Electricity Distribution Price Review FY2027 to FY2031 (EDPR 2027-31)

Business case: East Gippsland 66kV loop augmentation business case

Date: 31 January 2025

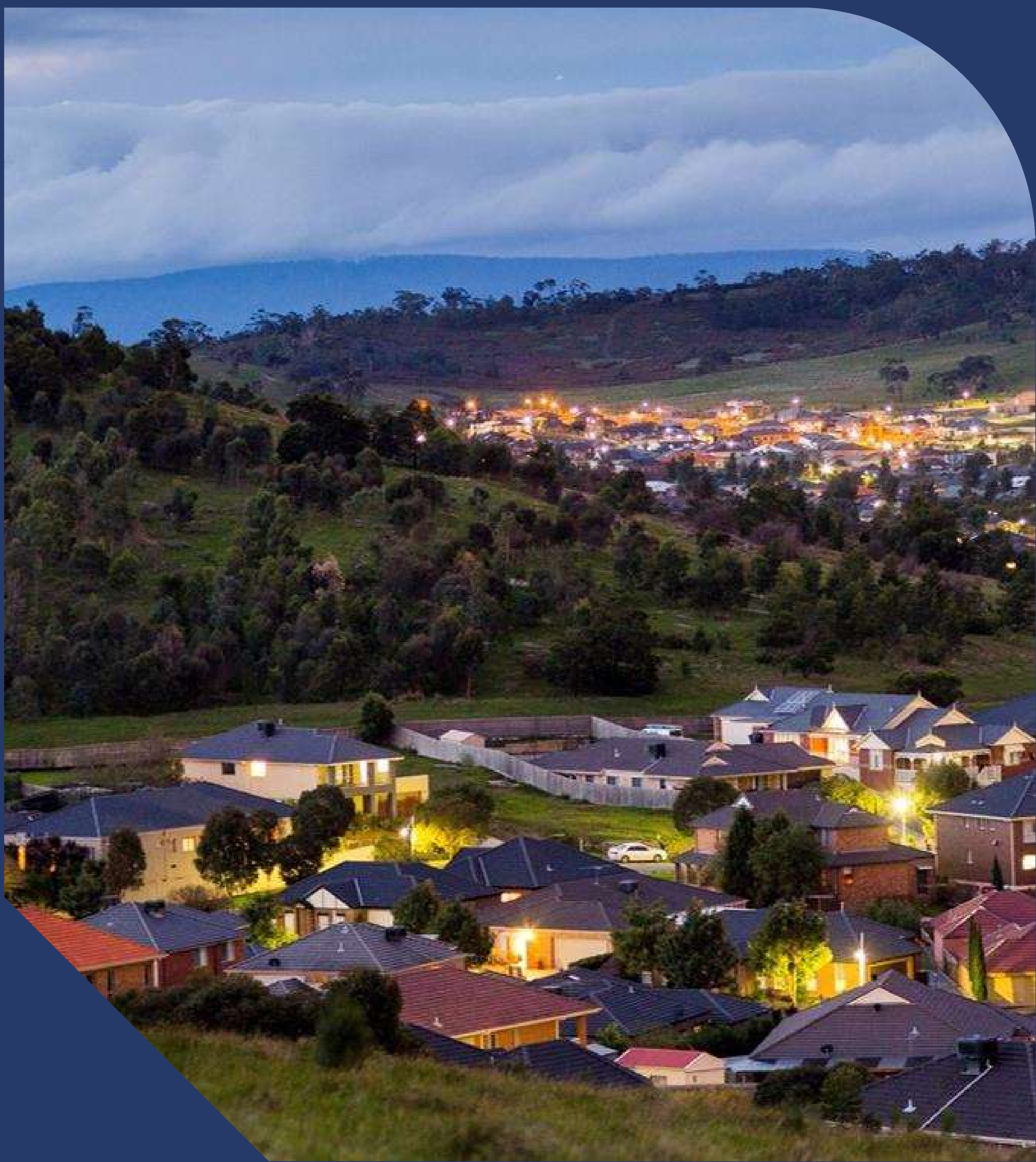


Table of contents

1. Executive summary

The East Gippsland 66kV network loop supplies electricity to over 71,200 customers. It originates from the Morwell Terminal Station (MWTS) and is comprised of six zone substations, including Traralgon (TGN), Sale (SLE), Maffra (MFA), Bairnsdale (BDL), Newmerella (NLA) and Cann River (CNR) and is geographically very isolated.

It is the longest sub-transmission network (by distance of line coverage) in AusNet's 66kV network. This network loop is particularly prone to voltage issues due to long line lengths and has limited capacity transfer ability due to its geographical remoteness.

AusNet has identified there is energy at risk over the summer period on the East Gippsland 66kV network loop driven by customer growth, gas electrification of homes, and electric vehicle (EV) uptake within the region. Specifically, our demand forecasts show:

- Demand is forecast to increase sharply in 2024 and continue to increase over the remainder of the regulatory control period.
- Coincidental loading at the six zone substations is forecast to reach 160MVA over the 2024/25 summer period under POE10 conditions, which exceeds the loops N capacity of 147MVA and is expected to exceed capacity under POE50 conditions by 2027.
- The N voltage collapse limit of 180MVA for the loop is expected to be reached by summer 2031/2032 under POE10 conditions.
- Under worst case N-1 conditions (i.e. with the major MWTS-SLE section being out of service), the loop has a thermal capacity limit of 86.5MVA, which is already exceeded even under POE50 conditions.

If left unaddressed, existing summer contingency plans currently require immediate load shedding of 50% of total demand on all six zone substations under certain N-1 scenarios to prevent loop voltage collapse and thermal overload issues. This will result in a probability weighted unserved energy valued at $169.50 million (including the terminal value) over the assessment period.

AusNet is committed to meeting customer and community energy needs both now and into the future to ensure that our customers have 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 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. Our network planning indicates that we require approximately 48MW of additional capacity or load reduction/generation of approximately 40MW through alternative non-network approaches, such as demand management or network support agreements at strategic locations on the loop, to enable the ongoing reliable supply the total load limit for the loop.

AusNet has identified 5 credible options for addressing the identified need which are summarised in Table 1 below and are discussed in further detail in section 4.2. Two non-credible options were also identified relating to demand management which was assessed as not meeting the identified need and the establishment of a new Bairnsdale terminal station which was assessed as not being economically viable.

Table 1 - Overview of credible options

OPTION	DESCRIPTION
Option 0: Do nothing	This option would entail no mitigative action beyond existing measures to address the identified risk.
Option 1: Reconductor the entire Traralgon - Maffra (TGN-MFA) 66 KV line	This option involves reconductoring the full length of the TGN-MFA line.
Option 2: Construct new Traralgon - Sale (TGN-SLE) 66kV line	This option involves constructing a new TGN-SLE 66kV line by predominately rebuilding the 22kV line section adjacent to or along the Princess Highway.
Option 3: Establish a TGN-SLE/MFA 66kV line	This option involves constructing a new 66kV switching station at the existing TGN-MFA from the new switching station at Sale (SLE) and reconducting the line between TGN and the new tee point.
Option 4: Construct a 30MW/150MWh Battery Energy Storage System	This option involves constructing a 30MW/150MWh battery at the existing Bairnsdale 66kV switching station to provide support to a major load centre on the East Gippsland 66kV network loop.

