# HV feeder upgrades

## PAL BUS 6.05 - HV feeder program justification - Jan2020 - Public

## Regulatory proposal 2021–2026

Powercor

January 2020

# Contents

# 1 Overview

Load growth continues to drive demand-related high voltage (**HV**) feeder investment throughout our network. In particular, Melbourne's western suburbs, and the Geelong, Bendigo and Ballarat areas are continuing to see large greenfield developments and significant residential, commercial and industrial load growth.

As the distribution network close to our zone substations becomes established, new distribution feeders combined with capacity augmentation to the existing network are required to supply new urban fringe development areas.

This document describes our approach to forecasting feeder projects. It also sets out our assessment of key feeder projects forecast for completion during the 2021–2026 regulatory period (as summarised in table 1.1).

**Table 1.1 Key feeder projects: 2021–2026 regulatory period ($ million, 2019)**

| Feeder | Optimal year for commissioning | Cost |
|---|---|---|
| GL013 feeder extension to Batesford | 2022/23 | 3.6 |
| FNS032 feeder extension into Lara | 2024/25 | 2.3 |
| BAS033 new feeder to Sebastopol | 2023/24 | 1.1 |
| MLN031 new feeder to offload MLN011, MLN013 and MLN024 | 2025/26 | 1.5 |
| MLN034 new feeder to offload MLN012 and MLN022 | 2022/23 | 1.5 |
| TNA012 and TNA031 new feeders | 2022/23 | 4.8 |
| Re-direct WBE012 and WBE032 feeders into Point Cook | 2021/22 | 3.1 |

