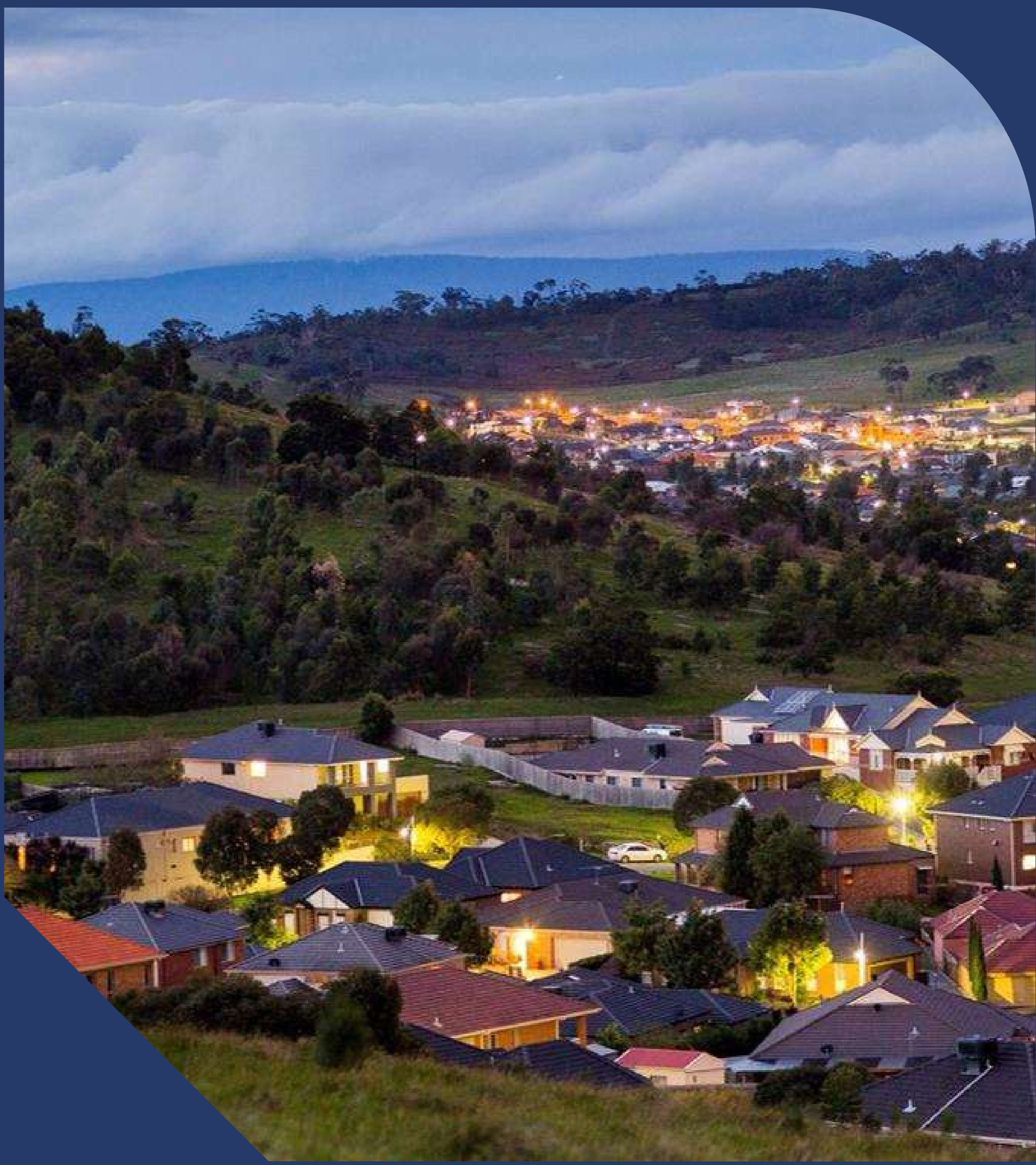
AusNet

Electricity Distribution Price Review (EDPR 2026-31)

Business case: East Cranbourne 66kV loop augmentation

Date: 31 January 2025



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1. Executive summary

The Eastern Cranbourne 66kV network loop supplies electricity to over 102,516 customers. This loop is supplied by the Cranbourne terminal station (CBTS) and is comprised of seven zone substations, including, Lysterfield (LYD), Narre Warren (NRN), Pakenham (PHM), Officer (OFR), Berwick North (BWN), Lang Lang (LLG), and Clyde North (CLN).

AusNet has identified there is energy at risk over the summer period on the Eastern Cranbourne 66kV network loop driven by the establishment of a new South-East Growth Corridor in the network area. Specifically, our demand forecasts show:

- Maximum demand on the Eastern Cranbourne loop will exceed capacity by 2026 under summer 10% probability of exceedance (POE) scenario and no later than 2031 under summer 50% POE demand forecasts.
- Capacity constraints driven by increased growth from the South-East Growth Corridor (approximately 153MW by 2038) are primarily thermal capacity driven. The N rating of the loop is 322MVA in summer after all possible transfers are exhausted. The firm capacity of the loop (N-1 capacity of 255 MVA) is exceeded under coincident POE50 conditions from 2023 and is expected to worsen, with coincident maximum demand expected to increase to 332 MVA in 2026 and to 363 MVA in 2028.
- The worst-case outage is the loss of the Cranbourne Terminal Station to Lysterfield (CBTS-LYD) 66kV line where loading of the Cranbourne Terminal Station to Berwick North (CBTS-BWN) 66kV line will exceed its rating at maximum demand.
- The major source of capacity risks on the Eastern Cranbourne network is associated with CBTS-BWN and CBTS-LYD, with these two segments of the network loop expected to overload first and then second.

Our analysis shows that under 'do nothing' this will result in a probability weighted unserved energy valued at $280.28 million (including the terminal value) over the assessment period.

AusNet is committed to supporting the achievement of Victoria Planning Authority's economic growth plans for the South-East Growth Corridor by ensuring that we plan and design our network to accommodate the growing needs of customers, communities, industry, and businesses. This is consistent with customer feedback which has underscored the importance of customers having access to reliable and affordable energy that meets their daily needs and supports the electrification of transport, homes and businesses.

To ensure that we deliver this to our customers, AusNet has undertaken a probabilistic planning approach to assess the energy at risk (load not being supplied) if no mitigation action is undertaken and whether it is economic to invest in risk mitigation action to reduce the forecast service level risk. Our network planning has identified that we require approximately 105MW additional capacity or reduction of 105MW through alternative non-network approaches such as demand management to enable the ongoing reliable supply the total load limit for the loop.

AusNet has identified 6 credible options for addressing the identified need which are summarised in Table 1 below and are discussed in further detail in section 4.2. A demand management option was also considered but deemed non-credible option as it did not address the identified need.

Table 1 - Overview of credible options

OPTION	DESCRIPTION
Option 0: Do nothing	This option would entail no mitigative action beyond existing business as usual measures to address the identified risk.
Option 1: Install a new Cranbourne Terminal Station to Officer (CBTS-OFR) 66kV line	This option involves installing a new 66kV line from CBTS to OFR (approximately 12km) to provide additional capacity to the northern section of the Eastern Cranbourne network loop.
Option 2: Install a new Cranbourne Terminal Station to Pakenham (CBTS-PHM) 66kV line	This option involves installing a new 66kV line from CBTS to PHM (approximately 25.5km) to provide additional capacity to the Pakenham area which is experiencing rapid growth.
Option 3: Install a new Cranbourne Terminal Station to Pakenham South (CBTS-PSH) and new PSH-PHM 66kV lines	This option involves installing a new 66kV line from CBTS to PHS and a new 66kV line from PSH-PHM (approximately 26.5km) and is a variation of Option 3.
Option 4: Install a new Cranbourne Terminal Station to Lang Lang (CBTS-LLG) 66kV line	This option involves installing a new 66kV line between CBTS to LLG (approximately 43.5km) to provide additional capacity.

OPTION	DESCRIPTION
Option 5: Install a new 25MW/100MWh battery at OFR zone substation	This option involves installing a new 25MW/100MWh battery at Officer zone station to support the Eastern Cranbourne network loop during peak loading.

Table 2 below provides a comparison of credible options.

Table 2 - Comparison of credible options

ASSETMENT METRICS	COMPARISON OF OPTIONS					
	0	1	2	3	4	5
Capex ($m, real FY24)	N/A	$ 33.78	$ 40.12	$ 44.30	$ 50.29	$ 150.00
NPV ($m, real FY24)	N/A	$239.04	$212.17	$ 189.83	$110.37	$ 26.27
Residual risk ($m, real FY24)	$280.28	$ 8.59	$ 29.34	$ 47.64	$128.87	$ 157.87
Optimal timing	N/A	2028	2028	2028	2031	2035
Meets customer expectations	No	Yes	Yes	Yes	Partial	Partial
Aligns with asset management objectives	No	Yes	Yes	Yes	Partial	Partial

Source: AusNet analysis

Based on our analysis of credible options Option 1 – Install a new CBTS-OFR 66kV line has been identified as the preferred option for the following reasons:

- Option 1 has the highest NPV and provides the largest reduction in residual risk relative to the other options.
- It is the least expensive option to implement and supports the northern portion of the Eastern Cranbourne network loop (CBTS-BWN and CBTS-LYD) which has the lower capacity conductors and have been identified as posing the most capacity risk on the network loop.
- Of the options considered, Option 1 involves installing the shortest line route to alleviate constrained parts of the network and will assist in supporting future growth in Officer South associated with the new industrial corridor between Officer and Pakenham under the South-East Growth Corridor.
- Given the optimal timing of the project is 2028, it best meets customer expectations of minimising supply interruptions and enabling electrification and best meets AusNet's asset management objectives of being future ready and meeting customer needs.

Further details of our options assessment and rationale for selecting Option 1 as the preferred option can be found in section 4 of this business case.

