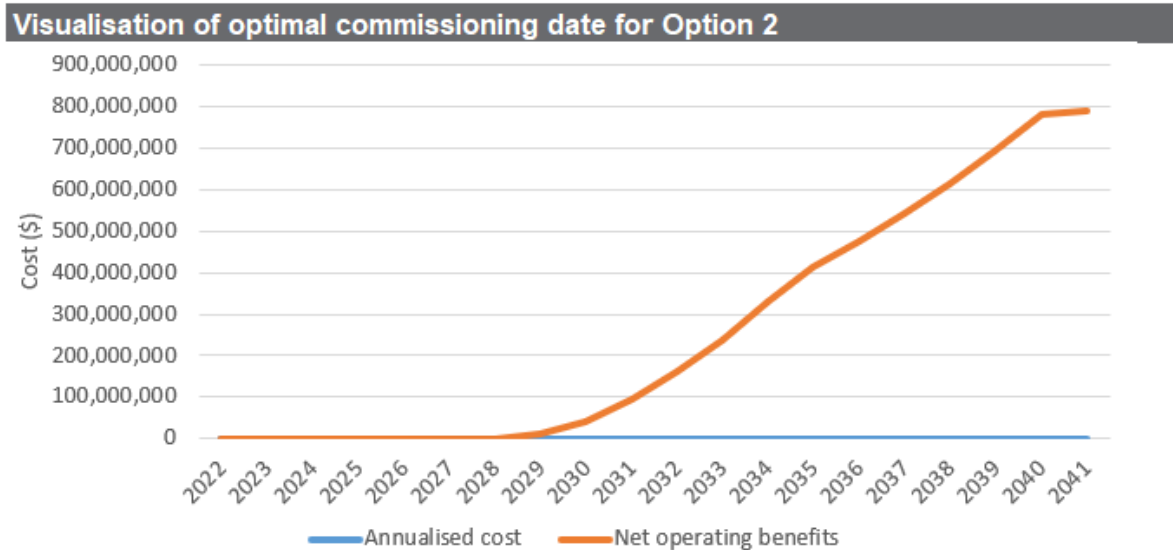


Figure 20 - Houston Kemp optimal timing output

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 mobile substation. Figure 21 shows the comparison of non-network solutions and network solutions against the base case (“no proactive intervention”), while Figure 22 compares non-network solutions against the network solution.

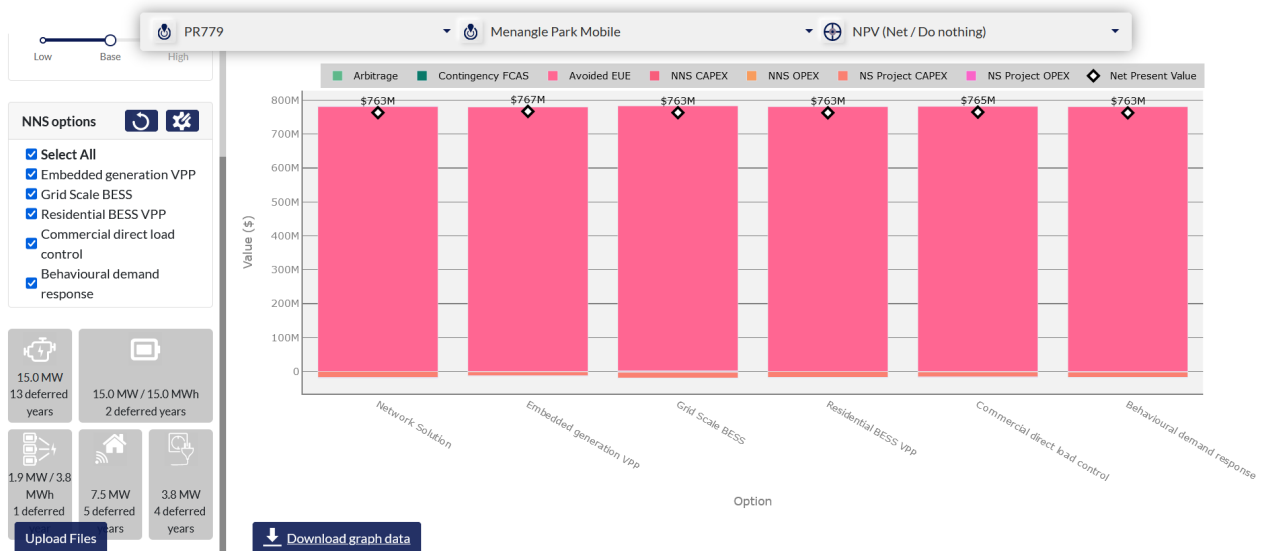


Figure 21 - NTMP Output for Non-Network Options when compared to the Base Case (“no proactive intervention”)