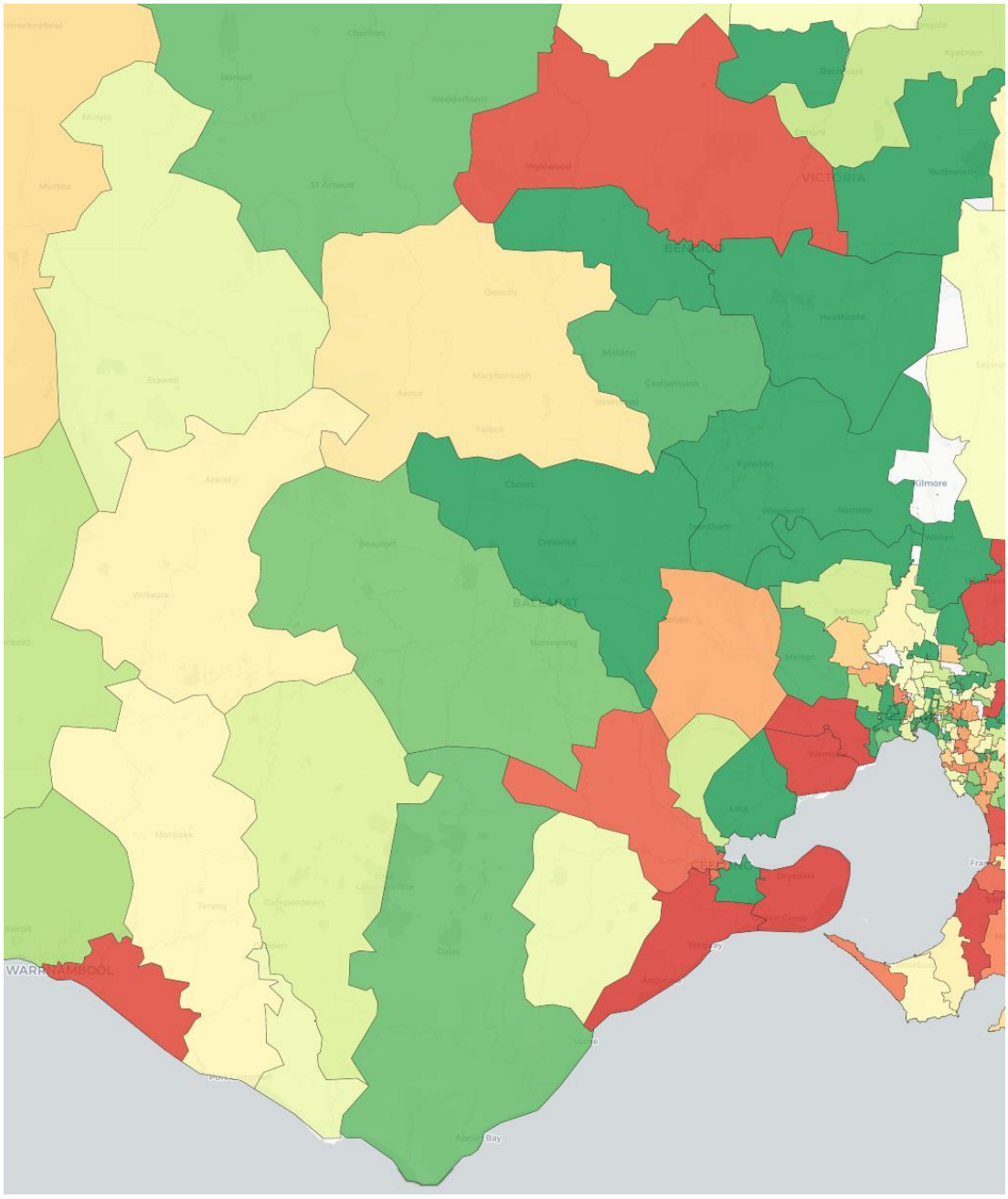
Source: Powercor

# 2 Forecast approach

This section sets out the type of constraints typically experienced across our feeder network and the process we undertake to forecast these constraints.

As outlined above, and in our regulatory proposal, growth on our network is particularly strong in Melbourne's western suburbs, and the Geelong, Bendigo and Ballarat areas. This is consistent with the constraints shown in figure 2.1. This figure is an excerpt from the network opportunity maps published by the Australian Renewable Energy Mapping Infrastructure (**AREMI**), where yellow, orange and red sections represent locations where available distribution capacity is limited.

**Figure 2.1 Available distribution capacity: 2019 (MVA)**




Source: AREMI

## 2.1 Feeder constraints

The type of feeder constraint typically experienced on our distribution network is the exceedance of conductor limits. Occasionally, we also experience breaches of compliance with the Electricity Distribution Code with respect to supply quality.

The conductor limits that are applied are the thermal limits of overhead and underground conductors that have been determined in accordance with Australian and international standards. The limits imposed are 100% of the thermal limit, which means that projects are planned to be completed in the year before the thermal limit is forecast to be reached.

The typical actions to address conductors that exceed thermal limits is to either replace the overhead conductor or underground cable with a higher rated conductor, upgrade an adjacent HV feeder and transfer load to it from the constrained feeder, or utilise non-network solutions (e.g. demand response).

Separately, forecast breaches of our supply quality requirements are determined through load flow analysis using forecast loads. Projects are planned to be completed in the year before a supply quality breach is forecast to occur. The typical actions to address supply quality breaches include installing voltage regulator devices, reactive power control devices (like line capacitors or reactors), or changing the impedance of the network by replacing small sections of conductor.

Projects to address supply quality constraints do not generally reach the expenditure thresholds for material feeder projects. In this report, all projects address conductors forecast to exceed thermal rating.

## 2.2 Feeder growth forecasts

Our approach to forecasting feeder growth includes both top-down and bottom-up considerations to ensure that all macro-economic and local variables are reflected in future load growth. This approach is consistent with that used for assessing sub-transmission lines and zone substation constraints.

### 2.2.1 Top-down considerations

Our top-down approach first considers independent terminal station forecasts developed by the Centre for International Economics (**CIE**). CIE forecasts are then extrapolated down to zone substations and HV feeders.

CIE's forecasting approach is discussed in detail in their corresponding report, provided with our regulatory proposal.[1]

### 2.2.2 Bottom-up considerations

Our bottom-up factors build on our top-down feeder forecasts. For example, any committed customer projects are added to the base (i.e. top-down) feeder forecasts:

- industrial or commercial loads are typically treated as block loads
- residential loads are matched to the existing residential load profile of the feeder.

Committed future transfers between feeders are also applied, using the percentage of the feeder energy being transferred. This allows us to determine a scaled version of the feeders existing profile to transfer and add to the 'receiving' feeder(s) profile.

---

[1] PAL ATT019: CIE, *CitiPower and Powercor maximum demand forecasts*, March 2019.

Lastly, committed generation at the feeder level is added as a generation block for synchronous generators, or as the average photovoltaic or wind profile (scaled to the size of the generator) for asynchronous generators. The average profiles are determined from the entire population of generators of that type connected to our network.

# 3 Feeder projects

The section sets out our assessment of key feeder projects forecast for completion during the 2021–2026 regulatory period.

## 3.1 Geelong zone substation

The Geelong (**GL**) zone substation supplies the domestic and commercial areas of Fyansford, Bannockburn, Shelford and Teesdale. It comprises two 20/40MVA transformers operating at 66/22kV, and nine feeders.

### 3.1.1 GL013 feeder extension to Batesford

GL012 and GL015 are two of the nine 22kV feeders supplying the area surrounding GL zone substation that are forecast to be constrained by the summer of 2025/2026.

The forecast limitations in GL012 and GL015 are due to load and voltage constraints at their extremities. These are both long rural feeders that supply townships to the western side of Geelong, including the fast-growing Bannockburn, Lethbridge and Meredith. The feeders are predominately radial with very little network ties to the adjacent feeders.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.1.