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
Capex ($m, real FY24)	N/A	$26.5	$50.7	$61.8	$180.0
NPV ($m, real FY24)	N/A	$142.6	$121.8	$113.1	$22.8
Residual risk ($m, real FY24)	$169.50	$3.3	$6.3	$8.7	$43.2
Optimal timing	N/A	2029	2031	2032	2037
Meets customer expectations	No	Yes	Partial	Partial	Partial
Aligns with asset management objectives	No	Yes	Partial	Partial	Partial

Source: AusNet analysis

Based on our analysis of credible options, Option 1 – Reconductor the MFA-TGN line has been identified as the preferred option. This option is considered the most prudent and efficient option for addressing the identified need and is consistent with the capex objectives as it:

- Has the highest NPV, relative to the other options assessed at $142.6 million.
- Is the least expensive option to implement, and the only option assessed as fully addressing all assessment criteria.
- Addresses the identified need by significantly increasing the thermal capacity of the East Gippsland 66kV network, increases the N-1 voltage collapse limits for an outage on either the MWTS-SLE or MWTS-MFA lines on the network loop, and reduces network losses.
- Provides the largest reduction in residual risk relative to the other options.
- 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

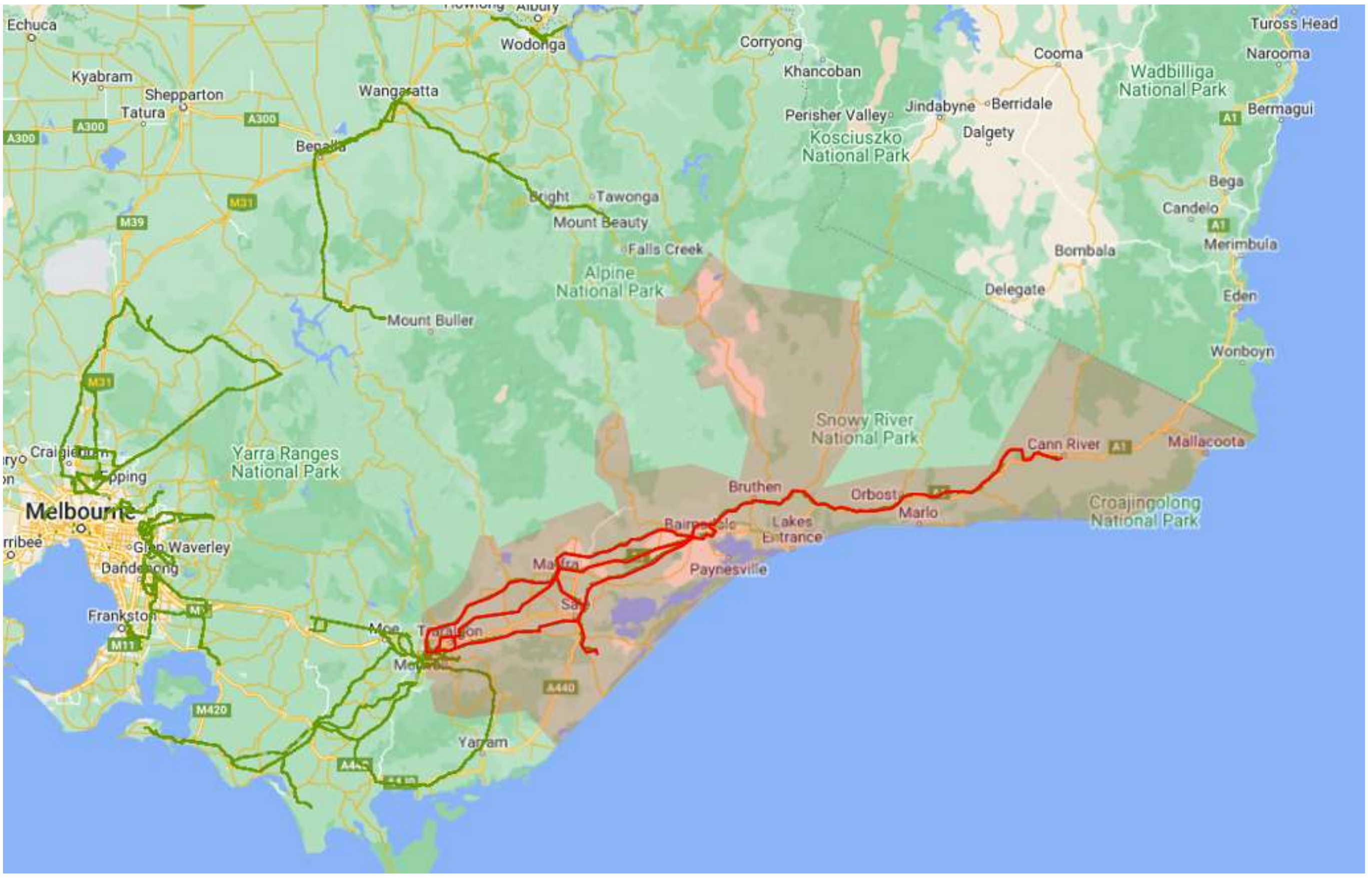
AusNet's network operating area is split into three distinct regions, Central, East, and North, that supply approximately 809,000 consumers ranging from the fringe of the northern and eastern Melbourne metropolitan area to the eastern half of rural Victoria.

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, and plant and equipment types. Consequently, 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 East Gippsland 66 kV network loop, located within the East part of AusNet's network operating area, as shown by Figure 1 below.

Figure 1 - AusNet network area map with East Gippsland 66kV network loop



The loop originates from Morwell Terminal Station (MWTS) and is comprised of six zone substations, including Traralgon (TGN), Sale (SLE), Maffra (MFA), Bairnsdale (BDL), Newmerella (NLA) and Cann River (CNR), as shown by Figure 2 below. Figure 3 below depicts a 66kV network diagram of the region and also indicates the high-capacity lines (these are represented by the thick lines in the diagram) and low capacity lines (denoted by the thin lines) on the East Gippsland network loop.