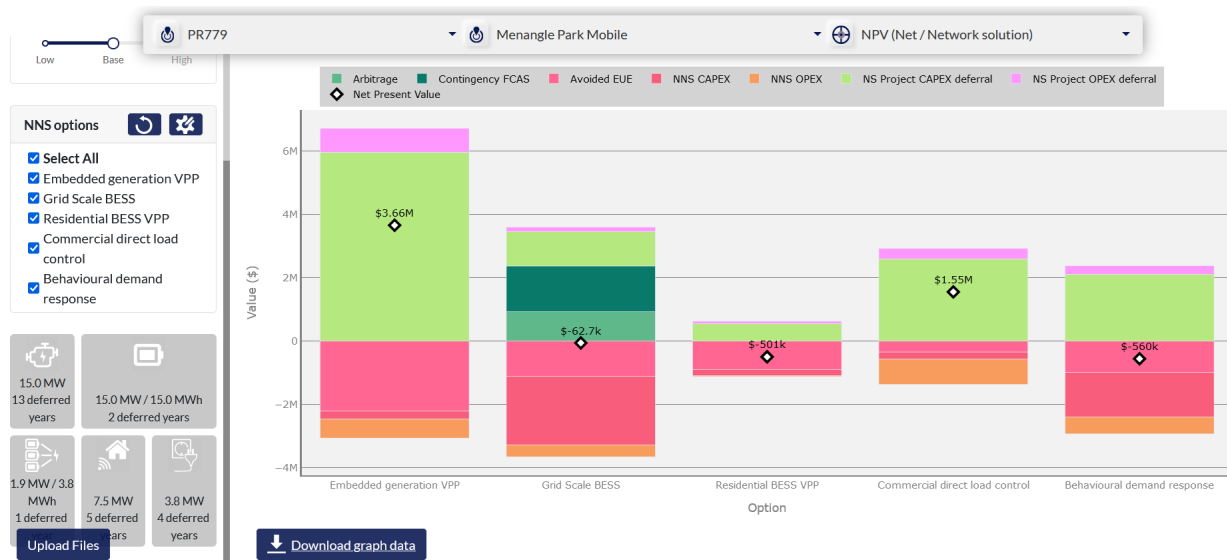


Figure 22 - NTMP Output for Non-Network Options when compared to the Network Solution

Table 20 provides an overview of the outputs from the NTMP tool and overlays with qualitative assessment.

Table 20 - Non-Network / New Technology Options

Non-Network Options	Outcomes	Qualitative Assessment	Comments
Grid-Scale Storage (15MW /15 MWh)	Potentially defer the network investment by 2 year	✗	Not feasible due to lack of greenfield infrastructure. Additionally, it is NPV negative when compared to the network option
VPP (13 MW)	Potentially defer the network investment by 13 years	✗	Not a feasible option as this is a new development. This uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure
Residential BESS VPP (1.8 MW /3.8 MWh)	Potentially defer the network investment by 1 year	✗	Not a feasible option as this is a new development. Additionally, it is NPV negative when compared to the network option and provides minimal deferral of network investment
Commercial Direct Load Control (7.5 MW)	Potentially defer the network investment by 5 years	✗	Not a feasible option as this is a new development. This uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure
Behavioural Demand Response (3.8 MW)	Potentially defer the network investment by 4 years	✗	This uptake initially requires customers to connect to the network which is not feasible with existing network infrastructure. Additionally, it is NPV negative when compared to the network option

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 proposed network infrastructure has been commissioned to defer future network investment.

4. Detailed description and costs of preferred option

The preferred option proposed in this CFI is to establish a 66/11 70MVA Menangle Park ZS, which has a total installed capacity of 70MVA, and a firm capacity of 35MVA, providing the N-1 security. The recommended option continues the establishment a new Menangle Park ZS which will be supplied from existing 66KV feeder 85P from Macarthur BSP and being rung into future 66kV feeder 85J.

The scope of works for the preferred network option includes:

Zone Substation:

- 66/11kV 2 x 35 MVA transformer.
- 3 x Transmission Feeder bays
- 3 x 66kV busbars
- 2 x 11kV busbar each with 6 x 11kV circuit breakers

Transmission Lines:

- Establish two underground 66kV feeder linkages ringing into the future adjacent 66kV feeder 85J via two new 66kV UGOHs.
- Disconnect existing 66kV feeder 85P from mobile substation and terminate into new Menangle Park zone substation.

