RIT-D Final Project Assessment Report

Box Hill Development Area

16 September 2021

Endeavour Energy

Contents

1. Executive summary

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

The purpose of this report is to demonstrate the basis for determining the selected option to address the network limitations in the Box Hill development area. This report was prepared following publication of the Draft Project Assessment Report (DPAR). No submissions were received during the consultation period. A Non-Network Options Report (NNOR) was published prior to the DPAR to seek submissions from interested parties for proposals for non-network solutions and two submissions were received including a grid-connected Battery Energy Storage System (BESS) solution and a residential demand response solution.

The Box Hill development area which is comprised of Box Hill, Box Hill Industrial and Box Hill North precincts, will altogether deliver 14,000 new homes, two town centres and village centres, 133 hectares of employment land, 58 hectares of recreational and environmental space, new primary and high schools. The development will ultimately require an estimated capacity of 41MVA.

The identified need for this investment is to establish electricity supply to new developments within the Box Hill development area. Currently, the area is supplied mainly by three 22kV feeders from Mungerie Park Zone Substation (ZS).

Two network options and one non-network option were determined to be credible to address the network need. The credible options are listed below:

- Do Nothing : Base case;
- Option 1 : Staged implementation of 132/22kV zone substation;
- Option 2 : Complete implementation of 132/22kV zone substation; and
- Option 3 : Grid BESS solution to defer network investment (non-network option).

The ‘Do Nothing’ option will result in significant expected unserved energy in the development area which would mean that new connections will not be able to be facilitated from 2023 onwards.

Option 1 proposes the establishment of a new zone substation in two stages. Stage 1 of this solution, which will have a single transformer and single transmission feeder, will satisfy short to medium term capacity needs in the area until FY29. A staged approach provides option value in the ability to consider potential non-network solutions that may defer the installation of a second transformer and transmission feeder in Stage 2.

Option 2 involves the establishment of a new zone substation with two transformers and two transmission feeders upfront. This option meets all requirements for short to medium capacity needs as well as provides the ability to instantly respond to potential large spot load connection requests in the area.

Option 3 proposes a non-network solution in the form of centralised BESS ‘as a service’ to defer network investment. The proposed solution removes ownership, operation and development responsibilities from Endeavour Energy in exchange for agreed annual network support payments. While it was considered as a potentially credible option, the proponent was unable to establish a binding offer. Given this, a complete economic evaluation could therefore not be performed against this option.

A proposal for a non-network solution pertaining to demand response was received but was determined as not credible hence was not included in the economic evaluation. The proposed solution was to implement a residential demand management program which involves air conditioner control, battery energy storage control and installation of solar panels. The demand reduction proposal relied heavily on widespread customer participation and thus presented an unacceptably high degree of risk.

The economic assessment of the credible options is shown in Table 1 and indicates that Option 1 presents the greatest net present value (NPV) of the market benefits considered in the evaluation. The assessment period for calculating the NPV is 30 years. Market benefits are based predominantly on expected unserved energy which is monetised by using Value of Customer Reliability (VCR). The VCR values used by Endeavour in its modelling are based on the Values of Customer Reliability Report published by the Australian Energy Regulator (AER) in December 2019.

Table 1: Summary of Credible Options (base case)

Option	Description	Project NNO Opex nominal ($M)	Project capex nominal ($M)	PV of Market Benefits ($m)	PV of Costs ($M)	NPV ($M)	Rank
1	Staged implementation of 132/22kV zone substation	0	44.8	141.8	31.4	110.4	1
2	Complete implementation of 132/22kV zone substation	0	44.1	142.2	35.6	106.6	2

Considering the capital cost, value of market benefits, identified risks and NPV, the selected option is Option 1 which is the staged implementation of 132/22kV zone substation.

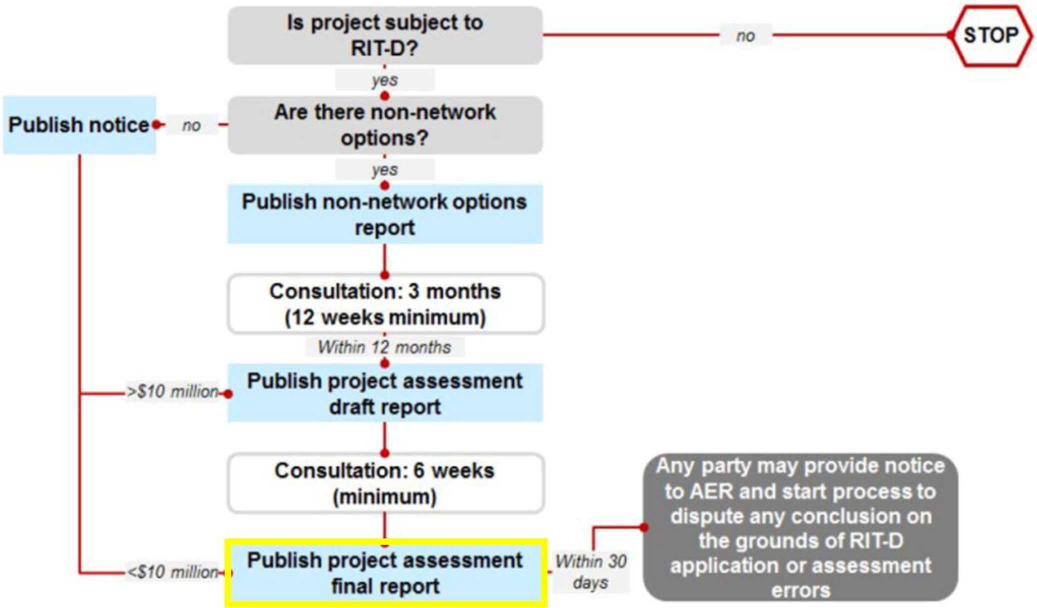
2. RIT-D Process

This FPAR was prepared by Endeavour Energy in accordance with the requirements of Section 5.17.4 of the National Electricity Rules. This report describes the application of the Regulatory Investment Test – Distribution (RIT-D) for addressing network limitations in the Box Hill development area. This report was prepared following publication of the Draft Project Assessment Report (DPAR).