Figure 2 – Map showing East Gippsland 66kV network loop and location of terminal station and zone substations

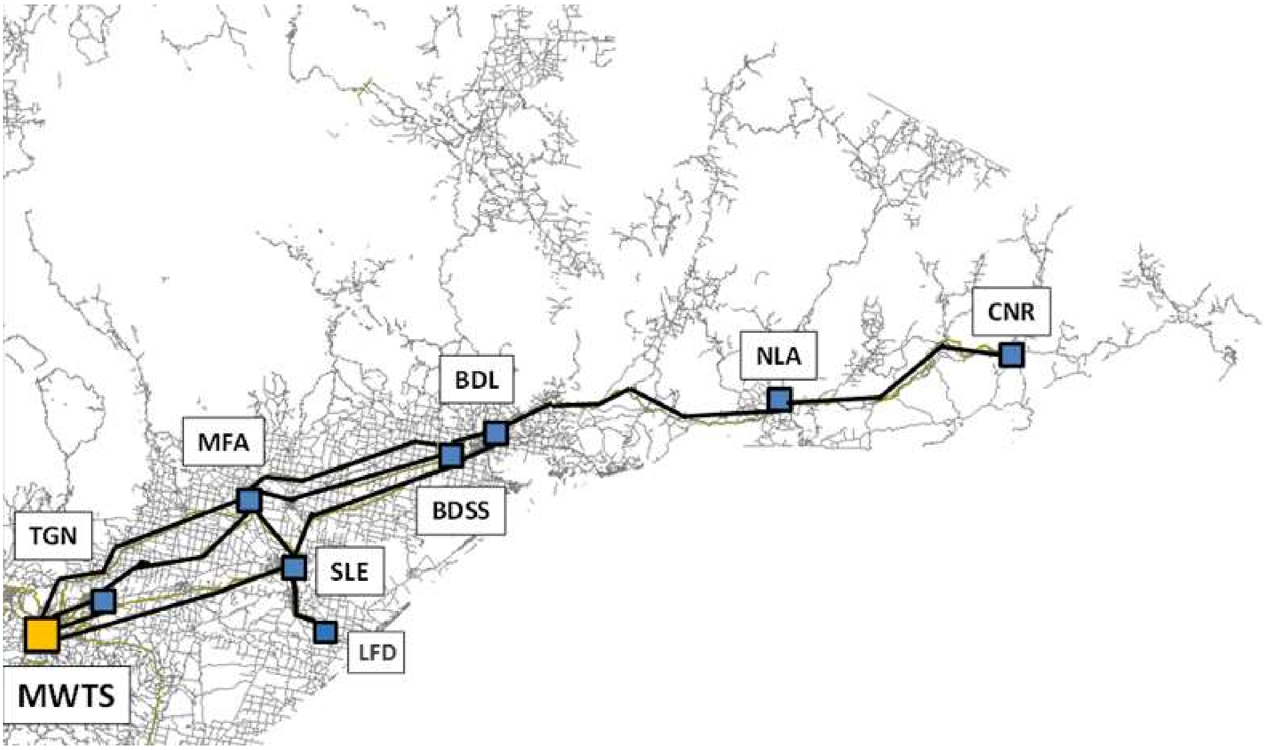
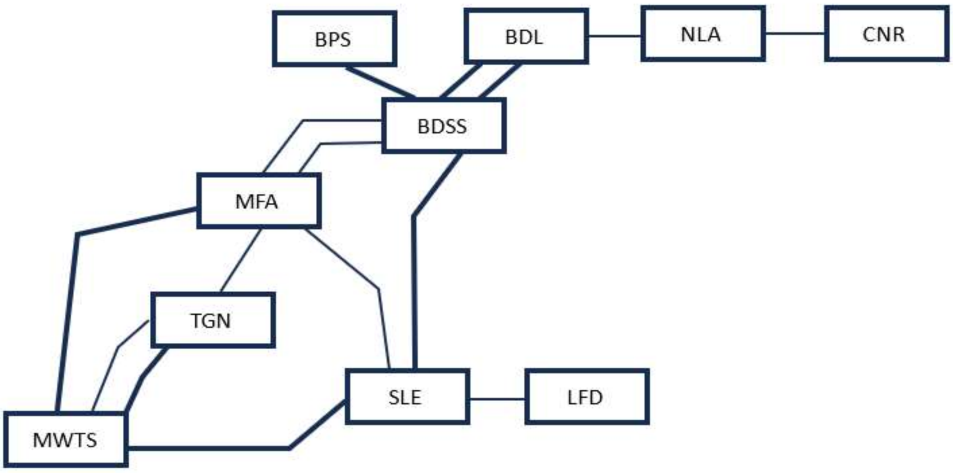


Figure 3 – Location of high-capacity and low-capacity lines on the East Gippsland 66kV network loop



The loop supplies electricity to over 71,200 customers comprising of commercial (34%), farms (12%), industrial (10%), and residential (44%) consumers. The East Gippsland loop is geographically very isolated, servicing an extensive area between Traralgon and Mallacoota and is the longest sub-transmission network (by distance of line coverage) in AusNet's 66kV network. This characteristic makes the East Gippsland 66kV network particularly prone to voltage issues due to the long line lengths and has necessitated the installation of three voltage regulators to help in managing voltage. Additionally, due to the remoteness and geographic isolation from other 66kV networks, this network loop has less transfer capability than other 66kV network loops in AusNet's network, with transfers only available in the west portion of the loop at Traralgon (TGN). All other zone substations on this loop have no available transfers out of loop, which creates operational challenges in managing the load limit on this loop.

The East Gippsland 66kV loop has a:

- maximum (N) capacity of 147MVA and firm capacity (N-1) of 86.5MVA
- voltage limit of 180MVA and 114MVA under (N-1) conditions
- transfer capacity of 8MVA which is expected to diminish overtime from load growth at receiving stations. Additionally as the primary constraint is located further down the subtransmission loop from TGN, these transfers have an extremely limited ability to mitigate risk.

