Malvern supply area

UE BUS 6.03

Regulatory proposal 2021–2026

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Contents

1 Overview

The Malvern supply area services customers in Caulfield, Carnegie, Glen Iris, Glen Huntly, Malvern and Malvern East. Electricity in this area is provided by zone substations at Caulfield (**CFD**), East Malvern (**EM**) and Gardiner (**K**).

Each zone substation in the Malvern supply is forecast to exceed its N-1 summer cyclic rating. Further, several of the feeders servicing the area are heavily utilised and/or forecast to be overloaded in the next five years. This follows continued commercial growth and residential in-fill projects.

This business case assesses options to support the growing electricity demand in the Malvern supply area. Our preferred network option to address the identified need includes the following:

- install a new 11kV switchboard at our EM zone substation
- establish three new feeders at our EM zone substation, and reconfigure the existing network.

The forecast capital and operating expenditure requirements for the preferred network option are outlined in table 1. These forecasts have been developed in calendar year terms, and converted to financial years in our consolidated expenditure modelling following changes to our reporting period (as required by the Victorian Government and the Australian Energy Regulator).

Table 1 Expenditure forecasts for preferred option ($ million, 2019)

Expenditure forecast	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capital expenditure	-	4.07	3.14	-	-	7.22
Operating expenditure	-	-	0.04	0.07	0.07	0.18
Total	**-**	**4.07**	**3.18**	**0.07**	**0.07**	**7.40**

Source: United Energy
Note: Numbers may not add due to rounding

This project will also be subject to assessment as required under the regulatory investment test for distribution (**RIT-D**). We will initiate consultation well before the economic timing of the preferred network option in order to maximise the chance of a viable non-network solution being identified.

2 Background

The Malvern supply area provides electricity supply to approximately 40,000 customers in the Caulfield, Carnegie, Glen Iris, Malvern and East Malvern areas (as shown in figure 1). These customers are predominantly residential, with a mix of small to large commercial establishments including Cabrini Hospital, Caulfield Racecourse, Monash University Caulfield Campus and parts of the Chadstone Shopping Precinct.

Figure 1 Malvern supply area

Source: United Energy

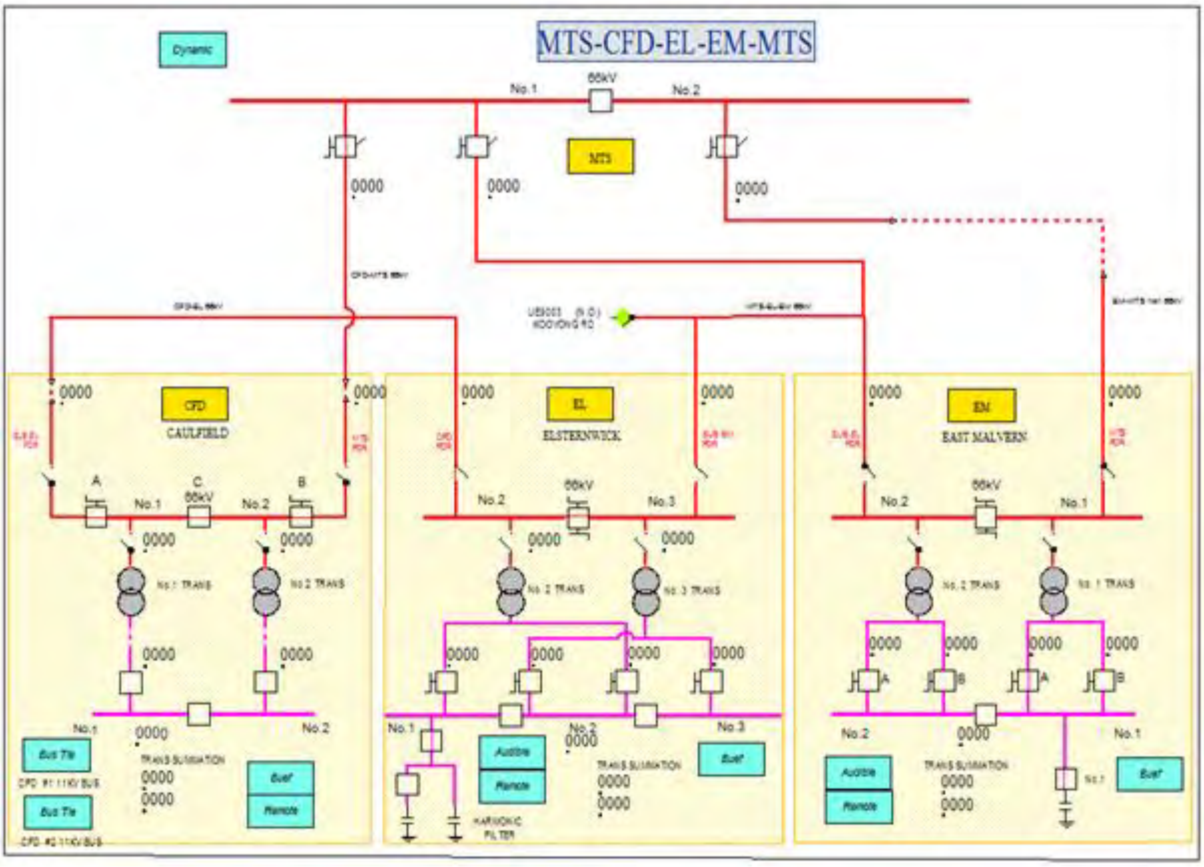
2.1 Existing network characteristics

2.1.1 Sub-transmission and zone substation

CFD zone substation was established in 2007 and comprises of two 20/33MVA transformers. EM zone substation was established in the 1960s and comprises of two 20/27MVA transformers. Both these zone substations are connected to the Malvern Terminal Station (**MTS**) in a loop with Elsternwick (**EL**) zone substation, forming the MTS-EM-EL-CFD-MTS sub-transmission loop (as shown in figure 2).

There are no 66kV sub-transmission line circuit breakers at EM. This means that a fault on one of the sub-transmission lines (which is predominantly an overhead network) will lead to an outage of one of the 66/11kV transformers until the transformer is manually switched into service by the field crew.