Endeavour Energy adopts a process of exploring feasible methods of supply in assessing the ability to supply development applications. However, for greenfield sites, Endeavour Energy needs to determine the length of time that the existing network will be able to sustain the prevailing precinct development rate. Endeavour Energy needs to balance timely investment with the ramping up of demand as the development progresses. This is required to mitigate the risks of stalling developments due to delayed supply of power to the area which has an adverse impact on the supply of land for housing, as well as commercial and employment needs.

Endeavour Energy does request legally binding offers for non-network options which may identify alternative sources of supply and which may defer or avoid the need for investment in network infrastructure. This is achieved through the NNOR stage of the RIT-D. Figure 1 below illustrates the RIT-D process highlighting the FPAR stage.

Figure 1: The RIT-D Process



2.1 Submissions received

Endeavour Energy has published a NNOR for the Box Hill development area on 24th April 2020 and two submissions were received. A DPAR was also published on 22nd July 2021 and open for submissions until 3rd September 2021. No submissions were received during the consultation period.

2.2 Contact details

All enquiries regarding this FPAR should be directed to Endeavour Energy's Head of Asset Planning and Performance at consultation@endeavourenergy.com.au.

3. Description of network need

The development of 14,000 new homes along with town centres, village centres, schools and employment land will eventually require 41 MVA of capacity.

The distribution capacity available to supply the development area is provided by three 22kV feeders from Mungerie Park ZS with a total capacity of 27MVA as shown in Table 2. It is noted that two of the feeders are dedicated to Box Hill while one feeder also supplies an area outside of the development area with a load of 4MVA. Hence the capacity available to supply the Box Hill development area is only 23MVA.

In addition to the three 22kV feeders out of Mungerie Park ZS, small areas of Box Hill are supplied by one 11kV feeder from Riverstone ZS. This feeder currently has spare capacity of approximately 1 MVA based on the most recent data. However, due to the length of this feeder this capacity cannot be utilised due to voltage drop issues. Therefore, additional load from the development area cannot be connected to this feeder.

Table 2: Distribution Feeders Supplying Box Hill Development Area

Feeder no.	Description	Capacity (MVA)	2018 Actual Load (MVA)	Available Capacity (MVA)
MR2218	22kV feeder dedicated to Box Hill	9.0	1.0	8.0
MR2272	22kV feeder dedicated to Box Hill	9.0	0.9	8.1
MR2232	22kV feeder supplying Box Hill and existing area outside Box Hill	9.0	4.0	5.0
Total		**27.0**	**6.0**	**21.0**

Note: The 4 MVA load from Feeder MR2232 is from existing areas neighbouring Box Hill development area

A discussion on load forecast and network limitations and constraints as they relate to the network need is provided in the appendix page.

4. Selected option

The option that presents the greatest net market benefit and thus considered as the selected option, is Option 1 (Staged implementation of 132/22kV zone substation). This option proposes the implementation of a new zone substation in two stages. Stage 1 of the new zone substation will ensure network capacity is available in short to medium term to facilitate new customer connections as the development in the Box Hill area progress. This option offers option value in terms of the possibility to further defer the construction of Stage 2 if demand does not materialise in accordance with the forecast, or the relative value of non-networks solutions increases.

Stage 1 will involve a single transformer and one transmission feeder at a cost of $24.4 Million plus a contingency of $2.2 Million. The first stage will be constructed over two years for commissioning in FY23. Stage 2 will add a second transformer, a second transmission feeder and additional 22kV components which, based on current forecast, will be required to be operational by FY29. A cost of $20.4 Million will be incurred in Stage 2.

The technical characteristics of the project are as follows:

- Establish a new 132/22kV zone substation in two stages;
  - Stage 1:
    - One 132/22kV 45MVA transformer
    - One 132kV feeder from Vineyard BSP to Box Hill
    - 22kV switchboard
  - Stage 2:
    - Second 132/22kV 45MVA transformer
    - Second 132kV feeder
    - Second 22kV switchboard
- Associated civil works;
- Distribution works – establish new 22kV feeders to connect to the substation; and
- Communication works.

5. Credible options considered

There were several options considered in the evaluation out of which two network options and one non-network option were determined to be credible to address the identified network need. The credible options are listed below, and details are further discussed in this section.

One further proposal for a non-network solution was received but was considered not credible. The proposed solution was for a residential demand response program which aimed to defer Option 1 by one year. A summary and commentary on this proposal is provided in Section 5.7.

- Do Nothing : Base case;
- Option 1 : Staged implementation of 132/22kV zone substation;
- Option 2 : Complete implementation of 132/22kV zone substation; and
- Option 3 : Grid BESS solution to defer network investment (non-network option)

5.1 Base Case ('Do Nothing' option)

A baseline risk position has been established based on a 'Do Nothing' option. The project involves the extension of supply into a greenfield development area which will ultimately involve approximately 14,000 new homes, employment lands and two town centres. The Box Hill development area is part of the NSW Government's North West Priority Growth Area.

The 'Do Nothing' approach will result in significant expected unserved energy in the development precincts from 2023 onwards. It also carries with it significant economic development implications and reputational risks of negative press and NSW Government dissatisfaction if Endeavour Energy is unable to meet supply requirements for this area.

In terms of risk cost assessment, the 'Do Nothing' option provides a base case where the risks are valued by applying a Value of Customer Reliability (VCR) to the forecast expected unserved energy. The VCR used by Endeavour Energy in its modelling is based on values published by the AER on its Values of Customer Reliability Report in December 2019. This approach was endorsed by the AER during the determination process. Table 3 shows the annualised risk cost of no proactive intervention.

Table 3 – Risk Cost of 'no proactive intervention'

	2023	2024	2025	2026	2027
Risk cost ($)	176	2,194	489,524	2,860,815	6,402,837

5.2 Option 1: Staged implementation of 132/22kV zone substation

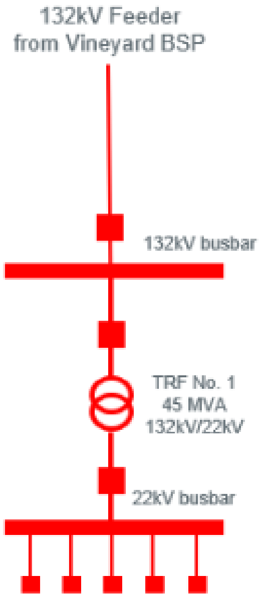
This option proposes the establishment of a new zone substation in two stages. The first 45 MVA transformer, one section of 22kV circuit breakers and a single 132kV feeder from Vineyard bulk supply point (BSP) will form part of Stage 1. It will be commissioned in FY23 to provide the first stage of supply to the Box Hill development area.