Mobile Substation

- Decommission existing mobile zone substation which is currently onsite. This will include transferring existing assets from the mobile substation to the permanent substation, transportation costs, craneage, disconnection, remediation of the plinth.

High level cost estimate:

Table 14: Option 2 - 66/11kV 70MVA Zone Substation at Menangle Park

Description	Cost (\$M)
New Modular Build Substation 66/11kV, 2 x 35MVA, 3 x TR feeder bays, 12 x 11kV CB's	16.6
Decommissioning Mobile Substation and Relocation of Assets	1
Additional cost of 2 new 66 kV UGOHs for Future 85J	0.328
Additional 66kV Cable to Future 85J	0.865
TOTAL	18.793

Note: Substation Primary Design and Transmission Mains groups to confirm the above and further scope during full proper budget estimate.

Cost

The total cost of the above works is estimated to be \$18.793M

5. Recommendations and Next Steps

This CFI recommends the establishment of the new 66/11kV outdoor Menangle Park ZS with a firm capacity of 35 MVA to supply the development area (Option 2). This substation would be supplied by two underground 66kV feeders, which will loop into the proposed 66kV feeder 85J that will run adjacent to the substation. This option has the highest Net Present Value (NPV) (\$7,066.2 Million) with an estimated cost of \$18.8 million, which is expected to be spread over three years, from FY25 to FY27.

It is recommended that the project value of \$18.8 M be approved for consideration in the FY25-FY29 regulatory period.

Based on the Endeavour Energy's RIT-D process (Figure 23), it is recommended that the next steps are::

- Endeavour Energy publish a screening report before progressing to a Draft Project Assessment Report (DPAR) as per the RIT-D process (Refer to Figure 23). 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 with preferred Option 2 which recommends capital expenditure to build Menangle Park ZS with a firm capacity of 35 MVA by 2026, supplied by two underground 66kV feeder linkages looping into the future adjacent 66kV feeder 85J. Preliminary release enables development of project definitions, detailed design, environmental assessment and preliminary market engagement activities in accordance with Company Procedure GRM0051.

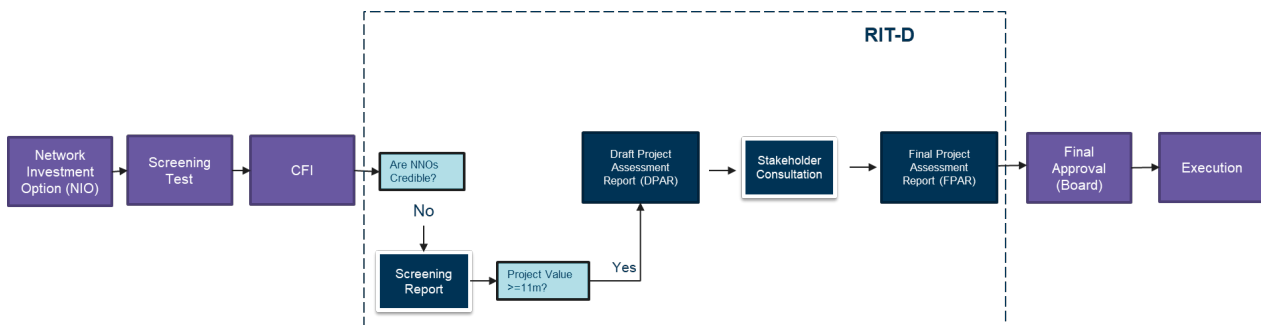


Figure 23 - Endeavour Energy's RIT-D Process for this Project

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Appendices

A. RIT-D / market engagement process

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) requires Distribution Network Service Providers (DNSP) to investigate non-network (demand management) options by utilising a thorough consultation process as part of planning for major network upgrades.

The NER calls for a regulatory investment test for distributors (RIT-D) process to be used in identifying the solution delivering the highest net market benefit in removing the network limitation. A “screening test” is performed for all network limitations where the most expensive credible option is greater than \$5 Million.

B. Referenced documents and appendices

- [1] Planning & Infrastructure, *Menangle Park Master Plan*, Campbelltown Council, 2018
- [2] Network Demand Forecasting, *Summer Demand Forecast 2022-2031*. Endeavour Energy, 2021.
- [3] Substation Design, *Updated unit rates (Substations estimates)*, Endeavour Energy, 2021.
- [5] Capacity Planning, *NIO PR258 Menangle Park ZS Final Draft*. Endeavour Energy, 2019.
- [6] Capacity Planning, *NPR-000002 (PR113) Southern Macarthur 66kV Supply*. Endeavour Energy, 2022.

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