**Table 3.1 Capacity and duration of unserved load above the thermal rating during system normal conditions**

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| GL012 | 2.6 | 14 |
| GL015 | 2.7 | 18 |

Source: Powercor

Given these load forecasts, we will not be able to supply all customers during high load periods (even after contingency transfers). To address the anticipated system constraints, we considered the solutions in table 3.2 to manage the unserved load.

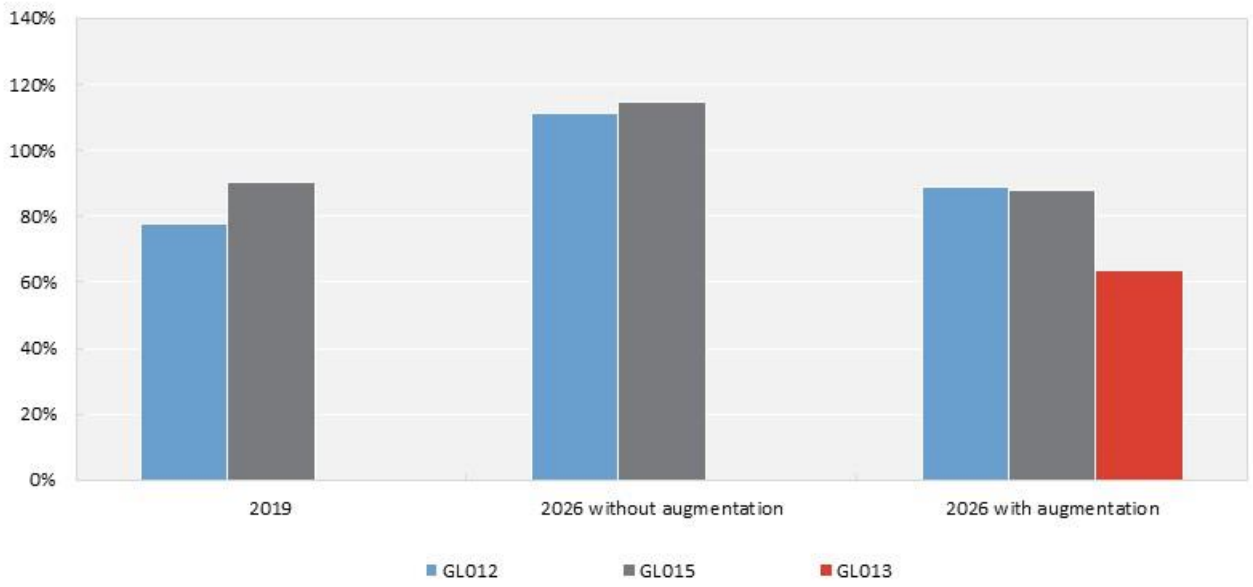
**Table 3.2 Feeder options ($ million, 2019)**

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the GL012 and GL015 feeders | 4.0 |
| GL013 feeder extension to Batesford | 3.6 |

Source: Powercor

The lowest cost option is to extend the GL013 feeder to serve the township of Batesford in 2022/23. A summary of the forecast feeder utilisation levels with and without this option are shown in figure 3.1.

Figure 3.1 Forecast feeder utilisations




Source: Powercor

A demand side initiative to reduce the forecast maximum demand load by 1 MW on GL012 and 1MW on GL015 feeder would defer the need for the capital investment by one year.

## 3.2 Ford North Shore zone substation

The Ford North Shore (**FNS**) zone substation supplies the domestic and commercial areas of Corio and Lara. It comprises three 20/27/33MVA transformers operating at 66/22kV.

### 3.2.1 FNS032 feeder extension into Lara

FNS032 feeder is one of five 22kV feeders supplying the area surrounding FNS zone substation. The limitation in FNS032 feeder is that it does not extend into the load centre of Lara just across the Princes Freeway. On the other side of the freeway, the FNS012 and FNS021 feeders have forecast demand above their thermal limits.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.3.

Table 3.3 Capacity and duration of unserved load above the thermal rating during system normal conditions

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| FNS012 | 2.4 | 7 |
| FNS021 | 2.2 | 8 |

Source: Powercor

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the solutions in table 3.4 to manage the unserved load.