2. Background

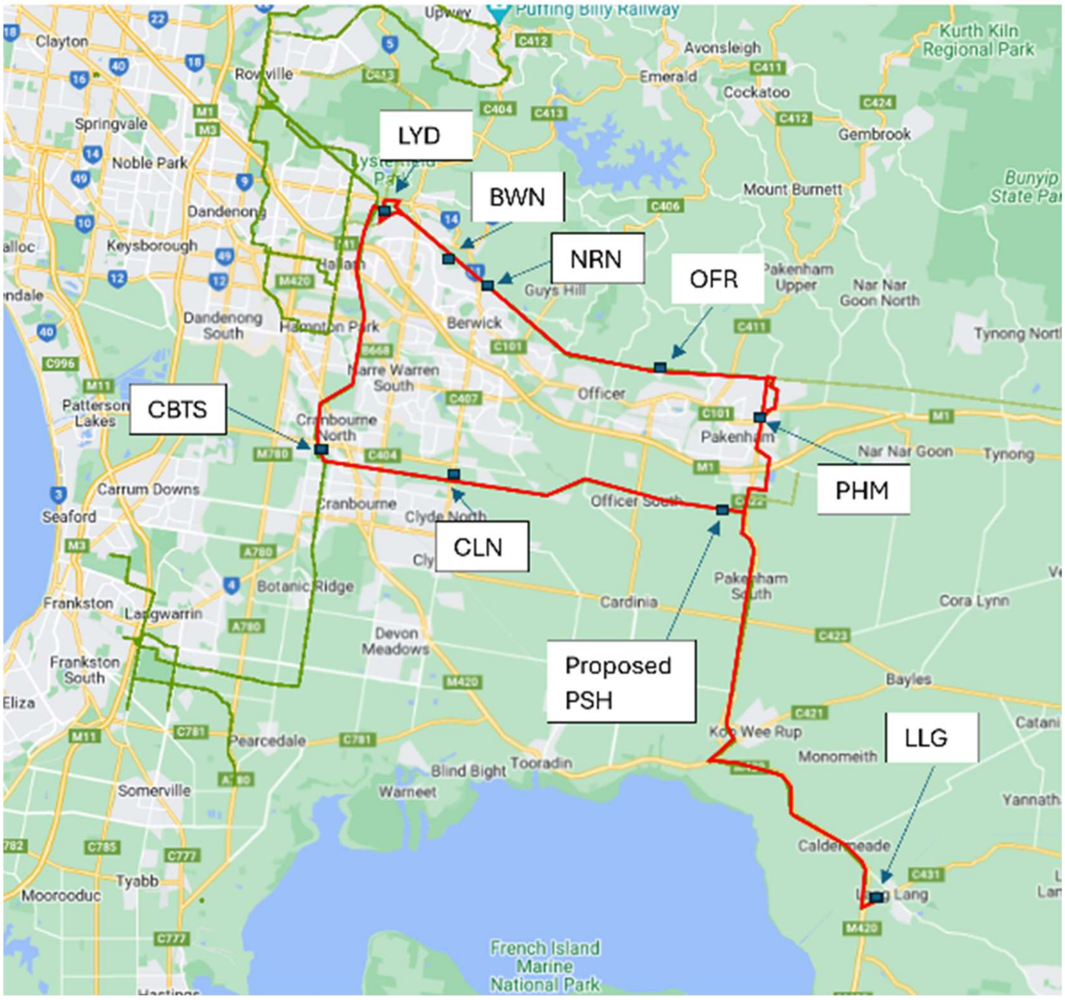
AusNet's network operating area is split into three distinct regions, Central, East, and North, that supply approximately 809,000 consumers ranging from the fringe of the northern and eastern Melbourne metropolitan area to the eastern half of rural Victoria.

AusNet's sub-transmission network consists of overhead electricity lines operating at 66kV, which are generally formed in loops and fed from individual terminal stations. The length of each 66kV sub-transmission loop on AusNet's network depends on the proximity of load centres to terminal stations. Our sub-transmission network has developed and evolved over many years, resulting in variations in design standards, plant and equipment types. A consequence of this is that each 66kV sub-transmission loop has differing supply capacities which are influenced by several factors including:

- Plant and equipment ratings
- Conductor size, type, and electrical characteristics
- Design working temperature
- Geographical layout of the network (this can impose loading or operational constraints via transfers)
- Design of the particular network (this can impose loading or operational constraints)
- Thermal loading and voltage stability under outage conditions
- Load centre distribution

This business case relates to the Eastern Cranbourne 66 kV network loop. This loop is supplied by the Cranbourne terminal station (CBTS) and is comprised of seven zone substations, including, Lysterfield (LYD), Narre Warren (NRN), Pakenham (PHM), Officer (OFR), Berwick North (BWN), Lang Lang (LLG), and Clyde North (CLN) as shown by Figure 1.

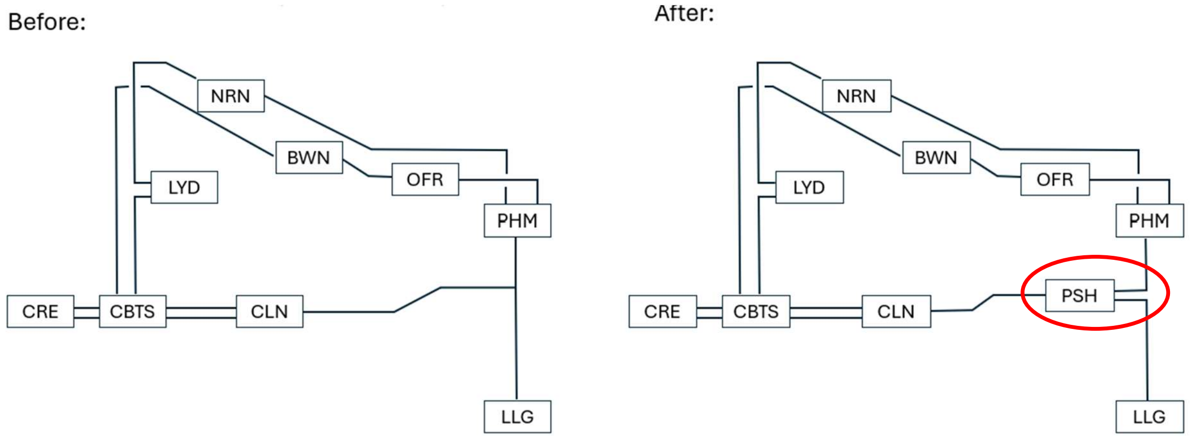
Figure 1 - Eastern Cranbourne 66kV network loop



This network loop supplies electricity to over 102,000 customers comprising of commercial (38.5%), farms (4.3%), industrial (4.1%), and residential (53.1%) consumers. Over recent years, demand on this 66kV loop (particularly in Clyde North, Officer South and Pakenham) has grown rapidly driven by increased residential connections and commercial/industrial developments. The loop also services the region's major shopping centre at Fountain Gate.

To address rapid growth in these sections of the network loop, a new Pakenham South zone substation (PSH) is proposed as part of the AusNet Electricity Distribution Price Review submission. This zone substation is expected to be in service by summer 2028/29 to accommodate anticipated demand growth on the Clyde North, Officer South, and Pakenham segment of the Eastern Cranbourne loop, as highlighted by Figure 2, below.

Figure 2 - Comparison of Eastern Cranbourne 66kV network loop after installation of PSH zone substation



As shown by Figure 2, under Eastern Cranbourne's current configuration, Lang Lang (LLG) is a single transformer zone substation connected radially to the main portion of the loop and relies heavily on the availability of 22kV transfers under single contingency conditions. One of the major transfers available to PHM is via the same pole line as the connecting 66kV line. This poses the risk that significant damage to a 66kV pole along the route will also significantly reduce the availability of transfers back into the loop in the event the 22kV tie to PHM is also affected.

The Eastern Cranbourne 66kV loop has:

- a maximum (N) capacity of 322MVA and firm capacity of 255MVA under (N-1) conditions
- transfer capacity and demand management of 46.3 MVA, however the majority of the transferable load can only be transferred from Clyde North and as a result does not provide sufficient benefits to northern section of the loop (LYD, BWN, NRN or OFR)

A summary of transfer capacity on the Eastern Cranbourne network loop is provided in Table 2 below.

Table 3 Summary of transfer capacity of zone substations

FROM ZONE SUBSTATION	TO ZONE SUBSTATION	TRANSFER AMOUNT (MW)
Berwick North	Belgrave	3.0
Clyde North	Cranbourne	13.1
Clyde North	Cranbourne	2.9
Clyde North	Hume Power Station	5.5
Clyde North	Demand Management Reduction	1.6
Officer	Belgrave	4.2
Lang Lang	Leongatha	1
Lang Lang	Wonthaggi	1
Lang Lang	Load Shedding Event	1.5
Lysterfield	Hampton Park	7.0
Lysterfield	Belgrave	3.5
Lysterfield	Dandenong	2.0

NOTE: transfer amount based on summer contingency

3. Identified need

Investment driver

Our demand forecasts show significant demand growth expected on this network loop driven by the Melbourne South-East Growth Corridor. This is one of four growth Corridor Plans in metropolitan Melbourne defined by the Victoria Planning Authority.[1] Several key growth towns within the growth corridor (Cranbourne, Berwick, Clyde, Clyde North, Pakenham and Officer) are serviced by the Eastern Cranbourne network loop, as shown by Figure 3 below.

The establishment of the South-East Growth Corridor is anticipated to accommodate between 86,000 and 110,000 new jobs across a range of employment sectors, with Clyde and Clyde North identified as major new town centres and a new industrial business corridor at Officer-Pakenham.[2]

Figure 3 - South-East Growth Corridor[3]