AusNet

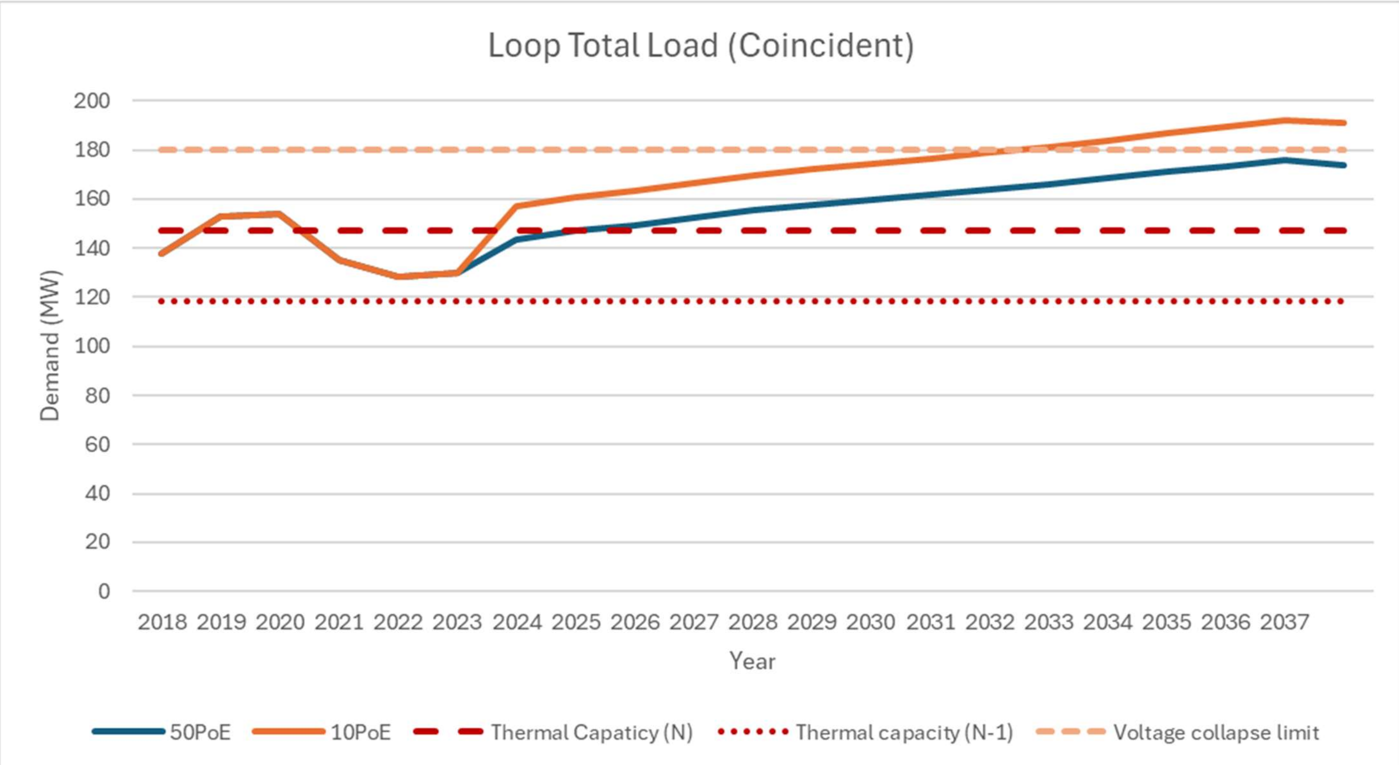
3. Identified need

Investment driver

AusNet has identified in its Distribution Annual Planning Report (DAPR) 2025-2029 that there is energy at risk over the summer period on the East Gippsland 66kV network loop (MWTS-TGN-SLE-MFA-BDSS-BDL-NLA-CNR), as highlighted by Figure 4, which shows that:

- Demand is forecast to increase sharply in 2024 and continue to increase over the remainder of the regulatory control period. This is primarily driven by customer growth, electrification of homes, and electric vehicle (EV) uptake within the region.[1]
- Coincidental loading at the six zone substations is forecast to reach 160MVA over the 2024/25 summer period under POE10 conditions, which exceeds the loops N capacity of 147MVA and is expected to exceed capacity under POE50 conditions by 2027.
- The N voltage collapse limit of 180MVA for the loop is expected to be reached by summer 2031/2032 under POE10 conditions.
- Under worst case N-1 conditions (i.e. with the major MWTS-SLE section being out of service), the loop has a thermal capacity limit of 86.5MVA, which has long been exceeded even under POE50 conditions.

Figure 4 - Load capacity of the East Gippsland 66kV network loop



While this loop has experienced N and N-1 thermal capacity exceedance for some time, AusNet has been able to mitigate the risk of thermal overload and voltage collapse under N-1 scenarios and planned maintenance periods through its network support agreement with Bairnsdale Power Station (BPS) to provide generation support under high load scenarios.

Guaranteed network support provided by Bairnsdale Power Station is longer available due to the expiry of the network support contract in 2022 and is a compounding factor for growing load constraints on the East Gippsland network loop. Bairnsdale Power Station now operates as a merchant generator and as such market operational drivers may not align with local support requirements, which has resulted in a dramatic increase in the supply risk of the East Gippsland region since the network support agreement's expiry in 2022.

Additionally, anticipated generation from Bairnsdale Power Station may become unreliable depending on factors beyond AusNet's visibility or control including Bairnsdale Power Station scheduled generator maintenance, changes to the availability/commerciality of gas supply or change to the particular division of the wholesale market Bairnsdale Power Station may wish to operate in (e.g. FCAS market) – all of which may cause generation from Bairnsdale Power Station to not coincide with loop peak loading times. The Victoria State Government has also

[1] Refer to Victoria State Government, 'Gas Substitution Roadmap – Update: Victoria's Electrification Pathway.'

signalled its intention to transition away from gas through its Gas Substitution Roadmap as part of its broader plan for navigating the state to a zero emissions future while improving affordability and ensuring reliability.[2]

Network load flow studies have found that with the loss of guaranteed service level network support functions supplied by Bairnsdale Power Station, there are voltage and thermal capacity issues that need to be addressed, particularly with load starting to exceed N thermal capacity limits from 2024, as shown by Figure 4 above.

This will become a growing issue over the next regulatory control period, given the loop has long exceeded N-1 thermal capacity limits. The emerging issue of voltage collapse limits is a complicating factor that places additional constraints on the network and limits the types of solutions that can be considered.

Economic modelling has found that these conditions result in a material expected cost to customers from energy not supplied and results in a material network reliability risk.

Thermal Capacity Limitations

From a thermal capacity perspective, without an emergency control scheme to enact load shedding in place the East Gippsland network should not be loaded above its secure system normal planning limit of 99 MVA 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, and can therefore result in irreversible conductor damage and cascade tripping of network elements.

Supply to the East Gippsland region is also limited under network outage conditions by the thermal capacity of some key 66 kV lines. Thermal ratings will be exceeded on the:[3]

- TGN-MFA 66kV line when all lines are in service and net load in the East Gippsland loop exceeds 147MVA.
- TGN-MFA 66 kV line when the MWTS-MFA 66 kV line is out of service and net load in the East Gippsland region exceeds 88.5 MVA.
- TGN-MFA 66 kV line when the MWTS-SLE 66 kV line is out of service and net load in the East Gippsland region exceeds 86.5 MVA.

Voltage Stability Limitations

The East Gippsland region is supplied by TGN, SLE, MFA, BDL, NLA and CNR zone substations. The 66 kV network supplying the region is subject to voltage instability, where outage of a 66 kV line during high demand periods can cause network voltages to drop uncontrollably (voltage collapse), ultimately leading to cascading 66 kV line trips and loss of supply to the 71,200 customers in the East Gippsland region.

The East Gippsland 66 kV sub-transmission network is voltage stable up to 179 MVA in summer with all lines in service and the BDSS static VAR compensator (SVC) operating at its full reactive power capability of 30 MVAR.

The network is also expected to suffer voltage collapse for any one of the following conditions: [4]

- MWTS-SLE 66 kV line is out of service when net load in the East Gippsland region exceeds 114 MVA.
- MWTS-MFA 66 kV line is out of service when net load in the East Gippsland region exceeds 127 MVA.
- TGN-MFA 66 kV line is out of service when net load in the East Gippsland region exceeds 147 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. AusNet's summer contingency plan specifically seeks to address potential network overloads created through incremental load growth to ensure it can meet forecast demand on its distribution network over the summer period.

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 identify and determine possible HV feeders to service out of loop transfers that may be rapidly enacted to protect assets from severe overload or to prevent loop voltage collapse.

Our summer contingency plans have identified that there is limited transfer availability (totalling 8MVA of out of loop transfers) available in the event of an outage on a major loop segment.[5] This is primarily due to the isolated geographical region in which this 66kV loop services and is considered insufficient for managing the coincident

[2] https://www.energy.vic.gov.au/renewable-energy/victorias-gas-substitution-roadmap
[3] Refer to Appendix A for further details on the line characteristics of the East Gippsland 66kV network loop.
[4] Refer to Appendix A for details line regulators and SVC characteristics on the East Gippsland network loop.
[5] Refer to Appendix B for further details.

demand forecasted on the loop. A further compounding factor, is the expiry of the network support agreement with Bairnsdale Power Station to provide generation support during high load scenarios.