Figure 2 Sub-transmission network around CFD and EM

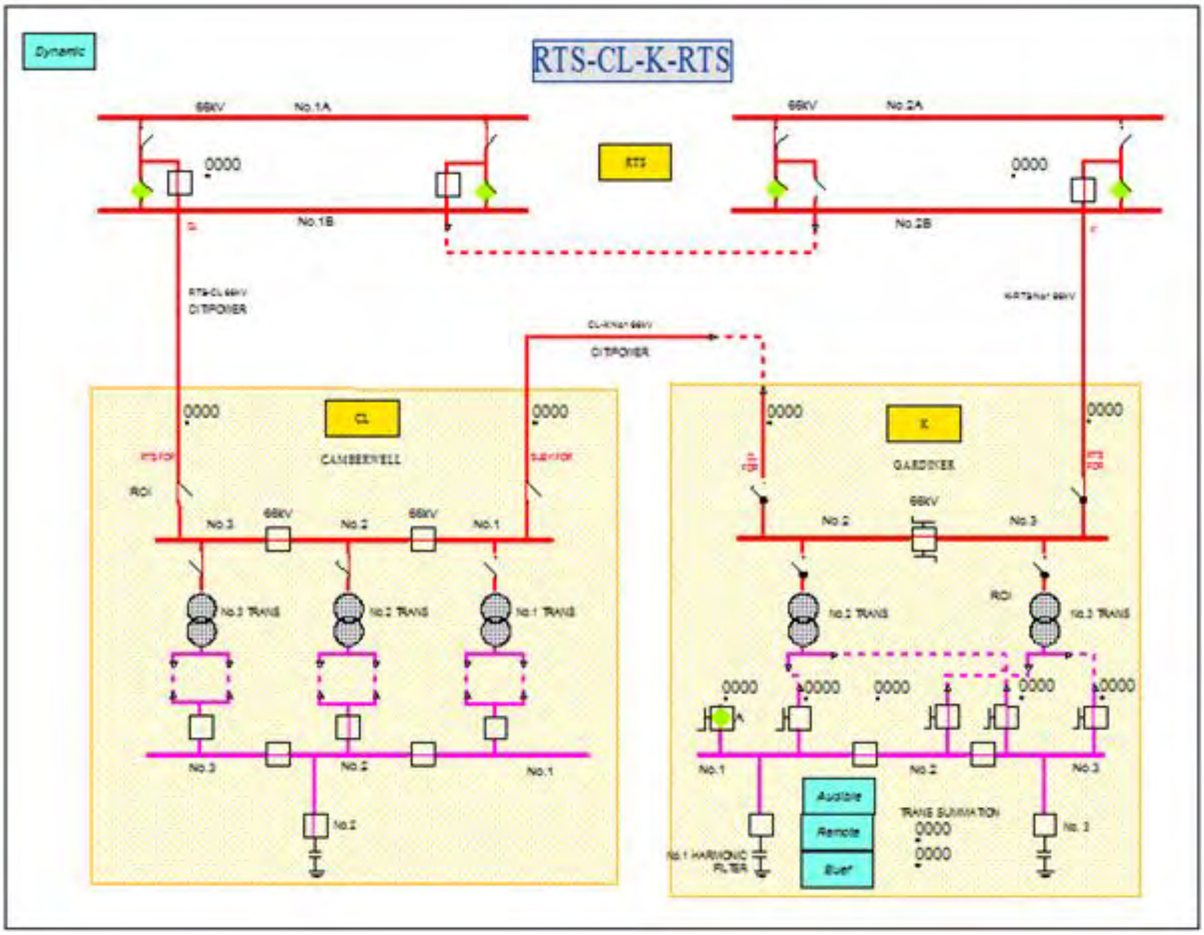


Source: United Energy

K zone substation was established in the 1960s and comprises of two 20/30MVA transformers and is connected to Richmond Terminal station (**RTS**) in a loop with CitiPower's Camberwell (**CL**) zone substation, forming the RTS-K-CL-RTS sub-transmission loop as shown in figure 3.

Similar to EM, there are no 66kV sub-transmission line circuit breakers at K. This means a fault on one of the sub-transmission lines (which is predominantly overhead network and therefore more prone to faults) will lead to an outage of one of the 66/11kV transformers until the transformer is manually switched into service by the field crew.

Figure 3 Sub-transmission network around K



Source: United Energy

2.1.2 Distribution feeders

CFD zone substation has 12 distribution feeders that supply customers from Caulfield to Glen Huntly. Three of these feeders are 'jumbo' feeders, where two feeders emanate from one circuit breaker. There are no spare 11kV circuit breakers to establish new feeders.

EM zone substation has 10 distribution feeders that supply customers from Malvern East to Chadstone. Jumbo feeders are not feasible at EM as the existing 11kV circuit breakers are rated at 400A. There are no spare 11kV circuit breakers to establish new feeders.

K zone substation has 12 distribution feeders that supply customers from Malvern to Glen Iris. Similar to EM, jumbo feeders are not feasible due to the existing circuit breaker ratings, and there are no spare 11kV circuit breakers to establish new feeders.

UE also takes supply from CitiPower’s distribution network, being Armadale (**AR**) and Riversdale (**RD**) zone substations.

2.2 Planning approach

We apply a probabilistic approach to planning our zone substation, sub-transmission and primary distribution feeder asset augmentations. This approach involves estimating the probability of an outage occurring within the peak loading season, and weighting the costs of such an occurrence by its probability to assess:

- the expected cost that will be incurred if no action is taken to address an emerging constraint, and therefore
- whether it is economic to augment the network capacity to reduce expected supply interruptions.

The quantity and value of energy at risk is a critical parameter in assessing a prospective network investment or other action in response to an emerging constraint. Probabilistic network planning aims to ensure that an economic balance is struck between:

- the cost of providing additional network capacity to remove constraints
- the cost of having some exposure to loading levels beyond the network's capability.

In other words, recognising that very extreme loading conditions may occur for only a few hours in each year, it may be uneconomic to provide additional capacity to cover the possibility that an outage of an item of network plant may occur under conditions of extreme loading. The probabilistic approach requires expenditure to be justified with reference to the expected benefits of lower unserved energy.

3 Identified need

The identified need is to maintain a reliable supply of electricity to customers in the Malvern supply area as the level of energy at risk on the existing infrastructure continues to grow over time. The level of energy at risk is discussed below.

3.1 Forecast demand

CFD, EM and K are summer critical zone substations. Growth in maximum demand is expected to increase in the coming years at average annual rates of 1.3%, 1.8% and 1.7% respectively.

The growth in demand in the Malvern supply area is due to the following:

- the expansion of Coles Headquarters (+1.3MVA in 2019), supplied from K
- new high-density residential developments surrounding the Caulfield Racecourse, supplied from CFD
- conversion of low-density dwellings into high-density luxury style townhouses, apartments and retirement complexes.

The drivers of electricity maximum demand growth in the Malvern supply area are further discussed in appendix A. This appendix highlights before and after images of the growing urban landscape at key sites.

3.1.1 Zone substation maximum demand

As shown in figure 4, figure 5 and figure 6, weather-corrected maximum demands at CFD, EM and K all exceeded the N-1 ratings at their respective zone substations (under 10% probability of exceedance (**PoE**) weather conditions).[1] Historical actual maximum demands also exceeded, or were near exceeding the relevant N-1 summer ratings.

[1] PoE refers to weather in any given summer exceeding the specified reference level (or the percentile) based on the last 50 years of historical weather data.

Figure 4 CFD zone substation maximum demand forecast at 10% probability of exceedance (MVA)

Source: United Energy

Figure 5 EM zone substation maximum demand forecast at 10% probability of exceedance (MVA)

Source: United Energy

Figure 6 K zone substation maximum demand forecast at 10% probability of exceedance (MVA)

Source: United Energy

3.1.2 Feeder utilisation

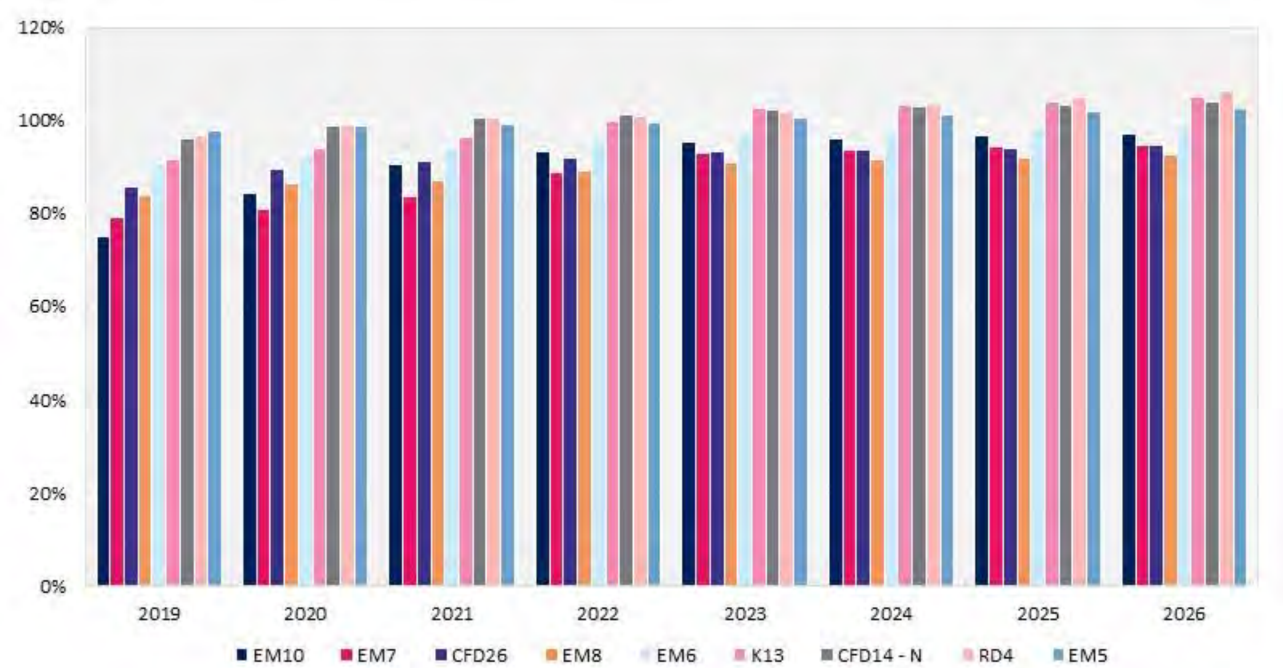
Several feeders from CFD, EM and K are forecast to exceed, or become close to exceeding, their respective utilisation ratings in the near term—for example, over the next five years:

- two of the CFD feeders are forecast to be heavily loaded, with one feeder forecast to become overloaded
- five of the EM feeders are forecast to be heavily loaded, with one feeder forecast to become overloaded
- one of the K feeders is forecast to be overloaded.

The ability to manage supply during both system-normal conditions and during emergencies (i.e. loss of a feeder due to unplanned faults) is further limited by the high utilisation of neighbouring feeders. In particular, one of CitiPower's Riversdale feeders (which supplies UE customers) is also forecast to become overloaded in the next five years due to diminished load transfer options.

A summary of the utilisation forecasts for key distribution feeders is shown in figure 7.

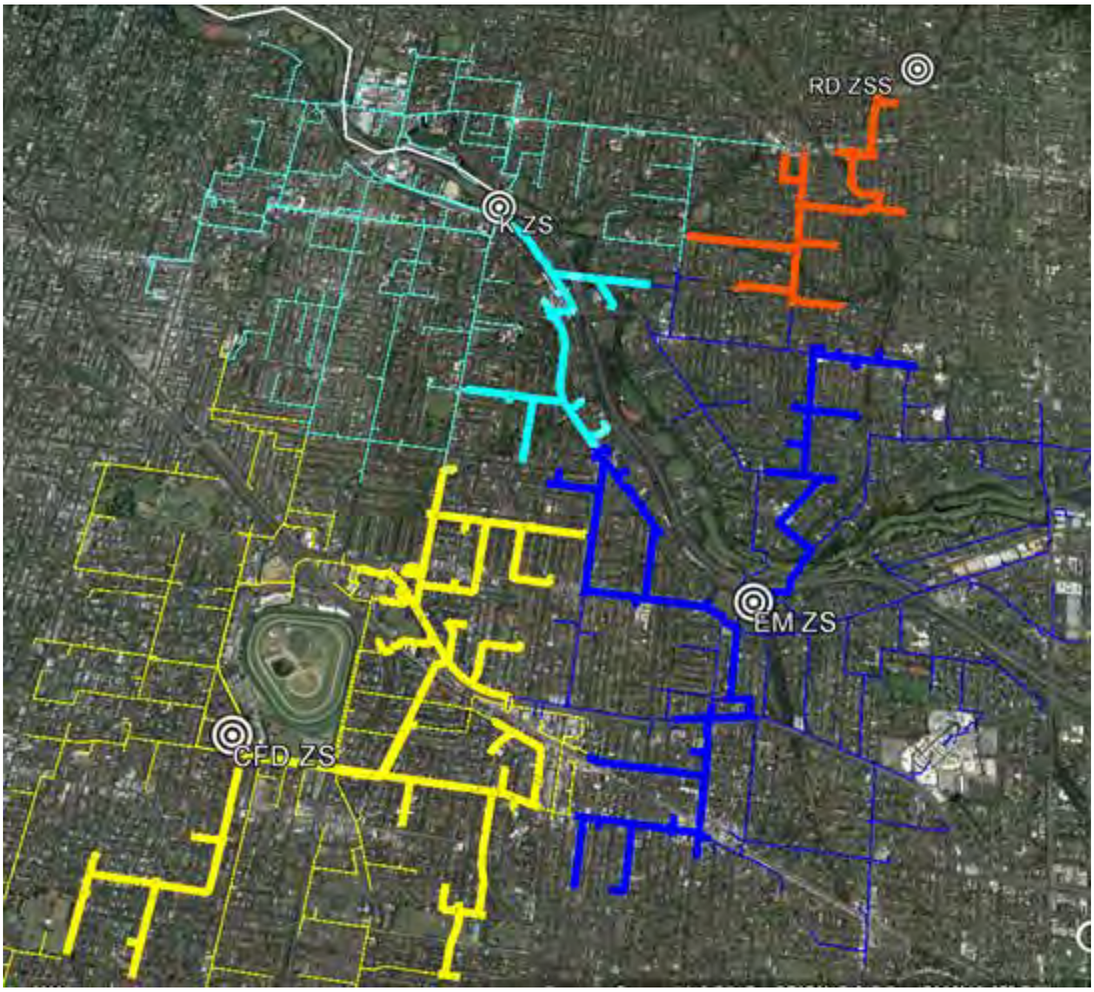
Figure 7 Feeder utilisation: ratio of maximum load to feeder summer cyclic rating (%)



Source: United Energy

The extent of the distribution feeders emanating from our CFD, EM and K zone substations are also presented in figure 8. The thicker lines show feeders that are presently heavily loaded, and forecast to become overloaded in the next five years.

Figure 8 Heavily loaded feeders in the Malvern supply area



Source: United Energy

3.1.3 Sub-transmission network maximum demand

In addition to the zone substation and distribution feeder constraints, the RTS-K-CL-RTS sub-transmission loop has also been operating above its N-1 rating since the 2014–2015 summer (on a weather-corrected basis).

3.2 Energy at risk

Consistent with our probabilistic planning approach, the quantity and value of energy at risk is a critical parameter in assessing a prospective network investment or other action in response to an emerging constraint.

3.2.1 Load transfer capacity

The available load transfer capacity between CFD, EM, K and surrounding zone substations is assessed to be 13MVA, 6MVA and 8MVA respectively during the 2018–2019 summer (as shown in the attached business case model).[2] With forecast demand growth on the feeders in this area, the available load transfer capability is

[2] UE MOD 6.06 - EM supply area - Jan2020 - Public.

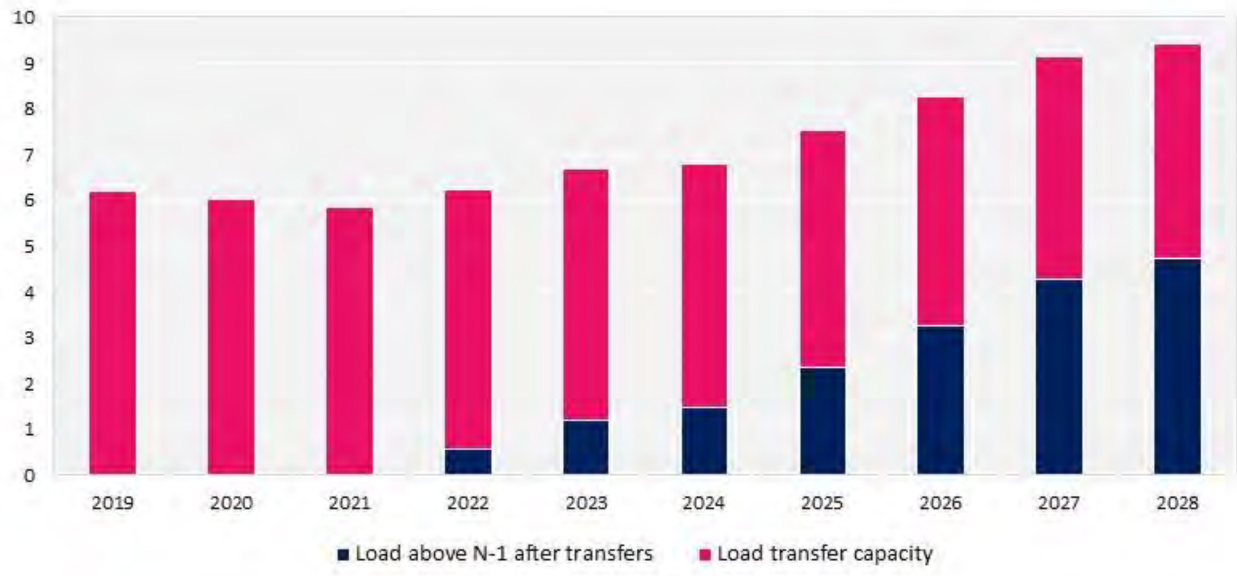
expected to reduce further. This will leave more customers exposed to the risk of supply interruptions for longer periods of time.

The expected load above N-1 after transfers following a major outage at either of the CFD, EM or K transformers during peak demand conditions is shown in the figures below. After load transfers are established, shortfalls in capacity of approximately 9MVA, 5MVA and 10MVA respectively are forecast in 2028 (or loss of supply for a total of 10,000 customers).

Figure 9 CFD zone substation: load above N-1 after transfers (MVA)

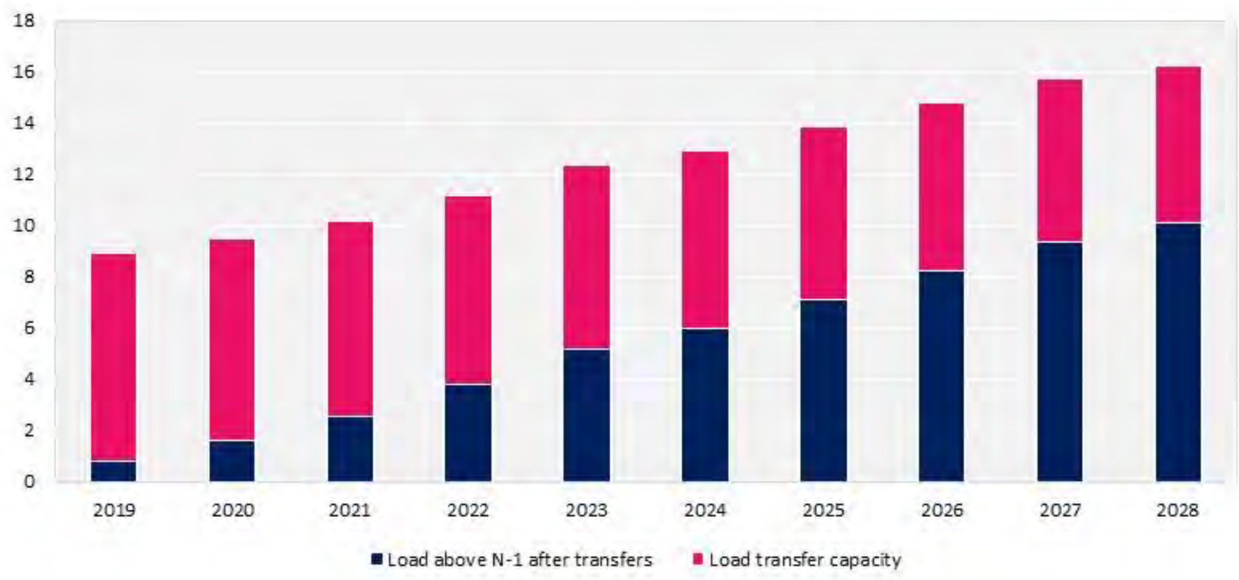
Source: United Energy

Figure 10 EM zone substation: load above N-1 after transfers (MVA)



Source: United Energy

Figure 11 K zone substation: load above N-1 after transfers (MVA)



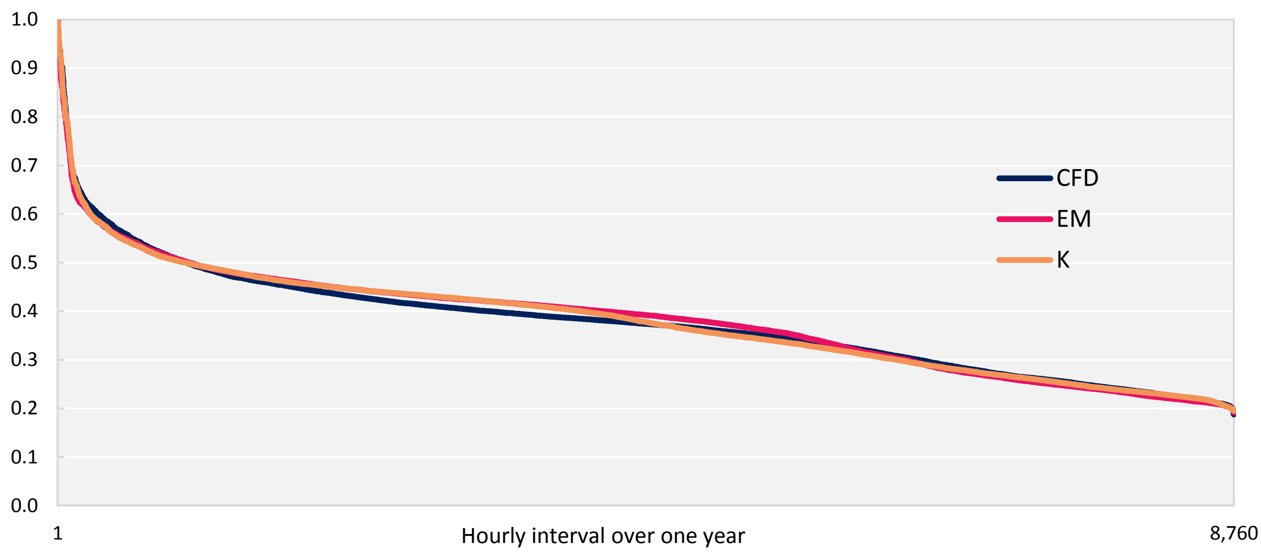
Source: United Energy

3.2.2 Energy at risk after load transfers

Our approach for calculating energy at risk is consistent with the probabilistic approach applied by the Australian Energy Market Operator (**AEMO**) to plan the Victorian shared transmission network.

A load-duration curve, based on historical load data, is used to determine the amount of energy at risk over the N and N-1 ratings each year. The load-duration curves for our CFD, EM, K zone substations are shown in figure 12.

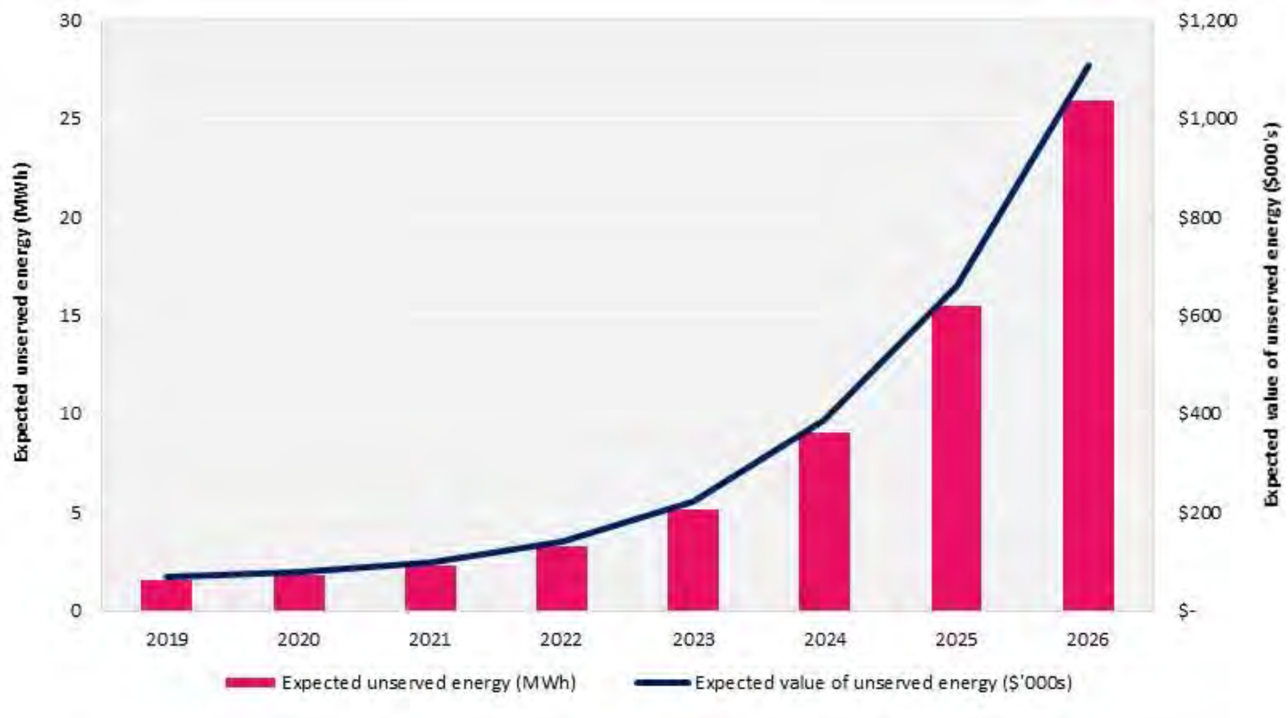
Figure 12 Load-duration curve (percentage of maximum demand)



Source: United Energy

The energy at risk is weighted by the probability of an outage to determine the expected unserved energy. The expected unserved energy is estimated using a 30:70 weighting of the 10% PoE and 50% PoE. The expected unserved energy and value of unserved energy (under a 'do-nothing' scenario) is shown in figure 13.

Figure 13 Do-nothing scenario: expected unserved energy (MWh) and value of unserved energy ($'000s)



Source: United Energy

Figure 13 demonstrates that the expected unserved energy levels for the supply area will increase significantly from current levels. This will result in deteriorating reliability of supply for the customers in this area, particularly during hot summer days. This business case demonstrates there is an identified need and an economic case to invest in the area to maintain reliability of supply at current levels.

4 Options analysis

Several options were considered to address the identified need in the Malvern supply area. These options address the identified need to varying extents, and as such, the preferred option is that which maximises the net economic benefits. This assessment of net economic benefits is presented relative to a 'do-nothing' scenario.

As shown in table 2, the preferred network solution is option one—install three new feeders at EM and permanently offload the heavily utilised distribution feeders in this area.

Table 2 Summary of net economic benefits ($ million, 2019)

	Option	Net economic benefits
Do-nothing	Maintain the status-quo	-
1	Install new switchboard and three new feeders at EM	17.96
2	Install third EM transformer with three new feeders	16.86
3	Install two new feeders at K and one new feeder at OR	9.35
4	Non-network solution to defer preferred network option	17.93
5	Power factor correction	N/A

Source: United Energy

The options considered are discussed in further detail below. The analysis supporting our assessment of alternative options, including relevant assumptions, is included in the attached model.[3]

4.1 Assessment of credible options

4.1.1 Do-nothing: maintain the status-quo

Maintaining the status quo—that is, continuing to supply customers within the Malvern supply area without any intervention to manage energy at risk—will lead to significant supply interruptions. This option, therefore, fails to address the identified need (as set out in section 3).

4.1.2 Option one: install new switchboard and three feeders at EM

This option proposes to install a new 11kV switchboard and three new distribution feeders at our EM zone substation, and reconfigure the network.

EM zone substation is centrally located to the forecast feeder constraints, and has less energy at risk than our CFD or K zone substations. The new feeders and network reconfiguration will address the forecast feeder constraints at CFD, EM, K and RD. By permanently offloading both CFD and K, it also reduces the forecast risk at CFD and K zone substations, as well as the two sub-transmission loops (being RTS-K-CL-RTS and MTS-EM-EL-CFD-MTS).

The scope of works for this option includes:

- installing a new 11kV indoor switchboard

3 UE MOD 6.06 - EM supply area - Jan2020 - Public.

- installing new transformer cables and terminating onto the new 11kV switchboard
- establishing three new distribution feeders and re-arranging the network.

A breakdown of the costs for this option is available in our Reset Regulatory Information Notice.[4]

This option addresses the identified need, and maximises the net economic benefits relative to other credible options. A summary of the market benefits and costs of this option relative to the do-nothing option is shown in table 3.

Table 3 Option one: benefits assessment summary ($million, 2019)

Option	NPV costs	NPV benefits	Net economic benefits
Install new switchboard and three feeders at EM	-3.61	21.57	17.96

Source: United Energy

4.1.3 Option two: install third EM transformer with three new feeders

This option is similar to option one, but also includes the installation of a third transformer at our EM zone substation to further reduce the energy at risk. The scope of works for this option includes the following:

- installing a new #3 66kV bus
- installing a new 2-3 66kV bus tie circuit breaker
- cutting in the MTS-EM/EL 66kV line to the new #3 bus
- installing a new #3 20/33MVA 66/11kV transformer
- installing a new 11kV indoor switchboard
- installing new transformer cables and terminating onto the new 11kV switchboard
- establishing three new distribution feeders and re-arranging the network.

A summary of the market benefits and costs of this option relative to the do-nothing option is shown in table 4.

Table 4 Option two: benefits assessment summary ($million, 2019)

Option	NPV costs	NPV benefits	Net economic benefits
Install third EM transformer with three new feeders	-4.72	21.58	16.86

Source: United Energy

4.1.4 Option three: install two new feeders at K and one feeder at OR

Another alternative we considered to address the identified need is establishing new feeders at zone substations adjacent to EM, including K and Ormond (**OR**) zone substation. The scope of works for this option, therefore, includes:

- installing a new 11kV indoor switchboard at K

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[4] UE RIN001 - Workbook 1 - Forecast templates - Jan2020 - Public, template 2.3(a).

- establishing two new distribution feeders at K
- establishing one new distribution feeder at OR.

A summary of the market benefits and costs of this option relative to the do-nothing option is shown in table 5. This option is considered less optimal than option two for the following reasons:

- it has lower net economic benefits
- it requires feeders to cross the Monash Freeway, which increases cost and reduces the distribution feeder benefits due to lower feeder ratings (i.e. there are no spare conduits across the Monash Freeway, and crossings must be at significant depths which de-rates the new feeders);
- increases the risk on the RTS-K-CL-RTS lines by having additional load at K
- increases the risk at K by having additional load.

Table 5 Option three: benefits assessment summary ($million, 2019)

Option	NPV costs	NPV benefits	Net economic benefits
Install two new feeders at K and one feeder at OR	-3.14	12.49	9.35

Source: United Energy

4.1.5 Option four: non-network solution to defer preferred network option

This option considers the ability of a non-network solution to defer the preferred network option. For this assessment, we have estimated the cost of a non-network solution that would result in the energy at risk remaining at the same level as that forecast in the year immediately prior to the commissioning date of the preferred solution.

We have based the cost of a non-network solution on a benchmark rate of $87,000 per MW per annum. This rate is based on our recently implemented non-network solutions, and is supported by comparative analysis of other distributors experience provided by CutlerMerz.[5]

The estimated non-network support requirements to defer the new switchboard and three new feeders in the preferred network option are summarised in table 6 (based on the feeder loading levels). For example, a 2.1MW non-network solution would bring the feeder load at risk back to the previous year's level and defer by one year the need for the new switchboard and three new feeders. The magnitude of the required non-network support required to maintain this energy at risk level increases over time.

Table 6 Non-network support requirements (MW)

Year	2022	2023	2024	2025	2026
Non-network support	-	-	2.1	2.4	2.7

Source: United Energy

Based on the above, the full costs of a demand management solution is equal to the required network support multiplied by the benchmark rate, plus the annual costs of any residual unserved energy. In this case the net

5 CutlerMerz, Review of demand management unit rates, February 2019 (UE ATT102).

economic benefits of the demand management option are not as great as the preferred option, due in part to the lower residual unserved energy in the preferred option.

A summary of the market benefits and costs of this option relative to the do-nothing option is shown in table 7.

Table 7 Option four: benefits assessment summary ($million, 2019)

Option	NPV costs	NPV benefits	Net economic benefits
Non-network solution to defer preferred network option	-3.48	21.41	17.93

Source: United Energy

This analysis shows that the non-network solution fails to economically defer the project. Irrespective of this high-level assessment, this project will be subject to assessment as required under the RIT-D. In order to facilitate non-network solutions, we have already begun working with the community, retailers and non-network providers to seek out demand-side options to defer part or all of the preferred network solution. We will initiate consultation well before the economic timing of the preferred network option to maximise the chance of a viable non-network solution being identified.

4.1.6 Option five: power factor correction

Installing capacitor banks may be used to reduce reactive power, and as such, can sometimes be a cheaper alternative to defer augmentation. Pole-top capacitor banks, however, are already installed on the relevant feeders (such that they already operate close to unity power factor). Consequently, this option is not technically feasible as the network is fully compensated and further capacitors will not deliver any material load reduction. The economics of this option, therefore, have not been explored further.

4.2 Sensitivity analysis

A detailed sensitivity assessment was performed to assess the impact on the ranking of the options from varying the demand forecast, assumed discount rates, and the capital and operating expenditure forecasts. Two extreme scenarios were applied (equal to ±4% for demand forecasts, and ±10% for other variables), reflecting best and worst-case scenarios.[6]

The results found the ranking of the preferred option (option 1) remains unchanged in under the 'best-case' scenario. In the 'worst case' scenario, using a non-network solution to defer the third switchboard and 3 feeders by one year, marginally out ranks the preferred option due to the lower residual energy at risk and higher capital and operating costs of the preferred solution.

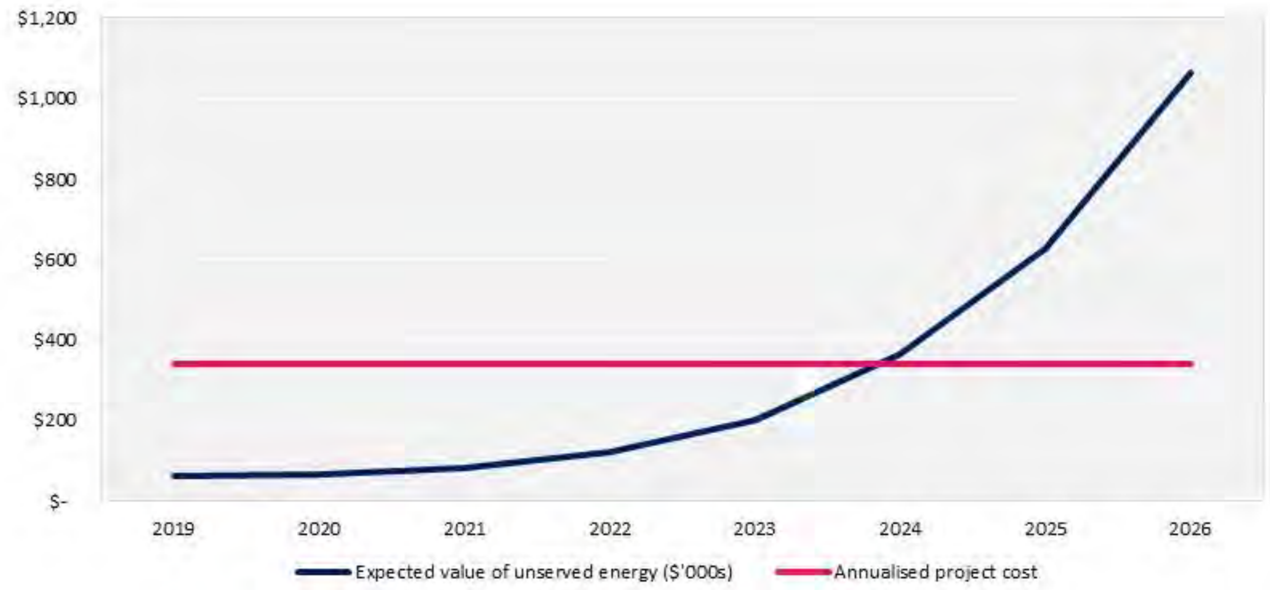
6 The sensitivity variance for demand forecasts (±4%) is consistent with the difference in growth between NIEIR's base, high and low forecast scenarios.

5 Recommendation

The preferred network option, as set out in section 4, is to install a new switchboard and three feeders at our EM zone substation, and reconfigure the distribution network to alleviate the forecast feeder constraints. This will also reduce the risk at a number of zone substations and sub-transmission loops which are forecast to operate above their N-1 ratings. The required changes to the EM zone substation and distribution feeder network are shown in appendix B.

A detailed economic assessment was performed to evaluate the optimum timing of the preferred network option. As shown in figure 14, the net market benefits of the preferred option exceed the annualised cost in 2024. This demonstrates that the optimal timing for commissioning the new switchboard and three feeders is before December 2023.

Figure 14 Timing assessment of the preferred option ($ million, 2019)



Source: United Energy

The forecast capital and operating expenditure requirements for the 2021–2026 regulatory period are outlined in table 8. These forecasts have been developed in calendar year terms, and converted to financial years in our consolidated expenditure modelling following changes to our reporting period (as required by the Victorian Government and the Australian Energy Regulator).

Table 8 Expenditure forecasts for preferred option ($ million, 2019)

Expenditure forecast	2021/22	2022/23	2023/24	2024/25	2025/26	Total
Capital expenditure	-	4.07	3.14	-	-	7.22
Operating expenditure	-	-	0.04	0.07	0.07	0.18
Total	**-**	**4.07**	**3.18**	**0.07**	**0.07**	**7.40**

Source: United Energy
Note: Numbers may not add due to rounding

A Malvern supply area demand growth

The demand growth in the Malvern supply area in recent years is supported by the series of figures below.

A.1 Caulfield Village Estate development

The Caulfield Village Estate residential development is currently under construction in three stages. The first stage was completed in 2017. The remaining two stages are expected to be completed in 2020. This development supports both commercial (retail) and high-density residential townhouses and apartments. The images below show the changes in Station Street, Caulfield.

Figure 15 Stage one of the Caulfield Village Estate development: before and current status

Figure 16 Overall development: before and current status

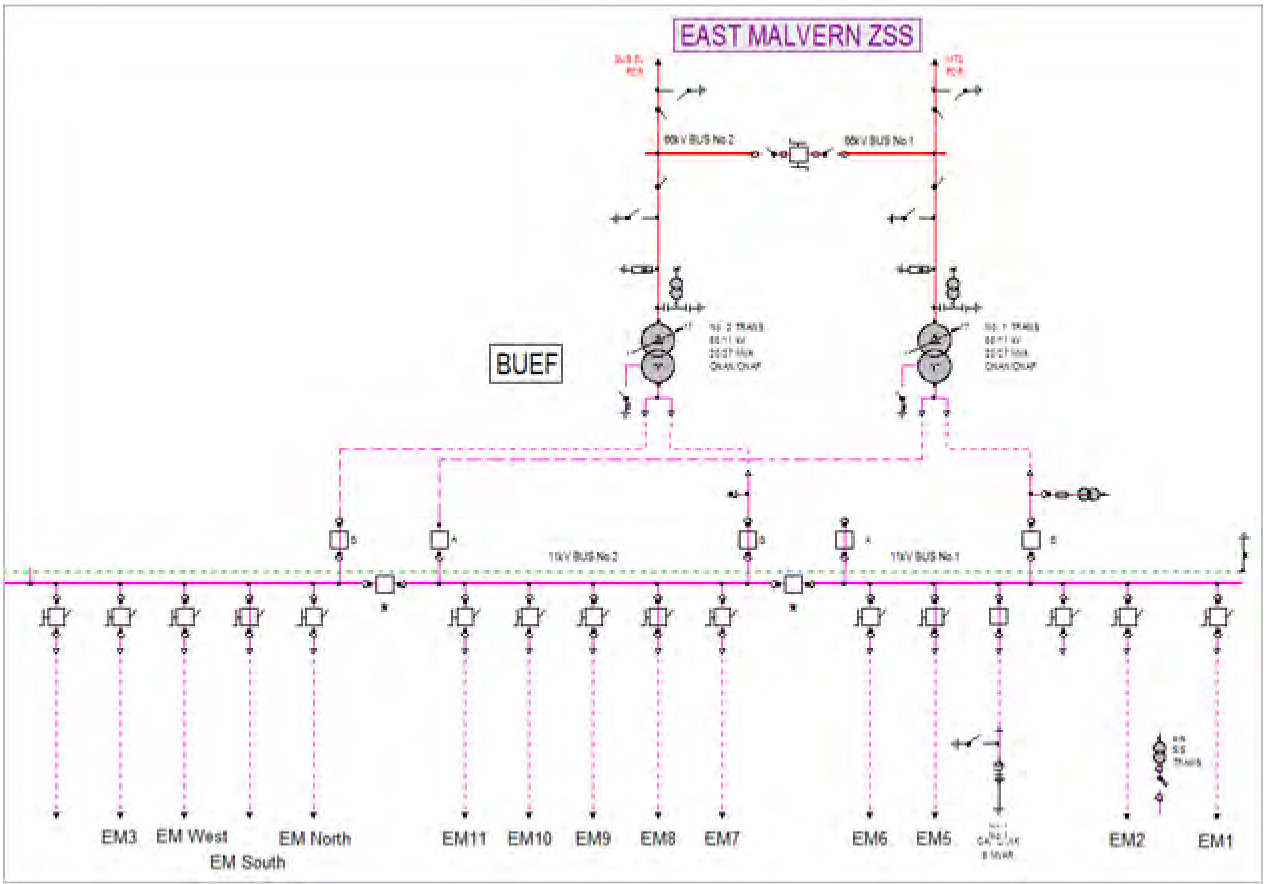
A.2 High-density residential developments

The Malvern supply area is well developed, and therefore, existing low-density housing stocks are being converted into high-density residential townhouses, apartments and retirement complexes. Such changes are visible in and around existing public transport hubs. Figure 17, below, provides an example of typical in-fill developments in Carnegie.

Figure 17 In-fill development in Carnegie: before and current status

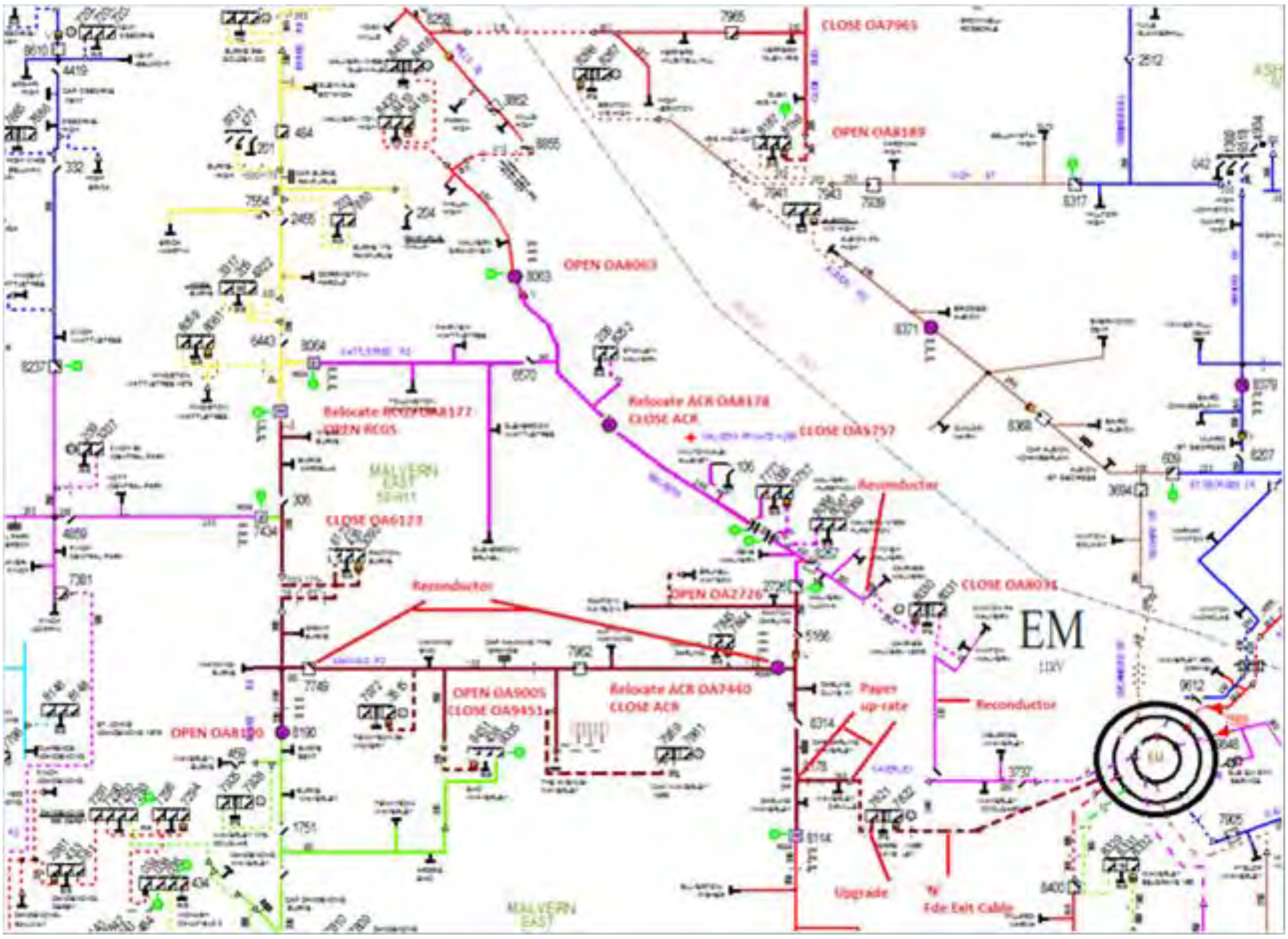
B Design of preferred option

Figure 18 Proposed EM zone substation arrangement



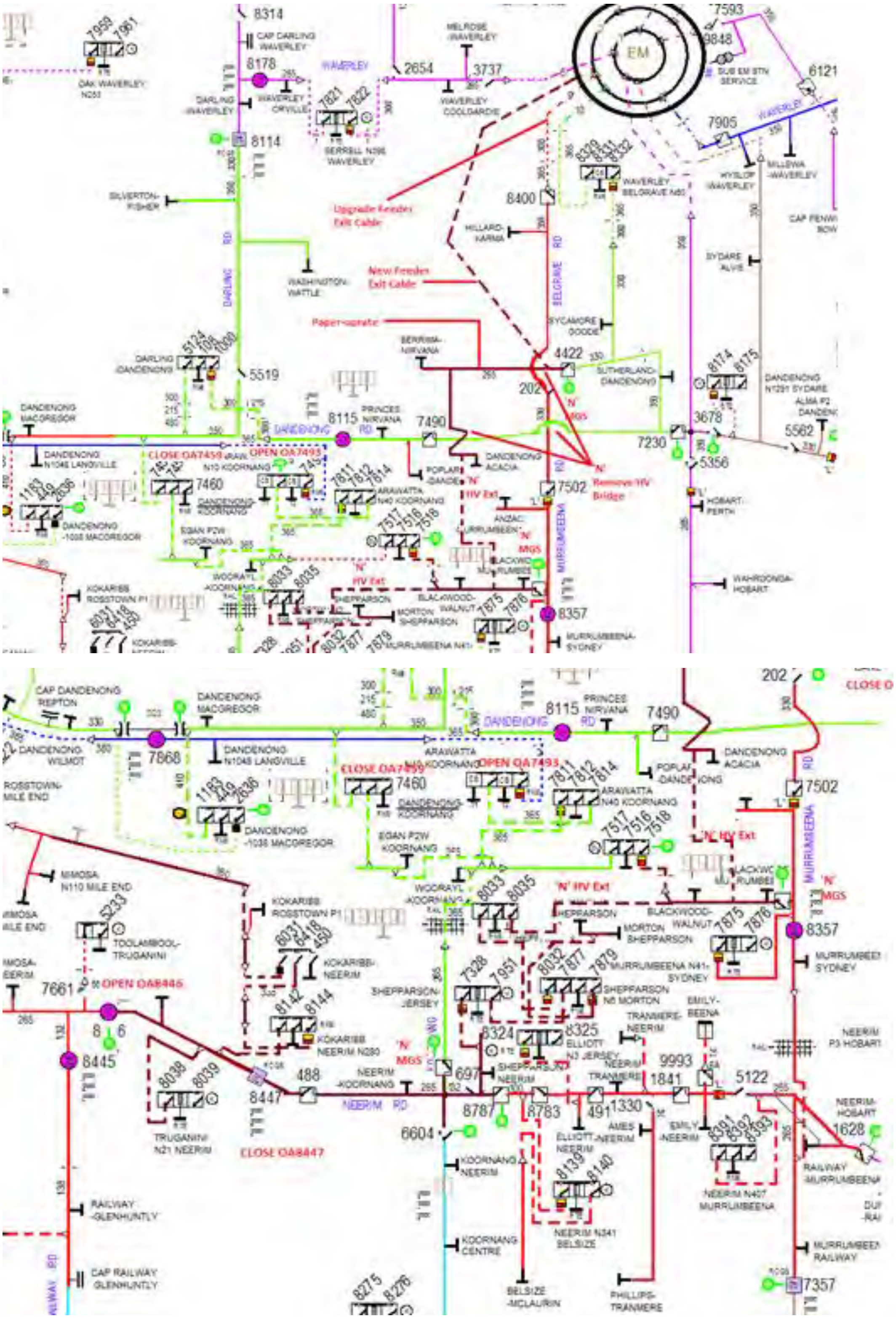
Source: Unitd Energy

Figure 19 Proposed EM feeders: EM west feeder



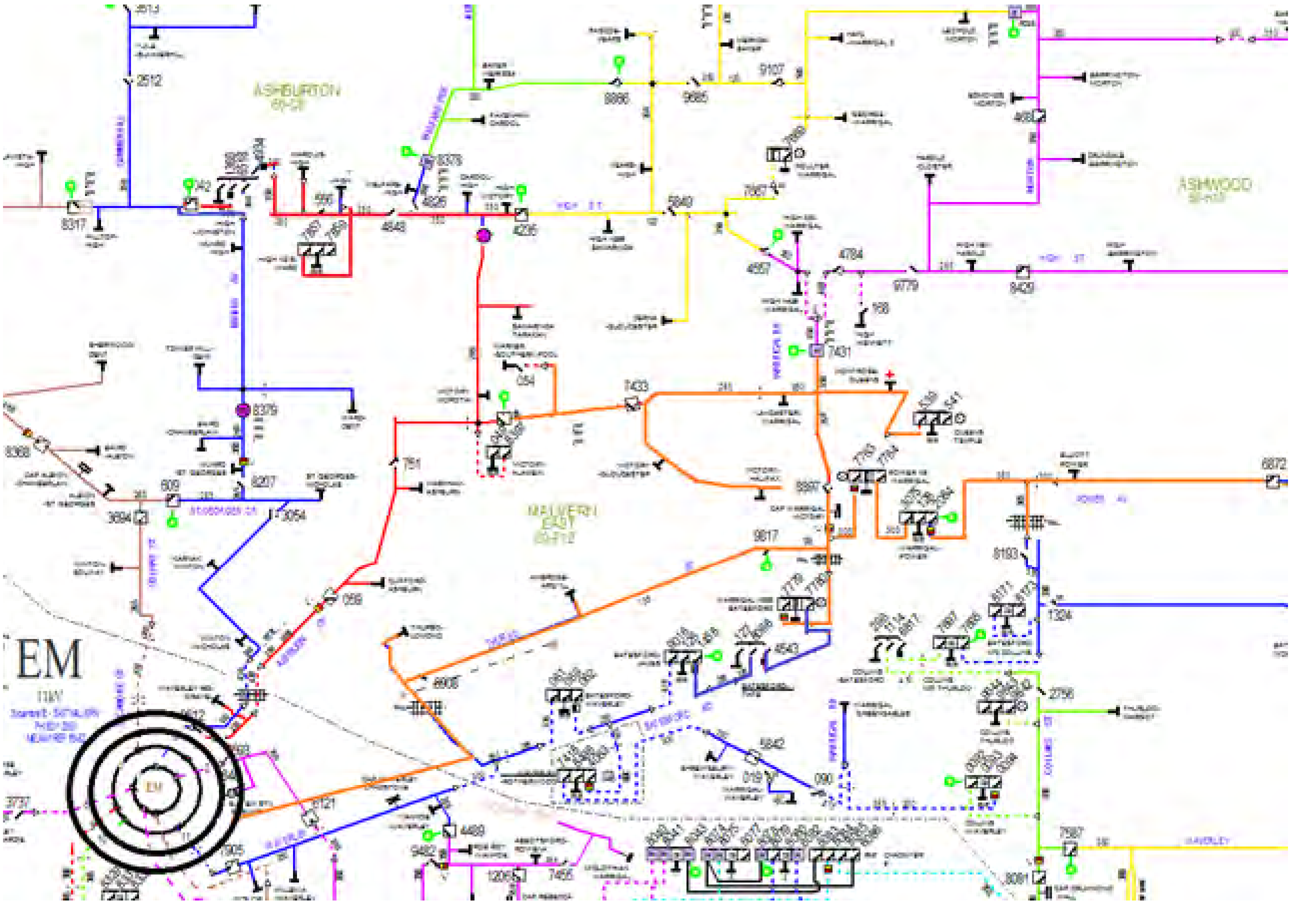
Source: United Energy

Figure 20 Proposed EM feeders: EM south feeder



Source: United Energy

Figure 21 Proposed EM feeders: EM north feeder



Source: United Energy