It will satisfy short to medium term capacity needs without providing redundancy (N-1) until Stage 2 works are implemented. It would involve Stage 1 works being constructed so as not to impede any Stage 2 construction works in the future. As a result, Stage 2 works could be established according to the recorded load growth rate in the area. Based on the most recent forecast, Stage 2 would be required by FY29, allowing for a six-year deferral of the second power transformer, second transmission feeder and additional 22kV components.

The total cost of this project (Stage 1 and 2) is $44.8 Million with $24.4 Million plus a contingency of $2.2 Million to be incurred in Stage 1 and a further $20.4 Million in Stage 2. The single line diagram for Stage 1 is shown in Figure 2 below.

The staged ZS implementation also provides an opportunity within the next few years to test whether a non-network solution can technically and economically defer the Stage 2 works. A low load growth scenario could see Stage 2 deferred further while a high growth and large spot load connection requests can bring the need for Stage 2 forward.

Figure 2: Single Line Diagram for Stage 1

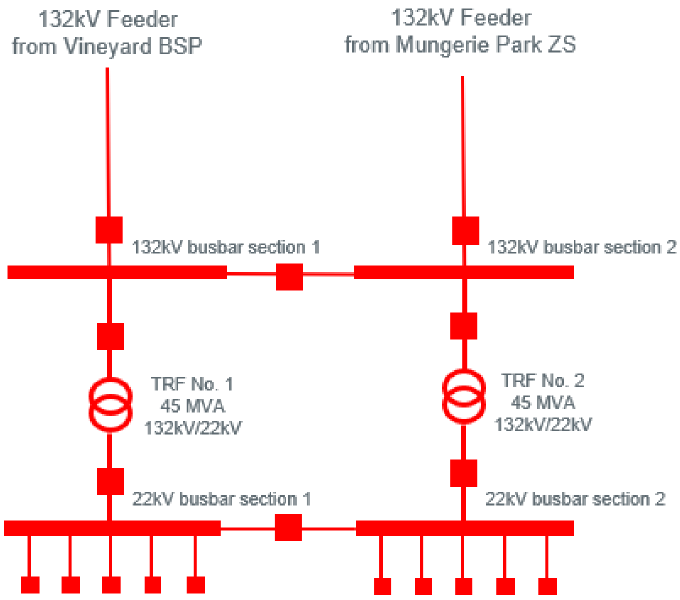


5.3 Option 2: Complete implementation of 132/22kV zone substation

This option proposes to establish a new zone substation with two 45MVA transformers and two transmission feeders. Proposed in a single stage implementation using standard substation design and firm 132kV supply, this option meets all requirements for short to medium term network capacity needs, as well as provides the opportunity to respond to large spot load connection requests in the area.

The zone substation will be constructed over three years (FY21 to FY23) and will be commissioned in FY23. The single line diagram for this network option is shown in Figure 3. The cost of the project is estimated to be $44.1 Million.

Figure 3: Single Line Diagram for Complete ZS



5.4 Option 3: Grid BESS solution to defer network investment

A proposal for a non-network solution comprising of multiple BESS configurations (distributed and centralised) was received to address the network constraint in the area and defer network investment. Of these, a centralised BESS 'as a service' solution having 18MW / 36MWh capacity was considered as a potential credible option. This proposal accounted for load requirements and limited connection opportunities to existing feeders for a number of years and thus was considered credible. The proposed solution was based on the proponent providing energy and thus network service when required from the independently owned battery in exchange for agreed annual network support payments.

Considering the load forecast and peak demand profile, the BESS solution had the potential to defer the zone substation by three years. Beyond this, the battery would not have sufficient capacity to meet the forecast demand.

Endeavour spent considerable time evaluating the proposal and engaging with the proponent to understand further details to establish both the commercial and technical feasibility. However, the proposal did not progress to complete economic evaluation as the proponent was unable to establish a binding offer that could be favourably compared to the network solution.

5.5 Option not considered as credible

5.5.1 Non-network proposal for demand response

A proposal for a non-network solution in the form of demand response was received. The proposed solution involved implementing a residential demand management program which included the control of customer-owned batteries, solar panels and air conditioners.

Establishing a Distributed Energy Resource Management System (DERMS) platform formed part of the solution that would be utilised to manage and orchestrate the dispatchable assets to achieve the demand reduction required.

The demand reduction using the proposed solution relied heavily on customer participation and the proponent could not provide a guarantee that the demand reduction target will be achieved. The proponent's forecast of the number of residential connections in the area by 2023 and 2024 as well as the number of participants required to achieve the demand reduction target was considered to be unrealistic when compared to similar projects undertaken by Endeavour and others, and thus presented an unacceptably high degree of risk for Endeavour Energy and its customers in the area.

The proposal was carefully evaluated being a high quality submission with potential to provide demand reduction. However, based on risks and uncertainties in customer participation towards the proposed demand management programs as well as concerns on some technical aspects of the solution, it was determined that the proposal was not credible.

5.6 Non-Network Option Objectives

Endeavour Energy published the NNOR with the following objectives and technical characteristics as detailed in Table 4.

Table 4 – Non-network Option Technical Characteristics

Objective	Target
Time of year	1 November to 31 March 2022/23 1 November to 31 March 2023/24 and 1 June to 31 August 2024 all year round after 1 November 2024
Time of day	3pm to 9pm Summer Period - (refer Figure 4) 6am to 10am and 5pm to 9pm Winter Period - (refer Figure 5) 6am to 10am & 3pm to 9pm everyday post 1 Nov 2024 (maximum daily temperature above 30^{O} & below 14^{O})
Season condition	2022/23 Summer, 2024 Winter, all year round after 1 November 2024
Day type	Days above 30^{O} and Days below 14^{O} - (refer Figures 4 and 5)
Demand reduction required	Refer Table 5

The load at risk which represents the demand reduction target is shown in Table 5.

Table 5 – Demand Management Program Reduction Target

Item	Forecast (MVA)								
Summer	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Residential Demand	7.8	11.8	16.0	20.2	24.4	28.6	31.6	33.8	36.0
Commercial / Industrial Demand	0.0	0.0	0.0	0.0	1.0	2.0	3.0	4.0	5.0
Total Demand Box Hill Development Area	7.8	11.8	16.0	20.2	25.4	30.6	34.6	37.8	41.0
Existing Area Demand	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Total Demand	11.8	15.8	20.0	24.2	29.4	34.6	38.6	41.8	45.0
Capacity (22kV Feeders)	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Load at Risk	**0.0**	**0.0**	**0.0**	**0.0**	**2.4**	**7.6**	**11.6**	**14.8**	**18.0**

6. Modelling & Assumptions

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

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

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

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

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

6.1 Assumptions

6.1.1 Energy at risk and expected unserved energy

A core justification for this project is based on load at risk and energy not able to be supplied to customers waiting to connect. This is different to a situation where already connected customers risk losing supply. The same VCR value has been applied as a default position to the energy at risk values established from the proposals received. For a greenfield development such as this, where the forecast demand rapidly exceeds the available capacity in the network, the VCR benefits to be captured from implementing a project to address network constraints can quickly rise to extremely large amounts.

The Energy at Risk (EAR) has been estimated from the annual peak demand forecasts and load duration curves. The energy at risk is considered as the energy above firm capacity (or above N-1 capacity). Two components of energy at risk are calculated:

a) Energy at risk above N-1 capacity but below N capacity
b) Energy at risk above N capacity.

In the former case, the energy at risk is subject to the probability of an outage occurring and reflects the expected unserved energy.

In the latter case, if new connections to the existing network continues, the energy at risk above N capacity simply refers to the energy that cannot be supplied at all due to insufficient capacity in the network. Hence in this situation, the expected unserved energy is the same as total energy at risk.

6.1.2 Load profile characteristics

The summer and winter peak load profiles of the 22kV feeders supplying the development area is shown in Figures 4 and 5 respectively. The load type currently connected to these feeders is predominantly residential in nature and peaking in the evening. It is expected that as development progresses, the residential peak will dominate with the 3pm to 9pm peak increasing in magnitude for both summer and winter.

Figure 4: Box Hill Development Area 22kV Feeder Load - Summer Peak Profile 19 December 2017

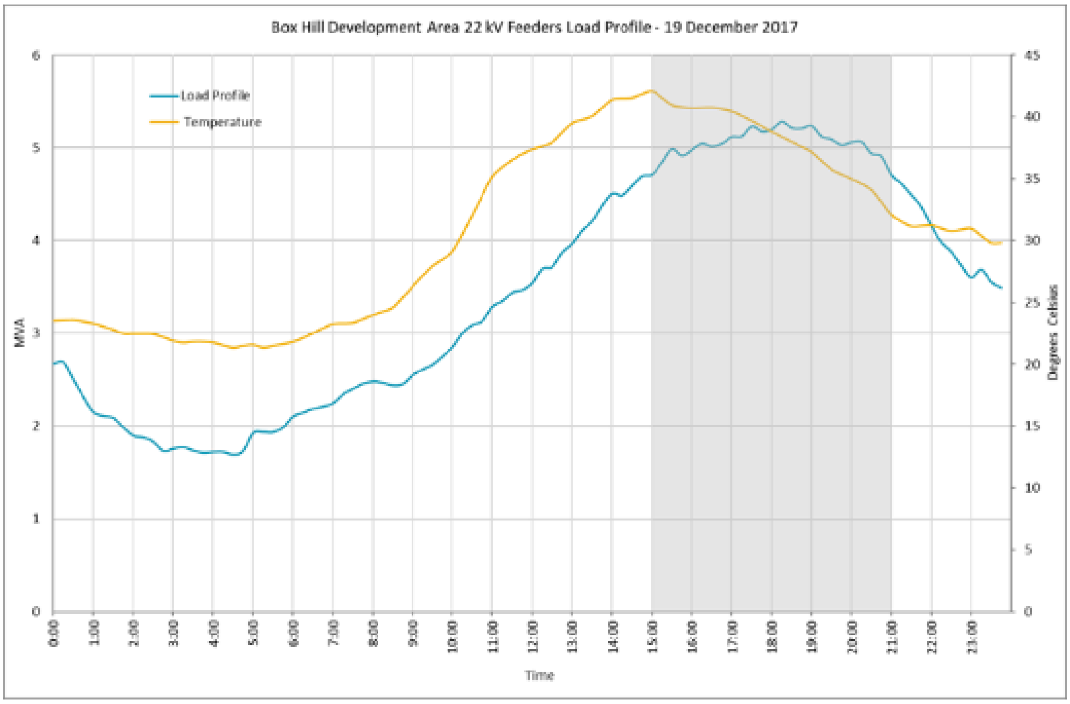
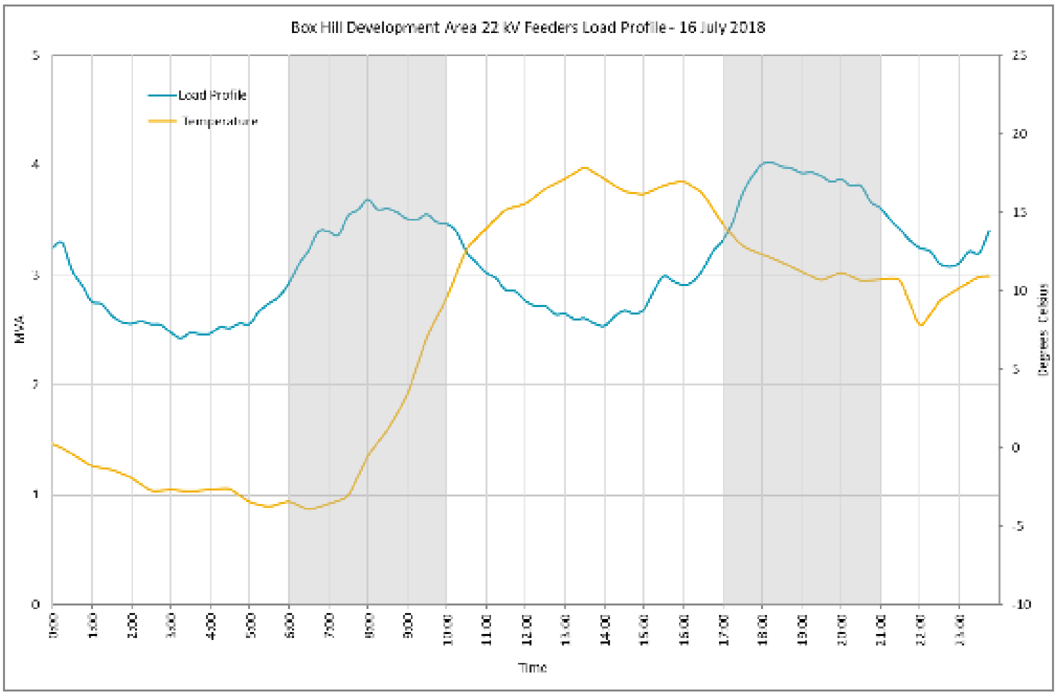
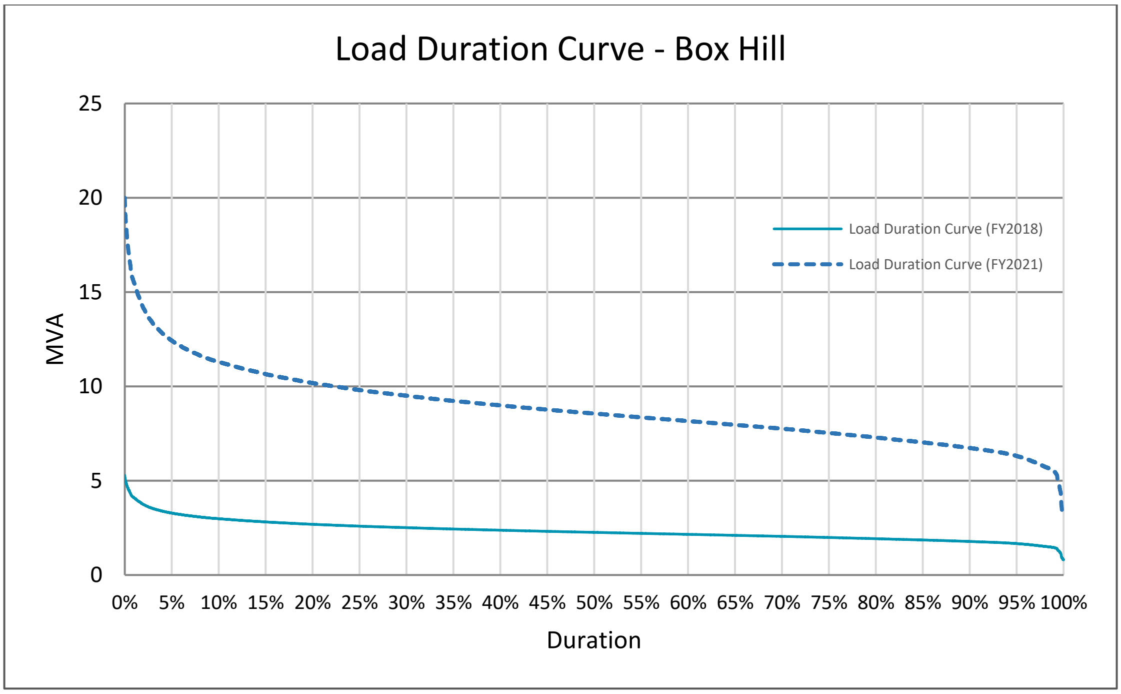


Figure 5: Box Hill Development Area 22kV Feeder Load - Winter Peak Profile 16th July 2018



Due to the initial low level of load and capacity compared with the forecast load increase, the energy at risk value under the load duration curve can increase quickly. Similarly, the duration when capacity is exceeded also increases quickly, as demonstrated by the dotted line in Figure 6.

Figure 6: Load Duration Curve - Box Hill Development Area 22kV Feeders



6.1.3 Plant failure rates

As this project involves, as the base case, utilisation of existing distribution capacity to facilitate new customer connections from the closest points of supply, the most significant risk in the base case is the failure of the feeders supplying the area. There is limited backup capacity in the region to service the current loads, and any further connections will be subject to the risk of extended outages in the event of failure of the feeders supplying the area. However, this is not a dominant issue in expected unserved energy as the underlying problem is the lack of capacity that is required to connect new loads to the network. The distribution failure rate is shown in Table 6.

Table 6: Distribution Feeder Failure Rates

Major Plant Item: Distribution Feeder	
Distribution Feeder Failure Rate	7 failures per 100km of line per annum
Duration of outage	4 hours

6.1.4 Plant Ratings

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

6.1.5 Value of customer reliability

The value of unserved energy is calculated using the value of customer reliability (VCR). This represents an estimate of the value electricity consumers place on a reliable electricity supply. Endeavour Energy used a VCR of $32.14 per kWh in the evaluation which is based on the 2019 VCR values provided by the AER, weighted in accordance with the composition of the commercial, industrial and residential load within the Box Hill development area. The VCR values are shown in Table 7 below.

Table 7: Value of customer reliability

Load Type	22kV Supply to Box Hill Development Area	VCR ($ per kWh)
Residential	80%	$25.85
Commercial	10%	$44.52
Industrial	10%	$63.79

6.2 Classes of market benefit considered

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

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

One class of market benefits that are considered material but have not been quantified in this RIT-D assessment is:

- Option value

6.2.1 Changes in involuntary load shedding

Increasing the supply capability in the Box Hill development supply area increases the supply available to meet the growth in demand within these areas. This will provide greater reliability for this region by reducing potential supply interruptions and consequent risk of involuntary load shedding. The present rules only allow for consideration of changes in involuntary load shedding for connected customers. The establishment of supply in a greenfield residential development area where potential customers would otherwise have to go without supply is therefore captured using changes in involuntary load shedding.

6.2.2 Differences in timing of expenditure

A fundamental difference between the two groups of options considered is whether to build the zone substation in full configuration upfront or to implement the first stage of works first and wait for the capacity provided by these works to be exhausted before a second stage is planned to be brought online.

The NPV calculation intrinsically considers the savings from deferring the second stage of the zone substation.

6.2.3 Option Value

Endeavour Energy notes that the AER's view is that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the RIT-D proponent are sufficiently flexible to respond to that change.

Endeavour Energy also notes the AER's view that appropriate identification of the credible option and reasonable scenarios captures any option value as a class of market benefit under the RIT-D.

Endeavour Energy considers that the estimation of any option value benefits captured via the scenario analysis and comparison of the credible option under those scenarios is adequate to meet NER requirements to consider option value as a class of market benefit.

A qualitative assessment has indicated that Option 1 will provide option value benefits, as this option is based on installing the second transformer at a later stage. As option 1 (Staged implementation) is the lowest cost option and is already ranked highest in terms of NPV of the two options considered, Endeavour Energy does not propose to carry out further option value analysis.

6.3 Classes of market benefit not considered to be material

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

- Changes in voluntary load curtailment;
- Changes in load transfer capacity and the capacity of embedded generators to take up load;
- Changes in costs to other parties; and
- Changes in electrical energy losses.

6.3.1 Changes in voluntary load curtailment

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

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

6.3.2 Changes in load transfer capability

The surrounding areas of Box Hill are supplied by 11kV network from adjacent zone substations (Cattai ZS, Windsor ZS, South Windsor ZS, Riverstone ZS, Schofields ZS, Kellyville ZS and Kenthurst ZS).

The three feeders from Mungerie Park ZS supplying the Box Hill Development Area uses 22kV reticulation voltage. Parklea ZS supplies a 22kV catchment area much further south of the Mungerie Park ZS catchment area However, Parklea ZS has a capacity constraint and is already configured to transfer load to Mungerie Park ZS when required. Therefore, it is not possible to transfer loads from the three 22kV feeders from Mungerie Park to Parklea ZS.

An 11kV feeder from Riverstone ZS supplies a small part of the Box Hill Development Area. There are two zone substations with 11kV feeder ties to Riverstone ZS. However, these 11kV feeders have limited spare capacity. Also, due to its rural overhead construction and distance from Box Hill load centre, offloading to these feeders will result in voltage regulation issues. Hence, load transfer cannot be considered as an option.

6.3.3 Changes in costs to other parties

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

6.3.4 Changes in electrical losses

Endeavour Energy recognises that there would be small changes in the loss profile for customers serviced out via the options considered. As the majority of the customers to be connected will be general customers (rather than site specific customers), the impact of the small change in loss profile for these customers is unlikely to have a significant impact on the network wide distribution loss factors which would be applicable to these and other customers. Hence changes in electrical losses have not been modelled.

6.4 Option costs

The capital cost assumptions for each credible option, based on standard planning estimates, are summarised in Table 8.

Table 8: Option Costs

Option	Initial Capital Cost ($M)	Future Capital Costs ($M)	Year of future costs	Estimated Permanent ZS Deferral
Baseline Risk	0	0	N/A	N/A
Option 1 – Staged implementation of 132/22kV zone substation	24.4	20.4	FY29	N/A
Option 2 – Complete implementation of 132/22kV zone substation	44.1	0	N/A	N/A

6.5 Scenarios and sensitivities

The capital and operating cost assumptions for each credible option are summarised in Table 9.

Table 9: Capital and Operating Cost Assumptions

Variables	Values
Maximum demand forecasts	Base (expected) growth scenario presented in section 8.2
Capital costs	Base estimates provided in Table 8.
O&M costs	0.4% of capital spend unless otherwise stated.
Value of customer reliability	Base estimates provided in section 6.5.3

6.5.1 Demand forecasts

The maximum demand forecasts have been derived from a projection of the take up of residential lots released by developers. Notionally, this is on a 50% probability of exceedance basis. For sensitivity analysis, this base forecast has been varied by ± 10%.

6.5.2 Capital costs

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

6.5.3 Value of customer reliability

This analysis adopts the value of customer reliability values published by AER to calculate the expected unserved energy. The ratio of load types has been estimated and used to calculate the weighted aggregate VCR value and then applied to the energy at risk. Based on the estimated load composition of the subject area, a volume weighted VCR value of $32.141 per kWh has been derived and used in the RIT-D analysis. A variation of ±30% has been used for sensitivity testing in accordance with AER guidelines.

6.5.4 Discount Rate

The discount rate used in the financial analysis will impact the estimated present value of net market benefits and may affect the ranking of credible options. Endeavour Energy has employed a real, pre-tax discount rate as a central and low value. For sensitivity analysis, a higher bound discount rate of +1% of the central value was applied.

6.5.5 Summary of sensitivities

The Table 10 below describes the variations in input parameters used for the purpose of defining various scenarios.

Table 10: Variables for Sensitivity Testing

Variable for Sensitivity Testing	Lower Bound	Base Case	Upper Bound
Maximum Demand	Low (Base estimates -10%)	Base estimates	High (Base estimates +10%)
Capital expenditure	Low (Base estimates -25%)	Base estimates	High (Base estimates +25%)
Value of Customer Reliability	Low (Base estimates -30%)	Base estimates	High (Base estimates +30%)
Discount Rate	Low (Base estimates)	Base estimates	High (Base estimates +1%)

7. Results of analysis

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

7.1 Base case results

The economic analysis of the options under the base case scenario is shown in Table 11.

Table 11: Base case results

Option	Description	Project Cost ($m)[1]	PV of Market Benefits ($m)	PV of Costs ($m)[2]	NPV ($m)	Rank
1	Staged implementation of 132/22kV zone substation	44.8	141.8	31.4	110.4	1
2	Complete implementation of 132/22kV zone substation	44.1	142.2	35.6	106.6	2

Note 1: Project cost includes costs for later stages

7.2 Sensitivity and scenario assessment

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

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

Detailed in Figure 7 are the scenarios used in sensitivity testing and their relative weightings.

Figure 7: Scenarios used in sensitivity testing

User Interface

Scenarios	
Scenario selection	
Scenario	Scenario 1

Scenario weighting	Scenario 1	Scenario 2	Scenario 3
Weighting	0.50	0.25	0.25

General inputs							
General	**Unit**	**Value**	**Selection**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**User defined**
Commercial discount rate	Percent		Central	Central	High	Low	Central

Cost inputs							
Cost	**Unit**	**Value**	**Selection**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**User defined**
Capital cost	Percent	100%	Central	Central	High	Low	Central
Planned routine maintenance and refurbishment	Percent	100%	Central	Central	Low	High	Central
Unplanned corrective maintenance	Percent	100%	Central	Central	Low	High	Central
Decommissioning costs	Percent	100%	Central	Central	Central	Central	Central
Non-network option provider costs	Percent	100%	Central	Central	High	Low	Central

Benefit inputs

Avoided 'risk cost' benefits	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Reliability and security risk costs	Scenario	NA	Central	Central	Low	High	Central
Safety and health risk costs	Scenario	NA	Central	Central	Low	High	Central
Environmental risk costs	Scenario	NA	Central	Central	Low	High	Central
Legal/regulatory compliance risk costs	Scenario	NA	Central	Central	Low	High	Central
Financial risk costs	Scenario	NA	Central	Central	Low	High	Central

Market benefits	Unit	Value	Selection	Scenario 1	Scenario 2	Scenario 3	User defined
Involuntary load shedding - VCR	$/MWh	32,141	Central	Central	Low	High	Central
Involuntary load shedding - MWh	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Scenario	NA	Central	Central	Low	High	Central
Difference in timing of unrelated expenditure	Percent	100%	Central	Central	Low	High	Central
Voluntary load curtailment - VCR	$/MWh	32,141	Central	Central	Low	High	Central
Voluntary load curtailment - MWh	Scenario	NA	Central	Central	Low	High	Central
Costs for non RIT-D proponent parties	Percent	100%	Central	Central	Central	Central	Central
Electricity energy losses	$/MWh	100	Central	Central	Central	Central	Central
Change in load transfer capacity and the capacity for embedded generators to take up l	Percent	100%	Central	Central	Central	Central	Central
Other classes of market benefits	Percent	100%	Central	Central	Central	Central	Central

Detailed in Table 12 are the results of the sensitivity analysis.

Table 12 - Sensitivity and Scenario Assessment

Option	Description	Scenario 1 Rank	Scenario 2 Rank	Scenario 3 Rank	Weighted Scenario Rank
1	Staged implementation of 132/22kV zone substation	1	1	2	1
2	Complete implementation of 132/22kV zone substation	2	2	1	2

The results show that Option 1 (Staged implementation of 132/22kV zone substation) maximises the net market benefit in the base case as well as the weighted scenarios considered for sensitivity analysis.

7.3 Economic timing

The economic timing of the selected option may be taken to be the point when the cost of lost load (or VCR benefits that can be attributed to the project) exceeds the annualised cost of the selected option. Also, it may be the point where network capacity is insufficient to connect new customers.

The Box Hill development area requires connection capacity to be made available as soon as the existing available capacity in the network is exhausted. Based on current demand forecast, this is expected to occur in FY23. Consequently, this date is seen as the economic timing for this project.

8. Appendix - Network need

8.1 Existing Network Overview

The Box Hill and Box Hill Industrial precincts are part of the NSW Government's North West Priority Growth Area. Box Hill previously had a rural zoning with large landholdings, making it a greenfield site in terms of urban development. Box Hill was subject to an approved rezoning to urban development in April 2013. The two precincts combined will deliver approximately 10,000 new homes with employment lands and a new town centre.

At a similar time, a developer had a large parcel of land at Box Hill North. This land is adjacent to, but outside of, the boundary of the North West Priority Growth Centre. This land was also approved for urban development under the Precinct Acceleration Protocol. The Box Hill North developer will deliver approximately 4000 new homes with a new town centre.

The Box Hill Development Area which is comprised of Box Hill, Box Hill Industrial and Box Hill North precincts, will altogether deliver 14,000 new homes, two town centres and village centres, 133 hectares of employment land, 58 hectares of recreational and environmental space and new primary and high schools. Development has already commenced in Box Hill and Box Hill North with new home owners starting to occupy the new residential subdivisions. Figure 8 below shows the boundary of the entire Box Hill development area.

Figure 8: Box Hill Development Area

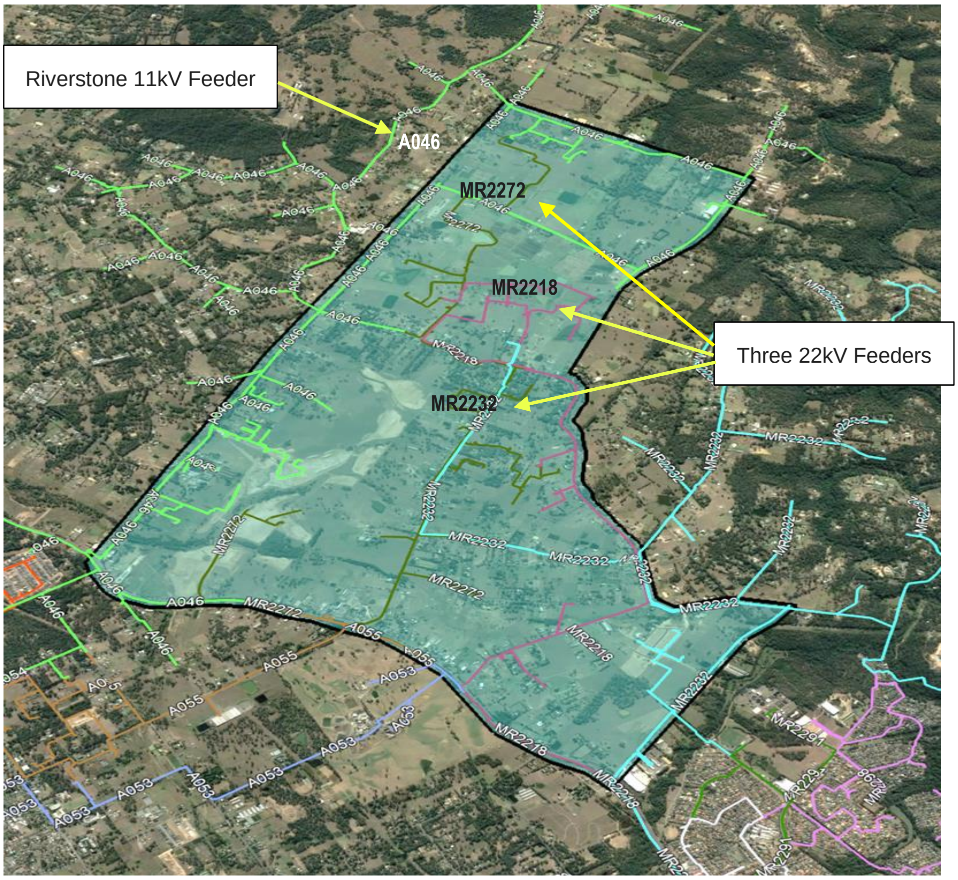
Originally, the Box Hill Development Area was supplied by three 11kV overhead feeders from Riverstone ZS. These feeders were built to a rural standard and previous analysis indicated that although there was capacity available in the 11kV distribution network, the addition of load from the development area would produce excessive voltage drops greater than 6% resulting in voltage delivered to customers below the levels stipulated in AS/NSZ 61000. A zone substation was originally proposed to be constructed in the area by 2016. A RIT-D consultation process carried out in 2016 determined that the extension of distribution feeders into the area to defer the construction of the zone substation delivered the highest net market benefits.

Due to the limitations in the Riverstone ZS and the proximity of Mungerie Park ZS to the development area, two new 22kV feeders from Mungerie Park ZS were constructed in 2017 as part of the first stage of establishing supply in the area. Mungerie Park ZS is situated at a similar distance from Box Hill Development Area as Riverstone ZS but has a reticulation voltage of 22kV. Mungerie Park ZS also at that time had capacity available to supply the area.

Another 22kV feeder from Mungerie Park ZS currently supplies the built areas of Annangrove, Nelson and a small part of Rouse Hill at 11kV via a 22/11kV auto transformer. In 2018, an extension of this feeder was constructed through developer funding. The extension of the existing feeder now supplies the development area at 22kV.

In addition to the three 22kV feeders from Mungerie Park ZS, small areas of Box Hill are supplied from one 11kV feeder from Riverstone ZS. The three 22kV feeders and one 11kV feeder are shown in Figure 9 below.

Figure 9: Feeders Supplying Box Hill Development Area



8.2 Load forecast

The demand forecast for the Box Hill development area as shown in Table 13 is based on lot release information from the developer and the Department of Planning, Industry and Environment for the North West Priority Growth Area.

The demand forecast table includes the Box Hill development area and the existing areas of Annangrove, Nelson and a small part of Rouse Hill which are supplied by one of the 22kV distribution feeder from Mungerie Park ZS. Endeavour Energy has already received and agreed to firm subdivision connection applications for over 5,000 homes and apartments which will exceed existing capacity when fully developed. The forecast table below shows that there is load at risk from FY23.

Table 13: Demand Forecast for Box Hill Development Area

	Actual (MVA)			Forecast (MVA)						
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Residential Demand	2.0	3.4	9.0	16.0	20.2	24.4	28.6	31.6	33.8	36.0
Commercial / Industrial Demand	0.0	0.0	0.0	0.0	0.0	1.0	2.0	3.0	4.0	5.0
Total Demand Box Hill Development Area	2.0	3.4	9.0	16.0	20.2	25.4	30.6	34.6	37.8	41.0
Existing Area Demand[1]	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Total Demand	6.0	7.4	13.0	20.0	24.2	29.4	34.6	38.6	41.8	45.0
Capacity (22kV Feeders)	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0	27.0
Load at Risk	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.4**	**7.6**	**11.6**	**14.8**	**18.0**

Note 1: Refer to Table 2 for the actual load from the existing area supplied by Feeder MR2232.

8.3 Network Limitation

The distribution network is designed, constructed and augmented in accordance with probabilistic planning principles in line with general industry practice. Taken into consideration are the conditions driving network augmentation and construction. Endeavour Energy analyses constraints resulting from the capacity limitations by determining the load at risk and the expected unserved energy over the 10-year forecast period. The trigger for network investment is based on a cost benefit analysis and comparing the annualised cost of the selected network option with the market benefits.

Section 3 describes the network limitation on the distribution network. There is also an emerging network limitation at Mungerie Park ZS and capacity at the ZS is forecast to be constrained beyond 2021. Table 14 shows the demand forecast for Mungerie Park ZS and the load at risk.

Table 14: Mungerie Park ZS Demand Forecast

Year	Actual			Forecast (MVA)									
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
50% POE	50.5	57.4	74.7	80.8	98.2	106.1	103.7	107.6	110.9	113.8	116.0	117.6	118.8
10% POE	57.1	64.5	84.5	90.6	108.0	115.9	113.5	117.4	120.8	123.6	125.8	127.4	128.6
Firm Capacity	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Load at Risk[1]	0.0	0.0	0.0	0.0	8.2	16.1	13.7	17.6	20.9	23.8	26.0	27.6	28.8

Note 1: Based on 50% Probability of Exceedance (POE)

8.4 Load transfer and backup capacity

The surrounding areas of Box Hill are supplied by 11kV network from adjacent zone substations (Cattai ZS, Windsor ZS, South Windsor ZS, Riverstone ZS, Schofields ZS, Kellyville ZS and Kenthurst ZS).

The three feeders from Mungerie Park ZS supplying the development area use 22kV reticulation voltage. Parklea ZS supplies a 22kV catchment area much further south of Mungerie Park ZS catchment area However, Parklea ZS has a capacity constraint and is already configured to transfer load to Mungerie Park ZS when required. Therefore, it is not possible to transfer loads from the three 22kV feeders from Mungerie Park ZS to Parklea ZS.

As previously mentioned, the 11kV feeder from Riverstone ZS supplies a small part of Box Hill development area. There are two zone substations with 11kV feeder ties to Riverstone ZS as shown in Table 15. However, these 11kV feeders have limited spare capacity and due to its rural overhead construction and distance from Box Hill load centre, offloading to these feeders will result in voltage regulation issues.

Table 15: 11kV Backup Network Capacity

Load Transfer	Load (MVA)	Spare Capacity (MVA)	Voltage Regulation	Comments
From Feeder A046 (Riverstone ZS) to Feeder CX1206 (Cattai ZS)	3.8	0.7	6%	12 km from Box Hill load centre
From Feeder A046 (Riverstone ZS) to Feeder WD1225 (Windsor ZS)	4.1	0.4	4%	10 km from Box Hill load centre

Note: Voltage regulation limits for 11kV (rural) network is 6%

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