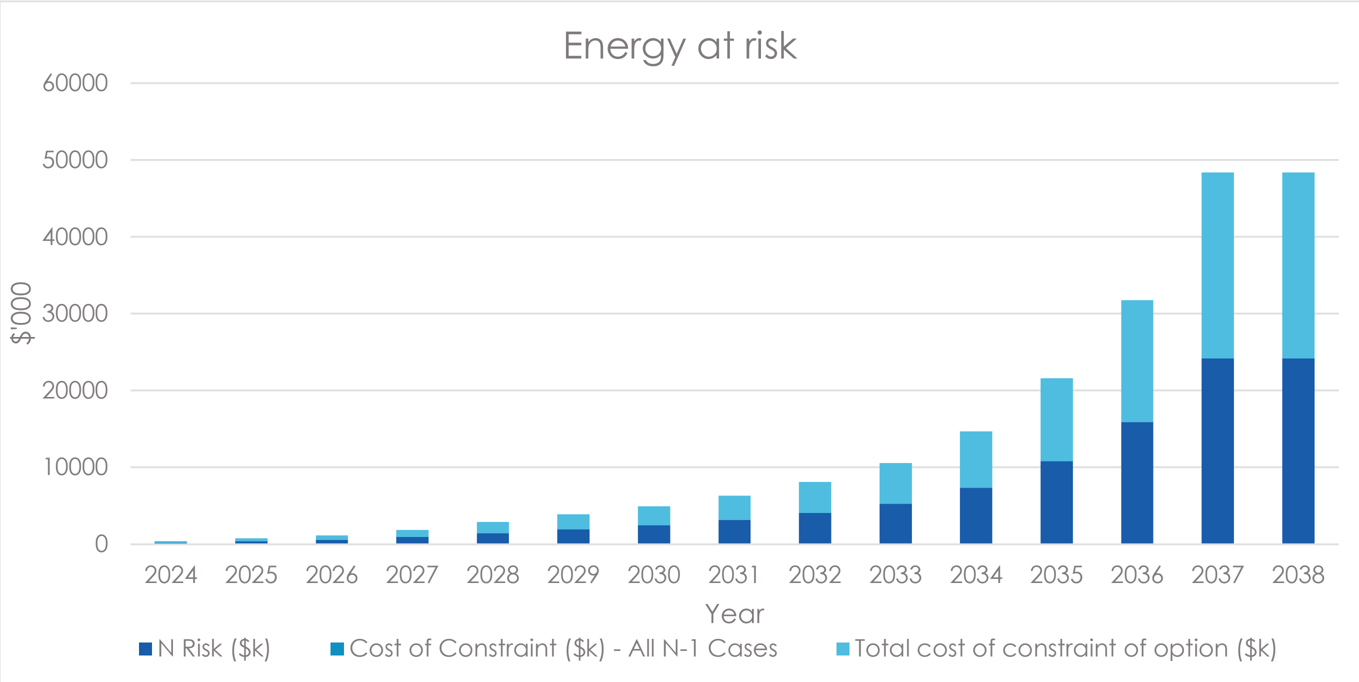
Risk assessment

If left unaddressed, existing summer contingency plans currently require immediate load shedding of up to 50% of total demand on four major zone substations under certain N-1 scenarios to prevent loop voltage collapse and thermal overload issues. This will result in a probability weighted unserved energy valued at $169.50 million (including the terminal value) over the assessment period. This represents the economic impact to customers and is based on the Value of Customer Reliability (VCR) published by the AER for each customer type.

AusNet is committed to meeting customer and community energy needs both now and into the future to ensure that our customers have access to reliable and affordable energy that meets their daily needs and supports the electrification of transport, homes 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] A risk assessment of the East Gippsland 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 5 below and shows that energy at risk is expected to continually increase at an increasing rate throughout the 15-year assessment period.

Figure 5 - Energy at risk on the East Gippsland 66kV network loop



In assessing the identified need, AusNet has taken into account the impact of the Large renewables enablement projects. This project will increase the capacity of the MWTS-TGN section of the East Gippsland 66kV network loop to enable the connection of a new major customer. The Large renewables enablement project is based solely on generation benefits. In contrast, the East Gippsland 66kV loop augmentation is primarily driven by demand growth and the need to provide additional load capacity and does not consider generation capacity benefits.

Our analysis of forecasted demand, coupled with existing thermal and voltage limits on this network loop, indicate that mitigation actions are required to address the increasing risk to provision of reliable services to our customers.

Summary of identified network need

Our network planning indicates that we require approximately 48MW of additional capacity or load reduction/generation of approximately 40MW through alternative non-network approaches such as demand management or network support agreements at strategic locations on the loop to enable the ongoing reliable supply the total load limit for the loop.

[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. See also: BFM 10-01 – Bushfire Mitigation Plan – Electricity Distribution Network

Addressing this identified capacity constraint will help to ensure that AusNet is able to prudently meet forecast load growth in the region, address thermal loading issues, and raise the voltage collapse limit of the loop to deliver improved customer outcomes.

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.[8] It also considers the impact of the Large renewables enablement projects.
- Asset capacity ratings – compared to the demand forecast demonstrate capacity limits are being reached.[9]
- Network studies have identified that there is an increasing risk of voltage collapse on the network loop under N-1 scenarios when demand is above 118MW and under N scenarios when coincident demand reaches the modelled limit of 180 MVA which is expected in 2032/33.
- Unavailability rates of subtransmission line segments is calculated based on 5 years of historic unplanned outage data from internal outage logs for the East Gippsland 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 East Gippsland Loop.
- 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.
- Bairnsdale Power Station's network support agreement has lapsed and is not expected to be reinstated. Historically, network support from Bairnsdale Power Station has been relied on to address network issues and defer network augmentation.
- The large renewables enablement works that will augment MWTS-TGN Lines 1 and 2 will be implemented by 2026, as forecasted, which will result in a reduction of $2.7 million capex needed by this project.
- 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 (terminal value).
- 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.
- Commercial solar generation is not factored into the economic assessment of this business case as peak maximum demand occurs roughly at 19:00pm, when solar PV output has a negligible effect on demand. However, the significant effect of 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 East Gippsland 66kV network loop.

[8] See AusNet's Demand Forecasting Methodology
[9] See Appendix A for further details on the line characteristics of the East Gippsland 66kV network loop.

4. Options assessment

AusNet has identified 5 possible options for addressing the identified need, as summarised by the Table 3 below.

Table 3 – Overview of identified options

OPTION	DESCRIPTION
Option 0: Do nothing	This option would entail no mitigative action beyond existing measures to address the identified risk.
Option 1: Reconductor the entire Traralgon - Maffra (TGN-MFA) 66 KV line	This option involves reconductoring the full length of the TGN-MFA line.
Option 2: Construct new Traralgon - Sale (TGN-SLE) 66kV line	This option involves constructing a new TGN-SLE 66kV line by predominately rebuilding the 22kV line section adjacent to or along the Princess Highway.
Option 3: Establish a TGN-SLE/MFA 66kV line	This option involves constructing a new 66kV switching station at the existing TGN-MFA from the new switching station at Sale (SLE) and reconducting the line between TGN and the new tee point.
Option 4: Construct a 30MW/150MWh Battery Energy Storage System	This option involves constructing a 30MW/150MWh battery at the existing Bairnsdale 66kV switching station to provide support to a major load centre on the East Gippsland 66kV network loop.