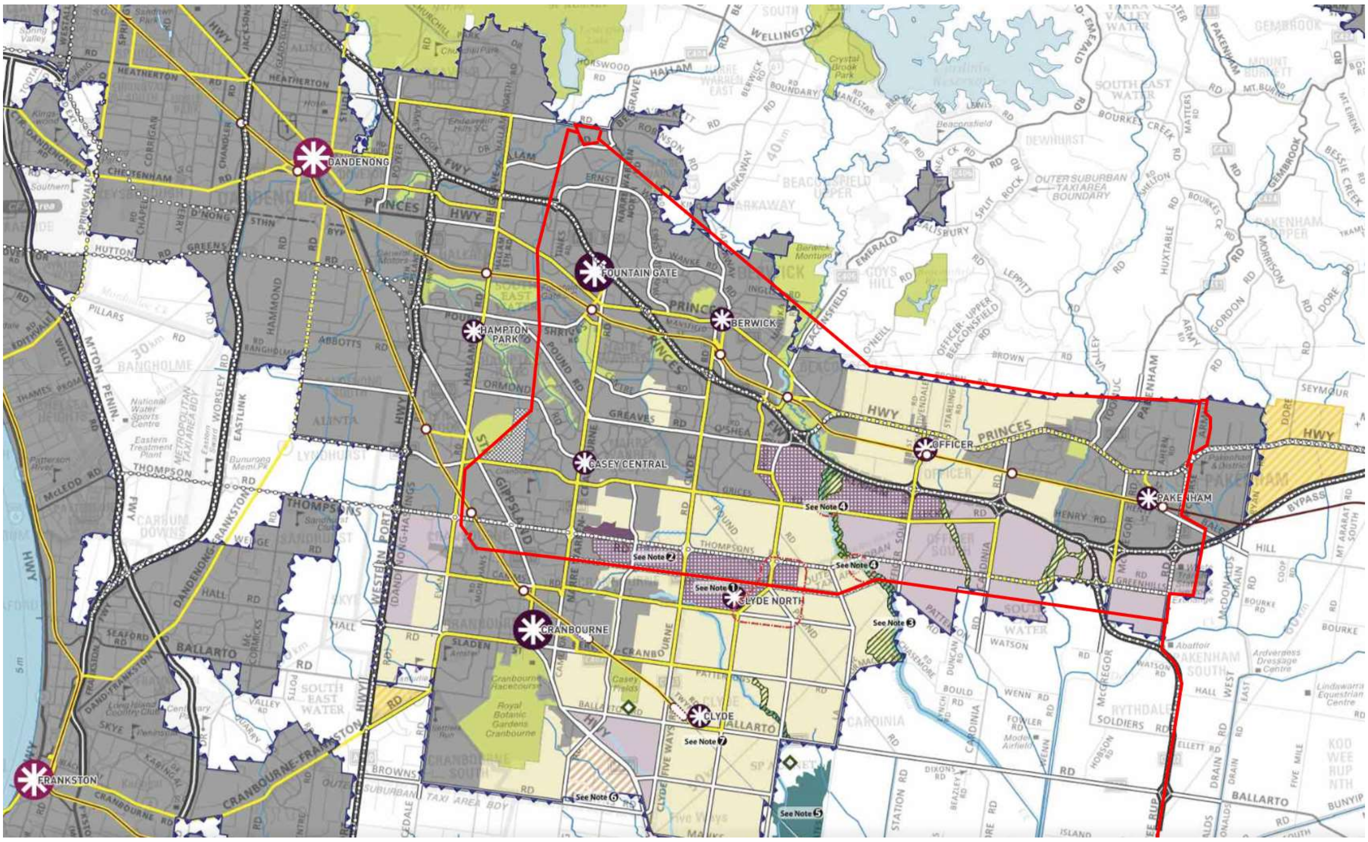
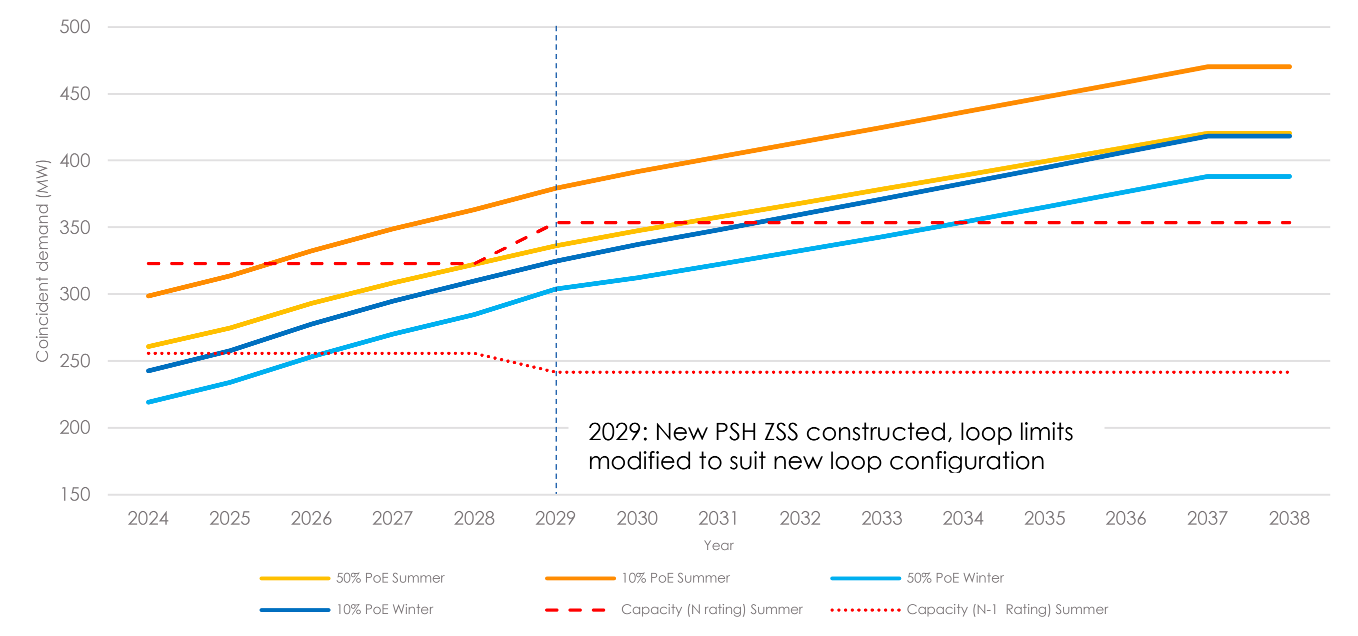


Figure 4 below, shows that N-1 capacity will be exceeded by 2026 in all scenarios and the N capacity will be exceeded by 2030 in all scenarios.

[1] See, https://vpa.vic.gov.au/metropolitan/growth-corridor-plans/
[2] See, https://vpa.vic.gov.au/wp-content/Assets/Files/GCP%20-%20Chapter%205%20North%20Corridor%20Plan.pdf
[3] Victoria Planning Authority, The South-East Growth Corridor Plan Map, https://vpa.vic.gov.au/metropolitan/growth-corridor-plans/

Figure 4 - Load capacity of the Eastern Cranbourne 66kV network loop

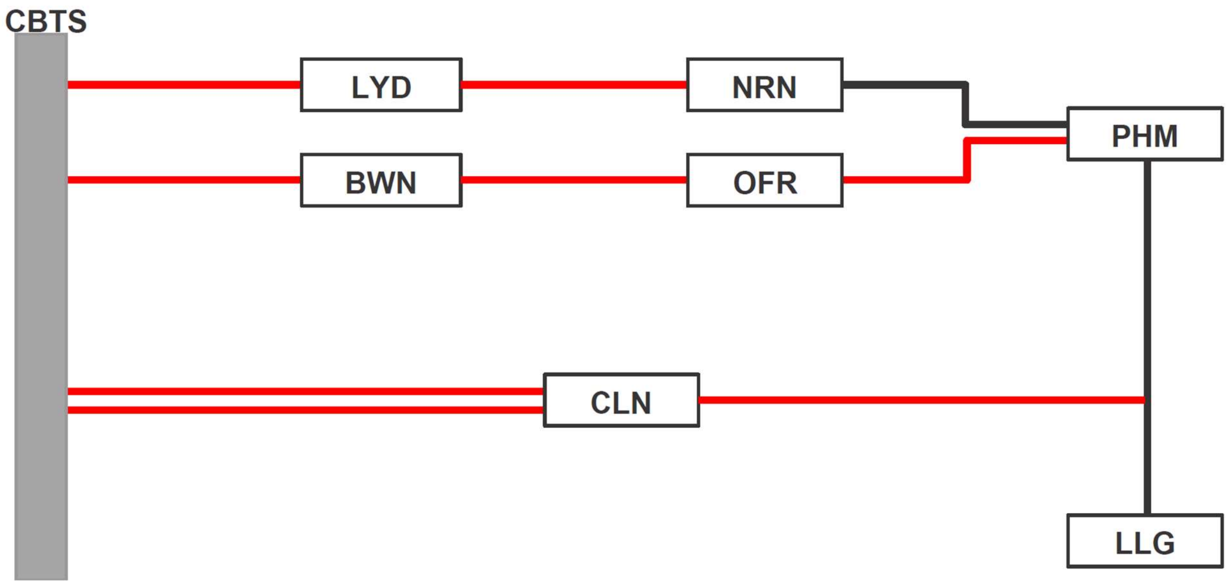


Our demand forecasts show that the establishment of the new South-East Growth Corridor will create capacity constraints on the Eastern Cranbourne network loop. Specifically:

- Maximum demand on the Eastern Cranbourne loop will exceed capacity by 2025 under summer POE 10 scenario and no later than 2031 under summer 50 probability of exceedance (POE) demand forecasts.
- Capacity constraints driven by increased growth from the South-East Growth Corridor (approximately 153MW by 2038) are primarily thermal capacity driven. The N rating of the loop is 322MVA in summer. The firm capacity of the loop (N-1 capacity of 255 MVA) is exceeded under coincident POE50 conditions from 2023 and is expected to worsen, with coincident maximum demand expected to increase to 332 MVA in 2026 and to 363 MVA in 2028.
- The worst-case outage is the loss of the Cranbourne Terminal Station to Lysterfield (CBTS-LYD) 66kV line where loading of the Cranbourne Terminal Station to Berwick North (CBTS-BWN) 66kV line will exceed its rating at maximum demand.
- The major source of capacity risks on the Eastern Cranbourne network is associated with CBTS-BWN and CBTS-LYD, with these two segments of the network loop expected to overload first and then second.

The level of expected overload on the Eastern Cranbourne network loop exceeds the load transfer capacity to zone substations supplied from other adjacent 66kV loops. Figure 5 below, shows a single line diagram of the Eastern Cranbourne 66kV network loop, highlighting constrained segments of the loop (coloured in red) under various single order contingency events in this loop.

Figure 5 - Constrained segments of the Eastern Cranbourne 66kV network loop under single order contingency events



Our Distribution Annual Planning Report (DAPR) 2025-2029, has identified energy at risk on the Eastern Cranbourne 66kV network loop over the summer period from December to March. Economic modelling shows these conditions result in a material expected cost to customers from energy not supplied and material risk to network reliability risk.

Thermal Capacity Limitations

From a thermal capacity perspective, the Eastern Cranbourne 66kV network should not be loaded above its secure system normal planning limit of 255MVA in summer. Doing so risks 66 kV lines being loaded above 120% of their normal rating immediately following a network outage. Due to conductor thermal inertia characteristics, loading 66 kV lines above 120% of their normal rating does not allow network controllers sufficient time to reduce load to within asset ratings, which can result in irreversible conductor damage and cascade tripping of network elements.

Supply to the Eastern Cranbourne region is also limited under network outage conditions by the thermal capacity of some key 66 kV lines as highlighted by Table 4 below.

Table 4- Exceedance of thermal ratings on key 66kV lines on the Eastern Cranbourne network loop[4]

EASTERN CRANBOURNE 66KV LINE	CONDITIONS IN WHICH THERMAL RATINGS WILL BE EXCEEDED
CBTS-BWN 66kV line	When all lines are in service and net load in the East Cranbourne loop exceeds 322MVA.
CBTS-BWN 66kV line	When the CBTS-LYD 66 kV line is out of service and net load in the East Cranbourne region exceeds 293 MVA.
CBTS-CLN No.2 66 kV line	When the CBTS-CLN No.1 66 kV line is out of service and net load in the East Cranbourne region exceeds 274 MVA
CBTS-CLN No.1 66 kV line	When the CBTS-CLN No.2 66 kV line is out of service and net load in the East Cranbourne region exceeds 274 MVA.
CBTS-BWN 66 kV line	When the CLN-PHM-LLG 66 kV line is out of service and net load in the East Cranbourne region exceeds 255 MVA.

Current and historical mitigation approaches

AusNet undertakes prudent contingency planning to mitigate the risk of network events associated with a range of different drivers including peak load. A contingency plan has been developed to transfer 46.3 MVA via 22kV lines to adjacent zone substations. However, the level of overload for summer 2023/2024 exceeds this load transfer capability. Most of the transfer capability is centred around Clyde North (CLN) transferring load away, however there is very little of the 46.3 MVA that can be transferred from Lysterfield (LYD), Narre Warren (NRN), Berwick North (BWN), and Officer (OFR) meaning that the northern section of the loop is exposed to an overloading risk under current capacity and configuration. Additionally, the highly loaded Pakenham (PHM) Zone Substation has no available out of loop transfers to assist with risk mitigation.

As part of summer contingency planning, annual line inspections and tree clearing are conducted to reduce the chances of line failure over the peak loading period. Summer contingency planning identifies and determines possible HV feeders to service out of loop transfers that may be rapidly enacted to protect assets from severe overload. Additionally, contingency planning engages identified customers available for demand management.

Should a single contingency event occur, operators may risk manage 66kV line assets up to 120 degrees Celsius for short durations of time under emergency management scenarios to maintain customer supply.[5]

Risk assessment

This will result in lost load valued at $280.28 million in present value terms (including the terminal value). The value of lost load represents the economic impact to customers and is based on the Value of Customer Reliability (VCR) published by the AER for each customer type.

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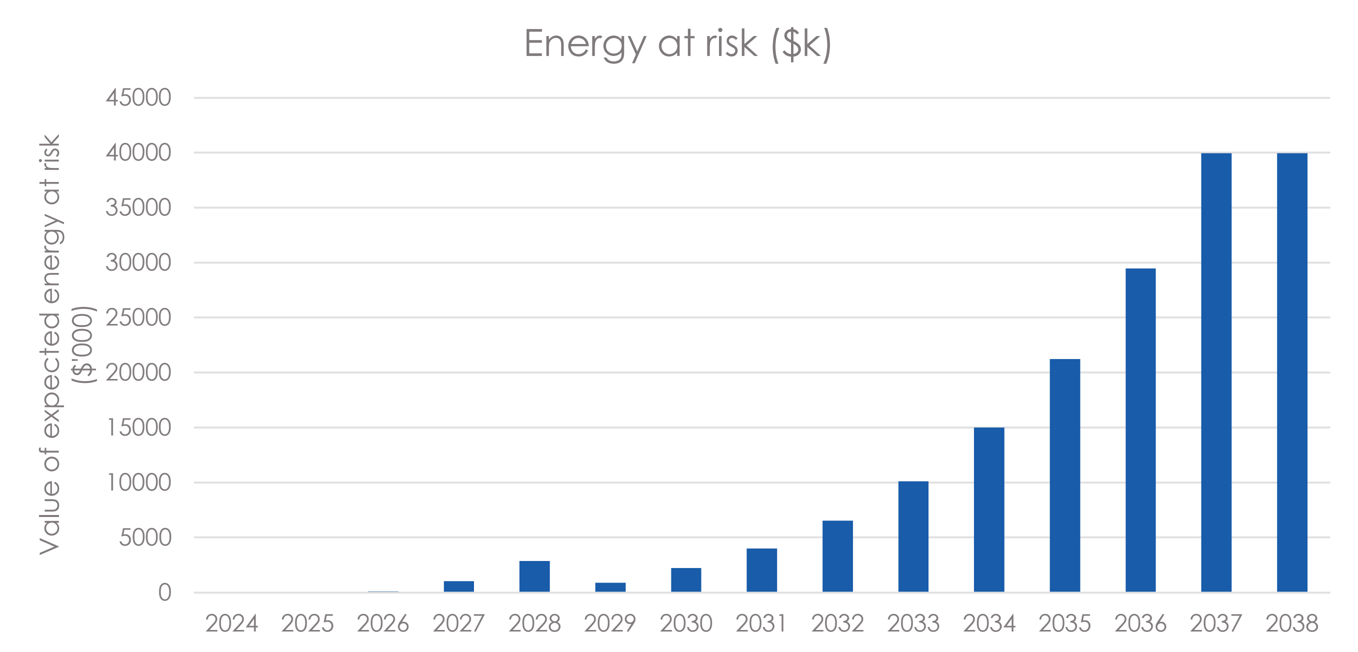
[4] Refer to Appendix A for further details on the line characteristics of the Eastern Cranbourne 66kV network loop.
[5] Refer to Appendix A, which provides an excerpt of summer contingencies.

AusNet is committed to supporting the achievement of Victoria Planning Authority's economic growth plans for the South-East Growth Corridor by ensuring that we plan and design our network to accommodate the growing needs of customers, communities, industry, and businesses.

We have undertaken a probabilistic planning approach to assess the energy at risk of load not being supplied if no mitigation action is undertaken and whether it is economic to invest in risk mitigation action to reduce the forecast service level risk.[6] We have undertaken a risk assessment of the Eastern Cranbourne 66kV loop to provide an estimate of energy at risk and expected unserved energy based on demand forecasts.[7] Our analysis of energy at risk is shown in Figure 6 below. The figure shows that energy art risk is expected to continually increase from 2027 at an increasing rate throughout the 15-year assessment period.

Figure 6 – Energy at risk on Eastern Cranbourne 66kV network loop



The Pakenham South (PSH) ZSS project, aimed at installing a new zone substation connected to the East Cranbourne 66kV network loop, will assist in supporting increased demand upon the 22kV distribution system within this region by increasing the 22kV distribution capacity in the Pakenham and Clyde North areas. While this will assist in addressing 22kV capacity constraints in the region, this does not adequately address forecast peak demand growth and overloading issues on the 66kV network loop. Our analysis indicates that approximately 105MW additional capacity or a reduction of 105MW is required to mitigate energy at risk on the Eastern Cranbourne network loop and assumes the installation of the new zone substation before augmentation on the Eastern Cranbourne 66kV loop is to proceed.

The PHS project will address 22kV of capacity constraints in the region by creating additional 66/22kV transformation and 22kV feeders, additionally, it will shift some load away from the northern segment of the loop to the higher capacity lines on the south, which reduces a portion of energy at risk in 2029 (as reflected by the drop in energy at risk in Figure 6 in 2029), however this alone is not sufficient to completely address the anticipated loading increase expected on the loop.

AusNet's analysis of forecasted demand coupled with existing thermal limits indicate that mitigation actions are required to address the increasing risk to the provision of reliable electricity supply to our customers.

Summary of identified network need

Our network planning indicates that approximately 105MW additional capacity or a reduction of 105MW through non-network approaches are required to enable AusNet to maintain reliable supply of the Eastern Cranbourne 66kV network within total load limits for this this loop. Addressing this identified capacity constraint will help to ensure that AusNet is able to prudently meet forecast load growth from the South-East Growth Corridor to:

- support economic growth anticipated for this region
- support the electrification of homes, businesses and transport[8]
- meet our customer expectations for AusNet to provide reliable electricity supply and take prudent actions to minimise unplanned outages

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[6] For further information on AusNet's network planning approach see AusNet's Distribution Annual Planning Report.
[7] See AusNet's Distribution Annual Planning Report for details on the methodology for assessing sub-transmission loop risk.
[8] Refer to Victoria State Government, 'Gas Substitution Roadmap – Update: Victoria's Electrification Pathway.'

Feedback from our customer engagement has underscored the importance of ensuring that we provide our customers with reliable electricity supply, with minimal unplanned disruptions. Customers have expressed concerns regarding the impacts of poor reliability given customers growing reliance on electricity to meet a range of different needs such as transport, telecommunications, working from home, maintaining comfort during extreme weather conditions, and to meet health needs.

3.1. Key inputs and assumptions

Key factors underpinning the identified need include:

- Demand forecast – the POE10 demand is forecast to exceed the thermal capacity of the line and the POE50 is already exceeded under N-1 conditions. The demand forecast is based on AusNet's standard forecasting methodology and accounts for organic growth and spot loads.[9]
- Asset data used in the network modelling to identify capacity constraints.[10]
- The value of customer reliability (VCR) used in the economic analysis is based on the 2023 AER VCR values and weighted based on energy consumption by customer type.
- A discount rate of 5.56% and opex rate of 1% have been applied.
- Cost benefit analysis based over a 30-year period, comprising of a forecast period of 15-years, and an extended analysis period of 15-years.
- Pakenham South ZSS is installed by summer 2028/29.
- Unavailability rates of subtransmission line segments is calculated based on 5 years of historic unplanned outage data from internal outage logs for the Eastern Cranbourne loop.
- Average unplanned outage time for this subtransmission loop is calculated based on 5 years of historic unplanned outage data from internal outage logs for the Eastern Cranbourne loop.
- All available HV transfers are exhausted in the determination of loop limits.
- Availability of HV transfers diminish over time as loading at transferring Zone substations increases.
- In the case of an N-1 event on the loop, where the loading is above the limit for voltage collapse, all load on the loop is assumed to be lost for a duration of 1 hour.
- Rooftop solar has been considered as a demand reducer at the time of maximum demand and is incorporated in the demand forecasts for each individual zone substation on the Eastern Cranbourne 66kV network loop.

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[9] See AusNet's "Demand Forecasting Methodology"
[10] See Appendix A for further details on the line characteristics of the Eastern Cranbourne 66kV network loop.

4. Options assessment

AusNet has identified 6 possible options for addressing the identified need, as summarised by the Table 5 below.

Table 5 – Overview of identified options

OPTION	DESCRIPTION
Option 0: Do nothing	This option would entail no mitigative action beyond existing business as usual measures to address the identified risk.
Option 1: Install a new Cranbourne Terminal Station to Officer (CBTS-OFR) 66kV line	This option would entail no mitigative action beyond existing business as usual measures to address the identified risk.
Option 2: Install a new Cranbourne Terminal Station to Pakenham (CBTS-PHM) 66kV line	This option involves installing a new 66kV line from CBTS to OFR (approximately 12km) to provide additional capacity to the northern section of the Eastern Cranbourne network loop.
Option 3: Install a new Cranbourne Terminal Station to Pakenham South (CBTS-PSH) and new PSH-PHM 66kV lines	This option involves installing a new 66kV line from CBTS to PHM (approximately 25.5km) to provide additional capacity to the Pakenham area which is experiencing rapid growth.
Option 4: Install a new Cranbourne Terminal Station to Lang Lang (CBTS-LLG) 66kV line	This option involves installing a new 66kV line from CBTS to PHS and a new 66kV line from PSH-PHM (approximately 26.5km) and is a variation of Option 3.
Option 5: Install a new 25MW/100MWh battery at OFR zone substation	This option involves installing a new 66kV line between CBTS to LLG (approximately 43.5km) to provide additional capacity.

4.1. Assessment approach

The options were assessed using a cost benefit analysis that considered the reduction in energy at risk of each option, compared to the based case, and the capital cost to implement that option. Energy at risk was calculated to be a cost associated with the base case that was negated (fully addressed) by each of the options. Hence, the net present value (NPV) of each option is the NPV of energy at risk less the NPV of the capital cost (capex).

The base case assumes that works to install a new zone substation at Pakenham South on the Eastern Cranbourne network loop is committed and will proceed according to the current schedule.

Preferred timing of each option is determined based on when the cost of the annual risk exceeds the annualised cost of the option, which is consistent with the AERs guideline for asset replacement planning. The project is assumed to take 3-years for construction and timed so that the asset is commissioned at the optimal time.

Energy at risk has been calculated using a probabilistic approach. We have used 2023 VCR values from the AER weighted based on energy consumption per customer type to quantify the value of customer reliability.

Our customer engagement process has identified that customers are increasingly concerned about network reliability due to increasing reliance on the electricity for more day to day activities. While we have not quantified the benefit to our customers other than through the economic impact using VCR, we consider meeting customer reliability expectations an important objective for AusNet.

Options have also been assessed against the degree to which they are consistent with and promote AusNet's asset management objectives.

Table 6 below outlines key assumptions used in the economic assessment of identified options.

Table 6: Key assumptions

ASSUMPTION	VALUE	COMMENTS
WACC	5.56%	The average of 4.11% and AEMO's IASR central discount rate of 7%.
Evaluation period	30 years	15 years plus terminal value
Value of Customer Reliability	$36.45k /MWh	Based on AER's 2023 update and weighted by customer type load
CECV		Not applicable
Energy at risk value	Variable	Calculated for each year of the evaluation period to reflect increasing forecast demand
Annual opex rate (% of capex)	1%	Conservative assumption for opex starting from the year of commissioning of the asset.

Source: AusNet analysis

4.2. Options analysis

4.2.1. Comparison of credible options

Our analysis has identified 6 credible options. Credible options are identified as options that address the identified need, are technically feasible, and can be implemented within the required timeframe. These options are described in further detail in the sections below. A detailed costing analysis of each of the options is provided in Appendix B.

As the expected costs of each of the options considered in this section exceeds the regulatory investment test for transmission (RIT-D) of $6 million a RIT-D will be required for this project.

Option 0: Do Nothing

The Do Nothing or business as usual (BAU) option assumes that AusNet would not undertake any investment, outside of normal operational and planning processes for managing peak demand and thermal overloading. This option is the counterfactual to the other options considered and establishes the base level of risk (base case) and basis for comparing other credible options.

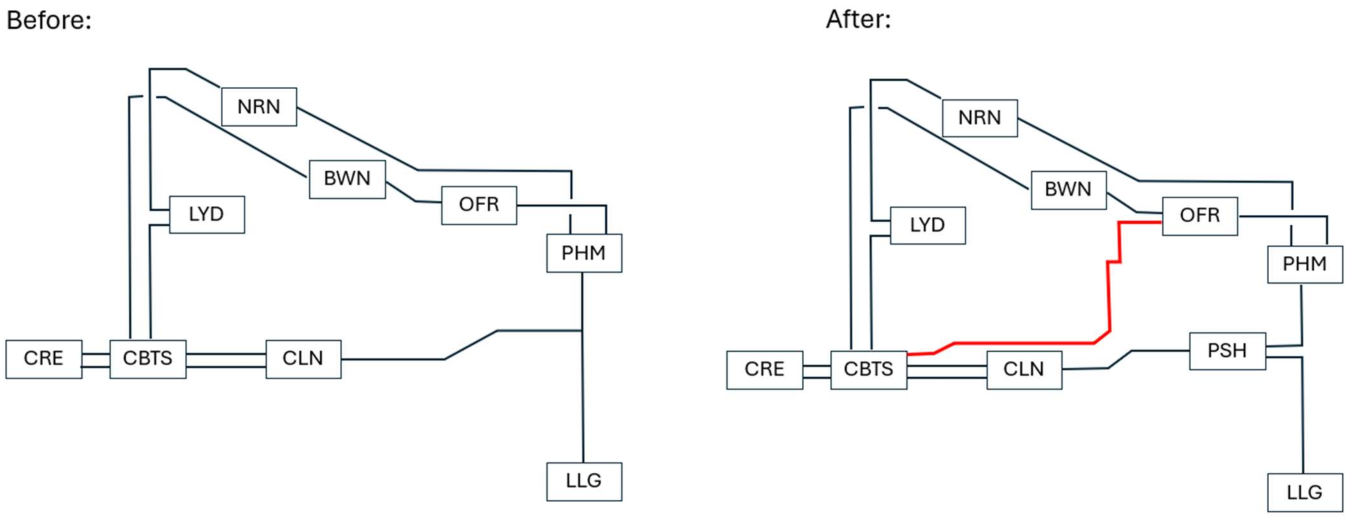
While this option does not entail any upfront capital costs, it exposes customers to the most risk of network outages as it does not address the identified risk of capacity being exceeded from the establishment of a new growth corridor in the network area. AusNet has quantified the value of energy at risk to be $286.80 million over the evaluation period.

This option does not meet our customers' expectations of AusNet to deliver reliable electricity supply and minimise unplanned network outages. Further, this option does not align with AusNet's asset management objectives of being future ready and meeting customer needs by maintaining the long-term reliability of our distribution network.

Option 1: Establish a new CBTS-OFR 66kV line

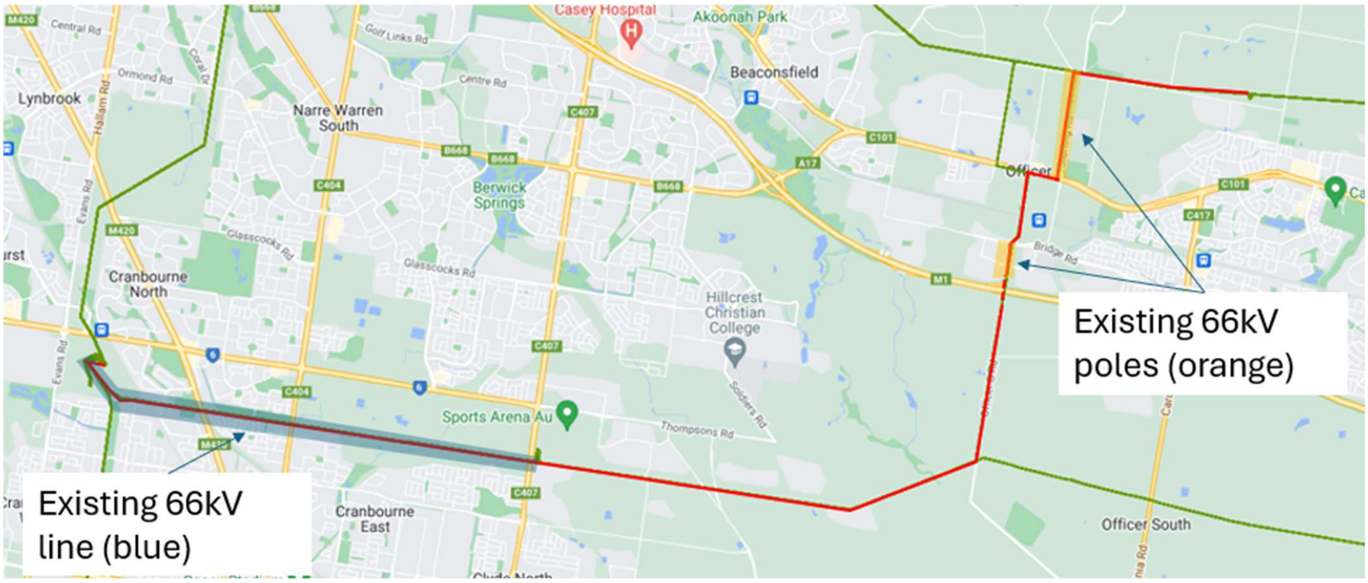
This option involves installing a new 66kV line from CBTS to OFR (as indicated by the red line in 7 below) to provide additional capacity to the northern section of the Eastern Cranbourne network loop.

Figure 7 – Comparison of Eastern Cranbourne 66kV loop after the installation of the new CBTS-OFR line



The installation of the new line will require installing 22km of new 37/3.75 AAC line thermally designed to 100 degrees Celsius and enabling works to the Cranbourne Terminal Station and Officer zone substation to accommodate the new 66kV line. Under this option 7.1km of existing 66kV conductor will be utilised to achieve a minimum summer cyclic rating of 117.17 MVA (shown in blue in the Figure 8 below) and 66kV poles along the Officer South Road and Starling Road (shown in orange in Figure 8).

Figure 8 – Map indicating new CBTS-OFR 66kV line route



We have identified several benefits associated with establishing a new CBTS-OFR 66kV line, including:

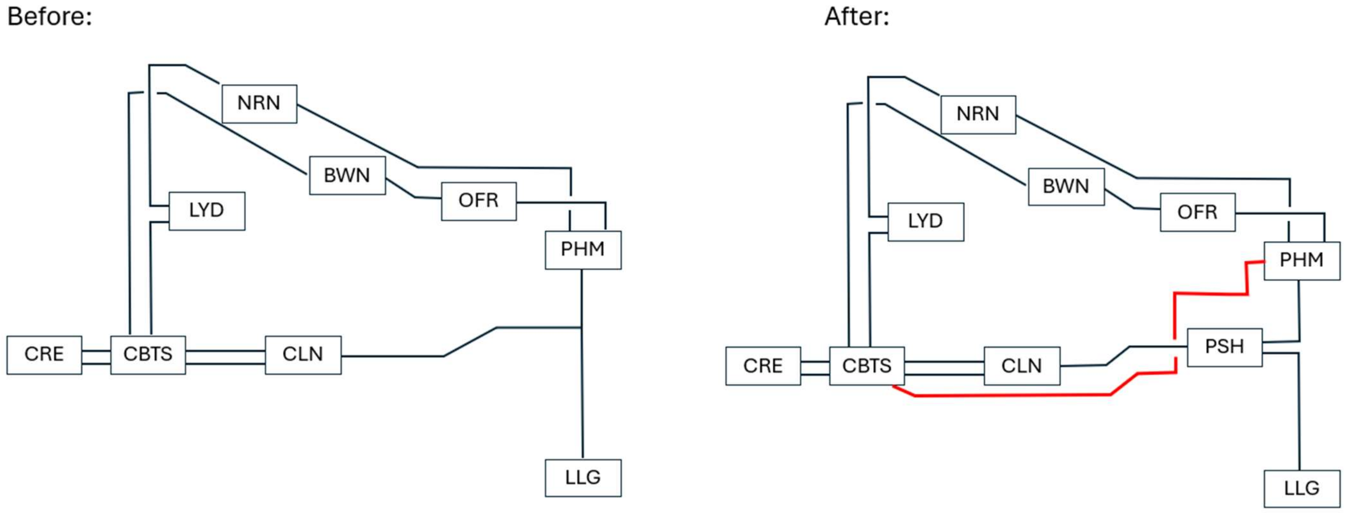
- It will significantly increase thermal capacity of the Eastern Cranbourne network loop
- It provides additional support to the Northern portion (CBTS-LYD and CBTS -BWN), which have older and lower capacity conductors.
- It utilises existing infrastructure (66kV conductor route to Officer and spare 66kV conductors between CBTS-CLN) to minimise costs.
- Is the shortest line route for installing an additional 66kV line on the Eastern Cranbourne network loop to alleviate constrained parts of the network.
- The addition of this line will assist in supporting future growth at Officer South associated with the new industrial corridor between Officer and Pakenham under the South-East Growth Corridor.

Of the options considered, Option 1 delivers the highest NPV of $239.04 million, is the least cost option identified, and provides the highest reduction in residual risk relative to the other options. This option is considered a credible option as it can be implemented within the required timeframe, is technically feasible, addresses the need, meets customer expectations in relation to reliability and is aligned with AusNet's asset management objectives of being future ready and meeting customer needs.

Option 2: Install a new CBTS-PHM line

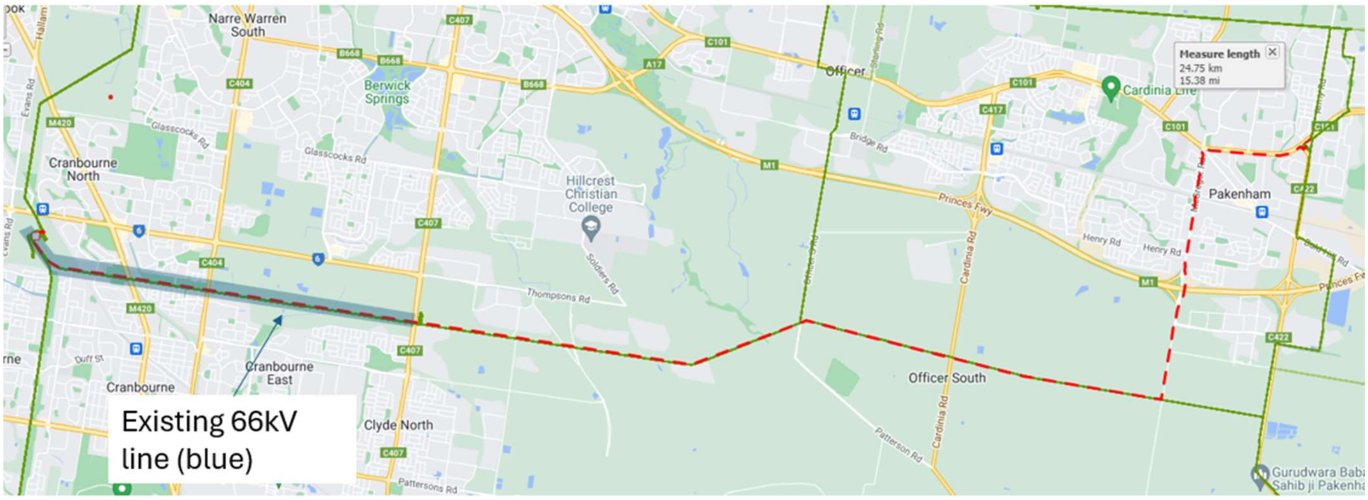
This option involves installing a new 66kV line from CBTS to PHM (as indicated by the red line in Figure 9 below) to provide additional capacity to the Pakenham area of the Eastern Cranbourne network loop, which is experiencing rapid growth.

Figure 9 - Comparison of Eastern Cranbourne 66kV loop after the installation of the new CBTS-OFR line



The installation of the new line will require installing 25.5km of new 37/3.75 AAC line thermally designed to 100 degrees Celsius and enabling works to the Cranbourne Terminal Station and Pakenham zone substation to accommodate an additional 66kV feeder. Under this option 7.1km of existing 66kV conductor will be utilised to achieve a minimum summer cyclic rating of 117.17 MVA (shown in blue in the Figure 10 below).

Figure 10 – Map indicating new CBTS-PHM 66kV line



Key benefits associated with this option include:

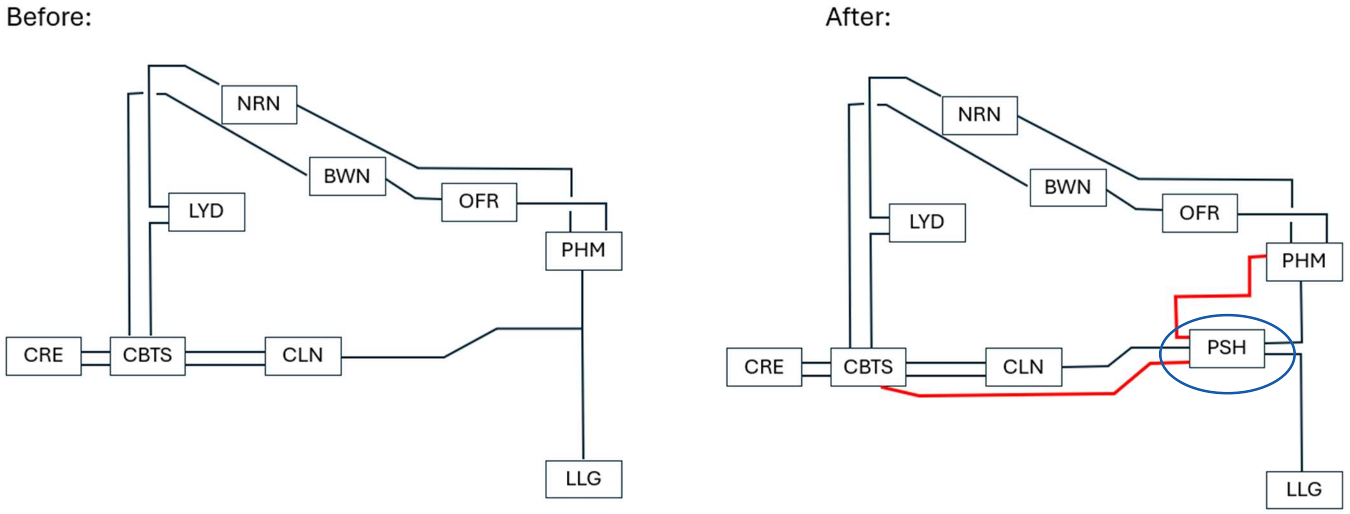
- It significantly increases thermal capacity of the Eastern Cranbourne network loop
- It provides additional support to the furthest major load centre on the network loop (PHM and OFR)
- It utilises existing spare 66kV conductors between CBTS-CLN to minimise costs
- It provides additional optionality for managing constraints in the future, as it can be easily configured to enable a tie into Pakenham South should a tie become required (1km of additional line)
- The line route is mostly within existing transmission easement, which helps in reducing implementation time and costs, and also minimises impact on the nearby community

While Option 2 delivers significant benefits and has the second highest NPV of $212.17 million, it is the second least costly option to implement and delivers the second largest reduction in residual risk relative to the other options considered. It is considered a credible option as it can be implemented within the required timeframe, is technically feasible, addresses the identified need, and is aligned with customer expectations of reliability and AusNet's asset management objectives of being future ready.

Option 3: Establish a new CBTS-PHS and PSH-PHM 66Kv line

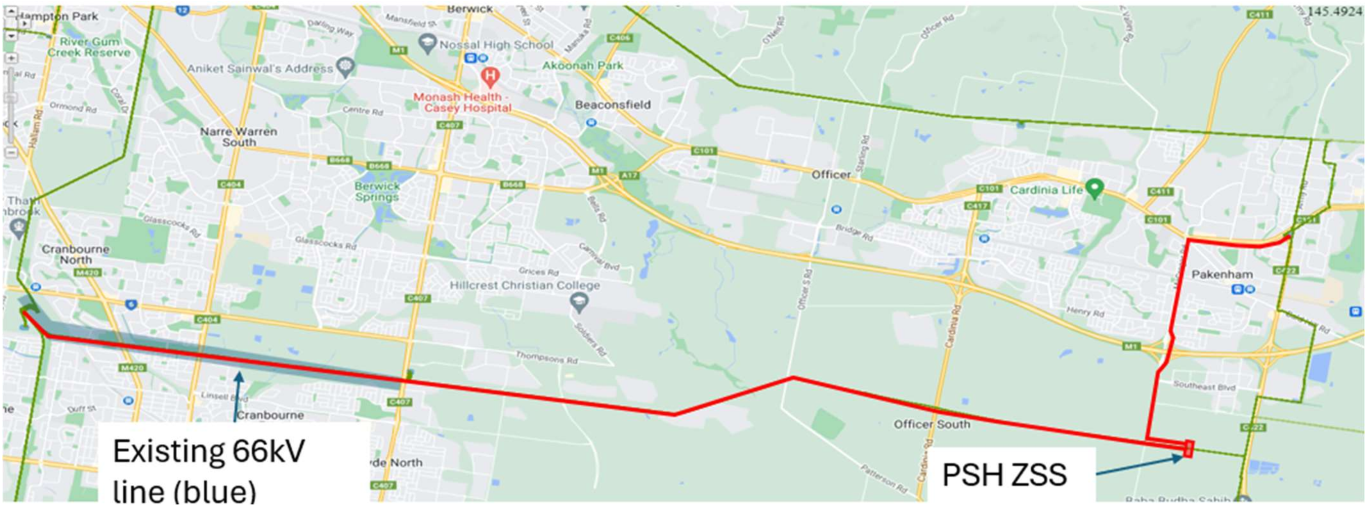
This option involves installing a new 66kV line from CBTS to PHS and a new 66kV line from PSH-PHM (as indicated by the red line in 11below). This will help to provide additional support to the Pakenham area, which is the furthest major load centre on the loop and is set to be part of a new industrial corridor under the South-East Growth Corridor.

Figure 11 - Comparison of Eastern Cranbourne loop after the installation of the new CBTS-PSH and PSH-PHM 66kV line



The installation of the new line will require installing 26.5km of new 37/3.75 AAC line thermally designed to 100 degrees Celsius and enabling works to the Cranbourne Terminal Station and Pakenham South zone substation to accommodate connect the new CBTS-PSH and PSH-PHM lines. Under this option 7.1km of existing 66kV conductor will be utilised to achieve a minimum summer cyclic rating of 117.17 MVA (shown in blue in the 2 below). This option is a variation to Option 2, with the key difference between the two options is that Option 3 includes a tie into the Pakenham South zone substation, as circled in Figure 11 above), which entails approximately 1km of additional conductor and associated switchgear at PSH zone substation.

Figure 12 - Map indicating new CBTS-PSH and PSH-PHM 66kV line



Key benefits associated with this option include:

- It significantly increases thermal capacity of the Eastern Cranbourne network loop
- It provides additional support to the highest growth part of the loop and supports the furthest major load centre
- It utilises existing spare 66kV conductors between CBTS-CLN to minimise costs and deliver greater affordability to customers
- The line route is mostly within existing transmission easement, which helps in reducing implementation time and costs, and also minimises impact on the nearby community

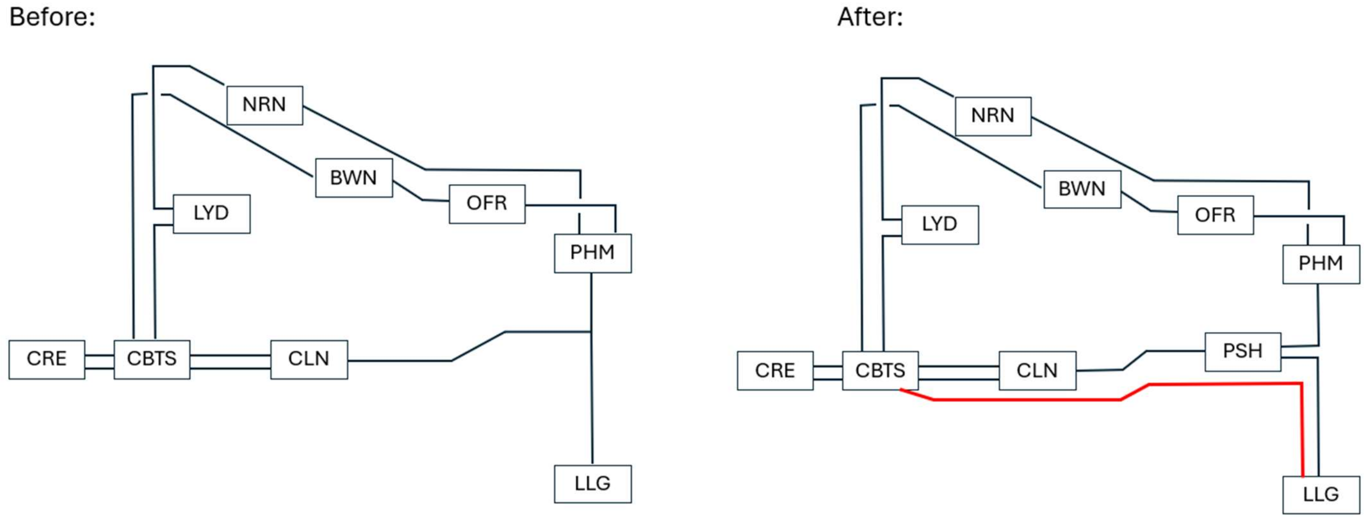
This option is the third least expensive option to implement at $44.30 million and delivers the third highest NPV. Whilst this option reduces residual risk, the reduction in risk is not as significant as Options 1 and 2.

This option is considered a credible option as it can be implemented within the required timeframe, is technically feasible, addresses the identified need, and is aligned with AusNet's asset management objectives of being future ready.

Option 4: Install a new CBTS-LLG 66kV line

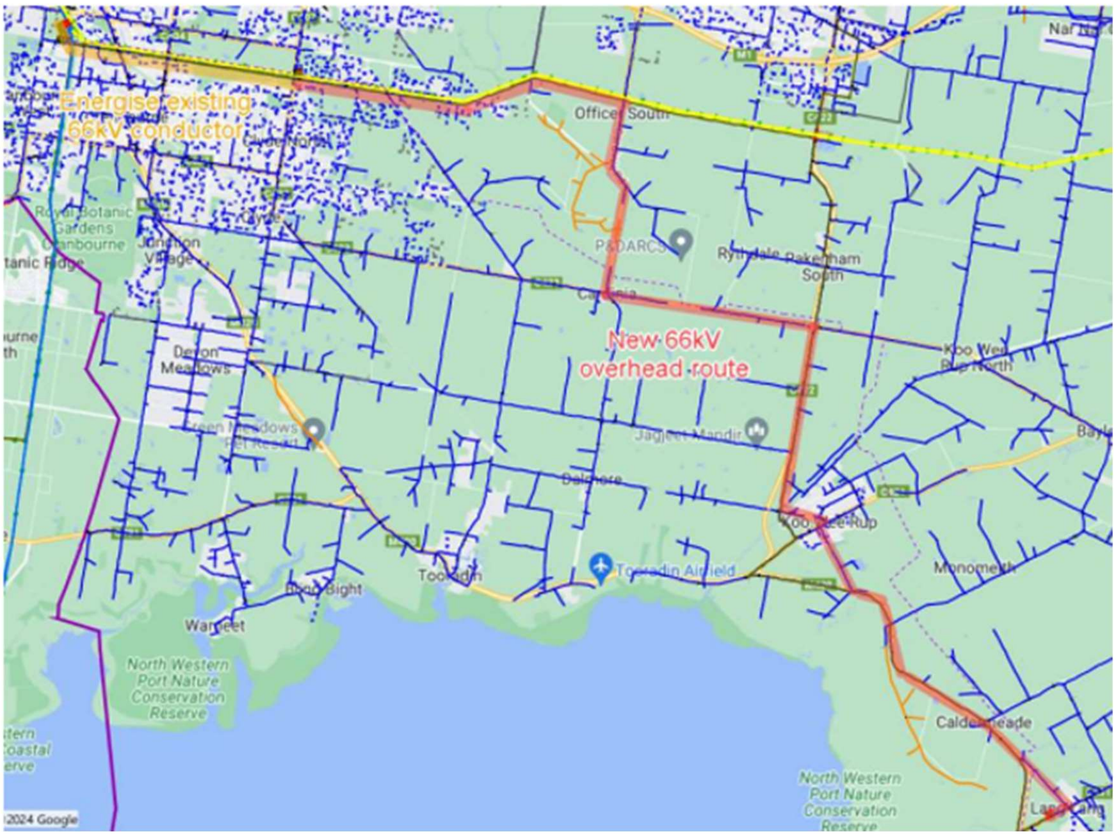
This option involves installing a new 66kV line between CBTS to LLG (as indicated by the red line in Figure 13 below) to provide additional capacity on the Eastern Cranbourne network loop.

Figure 13- Comparison of Eastern Cranbourne loop after the installation of the new CBTS-LLG 66kV line



The installation of the new line will require installing 43.5km of new 37/3.75 AAC line thermally designed to 100 degrees Celsius and enabling works to the Cranbourne Terminal Station and Lang Lang zone substation to accommodate connect the new CBTS-LLG line. Under this option 7.1km of existing 66kV conductor between CBTS-CLN will be utilised to achieve a minimum summer cyclic rating of 117.17 MVA. Figure 14 below shows the existing 66kV conductor marked in orange, while the red line indicates the route of the new overhead 66kV line.

Figure 14 - Map indicating new CBTS-LLG 66kV line



The key benefits associated with this option is that it increases thermal capacity of the Eastern Cranbourne. It also significantly increases reliability to customers in Lang Lang, which are currently radially supplied, by bringing them into the Eastern Cranbourne network loop.

While Option 4 utilises existing 66kV conductors between Cranbourne Terminal Station and Clyde North, which helps in reducing costs, it requires significantly more 66kV line to be installed than Options 1 and 2 and as a result is the second most expensive option for addressing the identified network need.

This option delivers a positive NPV of $110.37 million, this is less than half of the NPV delivered by Options 1 and 2 and delivers significantly less of a reduction in residual risk as much as Options 1, 2, and 3. Consequently, while this option is credible, technically feasible, and addresses the identified need, it has been assessed as only partially addressing customer expectations of reliability and affordability, and aligning with AusNet's objectives of being future ready.

Option 5: Install a new 25MW/100MWh battery at Officer zone substation

This option involves installing a new 25MW/100MWh battery at Officer zone station to support the Eastern Cranbourne network loop during peak loading. Whilst this option is technically feasible it is the most expensive option to implement at $150million and delivers the lowest NPV of the options considered $26.27 million and results in the highest residual risk outside of the base the case. For these reasons, this option is considered the least preferred option for addressing the identified need and has been assessed as only partially addressing customer expectations and AusNet's asset management objectives.

4.2.2. Non-credible options

Demand management – does not address the identified need

There is limited ability for demand reductions to reduce peak demand on the Eastern Cranbourne 66kV network loop as demand growth in the region far outweighs any demand management opportunities identified to date. Most notably, there are no connected 66kV customers or generators on this network. Further, while there are three customers which have active support agreements that are connected to Clyde North, these agreements only deliver a reduction of 1.65MW which is insufficient to meet the identified need and do not assist in addressing the two lines (CBTS-BWN and CBTS-LYD) which are the major source of N risk on the Eastern Cranbourne network loop.

Reconductor the CBTS-BWN with 37/3.75AAC – does not address the identified need

An initial assessment was completed to determine the feasibility of reconductoring aged conductor on the existing CBTS-BWN 66kV line, with modern high capacity 37/3.75AAC. Whilst this would be a technically feasible option to increase some capacity within the Eastern Cranbourne 66kV loop, it was found to be not credible due to the immense costs and constructability issues associated with the full reconstruction of the existing tower assets within the transmission easement. Additionally, this option only would have partially assisted in addressing the anticipated line overloads after PSH is established, leaving a large residual risk value to be associated with this option.

4.3. Preferred option

Table 7 below provides a comparison of credible options. Based on our analysis of credible options Option 1 – Install a new CBTS-OFR 66kVline has been identified as the preferred option for the following reasons:

- While both Options 1 and 2 fully address all of AusNet's assessment criteria, Option 1 has the highest NPV and provides the largest reduction in residual risk relative to the other options.
- It is the least expensive option to implement and supports the northern portion of the Eastern Cranbourne network loop (CBTS-BWN and CBTS-LYD) which have the lower capacity conductors and have been identified as posing the most capacity risk on the network loop.
- Of the options considered, Option 1 involves installing the shortest line route to alleviate constrained parts of the network and will assist in supporting future growth in Officer South associated with the new industrial corridor between Officer and Pakenham under the South-East Growth Corridor.
- Given the optimal timing of the project is 2029 it best meets customer expectations of minimising supply interruptions and enabling electrification and best meets AusNet's asset management objectives of being future ready and meeting customer needs.

Table 7 Summary of options analysis

ASSETMENT METRICS	COMPARISON OF OPTIONS					
	0	1	2	3	4	5
Capex ($m, real FY24)	N/A	$ 33.78	$ 40.12	$ 44.30	$ 50.29	$ 150.00
NPV ($m, real FY24)	N/A	$239.04	$212.17	$ 189.83	$110.37	$ 26.27
Residual risk ($m, real FY24)	$280.28	$ 8.59	$ 29.34	$ 47.64	$128.87	$ 157.87
Optimal timing	N/A	2028	2028	2028	2031	2035
Meets customer expectations	No	Yes	Yes	Yes	Partial	Partial
Aligns with asset management objectives	No	Yes	Yes	Yes	Partial	Partial

Table 8 below provides a detailed breakdown of costs and benefits associated with the preferred option. A high-level scope for the new line from CBTS-OFR is outlined in Appendix C.

Table 8: Option 1 costs ($m, real 2023-24)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Capex	$11.26	$11.26	$11.26			$33.78	30 years
Opex			$0.34	$0.34	$0.34	$1.01	30 years
Benefits[11]			$2.86	$0.86	$2.21	$5.93	30 years

Source: AusNet analysis

Sensitivity testing across a range of parameters including rate sensitivity, forecast sensitivity, cost sensitivity, and asset failure was undertaken to determine whether the preferred option changed.[12] Even with applying different assumptions, our sensitivity testing shows that Option 1 remains the preferred option as it delivers the highest NPV relative to the other options considered.

[11] As noted in section 4.1 the reduction in energy at risk is the only benefits that have been considered and quantified in the options analysis.
[12] See Appendix D for further details of sensitivity testing of credible options.

A. Eastern Cranbourne 66kV network loop characteristics

Line	Length (km)	Summer Rating (A)	Summer Rating (MVA)	Winter Rating (A)	Winter Rating (MVA)
BWN-OFR	9.84	680	77.73	860	98.31
CBTS-BWN	18.60	680	77.73	860	98.31
CBTS-CLN No.1	6.91	1025	117.17	1105	126.32
CBTS-CLN No.2	6.91	1025	117.17	1105	126.32
CBTS-LYD	12.20	825	94.31	1080	123.46
CLN-PSHTEE	13.87	1025	117.17	1105	126.32
PHM-PSHTEE	5.51	1025	117.17	1105	126.32
PSH-LLG	24.99	1025	117.17	1105	126.32
LYD-NRN	4.93	680	77.73	860	98.31
NRN-PHM	18.50	680	77.73	860	98.31
OFR-PHM	7.43	680	77.73	860	98.31

Excerpt of AusNet's summer contingency plans for short term contingencies

PRE-SUMMER WORK	SHORT TERM CONTINGENCIES (DURATION <=24HRS)
1. Thermoview and line inspection of CBTS-NRN-PHM-BWN-CBTS -- by **standard inspection cycle**.	1. Manage the line with dynamic ratings - based on the existing wind speed and ambient temperature.
2. Tree clearing of CBTS-NRN-PHM-BWN-CBTS line - by **standard inspection cycle**.	2. Risk managed the line up to 120^{0}C as per the procedure "Emergency Loading of 66kV OH Lines".
3. If heavy line fault occur on these lines prior or during the summer, then another thermoview need to be carried out	3. Use available DMs available 4. Load transfers available to adjacent loops 47.2MVA as follows: BWN - 3.0MVA NRN - 0 MVA CLN - 23.1 MVA OFR- 4.2 MVA PHM - 0 MVA LYD - 13.4 MVA (HPK=7.0, DN=2, BGE=3.5 MVA) - see LYD contingency plan LLG - 3.5MVA (LGA=1, WGI=1.0, Air Liquid load shed=1.5) For details please refer the attached "Load-Transfer" table. 5.The maximum load shed required is approximately 33 MVA prior to transfers. Please load shed using the load shed manager. Load shedding at CLN is effective when CBTS-CLN 1 or 2 is out of service. 6. If sufficient load transfers are not available then risk manage the line and use load transfers. 7.Mobile generators may be required.

B. Cost breakdown of credible options

Option 1: Install new CBTS-OFR 66kV line

Table 9: Install a new CBTS-OFR 66kV line ($m, real 2023-24 dollars)

Metric	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)	$11.26	$11.26	$11.26			$33.78	30 years
Opex ($m)			$0.34	$0.34	$0.34	$1.01	30 years

Source: AusNet analysis

Option 2: Install a new CBTS-PHM 66kV line

Table 10 – Install new CBTS-PHM 66kV line ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)	$13.37	$13.37	$13.37			$40.12	30 years
Opex ($m)			$0.40	$0.40	$0.40	$1.20	30 years

Source: AusNet analysis

Option 3: Install a new CBTS-PSH and new PSH-PHM

Table 11- Install new CBTS-PSH and new PSH-PHM line ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)	$14.7655	$14.7655	$14.7655			$44.30	30 years
Opex ($m)			$0.44	$0.44	$0.44	$1.33	30 years

Source: AusNet analysis

Option 4: Install a new CBTS-LLG 66kV line

Note: Project optimal timing is FY32, one additional year of expenditure required (outside of this assessment period), Opex to begin in FY32.

Table 12 – Install a new CBTS-LLG 66kV line ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)				$16.76	$16.76	$33.53	30 years
Opex ($m)						$ 0.00	30 years

Source: AusNet analysis

Option 5: Construct a 25MW/150MWh battery at Officer zone substation

Note: no expenditure in the FY27-FY31 regulatory period.

Table 13 – Install a new 25MW/150MWh battery at Officer zone substation ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)							30 years
Opex ($m)							30 years

Source: AusNet analysis

C. High-level scope

High level scope of works (Option 1):

- Utilise spare 66kV bay on CBTS 66kV No.1 bus (extension completed as part of a separate project) and install new 66kV breaker and all associated equipment (Isolators, CT's, etc.) to enable new line.
- Complete 66kV Ring bus arrangement (via bus extension) at OFR to facilitate one additional 66kV feeder, this will require 1 x rotary isolators and 2 new circuit breakers as well as required CT's etc.
- Install new 37/3.75AAC (thermally designed to 100 degrees to achieve a minimum summer cyclic rating of 117.17MVA from CBTS 66kV breaker to OFR breaker.
- Utilise 7.1km of existing 66kV line between CBTS and OFR (including 6.9 km existing between CBTS and CLN)
- Full route is approximately 22.5km of line
- Conduct plant protection review.

D. Sensitivity testing

The results of the model were tested for sensitivity to individual inputs to determine where a change in an input could result in a change to the preferred option. Also, where the model is sensitive to an input, further analysis is required to assess the and support the appropriate assumption.

The following four inputs were tested with the results shown in the tables below.

- Discount rate (Table 14) with a Low of 4.11%, base case of 5.56% and high of 7.00%.
- Forecast sensitivity (Table 15) with a forecast demand of Low of 89%, base case of 100% and high of 102%
- Cost sensitivity (Table 16) with a Low of 85%, base case of 100% and high of 115%
- Asset failure sensitivity (Table 17) with a Low case of 50%, base case of 100% and high of 150% outages per km line length
- VCR sensitivity (Table 18) with base case of 39.45 $/MWh, QCV case (AusNet residential rate only – AER rate for Commercial/Industrial/Agricultural) of 52.16 $/MWh and QCV case (All AusNet customer rates) of $43.43

Table 14: Discount rate sensitivity ($m, real 2023-24 dollars)

Rate sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV $m	Optimal timing	NPV $m	Optimal timing	NPV $m
Option 1 – Install a new CBTS-OFR 66kV line	2028	$239.04	2028	$313.99	2028	$183.27
Option 2 – Install a new CBTS-PHM 66kV line	2028	$212.17	2028	$280.49	2031	$163.98
Option 3 – Install a new CBTS-PSH and PSH-PHM 66kV lines	2028	$189.83	2028	$252.51	2031	$146.58
Option 4 – Install a new CBTS-LLG 66kV line	2031	$110.37	2028	$147.37	2031	$81.96
Option 5– Construct a 25MW/150MWh Battery at Officer zone substation	2035	$26.27	2034	$38.27	2035	$13.58
Max NPV $m	$239.04		$313.99		$183.27	
Highest NPV project	Option 1		Option 1		Option 1	

Source: AusNet analysis

Table 15 – Forecast sensitivity ($m, real 2023-24 dollars)

Forecast sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV $m	Optimal timing	NPV $m	Optimal timing	NPV $m
Option 1 – Install a new CBTS-OFR 66kV line	2028	$239.04	2031	$182.93	2028	$307.27
Option 2 – Install a new CBTS-PHM 66kV line	2028	$212.17	2031	$163.10	2028	$273.07
Option 3 – Install a new CBTS-PSH and PSH-PHM 66kV lines	2028	$189.83	2032	$146.20	2028	$245.01
Option 4 – Install a new CBTS-LLG 66kV line	2031	$110.37	2032	$82.00	2028	$141.77
Option 5– Construct a 25MW/150MWh Battery at Officer zone substation	2035	$26.27	2035	$3.42	2034	$46.90
Max NPV $m	$239.04		$182.93		$307.27	
Highest NPV project	Option 1		Option 1		Option 1	

Table 16 - Cost sensitivity ($m, real 2023-24 dollars)

Cost sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV $m	Optimal timing	NPV $m	Optimal timing	NPV $m
Option 1 – Install a new CBTS-OFR 66kV line	2028	$239.04	2028	$243.94	2028	$234.14
Option 2 – Install a new CBTS-PHM 66kV line	2028	$212.17	2028	$217.98	2028	$206.35
Option 3 – Install a new CBTS-PSH and PSH-PHM 66kV lines	2028	$189.83	2028	$196.25	2031	$186.51
Option 4 – Install a new CBTS-LLG 66kV line	2031	$110.37	2028	$114.46	2031	$104.21
Option 5– Construct a 25MW/150MWh Battery at Officer zone substation	2035	$26.27	2034	$36.04	2035	$11.85
Max NPV $m	$239.04		$243.94		$234.14	
Highest NPV project	Option 1		Option 1		Option 1	

Table 17 – Asset failure sensitivity ($m, real 2023-24 dollars)

Asst failure sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV $m	Optimal timing	NPV $m	Optimal timing	NPV $m
Option 1 – Install a new CBTS-OFR 66kV line	2028	$239.04	2028	$239.04	2028	$239.04
Option 2 – Install a new CBTS-PHM 66kV line	2028	$212.17	2028	$212.17	2028	$212.17
Option 3 – Install a new CBTS-PSH and PSH-PHM 66kV lines	2028	$189.83	2028	$189.83	2028	$189.83
Option 4 – Install a new CBTS-LLG 66kV line	2031	$110.37	2031	$110.37	2031	$110.37
Option 5– Construct a 25MW/150MWh Battery at Officer zone substation	2035	$26.27	2035	$26.27	2035	$26.27
Max NPV $m	$239.04		$239.04		$239.04	
Highest NPV project	Option 1		Option 1		Option 1	

Table 18 – VCR sensitivity ($m, real 2023-24 dollars)

VCR sensitivity	Base Case (AER)		QCV (AusNet Resi only)		QCV (Full AusNet QCV analysis)	
	Optimal timing	NPV $m	Optimal timing	NPV $m	Optimal timing	NPV $m
Option 1 – Install a new CBTS-OFR 66kV line	2028	$239.04	2028	$356.19	2028	$291.09
Option 2 – Install a new CBTS-PHM 66kV line	2028	$212.17	2028	$320.37	2028	$260.24
Option 3 – Install a new CBTS-PSH and PSH-PHM 66kV lines	2028	$189.83	2028	$290.14	2028	$234.40
Option 4 – Install a new CBTS-LLG 66kV line	2031	$110.37	2028	$174.34	2028	$137.01
Option 5– Construct a 25MW/150MWh Battery at Officer zone substation	2035	$26.27	2034	$73.56	2034	$44.25
Max NPV $m	$239.04		$356.19		$291.09	
Highest NPV project	Option 1		Option 1		Option 1	

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