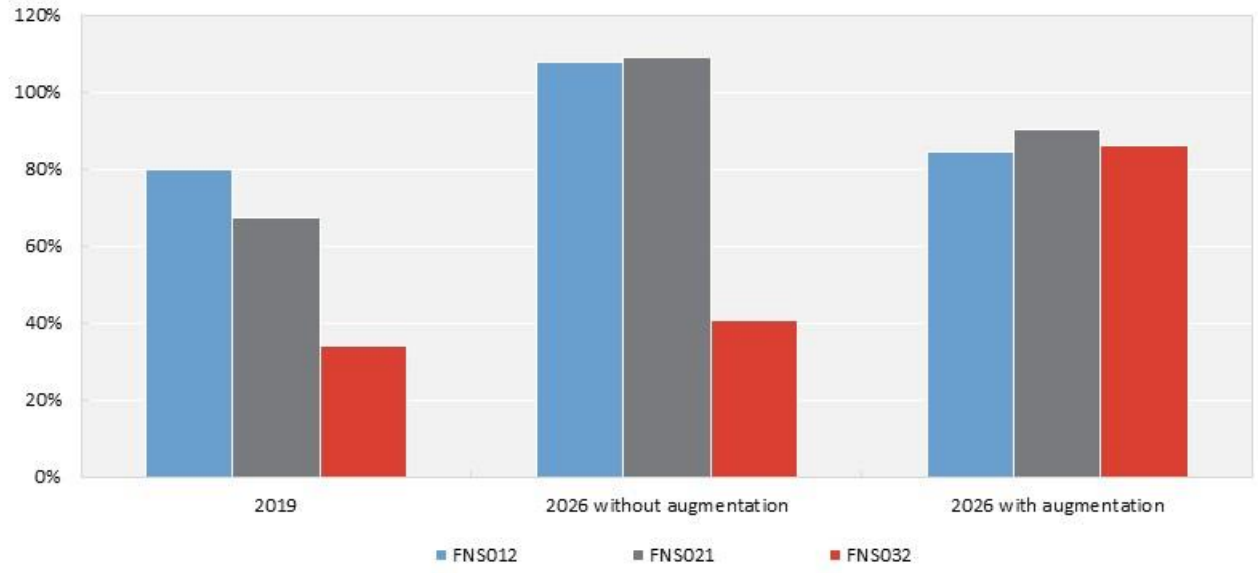
Table 3.4 Feeder options ($ million, 2019)

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the FNS012 and FNS021 feeder exits and backbones | 4.3 |
| FNS032 feeder extension into Lara | 2.3 |

Source: Powercor

The lowest cost option is to extend the FNS032 feeder into Lara in 2024/25. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.2.

Figure 3.2 Forecast feeder utilisations




Source: Powercor

A demand side initiative to reduce the forecast maximum demand load by 1 MW on FNS012 feeder and 1 MW on FNS021 would defer the need for this capital investment by one year.

## 3.3 Ballarat South zone substation

The Ballarat South (**BAS**) zone substation supplies the domestic and commercial areas of Ballarat South, and extends into the western and southern rural towns of Beaufort, Buninyong, Skipton and Windermere. It comprises two 20/27/33MVA and one 25/33MVA transformers operating at 66/22kV.

### 3.3.1 BAS033 new feeder to Sebastopol

The BAS011 and BAS022 feeders are two of nine 22kV feeders supplying the area south of our BAS zone substation. The limitation on BAS011 and BAS022 is due to residential and commercial growth.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.5.

Table 3.5 Capacity and duration of unserved load above the thermal rating during system normal conditions

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| BAS011 | 0.5 | 3 |
| BAS022 (summer) | 4.3 | 107 |
| BAS022 (winter) | 2.6 | 390 |

Source: Powercor

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the solutions in table 3.6 to manage the unserved load.[2]

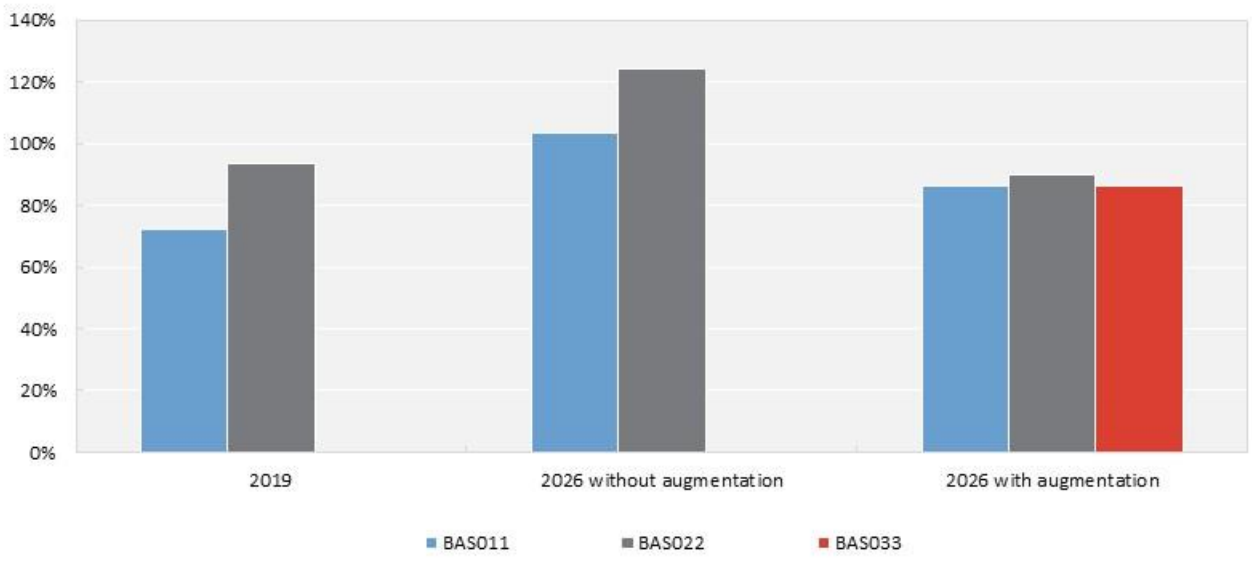
Table 3.6 Feeder options ($ million, 2019)

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the BAS011 and BAS022 feeder exits and backbones | 3.5 |
| BAS033 new feeder to Sebastopol | 1.1 |

Source: Powercor

The lowest cost option is to build a new BAS033 feeder to Sebastopol in 2023/24. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.3.

Figure 3.3 Forecast feeder utilisations




Source: Powercor

[2] As part of our REFCL program, we will be establishing a new zone substation at Ballarat West (**BAW**). This will offload the BAS zone substation, and areas to the north of BAS. Sebastopol is to the south of BAS, and as such, any load transfers to BAW will not alleviate the load growth on our southern feeders.

A demand side initiative to reduce the forecast demand load by 1MW on BAS011 and 1.8MW on BAS022 would defer the need for this capital investment by one year.

## 3.4 Melton zone substation

The Melton (**MLN**) zone substation supplies the domestic, commercial, industrial and farming areas of Melton, Melton South, Melton West, Kurunjang, Rockbank, Brookfield, and even extends west to supply parts of Bacchus Marsh. It comprises two 20/33MVA transformers, and one 25/33MVA transformer, operating at 66/22kV.

### 3.4.1 MLN031 new feeder to offload MLN011, MLN013 and MLN024

MLN011, MLN013 and MLN024 feeders are three of nine 22kV feeders supplying the area surrounding MLN zone substation. There are thermal limitations on these feeders due to continued residential and commercial development in Melton and surrounding suburbs.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.7.

**Table 3.7 Capacity and duration of unserved load above the thermal rating during system normal conditions**

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| MLN011 (summer) | 12.3 | 519 |
| MLN011 (winter) | 5.0 | 541 |
| MLN013 (summer) | 14.4 | 532 |
| MLN013 (winter) | 4.5 | 368 |
| MLN024 | 2.4 | 31 |

Source: Powercor

The MLN021 and MLN023 feeders that have ties with MLN011, MLN013 and MLN024 are also overloaded, and forecast to exceed their planning ratings by 2025/2026. Hence, there will be no opportunity to resolve the forecast MLN011, MLN013 and MLN024 constraints by transferring loads to adjacent feeders.

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the solutions in table 3.8 to manage the unserved load.

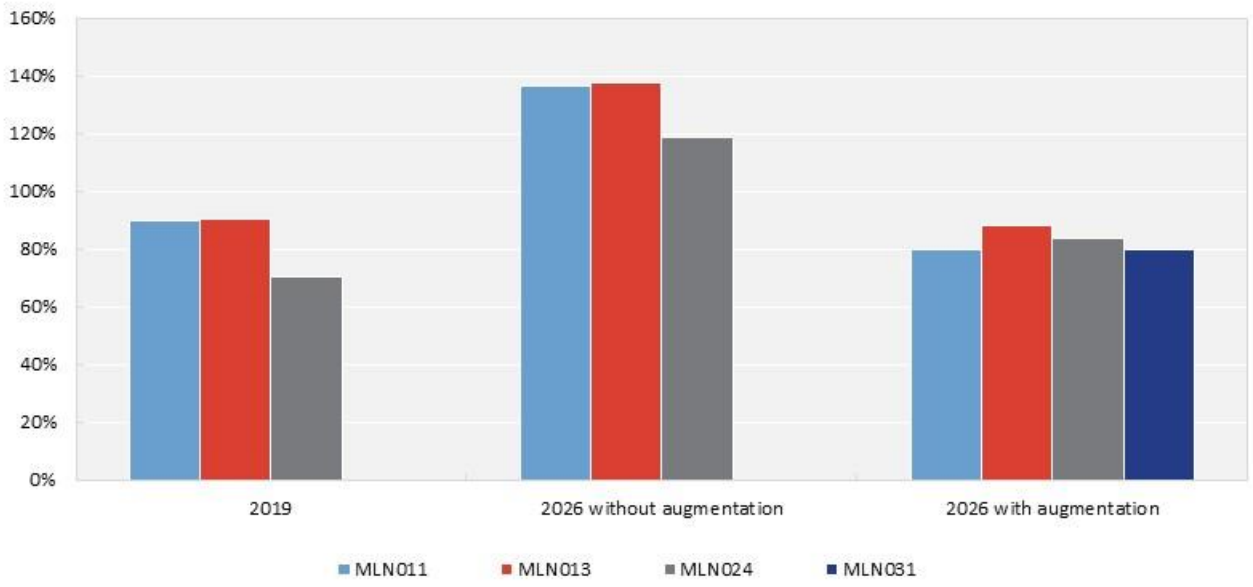
**Table 3.8 Feeder options ($ million, 2019)**

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the MLN011, MLN013 and MLN024 feeders | 3.9 |
| MLN031 new feeder to offload MLN011, MLN013 and MLN024 | 1.5 |

Source: Powercor

The lowest cost option is to build the new MLN031 22kV feeder in 2025/26. The project will eliminate the MLN011, MLN013 and MLN024 feeder constraints, and make provision for further load growth. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.4.

Figure 3.4 Forecast feeder utilisations




Source: Powercor

A demand side initiative to reduce the forecast maximum demand load by 2.5MVA on MLN011 would defer the need for this capital investment by one year.

### 3.4.2 MLN034 new feeder to offload MLN012 and MLN022

MLN012 and MLN022 feeders are two of nine 22kV feeders supplying the area surrounding MLN zone substation. The limitations on these feeders are thermal, and due to continued residential and commercial development in Melton and surrounding suburbs.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.9.

Table 3.9 Capacity and duration of unserved load above the thermal rating during system normal conditions

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| MLN012 | 2.1 | 31 |
| MLN022 | 5 | 111 |

Source: Powercor

The MLN014, MLN021 and MLN023 feeders that have ties with MLN012 and MLN022 are also forecast to have their loads exceed their planning rating by 2025/2026. Hence, there is no opportunity to transfer loads to adjacent feeders.

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the network solutions in table 3.10 to manage the unserved load.

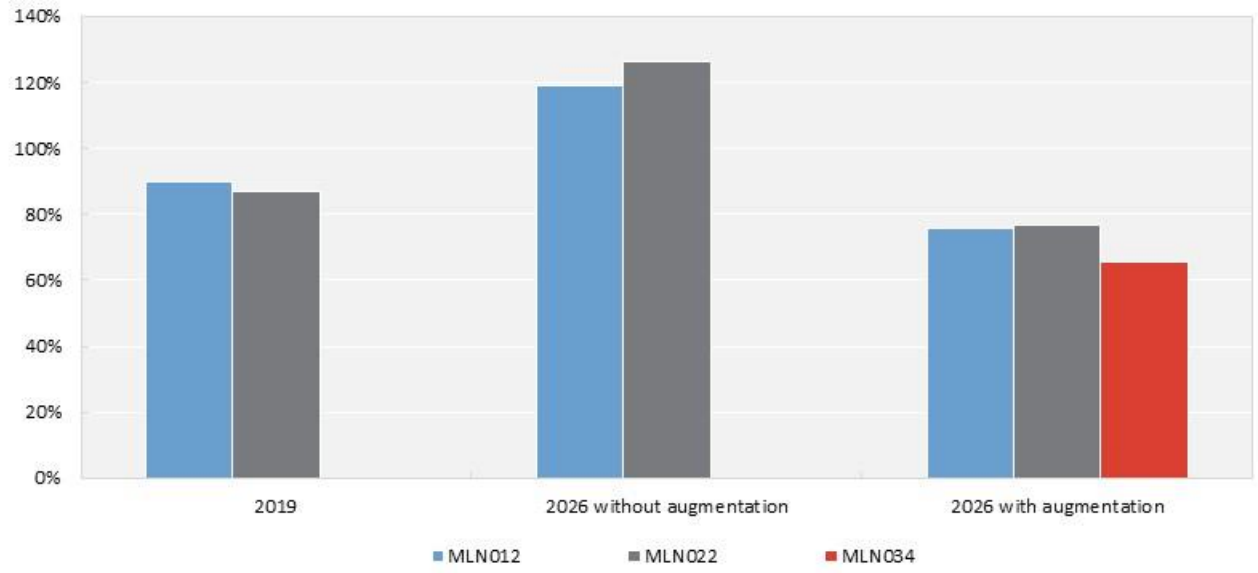
Table 3.10 Feeder options ($ million, 2019)

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the MLN012 and MLN022 feeders | 3.9 |
| MLN034 new feeder to offload MLN012 and MLN022 | 1.5 |

Source: Powercor

The lowest cost option is to build the new MLN034 22kV feeder in 2022/23. This project resolves the MLN012 and MLN022 feeder constraints, and allows for further load growth. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.5.

Figure 3.5 Forecast feeder utilisations




Source: Powercor

A demand side initiative to reduce the forecast maximum demand load by 1MVA on MLN012 and 1.2MVA on MLN022 would defer the need for this capital investment by one year.

## 3.5 Truganina zone substation

The Truganina (**TNA**) zone substation supplies the domestic and commercial areas of Truganina, Caroline Springs, Taylor Lakes, Mt Cottrell, Derrimut, Laverton North, Tarneit, Wyndham Vale, Werribee, Hoppers Crossing. It comprises two 25/33MVA transformers, operating at 66/22kV.

### 3.5.1 TNA012 and TNA031 new feeders

The TNA013, TNA021 and TNA023 feeders are three of six 22kV feeders supplying the areas of Caroline Springs, Truganina, Werribee, Wyndham Vale, Hoppers Crossing, Tarneit, Mt Cottrell, and Derrimut. The limitations on these feeders are thermal constraints, due to continued green-field residential and commercial development.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.11.

Table 3.11 Capacity and duration of unserved load above the thermal rating during system normal conditions

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| TNA013 | 3.1 | 38 |
| TNA021 | 2.9 | 17 |
| TNA023 (summer) | 9.6 | 195 |
| TNA023 (winter) | 5.1 | 49 |

Source: Powercor

There is limited 22kV system capacity to offload TNA013, TNA023 and TNA021 (due to adjacent zone substation loading constraints, as well as the feeder thermal restrictions).

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the solutions in table 3.12 to manage the unserved load.

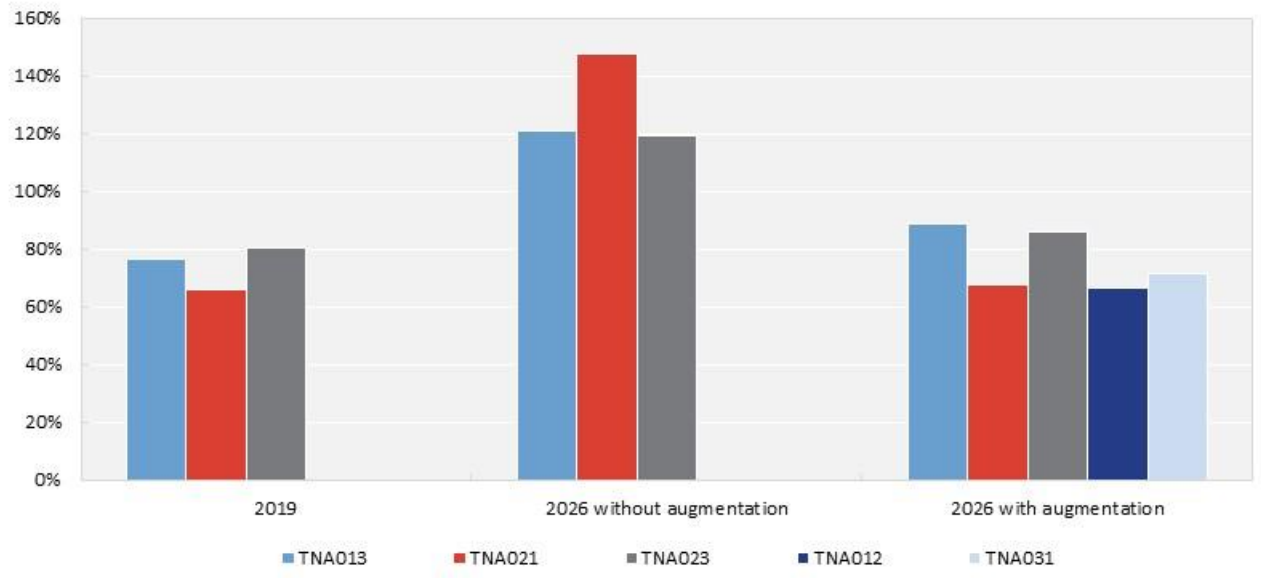
Table 3.12 Feeder options ($ million, 2019)

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the TNA013, SA009, SA011, LV004 and LV009 feeder exits and backbones | 5.9 |
| TNA012 and TNA031 new feeders | 4.8 |

Source: Powercor

The lowest cost option is to install new TNA031 and TNA012 feeders in 2022/23. This project will eliminate the TNA021, TNA013 and TNA023 feeder constraints, and allow for further load growth. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.6.

Figure 3.6 Forecast feeder utilisations




Source: Powercor

A demand side initiative to reduce the forecast maximum demand load by 3MVA on TNA013 and 2MW on TNA021 feeder in 2021 would defer the need for this capital investment by one year.

## 3.6 Werribee zone substation

The Werribee (**WBE**) zone substation supplies the domestic and commercial areas of Werribee, Wyndham Vale, Hoppers Crossing, Tarneit, Point Cook. It comprises two 20/33MVA and one 25/33MVA transformers operating at 66/22kV.

### 3.6.1 Re-direct WBE012 and WBE032 feeders into Point Cook

WBE013, WBE024 and WBE034 feeders are three of twelve 22kV feeders supplying the area surrounding WBE zone substation. There are thermal limitations on these feeders due to continued greenfield residential and commercial development in Point Cook, Werribee, Hoppers Crossing and surrounding areas.

Our estimate of the forecast capacity and duration of unserved load on these feeders in summer 2025/2026 is set out in table 3.13.

**Table 3.13 Capacity and duration of unserved load above the thermal rating during system normal conditions**

| Feeder | Unserved load (MVA) | Unserved load (hours) |
|---|---|---|
| WBE013 | 5.1 | 59 |
| WBE024 | 5.0 | 36 |
| WBE034 | 1.6 | 12 |

Source: Powercor

The WBE033, LV003 and LV004 feeders that have ties with WBE013, WBE024 WBE034 are also forecast to have loads exceed their rating by 2021. Hence, there is no opportunity to transfer loads to adjacent feeders.

Given these load forecasts, we will not be able to supply all customers during high load periods. To address the anticipated system constraints, we considered the solutions in table 3.14 to manage the unserved load.

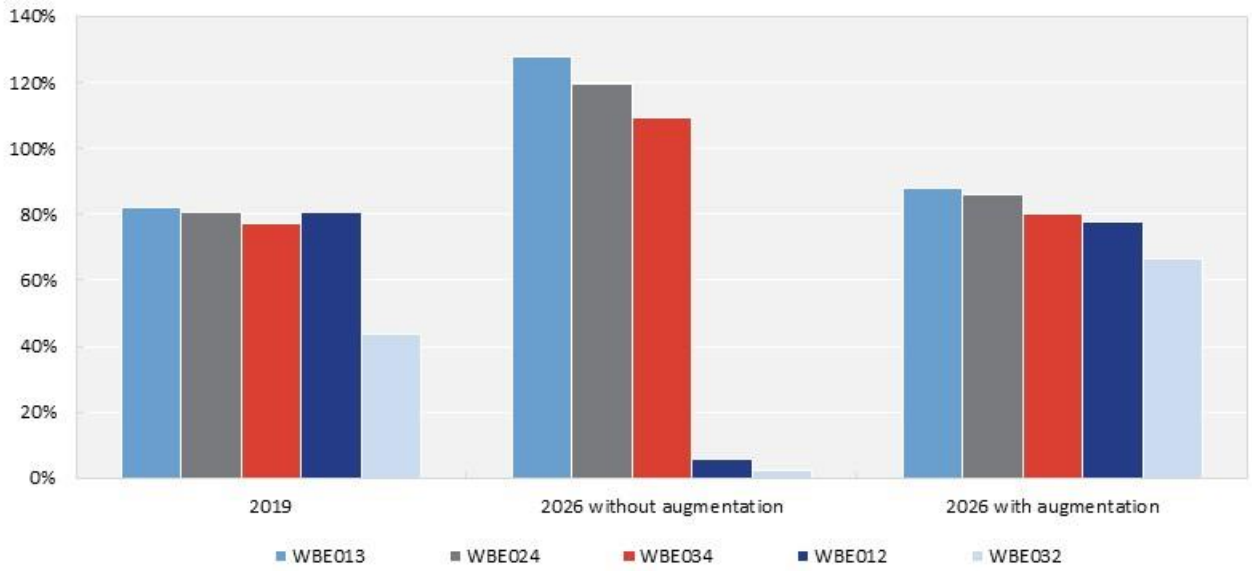
**Table 3.14 Feeder options ($ million, 2019)**

| Option | Cost |
|---|---|
| Upgrade/thermally uprate the WBE034, LV003, LV004, LV010 and LV006 feeder exits and backbones | 6.0 |
| Re-direct WBE012 and WBE032 feeders into Point Cook | 3.1 |

Source: Powercor

The lowest cost option is to re-direct the existing WBE012 and WBE032 feeders into Point Cook in 2021/22. These feeders are already subject to an offloading project in 2020 (following two new feeders at our TNA zone substation), so will have sufficient capacity available to eliminate the WBE013, WBE024 and WBE034 feeder constraints, and allow for further load growth. A summary of the forecast feeder utilisations with and without this option are shown in figure 3.7.

**Figure 3.7 Forecast feeder utilisations**




Source: Powercor
Note: In 2020, two new feeders (TNA022 and TNA032) will offload WBE012 and WBE032; hence, utilisation on these feeders will fall under the 'without augmentation' scenario.

A demand side initiative to reduce the forecast maximum demand load by 1MVA on WBE013 feeder would defer the need for this capital investment by one year.