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 base 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 the customer driven reinforcement from Morwell Terminal Station (MWTS) to Traralgon Zone Substation (TGN) is committed and will proceed according to the current schedule.

Preferred timing of each option is determined based on when the annualised benefit 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 the 2023 VCR update from the AER and weighted it 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 daily activities. While we have not quantified the wider economic benefit to customers, other than through the VCR, customers have expressed the wide-ranging impacts that poor reliability and supply interruptions have on their daily lives. This can range from physical discomfort, emotional distress, and financial losses.

Consequently, in addition to taking into account technical and economic impacts, our assessment also examines the degree to which different options meet customer expectations of minimising supply interruptions and supporting the electrification of transports, businesses and homes. Options have also been assessed against the degree to which they are consistent with AusNet's asset management objectives.

Table 4 below outlines key assumptions used in the economic assessment of identified options.

Table 4: 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	$39.45k /MWh	Based on the 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 5 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 C.

As the expected costs of each of the options considered in this section exceeds the regulatory investment test for distribution (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 voltage limits. 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.

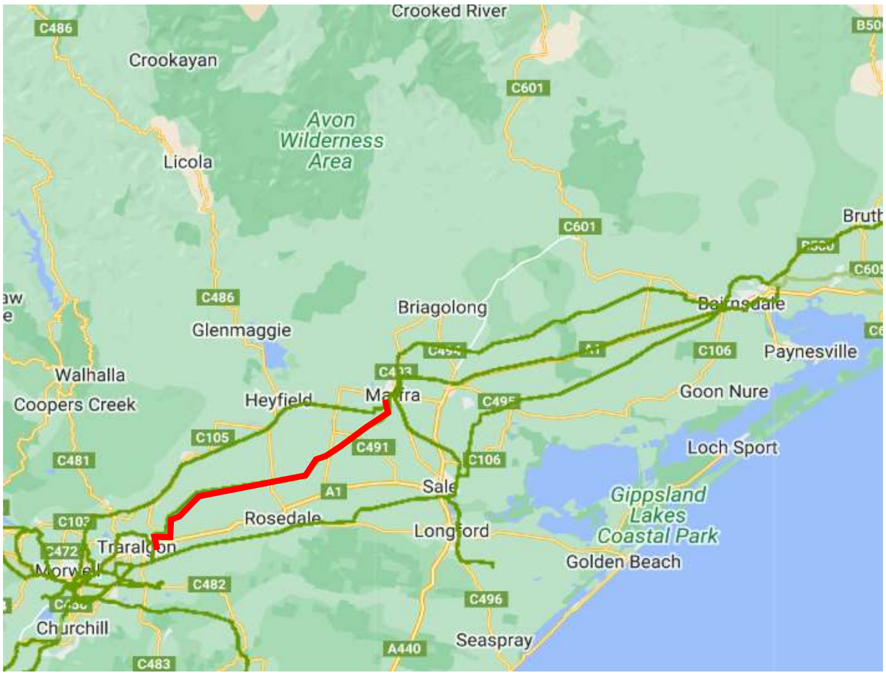
While this option does not entail any upfront capital costs, it exposes customers to the most risk of network outages as it does not address the identified risk of capacity and voltage limits on the loop being exceeded from increased demand growth in the network area. AusNet has quantified the value of energy at risk to be $169.50 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: Reconductor MFA-TGN line

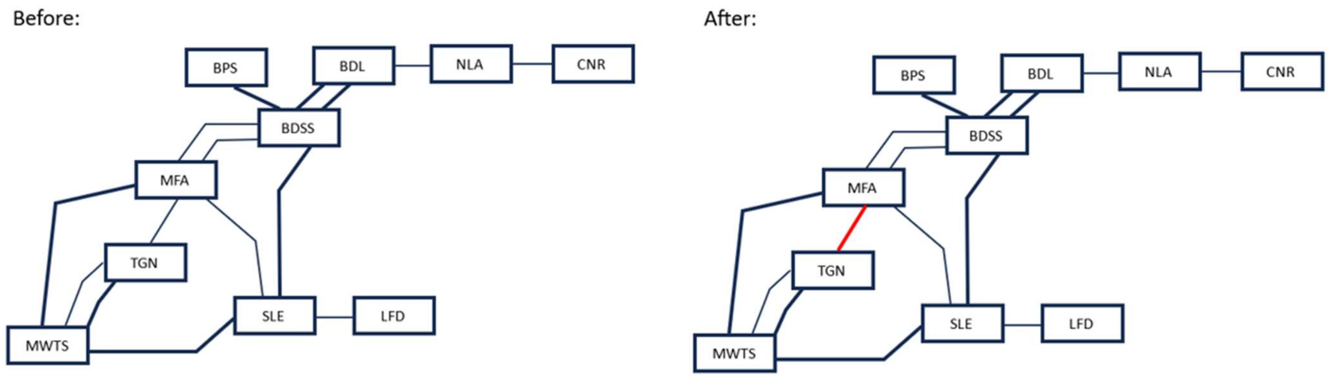
This option involves reconductoring all undersized conductors (6/4.72 7/1.57 ACSR) along the full length of the TGN-MFA 66 kV line (approximately 46.6km) with 19/4.75 AAC conductors and redesigning them to a maximum conductor temperature of 100 degrees celsius to achieve a minimum summer cyclic rating of 881A.

Figure 6 - Map indicating existing TGN-MFA 66kV line route



Undersized conductors on this network loop have been identified by AusNet with a complete list of conductors that need to be replaced. In total AusNet has identified 46 km of conductor that require replacement.[10] Figure 7 below compares the current configuration of the East Gippsland 66kV loop and the configuration of the loop after the TGN-MFA 66kV line has been reconductored. The bold lines in the diagram indicate 19/4.75AAC and higher rated lines on the network loop, with the red bold line reflecting the work to be carried out under this option.

Figure 7 - Comparison of East Gippsland 66kV loop after reconductoring MFA-TGN 66kV line



Reconductoring undersized conductions along the TGN-MFA line will increase the line rating from 345 A to 881A, while also significantly reducing the impedance of this line. Key benefits from this include:

- Significantly increasing the system normal planning limit and thermal capacity of the East Gippsland 66 kV network.
- Significantly increasing the N-1 voltage collapse limits for outages of either the Morwell Terminal Station to Sale (MWTS-SLE) or Morwell Terminal Station to Maffia (MWTS-MFA) 66 kV lines.
- Reducing network losses.

Of the options considered, Option 1 delivers the highest NPV of $142.6 million, is one of the least cost options identified, and provides the largest reduction in residual risk.

This option assumes the MWTS to TGN Connections Enablement Project is implemented according to the proposed schedule. The Connections Enablement Project will upgrade the lines between MWTS-TGN, whereas this option only considers the TGN-MFA segment.

[10] Refer to Appendix A for further details.

It 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: Construct new Traralgon - Sale (TGN-SLE) 66kV line

This option involves constructing a new TGN-SLE 66 kV line over a 51.5km route length, by predominately rebuilding 22 kV line segments adjacent to or along the Princess Highway, as shown by Figure 8 below.

Figure 8 - TGN-SLE 66Kv lines works (Reconductoring No1 MWTS - TGN line)

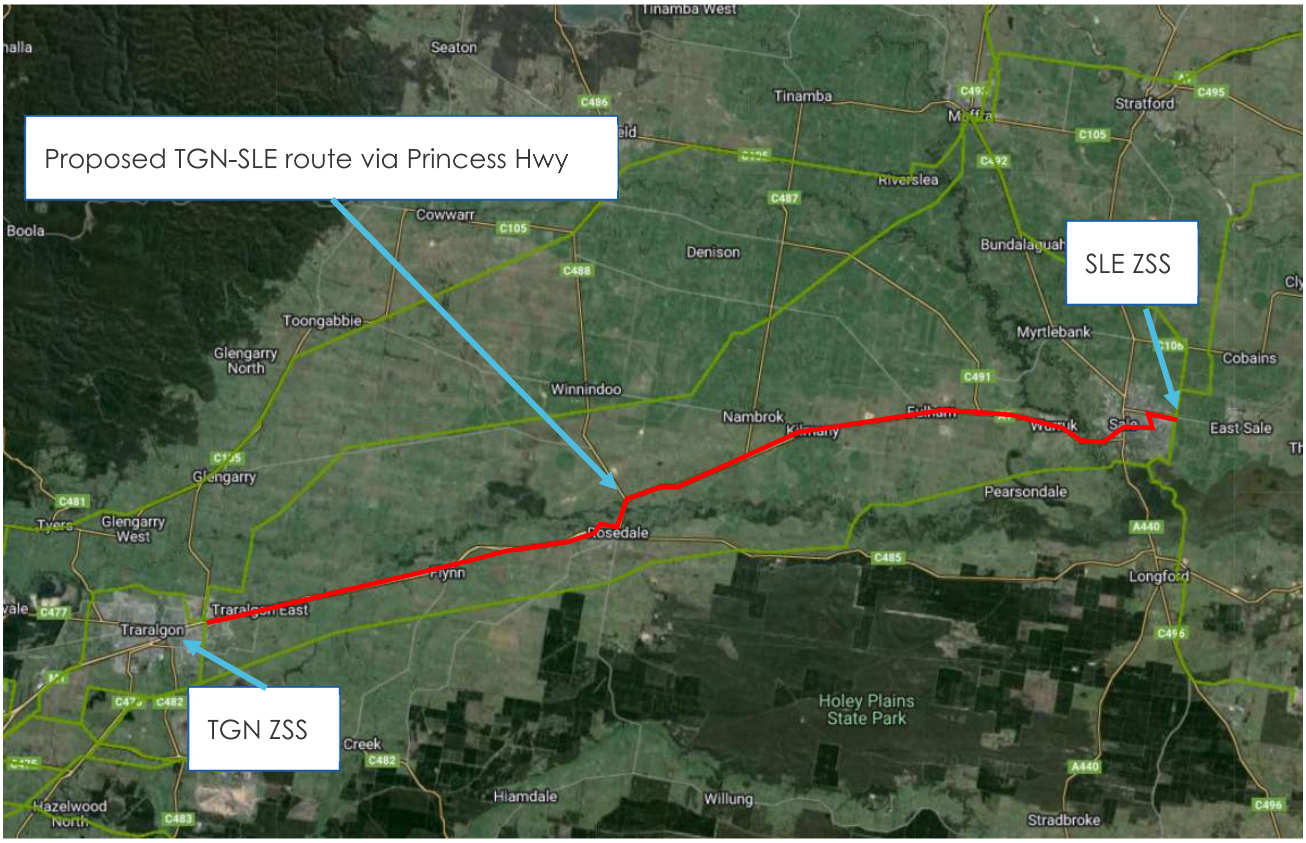
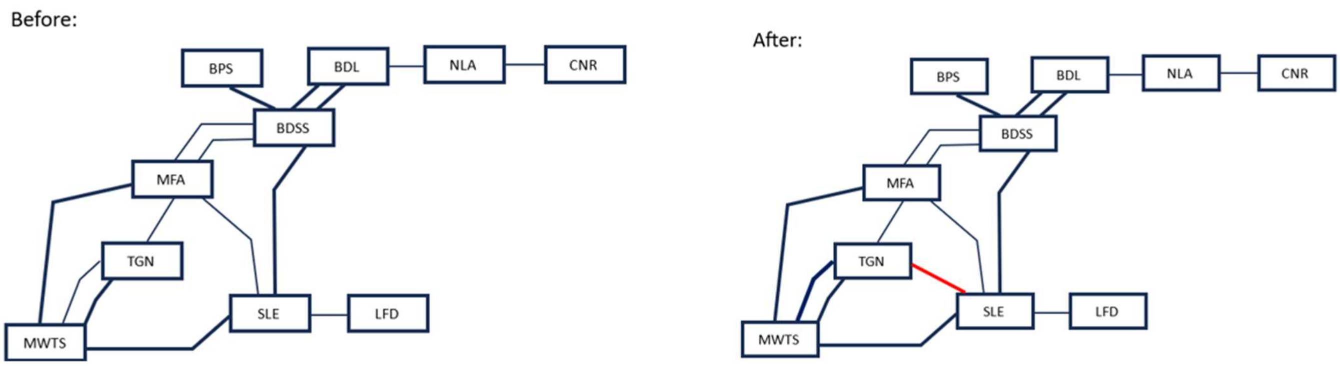


Figure 9 below, compares the current configuration of the East Gippsland 66kV loop and the configuration of the loop after the establishment of a new TGN-SLE 66kV line. The bold lines in the diagram indicate 19/4.75AAC and higher rated lines on the network loop, with the red bold line reflecting the work to be carried out under this option.

Figure 9 - Comparison of East Gippsland 66kV loop after reconductoring TGN-SLE 66kV line[11]



These works will establish a new TGN-SLE 66 kV line, constructed from 19/4.75 AAC conductor designed to a maximum conductor temperature of 100 degrees celsius, rated to 881A which will:

- Increase the thermal capacity of the East Gippsland 66 kV network.

[11] Note. This option only considers the TGN-SLE segment. "Connection Enablement: Morwell East Area" project is expected to upgrade the lines between MWTS-TGN.

- Significantly increase the N-1 voltage collapse limits for outage of either the Morwell Terminal Station to Sale (MWTS-SLE) and MWTS-MFA 66 kV lines.
- Reduce network losses.

The construction of a new 66kV TGN-SLE line will require enabling works to be carried out at both the Sale and Traralgon zone substations.

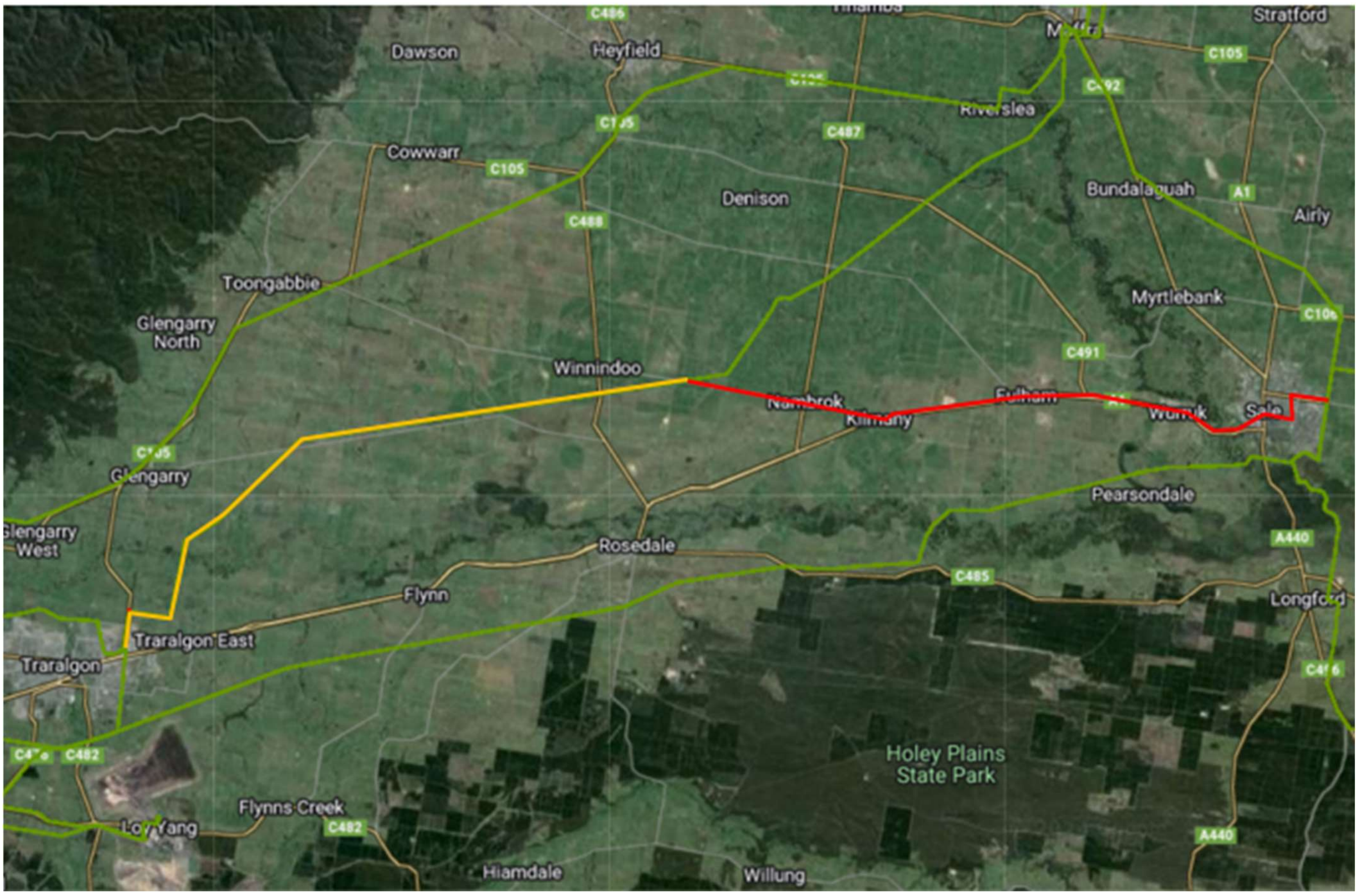
There are several possible alternative routes for installing new 19/4.75AAC 66kV line between Traralgon and Sale, along the Princess Highway. Factors that may impact on route selection or the need for undergrounding segments include river, rail, and road crossings, the need to avoid multiple lines on a pole or the lines crossing. The establishment of a new 66kV line will be in bushfire prone areas and a subsequently subject to stricter design and construction requirements. All new lines are to be constructed using concrete poles to mitigate the risk of bushfire hazards and are subject to stricter vegetation trimming requirements to maintain safe clearances.

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

Option 3: Establish a TGN-SLE/MFA 66kV line

This option involves constructing a new 66kV switching station on the existing TGN-MFA 66 kV line (approximately 27.5km from Traralgon), constructing 25km of new 66 kV line from the new 66kV switching station to Sale and reconductoring the 27km of line between Traralgon and the new tee point, as shown by Figure 10 below. These works will replace the existing TGN-MFA 66 kV line with a TGN-SLE/MFA 66 kV line.

Figure 10 - Map of new TGN-SLE/MFA 66 kV line

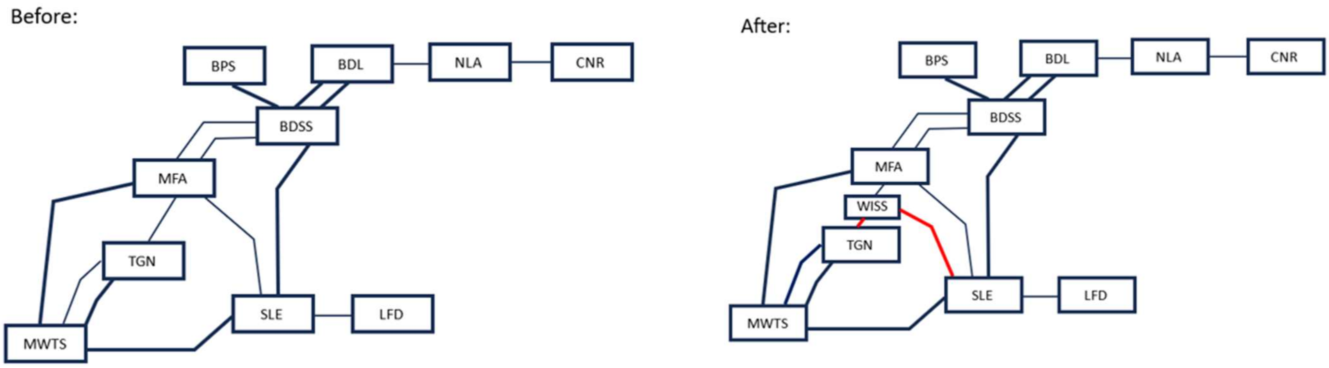


The new line segment between the 66kV switching station and the Sale zone substation will utilise the existing 22kV line easement by rebuilding 22kV poles to support the new 66kV line. This option will entail enabling works to the Sale zone substation to facilitate a new 66kV bay.

Sections of the new TGN-MFA line, up to the new 66kV switching station location, are to be reconductored. All reconductoring of undersized conductors and new lines are to utilise 19/4.75 AAC and designed to a maximum conductor temperature of 100 degrees to achieve a minimum 881A summer cyclic rating. Enabling works at the Sale zone substation include installation of one additional feeder.

Figure 11 below, compares the current configuration of the East Gippsland 66kV loop and the configuration of the loop after the establishment of the switching station at Winnindoo between Traralgon and Maffra zone substations and the new SLE-MFA line. The bold lines in the diagram indicate 19/4.75AAC and higher rated lines on the network loop, with the red bold line reflecting the work to be carried out under this option.

Figure 11 - