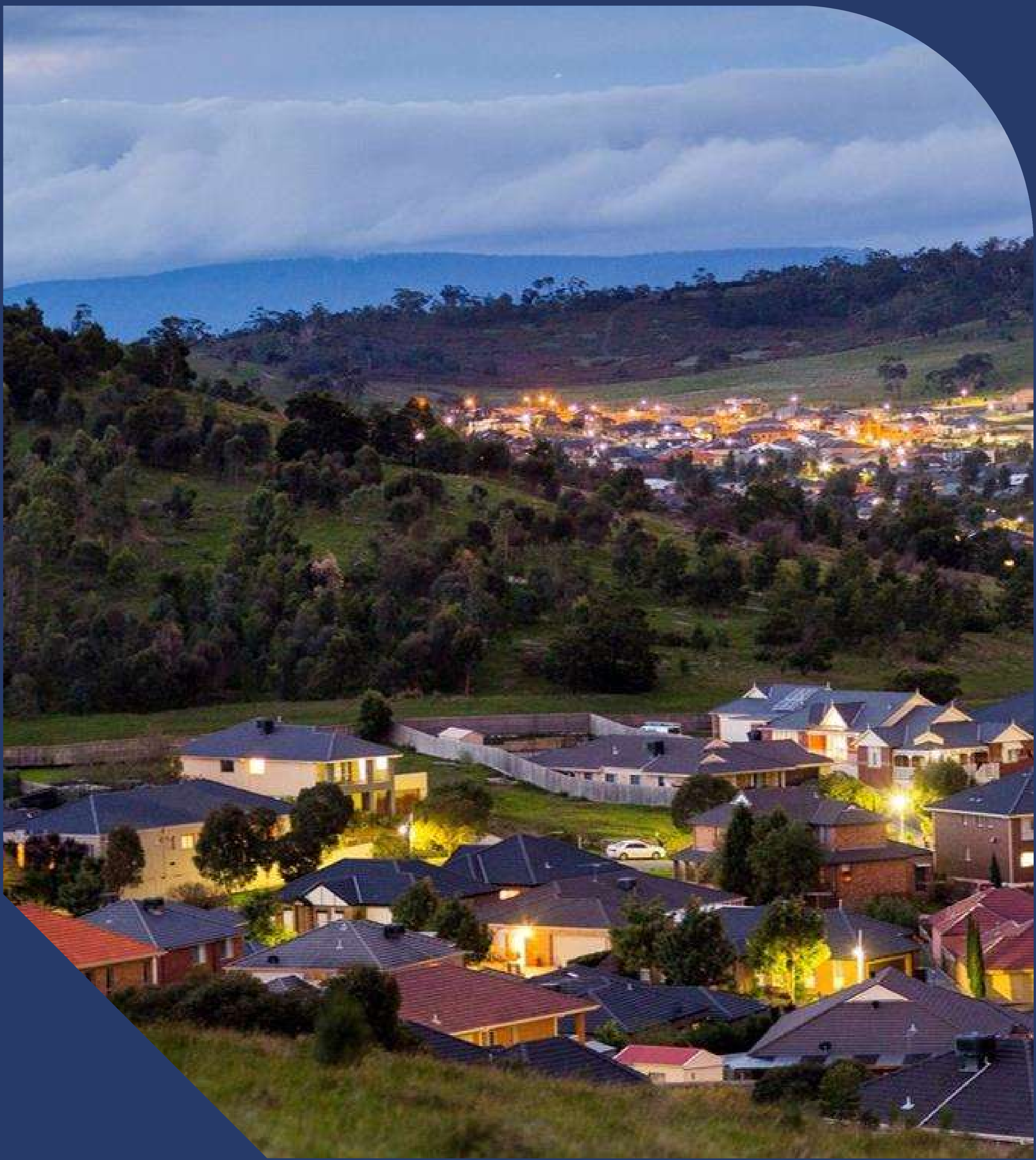
AusNet

# Electricity Distribution Price Review (EDPR 2026-31)

## Business case: Supply Security of Pakenham South

Date: 31 January 2025



# Table of contents

# Executive summary

AusNet Services is a regulated Victorian Distribution Network Service Provider (DNSP) that supplies electricity distribution services to more than 800,000 customers. Our electricity distribution network covers eastern and north-eastern Victoria and Melbourne's north and east.

As expected by our customers and required by the various regulatory instruments that we operate under, AusNet aims to maintain service levels at the lowest possible cost to our customers. To achieve this, we assess the requirements, identify emerging constraints, evaluate options to mitigate constraints and develop plans that aim to maximise the present value of net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (NEM).

AusNet uses a probabilistic approach to network planning. This approach considers the probabilities of a wide range of contingencies occurring (e.g., transformer failure rates), with probabilities assigned to a range of possible operating conditions, including demand levels and network topologies. This approach allows AusNet to delay or bring forward augmentation projects to achieve optimal timing and the optimal level of electricity supply and security.

Ausnet has developed this business case to demonstrate the need for investment in the Pakenham South area to maintain a reliable supply of existing customers and enable connection services to new customers throughout the assessment period.

## Identified need

State planning guidelines within the 'Victoria in Future' publication have forecast significant future industrial development in the Officer and Pakenham areas. There are 1,313 hectares of available industrial land supply of which 381 hectares, or 29% are zoned and occupied, 375 hectares, or 28,6% are zoned and vacant, and there is an additional 938 hectares of future supply that may ultimately be utilised[1].

The population projection[2] for the relevant local government area of Cardinia (which encompasses Pakenham South) has a growth rate 2.9% per annum on a base of approximately 123,580 people in 2023. As there are approximately 2.5 persons per household in Victoria, it therefore follows that there are approximately 49,400 households in Cardinia. The expected growth in households in the Cardinia area is thus approximately 1,400 per year.

By 2031 it is projected that approximately 128,000 additional jobs will be added to the Southern Region of Victoria. Over half of the new jobs in the region are expected to be within the growth area municipalities of Casey and Cardinia. The industries that are expected to experience the strongest growth are: health care and social assistance; retail trade; manufacturing; construction; education and training.

AusNet has already received several industrial/commercial customer connection applications in the Pakenham South area, including two large business parks, resulting in a 30MVA additional load added to AusNet's network. All these loads are expected to be fully operational by 2029.

Table 1 below shows the forecast maximum demand for the four existing zone substations in the Cardinia area (Clyde North, Officer, Pakenham, and Lang Lang). The table also shows the Rating (for the N-1 condition), which is the cyclic rating of the zone substation with one transformer out of service, accounting for the capacity that can be transferred to adjacent substations via the medium voltage network. We note that the Lang Lang zone substation has a single transformer, resulting in an N rating only. This increases the risk of expected unserved energy in the event of the transformer being out of service.

Across the whole assessment period, Expected Unserved Energy (EUE) and Value of Expected Unserved Energy are forecast to be 452,371 MWh and $6,044 million respectively.

[1] victoria-in-future-2019.pdf (planning.vic.gov.au)
[2] victoria-in-future-2019.pdf (planning.vic.gov.au)

**Table 1: Maximum demand as at FY31**

| Substation | Forecast Maximum demand (10 PoE) [MVA] | Forecast Maximum demand (50 PoE) [MVA] | Rating (N-1) [MVA] | Rating (N) [MVA] | Expected Unserved Energy (MWh) | Undiscounted Value of Expected Unserved Energy ($M) |
|---|---|---|---|---|---|---|
| Clyde North | 138 | 118 | 44 | 87 | 1,204.0 | 41 |
| Officer | 90 | 79 | 49 | 96 | 3.0 | 0.1 |
| Pakenham | 75 | 71 | 44 | 93 | 0 | 0 |
| Lang Lang | 28 | 25 | - | 47 | 165 | 7 |
| Total | | | | | 1,372 | 48 |

*Source: AusNet*

The maximum demand forecast has been weighted using the industry practice[3] of applying a 30% contribution from the 10PoE (probability of exceedance) forecast and a 70% contribution from the 50PoE forecast. POE is the likelihood that a maximum or minimum demand forecast will be met or exceeded. A 10% POE maximum demand forecast, for example, is expected to be exceeded, on average, one year in 10, while a 50% POE maximum demand forecast is expected to be exceeded once every two years.

## Options considered

The following options were considered to address the identified need:

- **Do nothing (Base Case):** Under a Do-Nothing approach, it is assumed that the present network configurations are maintained without change over the full assessment period.
- **Build a second transformer at Lang Lang (Option 1):** This option involves building a second transformer at Lang Lang to allow for N-1 rating and additional 22kV feeders to supply new customers from the Pakenham South area.
- **Build a new zone substation at Pakenham South (Option 2)**: This option involves augmenting the network by installing a new 2x33MVA 66/22kV zone substation in the Pakenham South area. This option relieves the loading at surrounding zone substations to reduce expected unserved energy and ensures there is sufficient capacity in the Pakenham South area to address forecast demand over the 30-year assessment period.

Based on our comprehensive analysis, the preferred option is to construct a new zone substation at Pakenham South (Option 2). This option provides a higher NPV compared to the alternative options.

**Table 2: Options summary ($m, FY24 dollars)**

| Options | FY27 to FY31 (undiscounted) | | | Full assessment period FY24 to FY53 (discounted) | | | Comments |
|---|---|---|---|---|---|---|---|
| | Capex | Opex | Total cost | Total cost | Total benefits | NPV | |
| Do nothing | - | - | - | - | - | - | - |
| Option 1 – Second Transformer at Lang Lang | 22.1 | 0.7 | 22.7 | 23.0 | 285.8 | 262.8 | Substantially lower benefits compared to Option 2. |
| **Option 2 – New Zone Substation at Pakenham South** | **49.2** | **1.0** | **50.2** | **52.8** | **5,903.7** | **5,851.0** | **This is the preferred option as it maximises the NPV and addresses most of the EUE risk compared to the do-nothing option.** |

*Source: AusNet analysis, compared to do nothing.*

[3] victorian-electricity-planning-approach.pdf (aemo.com.au)

# 1. Introduction

## 1.1. Purpose and scope

This report outlines the existing and emerging constraints to supplying electricity to the local government area of Cardinia which is forecasted to have significant industrial and commercial growth over the coming years. In line with this need, we assessed options, to identify the preferred solution that maximises the present value of net economic benefit to address the identified need in the area.

The scope of this report is limited to the following existing zone substations currently supplying the study area:

- Clyde North Zone Substation (CLN ZSS);
- Officer Zone Substation (OFR ZSS);
- Pakenham Zone Substation (PHM ZSS); and
- Lang Lang Zone Substation (LLG ZSS).

## 1.2. Background

The Pakenham South area is located between Officer and Cardinia to the south of the Princess Highway. The population projection[4] for the relevant local government area of Cardinia is a growth rate 2.9% per annum on a base of approximately 123,580 people in 2023. As there are approximately 2.5 persons per household in Victoria, it therefore follows that there are approximately 49,400 households in Cardinia. The expected growth in households in the Cardinia area is thus approximately 1,400 per year.

By 2031, it is projected that approximately 128,000 additional jobs will be added to the Southern Region of Victoria[5]. Over half of the new jobs in the region are expected to be within the growth area municipalities of Casey and Cardinia. The industries that are expected to experience the strongest growth are: health care and social assistance; retail trade; manufacturing; construction; education and training.

AusNet has already received several industrial/commercial customer connection applications in the Pakenham South area, including two large business parks, resulting in a 30MVA additional load added to AusNet's network. All these loads are expected to be fully operational by 2029.

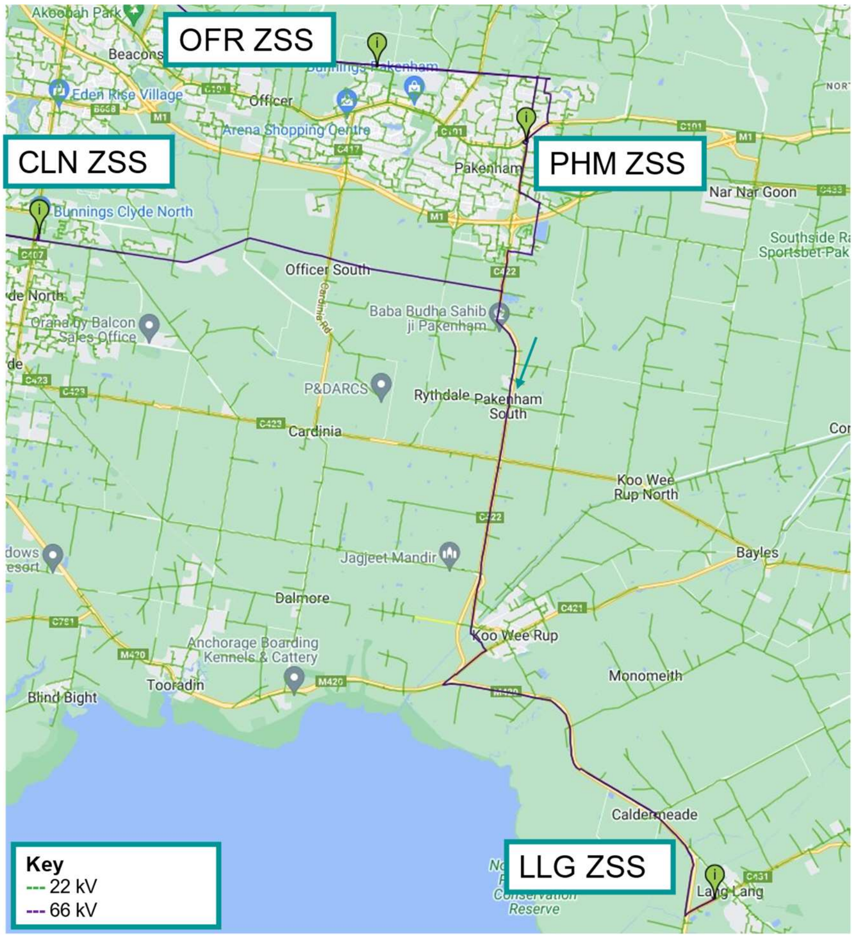
The area to the south of the Princess Highway where Pakenham South is located is largely zoned as industrial[6] and some development has commenced in the area. There are presently 1,313 hectares[7] of available industrial land supply of which 381 hectares are zoned and occupied, 375 hectares are zoned and vacant, and there is an additional 938 hectares of future supply that may ultimately be utilised. The Officer-Pakenham state-significant industrial precinct (or the Officer-Pakenham SSIP) is the largest area of industrial land in Cardinia. It is located adjacent to the Princess Highway and extends south to the edge of the Urban Growth Boundary (UGB) where development has started at the eastern most part of the SSIP near Pakenham. Most of the remaining land is currently not zoned for industrial purposes and is required to undergo a Precinct Structure Planning (PSP) process before it can be utilised.

The area surrounding Pakenham South along with existing distribution feeder infrastructure is shown in Figure 1 below.

---

[4] victoria-in-future-2019.pdf (planning.vic.gov.au)
[5] victoria-in-future-2019.pdf (planning.vic.gov.au)
[6] Mapping the urban development program (planning.vic.gov.au) – Urban Development Program Map
[7] Melbourne industrial and commercial land use plan (planning.vic.gov.au)

**Figure 1 – Pakenham South Area**



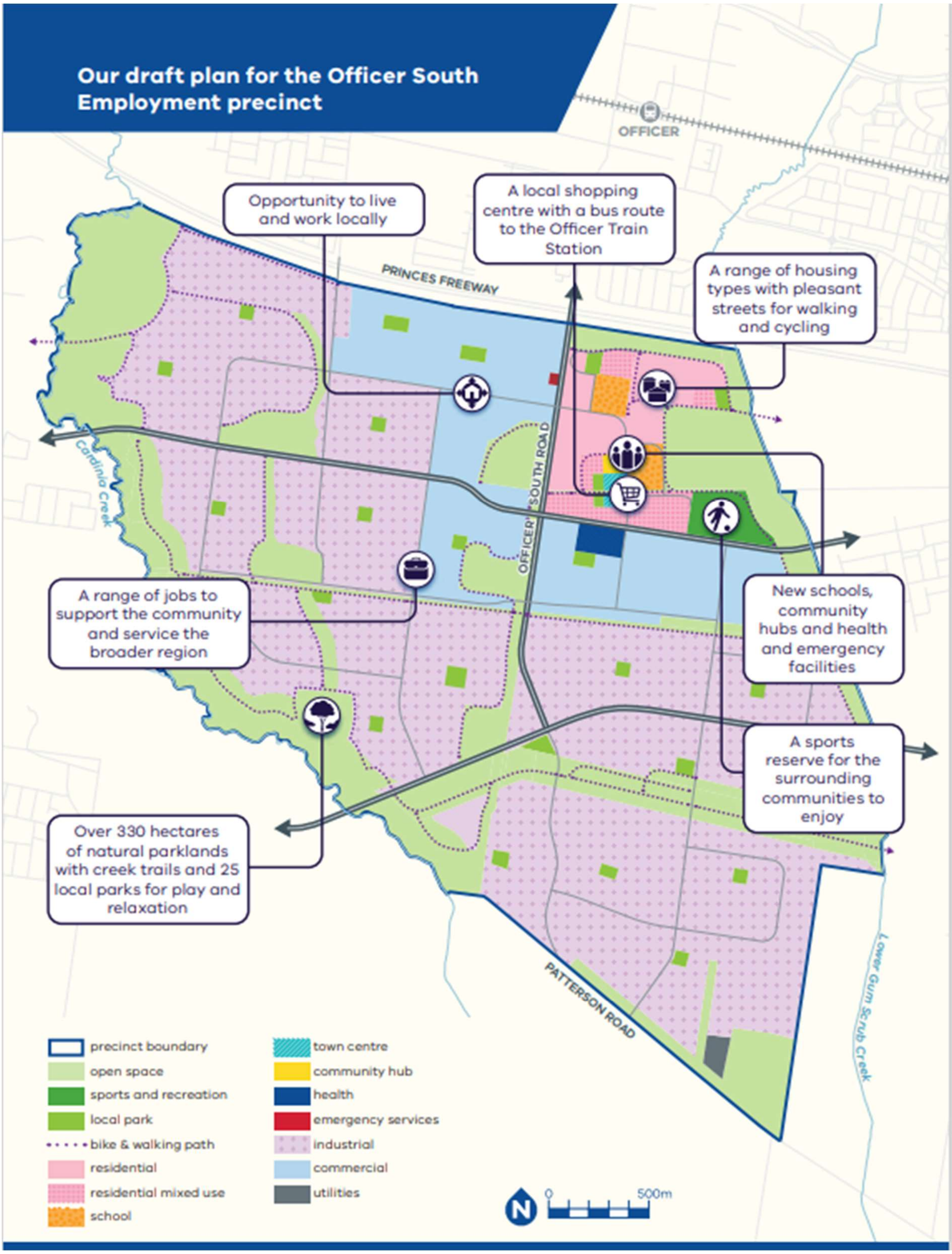

Zone substations that presently surround this area are Clyde North (CLN), Officer (OFR), Pakenham (PHM) and Lang Lang (LLG). Details of the size and capacity of each of these surrounding substations are provided in Table 3.

**Table 3 - Surrounding Substations**

| Substation | Transformer Capacity | N-1 rating (MVA) | Growth Rate | 2022 Load (MVA) | 2031 Load (MVA) |
|---|---|---|---|---|---|
| **Clyde North** | 3x33MVA | 43.5 | 3.68% | 73 | 121.1 |
| **Officer** | 2x33MVA | 48.6 | 2.37% | 51.9 | 72.0 |
| **Pakenham** | 2x33MVA | 43.9 | 0.86% | 49.5 | 55.8 |
| **Lang Lang** | 1x33MVA | 0 | 1.77% | 22.3 | 28.5 |

The zoning for Pakenham South and surrounding areas by the Victorian State Government is provided in Figure 2 below. This shows that the planned industrial zones are at the early stages of development and that there is a large area of additional land (not presently zoned) that will ultimately be available for future development.

**Figure 2 - Zoning of Officer South and surrounding areas**




Source: [Office-South-Employment-PSP-Fact-Sheet-September-2023.pdf (vpa-web.s3.amazonaws.com)]

# 1.3. Good Electricity Industry practice

The National Electricity Rules (NER) define 'Good Electricity Industry Practice' as shown below.

> *The exercise of that degree of skill, diligence, prudence and foresight that reasonably would be expected from a significant proportion of operators of facilities forming part of the power system for the generation, transmission or supply of electricity under conditions comparable to those applicable to the relevant facility consistent with applicable regulatory instruments, reliability, safety and environmental protection. The determination of comparable conditions is to take into account factors such as the relative size, duty, age and technological status of the relevant facility and the applicable regulatory instruments*[8]*.*

In the context of strategic investment options evaluation for the Cardinia area, good industry practice is interpreted as investment in the augmentation of the network to maintain the reliability of electricity supply to customers in the Cardinia supply area at an acceptable level amidst increasing risk of unserved energy.

Failure to provide appropriate mitigation to manage the risk of unserved energy will lead to increased supply interruptions, escalation in interruption durations, growing numbers of customers impacted, and potential asset failures as forecast demand reaches and exceeds the N-1 and N ratings of the substation assets.

[8] National Electricity Rules, Chapter 10, Version 18

# 2. Identified need

Under a do-nothing approach, maximum demand is forecast to exceed the ratings for the zone substations in the Cardinia area, resulting in **1,372 MWh** of EUE in 2031 and **20,581 MWh** of EUE in 2056. Additionally, existing 22kV feeders supplying the area are already thermally constrained, resulting in an inability to provide connection services to new customers. This shortfall translates to a cost of $6,044.3 million to our customers over the 30-year assessment period. These substantial figures underscore the need for investment to mitigate this risk and ensure reliable supply for our customers.

The following sections provide a detailed breakdown of the calculations that underpins the projected unserved energy costs:

- **Forecast Maximum Demand, Network Capacity, and Load Duration Curves (LDC):** We have provided a discussion of our forecast maximum demand, network capacity, and load duration curves (LDC) that has been used to derive the cost to customers. Detailed assumptions underpinning our demand forecasts, value of forecast maximum demand, and LDC are provided in the Demand Forecasting Methodology document.
- **Comparison of Forecast Maximum Demands Against Existing Capacities:** We have compared forecast maximum demands against existing zone substation and distribution network capacities to determine the expected unserved energy (EUE) under a do-nothing approach.
- **Calculation of EUE Value:** We have calculated the value of expected unserved energy over each year of the study period (FY24 to FY53 inclusive). This calculation considers:
  - 10 PoE maximum demand forecast at each zone substation
  - 50 PoE maximum demand forecast at each zone substation
  - Forecast load duration curves
  - Substation ratings (N and N-1)
  - Load transfer capacity between substations
  - Transformer unavailability data
  - Value of Customer Reliability

## 2.1. Zone substation capacity

AusNet employs a probabilistic approach to network planning. This method acknowledges that there may be instances where some load cannot be supplied, or some generation must be curtailed if a network element is out of service (thus not meeting the N-1 criterion). However, the value of the energy not supplied is often too low to justify further investment, given the likelihood of a forced outage of that specific network element. Consequently, this approach can defer network augmentation until it becomes necessary[9].

The figures in Appendix A show the maximum demand forecasts and supply capacities for the Clyde North, Officer, Pakenham, and Lang Lang zone substations. The supply capacity at a zone substation is measured by its rating. There are two types of ratings:

- **Rating (N)** is the cyclic rating of the zone substation with all transformers in service.
- **Rating (N-1)** is the cyclic rating of the zone substation with one transformer out of service.

Our analysis shows that:

- for the **Clyde North Zone Substation**, 50% PoE demand will exceed the summer N-1 in 2026.
- for the **Officer Zone Substation**, 50% PoE demand has already exceeded the summer N-1 rating.
- for the **Pakenham Zone Substation**, the 50% PoE demand has already exceeded the summer N-1 rating.
- for the **Lang Lang Zone Substation**, the N-1 cyclic rating is zero because it is a single transformer substation. Therefore, a failure at Lang Lang substation resulting in the loss of the transformer will result in significant energy at risk.

[9] AusNet, Distribution Annual Planning Report 2023-2027

# 2.2. Feeder capacity

## 2.2.1. Overall feeder capacity

Although the overall demand forecast in the Cardinia study area is not expected to exceed the combined capacity of the distribution feeders by 2031, there is a material shortfall in feeder capacity at the individual substation level, particularly with the Clyde North feeders, as shown in Table 4.

**Table 4: Total load and rated capacity at each zone substation in the** Cardinia **region by 2031**

| | Total load on all feeders by 2031 (MVA) | Total rated capacity of all feeders (MVA) | Total spare capacity of all feeders (MVA) |
|---|---|---|---|
| CLN | 137 | 106 | -31 |
| OFR | 44 | 80 | 36 |
| PHM | 77 | 98 | 21 |
| LLG | 28 | 55 | 27 |
| Total | **286** | **339** | **53** |

## 2.2.2. Clyde North

The forecast demand at Clyde North substation is projected to exceed its feeder capacity by 2031, as shown in Table 4. The RIT-D, "Service Constraints at Clyde North Zone Substation"[10] proposes addressing this feeder demand constraint by installing an additional 22kV switchboard at Clyde North, along with a proposed third transformer, to be completed in 2025[11]. This 22kV switchboard installation will provide the necessary flexibility in the network to address forecast demand requirements.

## 2.2.3. Lang Lang

As noted in Section 2.1, Lang Lang is a single transformer substation with an N-1 cyclic rating of zero. This necessitates load transfers from Lang Lang feeders to adjacent feeders in the event of a transformer failure. However, our analysis indicates that the adjacent feeders have limited capacity to accommodate this load. The zone substations adjacent to Lang Lang substation are:

- Cranbourne (CRE)
- Clyde North (CLN)
- Leongatha (LGA)
- Officer (OFR)
- Pakenham (PHM)
- Wonthaggi (WGI)
- Warragul (WGL)

Table 5 details the zone substation capacity and the transfer capacity of feeders adjacent to each Lang Lang feeder. The analysis indicates that there is limited capacity to transfer loads from the Lang Lang feeders. By 2031, approximately 7.5 MVA of the total 28.1 MVA demand at Lang Lang (around 27%) will remain at risk, even after utilising all available feeder transfer capacities. This includes capacities enabled through existing normally open connection points and those established through minor augmentations to connect feeder networks. Furthermore, transferring load away from Lang Lang substation significantly reduces the adjacent substations' ability to provide load transfer flexibility to the network.

Appendix B tabulates the full list of feeder ratings and forecast demand for the four substations in the Cardinia region.

[10] RIT-D Final Report - Service Constraints at Clyde North Zone Substation
[11] Distribution Annual Planning Report (ausnetservices.com.au)

**Table 5 Transfer capacity of feeders adjacent to each Lang Lang feeder**

| | | | Lang Lang feeder | | | |
|---|---|---|---|---|---|---|
| **Adjacent feeder** | **Zone Substation Capacity** | **Adjacent Feeder Transfer Capacity (MVA)** | **LLG11** | **LLG12** | **LLG13** | **LLG14** |
| **CRE33** | No capacity | No Transfer Capacity | - | - | - | Open Point |
| **CLN22** | 10 | 3.9 | - | - | - | Open Point |
| **LGA12** | 2 | 0.5 | - | Open Point | - | - |
| **LGA23** | | 0.8 | - | Open Point | ~5.5km of Overhead Line needs to be constructed. 5km of Overhead Line needs to be upgraded to create tie | - |
| **LGA24** | | 4.4 | - | ~2.5km Overhead Line needs to be constructed to create tie | - | - |
| **OFR22** | 24 | 3.6 | - | - | - | ~3km Overhead Line needs to be constructed to create tie |
| **PHM22** | 37 | No Transfer Capacity | - | - | - | Open Point |
| **PHM31** | | 7.5 | Open Point | - | - | Open Point |
| **PHM33** | | No Transfer Capacity | Open Point | - | - | - |
| **WGI23** | 22 | 3.4 | - | - | Open Point | - |
| **WGI34** | | 4.3 | - | - | Open Point | - |
| **WGL12** | No capacity | No Transfer Capacity | ~5km Overhead Line needs to be constructed to create tie | - | - | - |
| **Total transfer capacity (MVA)** | **-** | **-** | **7.5** | **2.0** | **7.7** | **7.5** |
| **LLG feeder 2031 demand (MVA)** | **-** | **-** | **4.2** | **7.4** | **6.9** | **9.6** |
| **Energy at Risk in 2031 (MVA)[12]** | **-** | **-** | **No EaR** | **5.4** | **No EaR** | **2.1** |
| **Available capacity to transfer** | **-** | **-** | **Yes** | **No** | **Yes** | **No** |

[12] Energy at Risk (MVA) = Total transfer capacity (MVA) - LLG feeder 2031 demand (MVA).

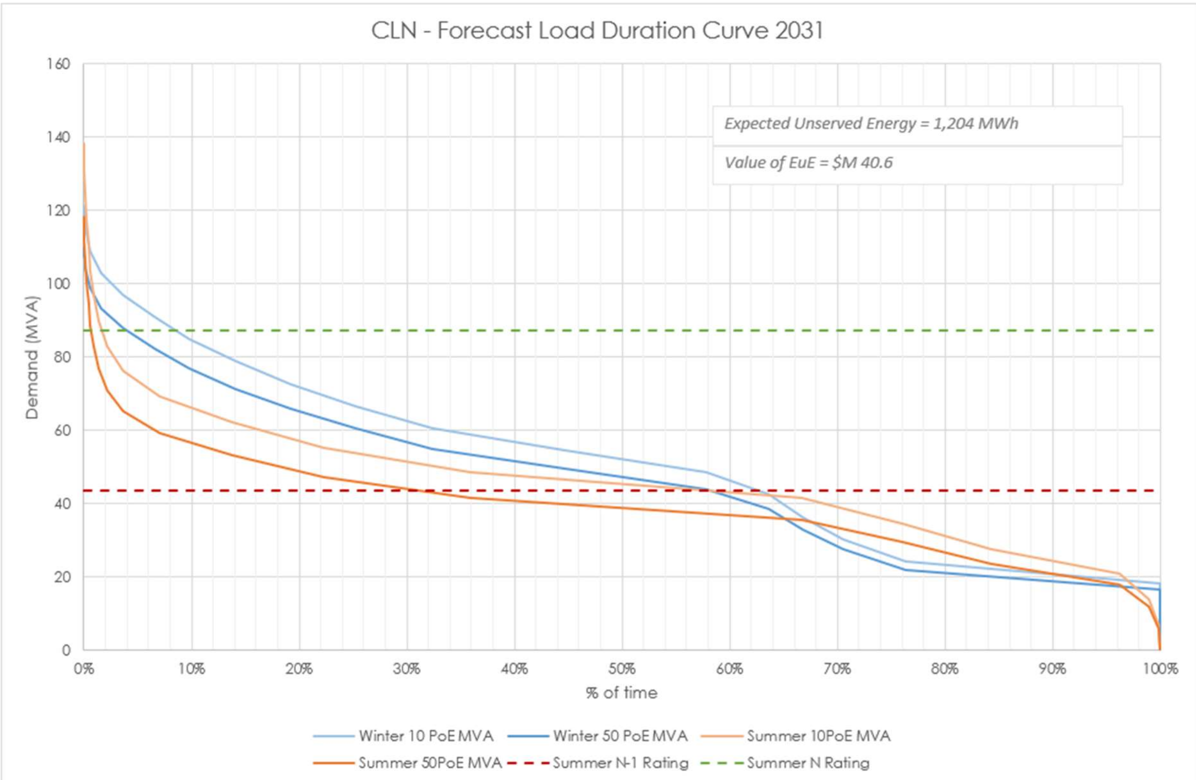
# 2.3. Load Duration Curve

The load duration curve (LDC) for the zone substations in the Cardinia area has been derived using SCADA data sourced from each of the substations and the maximum demand forecasts developed by AusNet. Specifically, we have used SCADA to derive the shape of the load duration curves and AusNet's maximum demand forecasts to determine the scale of the curve.

The charts below show the 10% POE and 50% POE LDCs for Clyde North, Officer, Pakenham and Lang Lang zone substations in 2037, the end of our forecasting period.

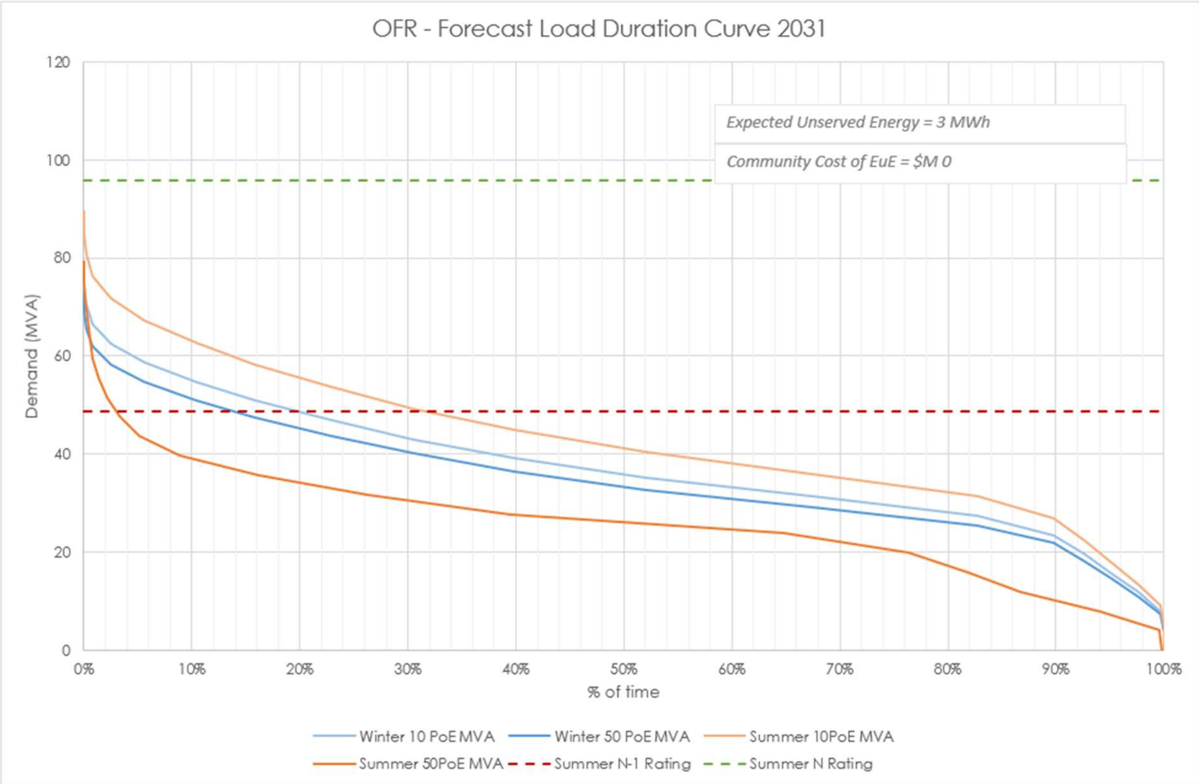
- Figure 3 shows that the forecasted summer demand at **Clyde North** zone substation is expected to exceed the summer N-1 rating of the substation for approximately 30% of the year based on a 50% PoE demand forecast. Additionally, the forecasted summer demand is expected to exceed the rating for about 58% of the year based on a 10% PoE demand forecast. There is expected unserved energy of 1,204 MWh with a value of $40.7M in 2037. This anticipated unserved energy is likely to increase as the load grows over time.
- Figure 4 shows that the forecasted summer demand at **Officer** zone substation is expected to exceed the N-1 rating of the substation for approximately 3% of the year based on a 50% PoE demand forecast. Additionally, it is expected to exceed the rating for about 40% of the year based on a 10% PoE demand forecast. There is expected unserved energy of 3 MWh with a limited community cost in 2031.
- Figure 5 shows that the forecasted summer demand at **Pakenham** zone substation is expected to exceed the N-1 rating of the substation for approximately 12% of the year based on a 50% PoE demand forecast. Additionally, it is expected to exceed the rating for about 20% of the year based on a 10% PoE demand forecast. There is expected unserved energy of 0.34 MWh with a value of $0.01M in 2031. This anticipated unserved energy is likely to increase as the load grows over time.
- Figure 6 shows that the forecasted summer and winter demand at **Lang Lang** zone substation is projected to remain within the substation's capacity. However, it is important to note that this is a single transformer substation. In the event of a transformer failure, the only load that can be supplied it the limited amount that can be transferred to other substations, as detailed in section 2.2.

**Figure 3 - Clyde North 2031 Load Duration Curve**



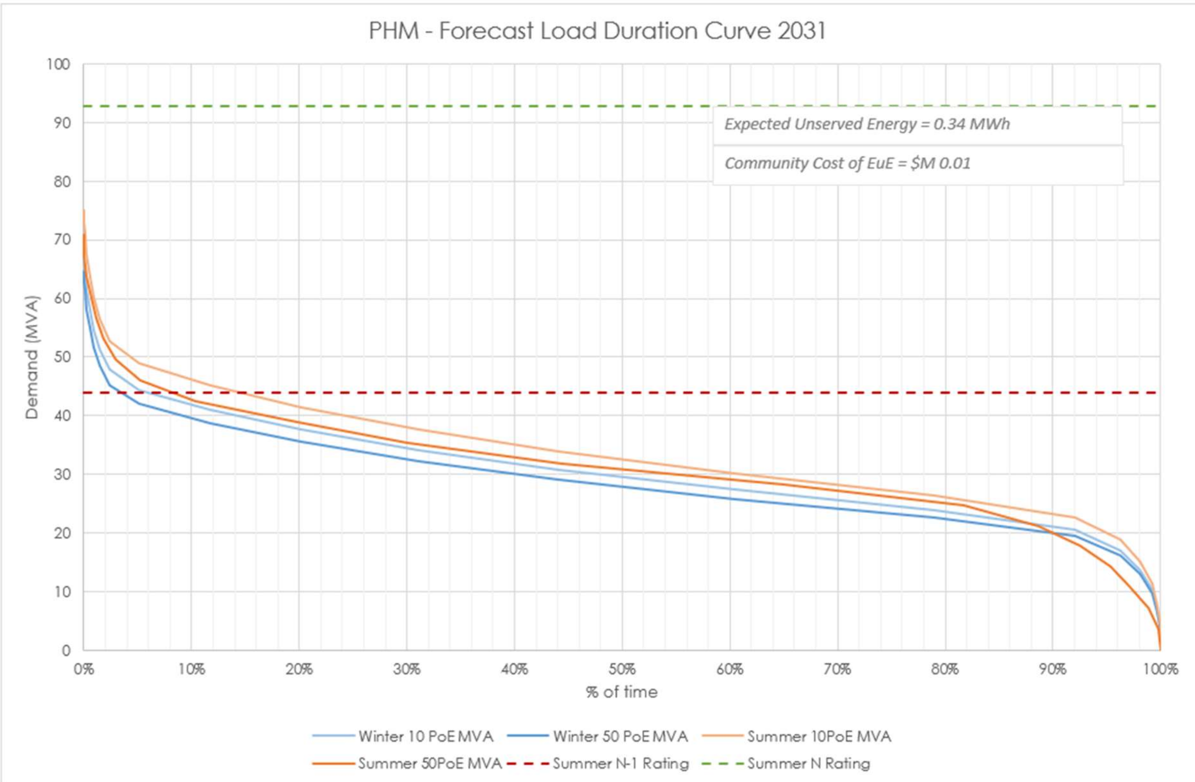

*Source: AusNet Analysis*

**Figure 4 – Officer 2031 Load Duration Curve**



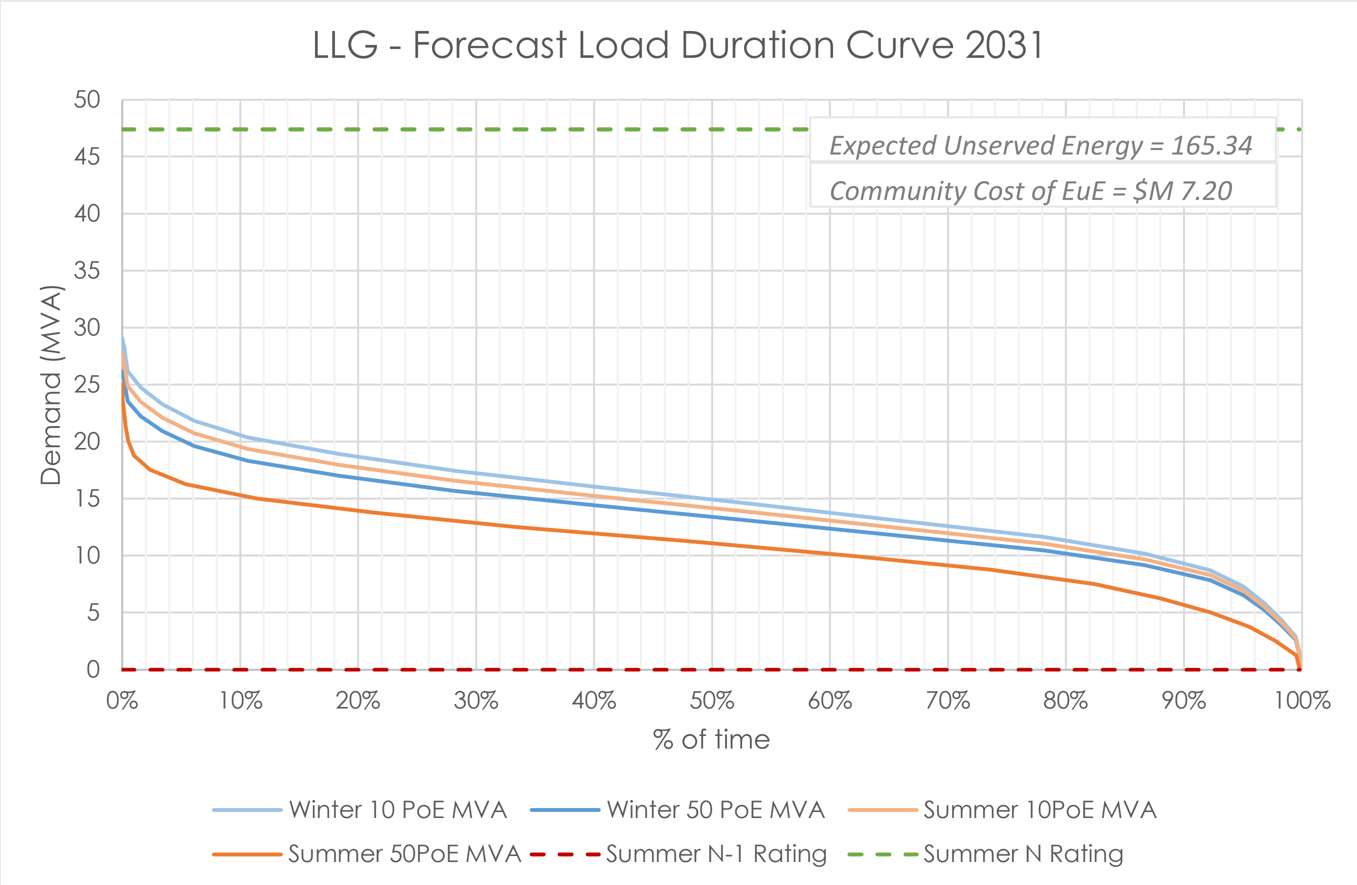

*Source: AusNet Analysis*

**Figure 5 - Pakenham 2031 Load Duration Curve**




*Source: AusNetAnalysis*

**Figure 6 - Lang Lang 2031 Load Duration Curve**




*Source: AusNet Analysis*

# 2.4. Value of expected unserved energy

Under a do-nothing approach, the key cost to the community is related to the value of expected unserved energy (EUE). This is defined as:

*Value of Expected Unserved Energy = VCR x EUE*

Where VCR is the Value of Customer Reliability

We have calculated the EUE by determining the amount of energy that would not be supplied under N-1 conditions (e.g., the failure of a single power transformer at a two or three transformer zone substation) in addition to the amount of energy that would not be supplied under N conditions, where all available zone substation equipment is in service.

**Box 1**: Expected Unserved Energy formula

$$EUE = [w_{10} x EAR_{D10} + w_{50} x EAR_{D50}] \times Pr(f)$$

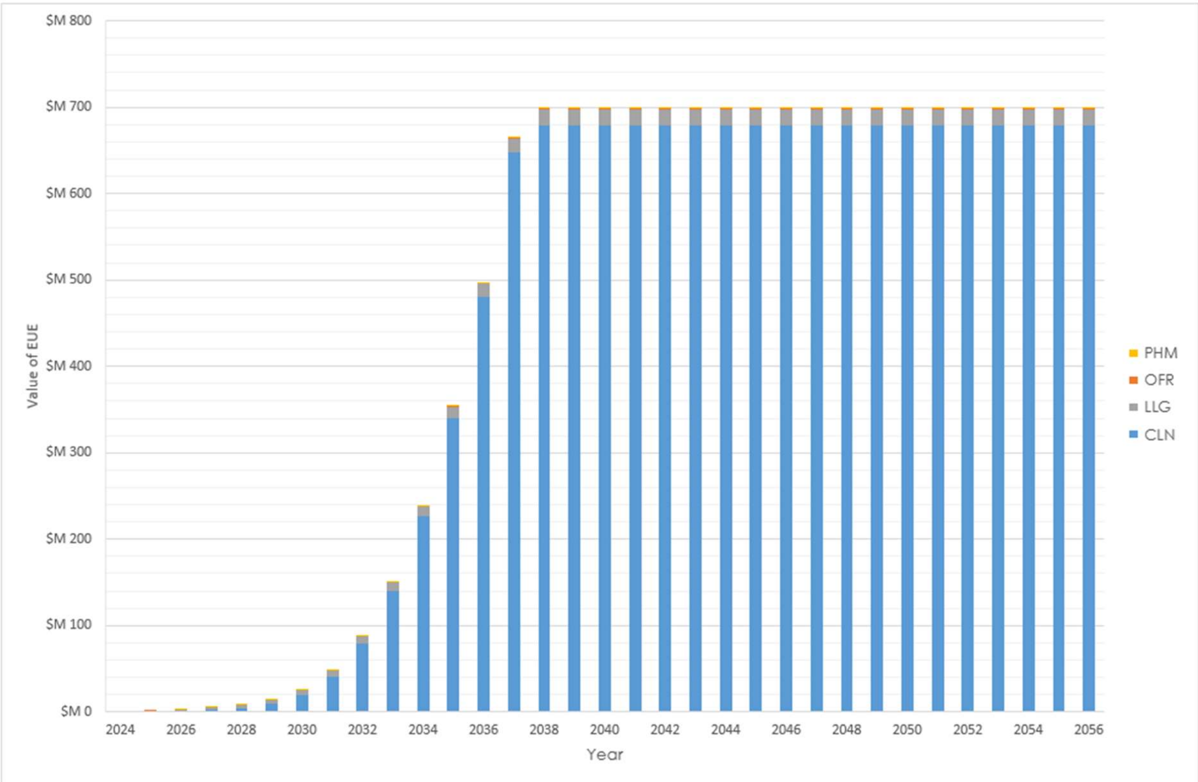
| | |
|---|---|
| $EAR_{D10}$ | Energy at Risk using 10%POE demand forecast |
| $EAR_{D50}$ | Energy at Risk using 50%POE demand forecast |

The **Expected Unserved Energy** at a zone substation is determined by:

- **Calculating the area under the curve**:
  - Compare the load forecast with the load duration curve at a specific zone substation.
  - Determine the area under the load duration curve, which represents the volume of energy that is met when the load exceeds the N-1 or N rating.
- **Applying the Probability of a failure**:
  - Multiply the area under the curve, which represents the volume of energy when the load is above the N-1 or N rating, by the probability of failure.
- **Expected Unserved Energy:**
  - Calculate the value of expected unserved energy by applying a weighted value of customer reliability (VCR) of $35,741 per MWh and then multiplying it with the expected unserved energy. This is based on adopting the AER's VCRs and weighting it by the mix of customers supplied from zone substations in the Cardinia area.

Figure 7 demonstrates that the value of expected unserved energy at Clyde North is expected to be approximately $680M per annum.

**Figure 7 - Forecast Value of Expected Unserved Energy**




*Source: AusNet Analysis*

# 2.5. Key inputs and assumptions

The purpose of this section is to state the key input assumptions that underpin the identified need.

**Table 6 -Key Assumptions**

| Parameter | Value | Source |
|---|---|---|
| **Officer South industrial land** | 1,313 ha of industrial land available.<br>381ha presently zoned and occupied. | Victoria in Future 2019[13] |
| **Assessment period** | 30 years | AER RIT-D guidelines[16] |
| **WACC** | 5.56% | The average of 4.11% and AEMO's IASR central discount rate of 7%. |
| **Value of Customer Reliability** | Average across zone substation | AusNet calculation across the different zone substations depending on customer mix of customer types |
| **Power transformer failure rate** | 0.22% per annum | AusNet Planning Guideline document |
| **Weightings of the POE curves** | 10% POE - 0.3<br>50% POE – 0.7 | AusNet Planning Guideline document |

*Source: AusNet analysis*

[13] Calculated from 'VIF2019-population-households-dwellings-2036-asgs.xlsx' downloaded from https://www.planning.vic.gov.au/guides-and-resources/data-and-insights/victoria-in-future

# 3. Options assessed

Given the clear and justifiable need for augmentation of supply in the Cardinia area, as identified in section 2, it is important to ensure that the selected investment is both prudent and efficient in the long term. According to the AER:

> *' ...the amount that would be invested by a prudent NSP acting efficiently in accordance with good industry practice'.*[14]

Section 3 assesses three options including the do-nothing scenario to understand which option maximises the NPV.

We have assessed the following options:

- **Do nothing (Base case)**– This option has been used to identify the risks if the present network configuration is maintained without change into the future.
- **Build a new transformer at Lang Lang (Option 1) -** This option involves building a second transformer at Lang Lang to allow for N-1 rating. No 22 kV feeder works are required since this option would only address the energy at risk due to failure of the existing Lang Lang transformer.
- **Build a new 66/22kV zone substation at Pakenham South. (Option 2)** – This option involves augmenting the network by installing a new 2x33MVA 66/22kV zone substation in the Pakenham South area. This option relieves the loading at surrounding zone substations to reduce expected unserved energy and ensures there is sufficient capacity in the Pakenham South area to address forecast demand over the 30-year assessment period.

Due to the critical need to ensure a secure supply at Pakenham South growth area, demand side options were considered unfeasible for this investment.

# 3.1. Assessment approach

We have assessed the Do-Nothing option against the two other options, quantifying the costs and benefits of each to determine the option with the highest NPV. We estimated high-level capital costs and annual operating costs for each option.

The capital cost estimates for each option have been prepared by Ausnet's cost estimation team. The capex development and implementation for all options is expected to take two years. Operating costs per annum have been calculated at 1% of the capital investment, consistent with the approach considered reasonable for other similar investment considerations by AusNet[15]. This estimate is considered reasonable for this high level assessment. Industry experience suggest estimates between 1% - 1.5%. Commencement of operating costs has been assumed to be the year following completion of capex works.

The optimal timing for the preferred option is investigated in the Section 4 further.

We have also estimated the benefits for each option. Our approach follows the framework laid out by the AER in the RIT-D guidelines document[16], where the only material market benefit to be quantified in this business case relates to the reduction in the value of expected unserved energy. This involved:

- Determining the total EUE (MWh) and the value of the EUE.
- Calculating the total EUE that may remain following the investment.
- Valuing the benefits for each option which is calculated as the difference between the base case EUE (MWh) and the residual EUE (MWh) multiplied by the Value of Customer Reliability ($/MWh) for the mix of customers supplied from the surrounding substations.

Other market benefits including a reduction in electrical energy losses are considered immaterial and have not been included.

Both costs and benefits were estimated in FY24 dollars. Where escalations were required, these were done using Australian Reserve Bank Consumer Price Index forecasts.

---

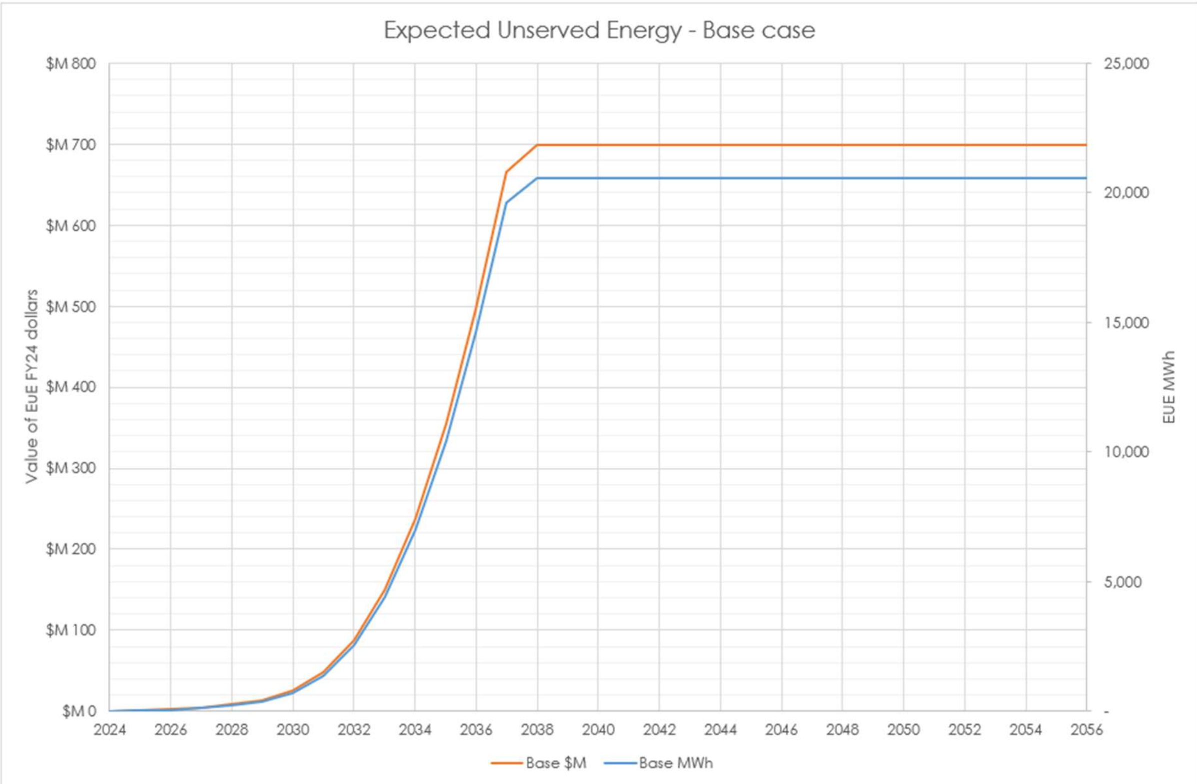
[14] S5.1 of the Draft statement of principles for the regulation of transmission revenues
[15] DD-0011571 – CLN 3rd Transformer and Switch Room – Business Case
[16] Australian Energy Regulator. Application guidelines - Regulatory investment test for distribution. August 2022.

# 3.2. Base Case: Do -nothing

The Do-Nothing option assumes that AusNet would not make any investments beyond the usual operation and maintenance to manage the forecast demand on the Officer South network. Although the cost of this option is zero, the value of expected unserved energy would reach 6,044M aggregated over the assessment period as seen in Table 7.

The annual EUE and value of EUE over the assessed period is provided in Figure 8 below.

**Figure 8 – EUE and Value of EUE for the zone substations surrounding Pakenham South**




*Source: AusNet Analysis*

**Table 7: Do-Nothing Summary ($m, discounted, FY24 dollars)**

| | FY27 | FY28 | FY29 | FY30 | FY31 | Total over assessment period |
|---|---|---|---|---|---|---|
| **Cost** | - | - | - | - | - | |
| **Benefit** | -4.7 | -7.6 | -12.5 | -21.6 | -38.6 | -6,044.3 |
| **NPV** | **-6,044.3** | | | | | |

*Source: AusNet analysis*

# 3.3. Option 1 - Install second transformer and associated bus works at Lang Lang

This option addresses the need by augmenting the existing Lang Lang single transformer zone substation. This will be achieved by adding an additional 66/22kV 33MVA transformer and associated 22kV bus works. This augmentation will eliminate the energy at risk at Lang Lang substation, as outlined in Section 2.4, Figure 7, and will substantially reduce the expected energy at risk in the study area during the FY27 to FY31 regulatory period. However, this option does not fully address the energy at risk at other zone substations identified in this business case over the long-term assessment period, nor does it provide a comprehensive solution for meeting new electricity demand growth.

**Figure 9** provides an overview of the Lang Lang substation and the available space to accommodate the proposed augmentation.

**Figure 9 Lang Lang Zone Substation Site**

### 3.3.1.1. Capex

The following table provides the expected capital investment over the regulatory period associated with this option. It assumes capital works start in FY29.

**Table 8: Option 1, Capital Costs ($m, discounted, FY24 dollars)**

| | FY27 | FY28 | FY29 | FY30 | FY31 | Full assessment period FY24-53 |
|---|---|---|---|---|---|---|
| Capex | 13.2 | 8.8 | | | - | 22.1 |

*Source: AusNet analysis*

### 3.3.1.2. Opex

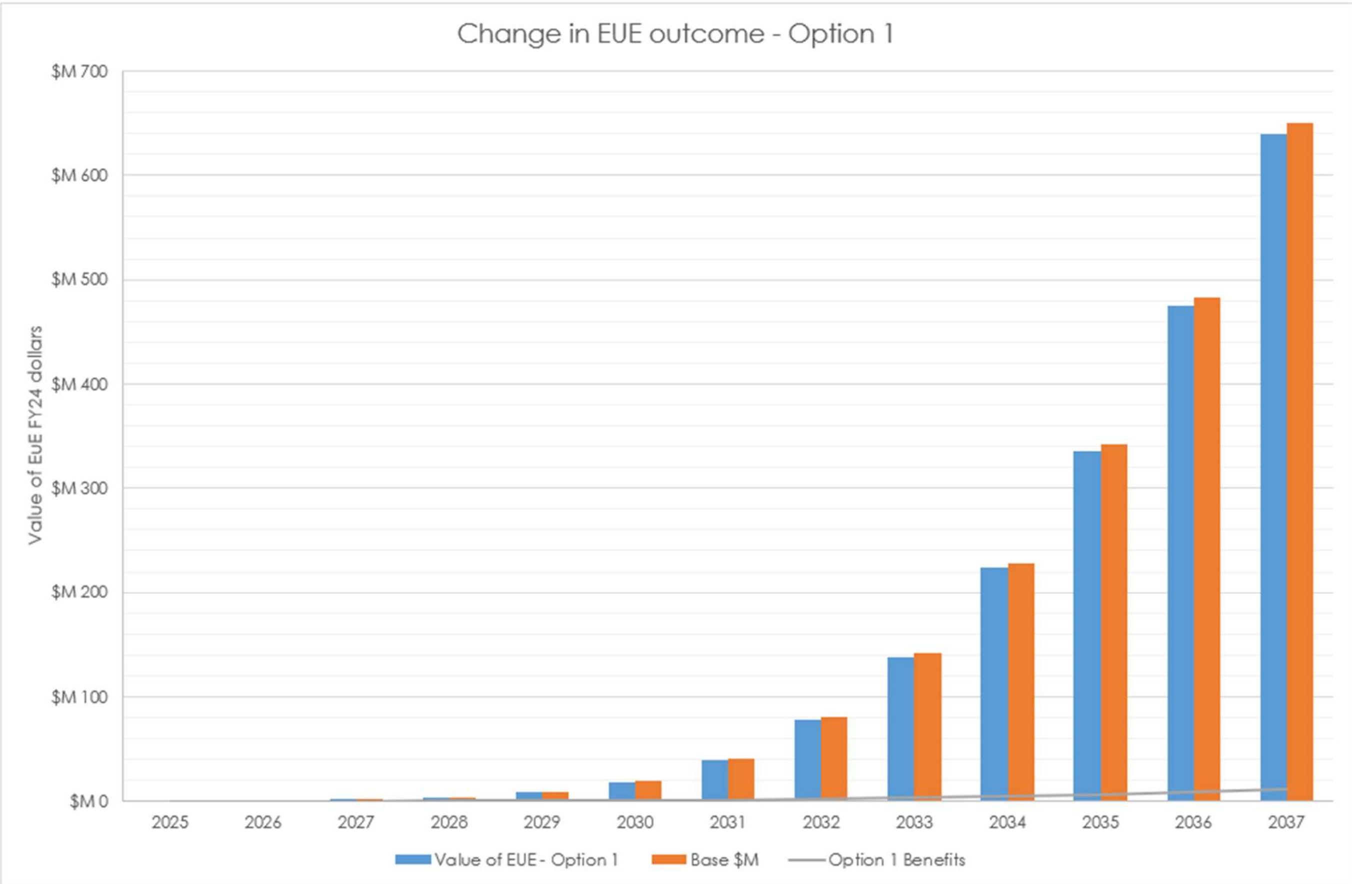
Operating costs are assumed to start the year of the practical completion of the project allowing for potential early expenditure associated with the connection of the new plant into the network. $0.25M per year is expected opex cost.

## 3.3.2. Benefits

This investment will address the EUE at Lang Lang in the event of a failure of the current single transformer. The benefits of this option are compared with the base case costs and the remaining value of EUE, as illustrated in Figure 10 below.

It is important to note that while this option significantly mitigates energy risks at Lang Lang, the EUE continuous to increase at Pakenham, Officer, and Clyde North Zone Substations.

**Figure 10 – Change in EUE outcome - Option 1**




*Source: AusNet Analysis*

## 3.3.3. NPV analysis

This section summarises the costs and benefits of implementing this option, with all prices in FY24 dollars, using our full approach for NPV which is described in Section 3.1. The costs are primarily upfront. Operating costs will be an ongoing expense once the investment is completed. The present value of benefits (avoided EUE) will continue to grow as the load at risk at Lang Lang increases over time. The first benefits are expected to accrue in FY27, the year of anticipated completion.

**Table 9 - NPV analysis summary – Option 1 (discounted, FY24)**

| | FY27 | FY28 | FY29 | FY30 | FY31 | Total FY27-31 | Full assessment period FY27-56 |
|---|---|---|---|---|---|---|---|
| Cost ($M) | 13.2 | 8.4 | 0.2 | 0.2 | 0.2 | 22.2 | 23.0 |
| Avoided EUE relative to Do-Nothing ($M) | 0 | 3.9 | 4.7 | 5.6 | 6.7 | 20.9 | 285.8 |
| NPV ($M) | 262.8 | | | | | | |

# 3.4. Option 2 – Build a new zone substation at Pakenham South

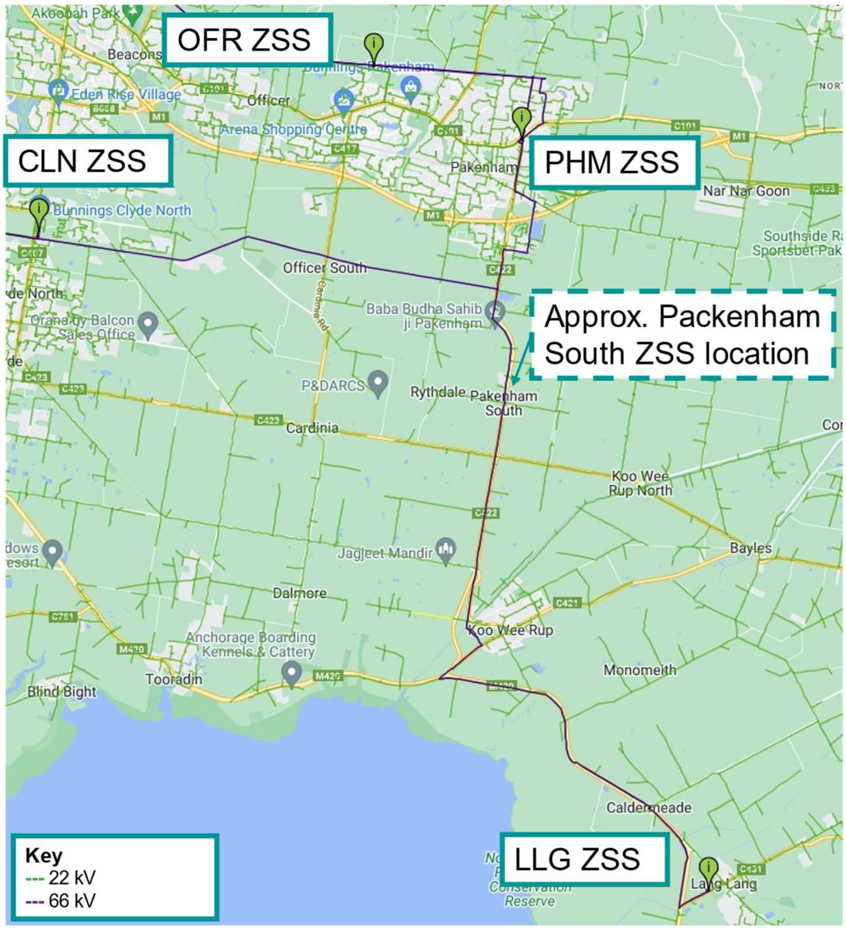
This option proposes the installation of a new 2 x 33 MVA 66/22 kV zone substation in the Pakenham South area as a strategic move to address the growing energy demands in the Pakenham South precinct. By situating the substation near the intersection of the Clyde North – Pakenham – Lang Lang 66kV sub transmission line and Ellett Road, this project would mitigate the energy at risk in the Cardinia region over the upcoming regulatory period.

Key features of this option include:

- Two 33 MVA 66/22 kV transformers
- Two 22 kV bus sections, each with four 22 kV feeders
- Provision for a third transformer and bus in the future
- 22kV feeder works

Figure 11 indicates a proposed location for connecting the proposed Pakenham South substation into the existing 66kV network.

**Figure 11 Approximate location of the Pakenham South Zone Substation**



A breakdown of the expected scope of work at a high level and the estimated cost of the augmentation work is provided in Table 9.

**Table 9c - Scope of capital work for Option 2**

| Asset items | Cost (undiscounted $m) |
|---|---|
| **Design** | C-I-C |
| **Internal Labour** | C-I-C |
| **Materials** | C-I-C |
| **Plant and Equipment** | C-I-C |
| **Contracts** | C-I-C |
| **Risk allowance-P50** | C-I-C |
| **Capex** | **40.4** |

The cost of running HV feeders is estimated at C-I-C.

The total capex cost includes 5% contingency.

## 3.4.1. Cost

### 3.4.1.1. Capex

The following table provides the capital investment associated with this option over the regulatory period. It assumes an immediate investment at the start of the upcoming regulatory period with practical completion by the end of FY28.

**Table 10: Option 1, Capital Costs ($m, discounted, FY24 dollars)**

| | FY27 | FY28 | FY29 | FY30 | FY31 | FY27-31 | Full assessment period FY27-56 |
|---|---|---|---|---|---|---|---|
| Capex | 16.4 | 15.5 | 14.7 | 0.0 | 0.0 | **46.7** | **46.7** |

*Source: AusNet analysis*

### 3.4.1.2. Opex

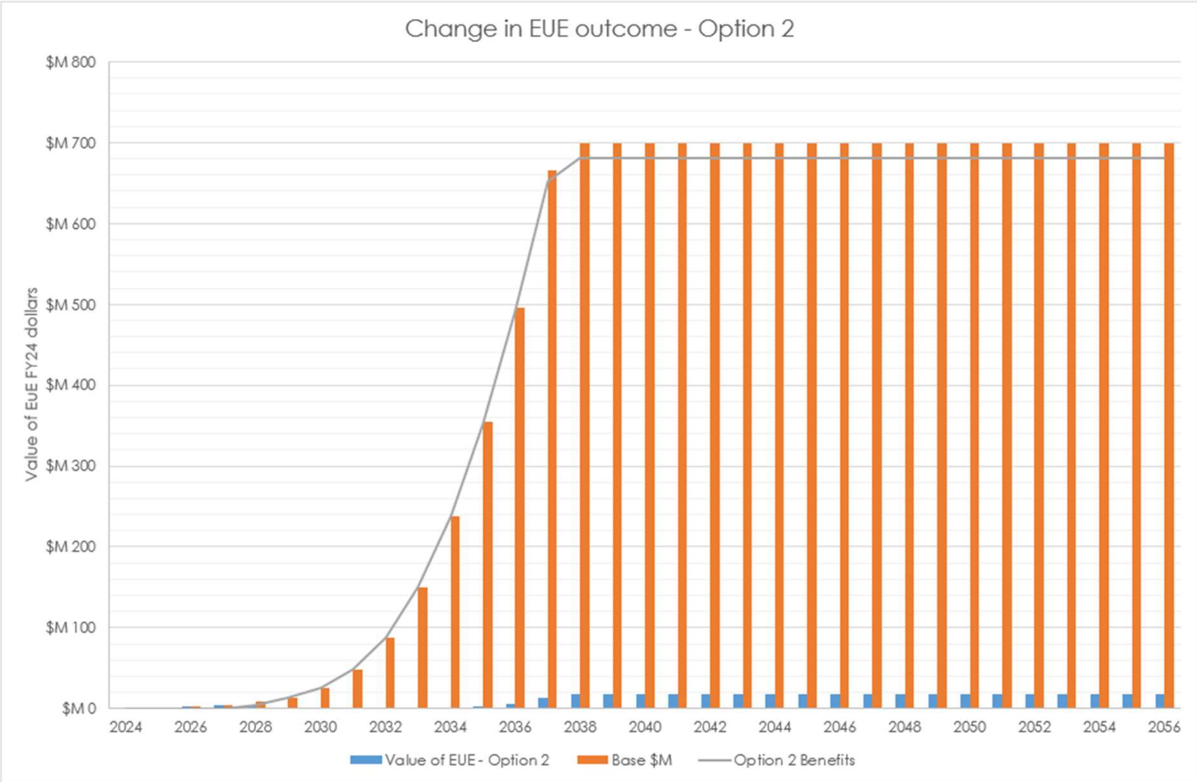
Operating costs are assumed to start the year of the practical completion of the project allowing for potential early expenditure associated with the connection of the new plant into the network. $0.5 M per year is estimated opex.

## 3.4.2. Benefits

The construction of a new zone substation at Pakenham South will result in $5,903.7M of cumulative benefits[16] by 2053 meeting nearly all EuE in the study area.

The benefits of Option 2 compared with the base case costs and the re-emerging value of EUE is provided in Figure 12 below.

**Figure 12 - Change in EUE outcome - Option 2**




*Source: AusNet Analysis*

## 3.4.3. NPV analysis

This section summarises the costs and benefits of implementing this option with all prices in FY24 dollars using our approach for NPV which is described in Section 3.1. Costs are expected to remain high during the construction phases with ongoing costs remaining stable on a real, undiscounted basis, with the benefits from avoided EUE increasing each year from the existing substations breaching N-1 and subsequent N ratings.

**Table 10b - NPV analysis summary (discounted, FY24)**

| | FY27 | FY28 | FY29 | FY30 | FY31 | Total FY27-31 | Full assessment period FY27-56 |
|---|---|---|---|---|---|---|---|
| Cost ($M) | 16.4 | 15.5 | 14.7 | 0.4 | 0.4 | 47.5 | 52.8 |
| Avoided EUE relative to Do-Nothing ($M) | 0 | 3.8 | 12.5 | 21.6 | 38.6 | 76.4 | 5,903.7 |
| NPV ($M) | 5,851.0 | | | | | | |

# 4. Preferred option and sensitivity testing

## 4.1. NPV comparison

Table 11 provides a comparison of the economic analysis of the options considered relative to the base case. Option 2 delivers the highest NPV among all the options assessed, making it the preferred investment option. However, it is essential to test the ranking and NPVs of all options under varying input assumptions. This sensitivity analysis is detailed in section 4.3.

**Table 11 - NPV comparisons ($m, discounted, FY24 dollars)**

| | NPV ($M) | Ranking |
|---|---|---|
| **Base case** | - | 3 |
| **Option 1 – 2nd TX at Lang Lang** | 263 | 2 |
| **Option 2 – New ZSS at Pakenham South** | **5,851** | **1** |

*Source: AusNet*

## 4.2. Sensitivity analysis

Table 12 presents the net present value (Real $2024) outcomes under various sensitivities. The economic assessment considers each option's total capital expenditure, operating and maintenance expenditure, compared to the reduction in service level risk cost that each option is expected to deliver. The robustness of the economic assessment is tested for the following sensitivities:

- Asset failure rates, varied at ±50% of the base failure rates;
- Maximum demand forecasts, varied to ±5% of the base forecast;
- Community cost of EUE, varied to $53.42/kWh for residential, and keeping the same AER VCR values for the remaining customer types and $53.42/kWh for residential and $32.10/kWh for commercial, industrial and agricultural
- Proposed option costs, varied to ±15% of the base option costs;
- Real discount rate of 5.56%, varied to 7.00% and 4.11% per annum

The sensitivity analysis indicates that the preferred option is Option 2, as it has the highest net benefit under all of the sensitivities tested.

**Table 12: NPV of net economic benefit analysis ($m, discounted, FY24 dollars)**

| Scenario | Option 1 | Option 2 |
|---|---|---|
| **Base Case** | $ 263 | $ 5,851 |
| **High Asset Failure Rate** | $ 324 | $ 5,945 |
| **Low Asset Failure Rate** | $ 208 | $ 5,770 |
| **High Demand** | $ 347 | $ 10,066 |
| **Low Demand** | $ 177 | $ 2,846 |
| **VCR Option 2** | $ 366 | $ 9,205 |

| | | |
|---|---|---|
| **VCR Option 3** | $ 286 | $ 8,057 |
| **High Option Cost** | $ 257 | $ 5,838 |
| **Low Option Cost** | $ 269 | $ 5,864 |
| **High Discount Rate** | $ 212 | $ 4,714 |
| **Low Discount Rate** | $ 329 | $ 7,351 |

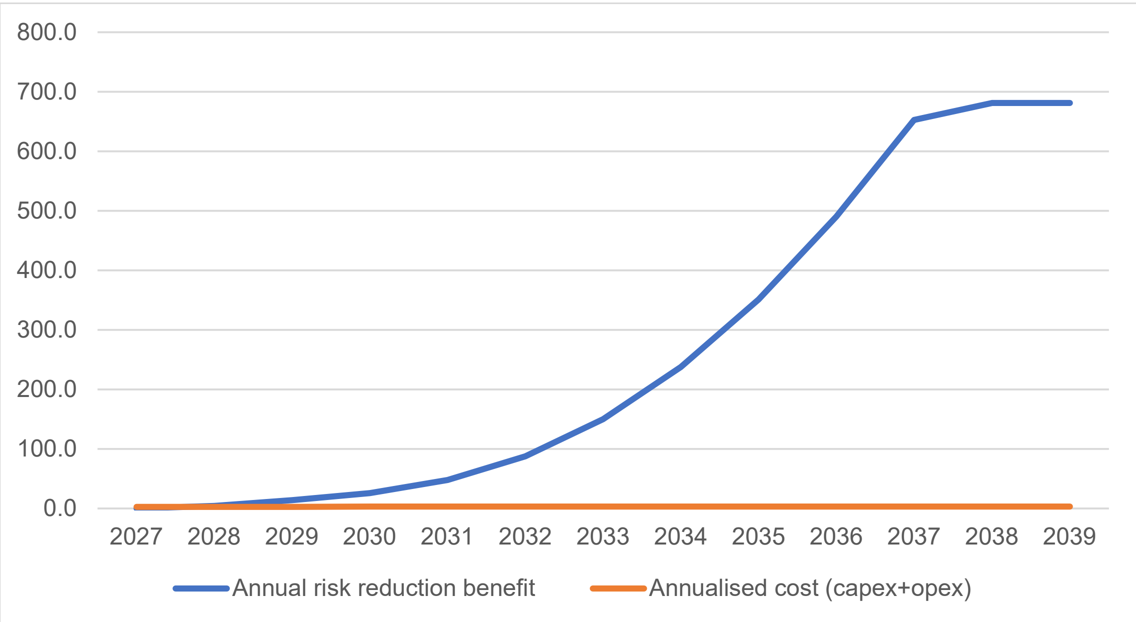
# 4.3. Optimal economic timing of the preferred option

The optimal economic timing of the preferred option is the point in time when the annual risk reduction benefit exceeds the annualised cost to implement the option, specifically:

- The **annual risk reduction benefit** of implementing the preferred option compared to the Do-Nothing scenario is the difference between the Do-Nothing risk costs for that year minus the preferred option residual risk costs for that year.
- The **annualised cost** is the preferred option's capex and opex converted into equivalent annual payments over the life of the asset at a specified discount rate. We use Microsoft Excel's inbuilt PMT formula to calculate the annualised cost.

The point in time when the annualised risk reduction benefit exceeds the annualised cost is FY28, as shown in Figure 13.

**Figure 13 - Economic timing of the proposed preferred option (Option 2)**



# 5. Conclusions

## 5.1. Recommendation

The need for augmentation in the Pakenham South area, as described in section 2, is driven by the high projected growth rates over the coming years. Given this expected growth, two credible options (in addition to the do-nothing scenario) were compared across a 30-year assessment period (FY24-FY53) to determine the most effective solution to reduce expected unserved energy. Based on our analysis, the Option 2 is the preferred option compared to the alternatives.

## 5.2. Next Steps

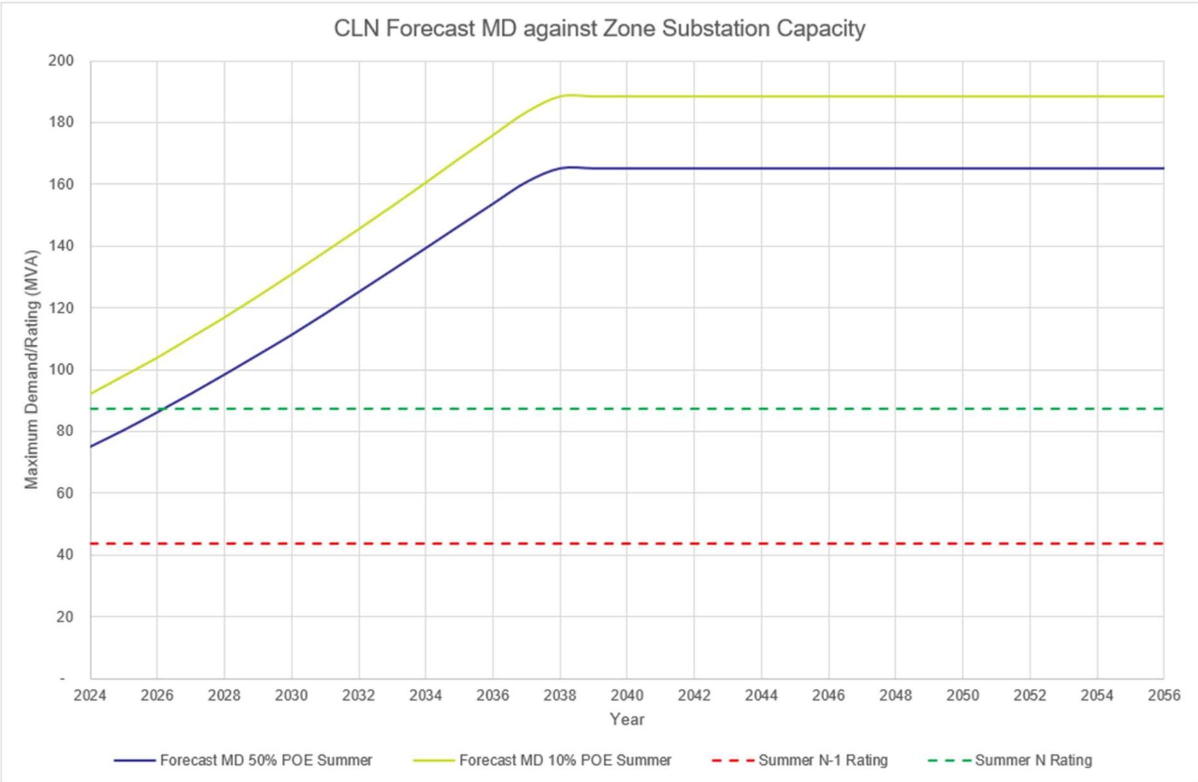
This business case outlines the need to mitigate expected unserved energy in the Pakenham South Area. The proposed investment is subject to the Regulatory Investment Test for Distribution (RIT-D). As such, the investment will be confirmed via the formal RIT-D process, which includes a consultation phase where interested parties can make submissions to help identify the optimal solution.

# 6. Appendix A

# A.1. Maximum Demand

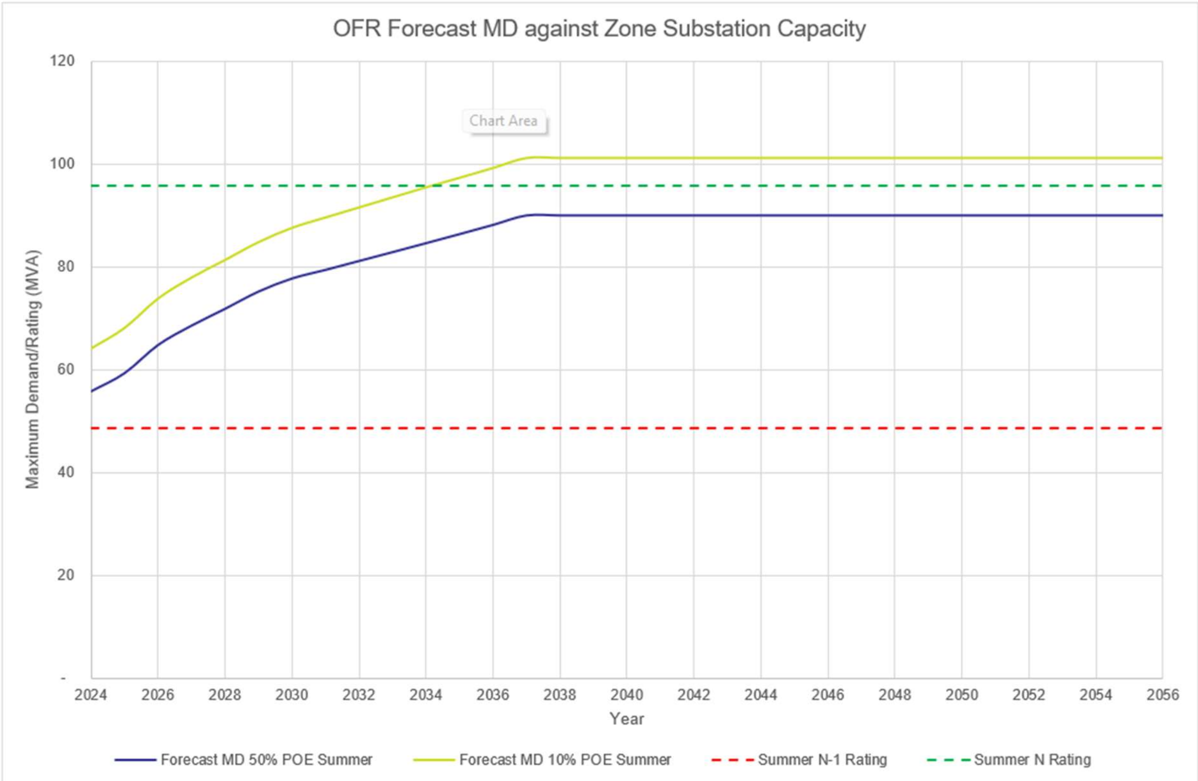
The following charts shows the maximum demand in relation to the applicable existing zone substation capacity in the Officer South Area.

**Figure 14 – Clyde North Zone Substation Forecast Maximum Demand**



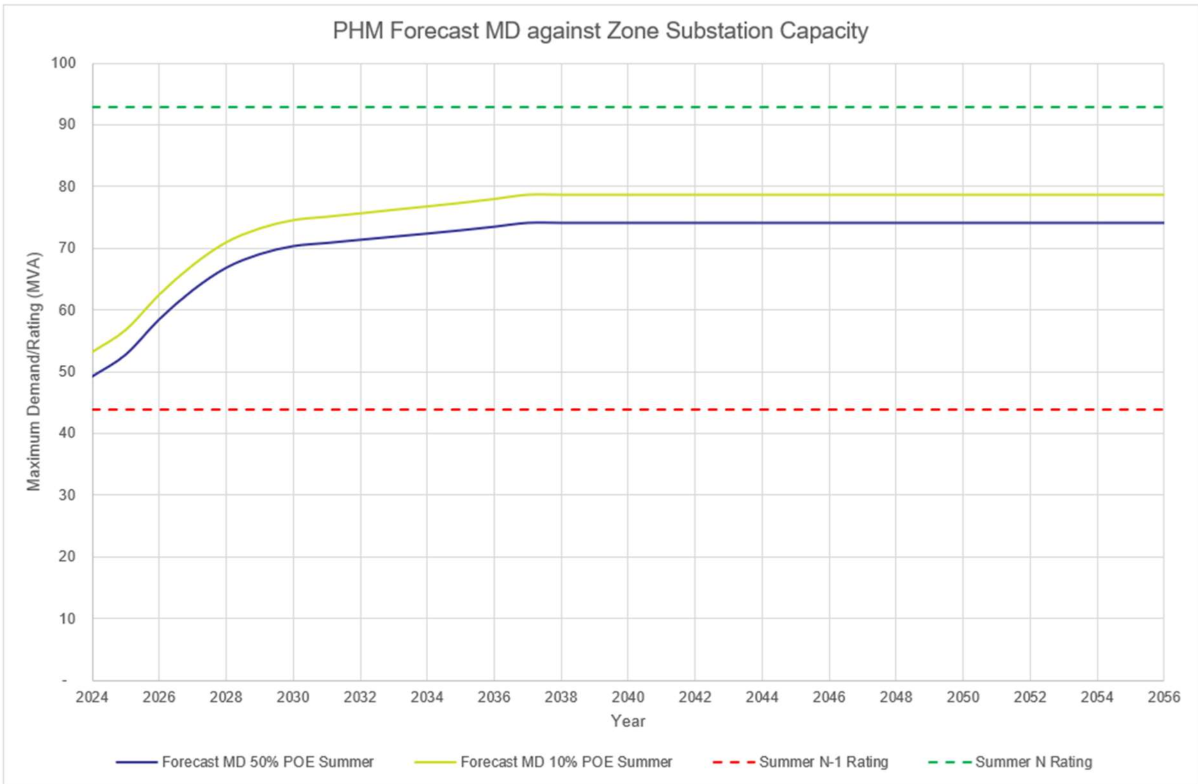

*Source: AusNet Analysis*

**Figure 15 - Officer Zone Substation Forecast Maximum Demand**



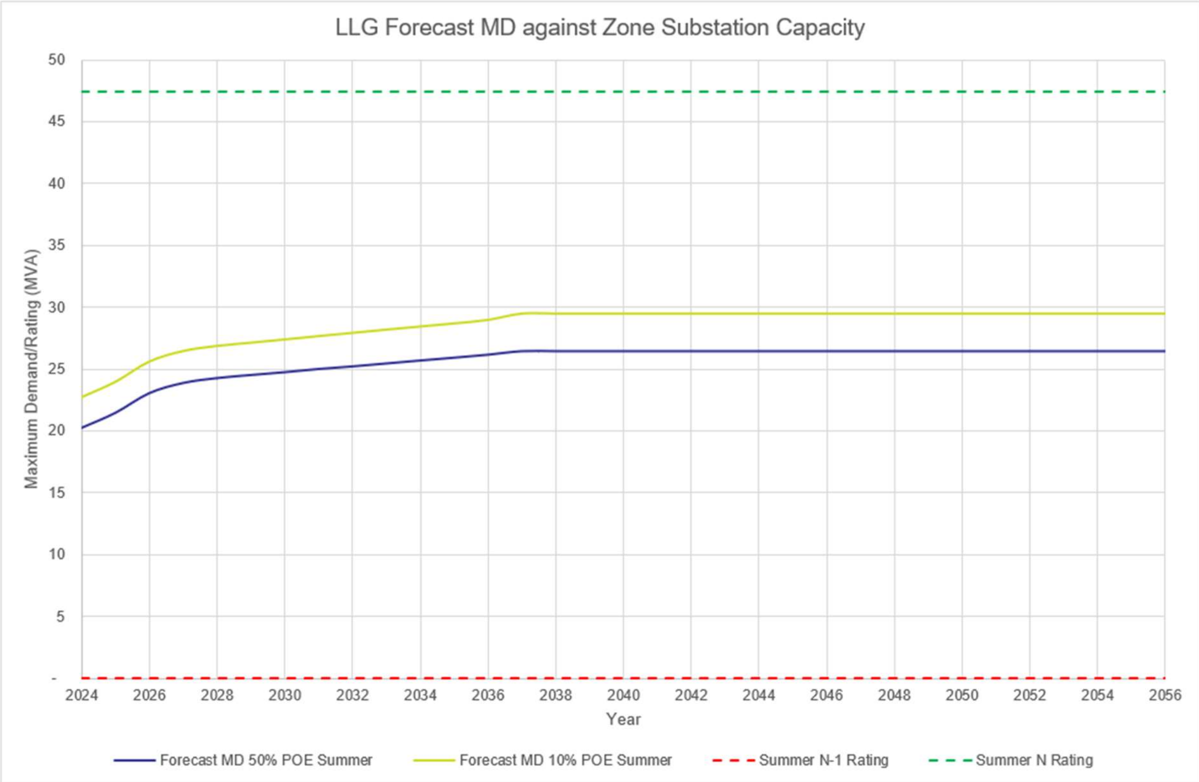

*Source: AusNet Analysis*

**Figure 16 - Pakenham Zone Substation Forecast Maximum Demand**




*Source: AusNet Analysis*

**Figure 17 – Lang Lang Zone Substation Forecast Maximum Demand**




*Source: AusNet Analysis*

# B. Appendix B

This appendix shows the feeder load growth for the Clyde North, Officer, Pakenham and Lang Lang substations in the Officer South region.

Table 13 shows that forecast demand is expected to be exceeded by 2031:

- Clyde North – 6 of 8 feeders will be overloaded.
- Officer – 1 of 4 feeders will be overloaded.
- Pakenham – 1 of 8 feeders will be overloaded.
- Lang Lang – no feeders will be overloaded.

Feeder ratings were sourced from AusNet RIN Sub-Transmission and Feeder Ratings for 2022 and load forecasts were sourced from the EDPR forecasts. Cells highlighted red show that the forecast load on the feeder exceeds its transformer capacity rating.

**Table 13: Feeder demand at Clyde North (CLN), Officer (OFR), Pakenham (PHM) and Lang Lang (LLG) substations**

| | | FORECAST LOAD (MVA) | | | | | |
|---|---|---|---|---|---|---|---|
| **Feeder ID** | **Rating (MVA)** | **2026** | **2027** | **2028** | **2029** | **2030** | **2031** |
| CLN11 | 13.72 | 25.5 | 27.7 | 29.9 | 32.1 | 34.3 | 36.5 |
| CLN12 | 12.77 | 13.2 | 13.3 | 13.4 | 13.4 | 13.6 | 13.7 |
| CLN13 | 13.11 | 15.7 | 16.2 | 16.7 | 17.3 | 17.8 | 18.4 |
| CLN14 | 12.38 | 14.8 | 15.4 | 16.0 | 16.6 | 17.3 | 17.9 |
| CLN21 | 13.64 | 14.3 | 14.6 | 14.9 | 15.2 | 15.6 | 15.9 |
| CLN22 | 14.29 | 5.8 | 6.5 | 7.2 | 7.9 | 8.6 | 9.3 |
| CLN23 | 12.31 | 13.9 | 14.6 | 15.4 | 16.1 | 16.9 | 17.7 |
| CLN24 | 13.72 | 4.8 | 5.3 | 5.8 | 6.3 | 6.8 | 7.3 |
| OFR21 | 14.29 | 14.1 | 14.4 | 14.6 | 14.9 | 15.1 | 15.4 |
| OFR22 | 13.72 | 5.1 | 5.2 | 5.4 | 5.6 | 5.8 | 6.0 |
| OFR23 | 24.27 | 9.3 | 9.6 | 9.9 | 10.2 | 10.5 | 10.8 |
| OFR24 | 27.44 | 10.4 | 10.7 | 11.0 | 11.3 | 11.6 | 11.8 |
| PHM21 | 12.77 | 9.4 | 9.5 | 9.7 | 9.9 | 10.1 | 10.2 |
| PHM22 | 12.80 | 11.7 | 12.6 | 13.5 | 14.3 | 15.2 | 16.1 |
| PHM23 | 13.72 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 |
| PHM24 | 11.43 | 5.9 | 5.9 | 6.0 | 6.1 | 6.1 | 6.2 |
| PHM31 | 12.38 | 2.7 | 2.8 | 2.8 | 2.8 | 2.9 | 2.9 |
| PHM32 | 13.15 | 11.8 | 12.0 | 12.2 | 12.4 | 12.6 | 12.8 |
| PHM33 | 12.19 | 9.6 | 9.8 | 10.0 | 10.2 | 10.4 | 10.6 |
| PHM34 | 9.53 | 6.9 | 7.1 | 7.2 | 7.4 | 7.5 | 7.6 |
| LLG11 | 13.72 | 3.8 | 3.9 | 4.0 | 4.1 | 4.1 | 4.2 |
| LLG12 | 13.91 | 6.4 | 6.6 | 6.8 | 7.0 | 7.2 | 7.4 |
| LLG13 | 13.91 | 6.1 | 6.3 | 6.4 | 6.6 | 6.7 | 6.9 |
| LLG14 | 13.72 | 8.8 | 9.0 | 9.1 | 9.3 | 9.5 | 9.6 |

*Source: AusNet Forecasts 2023*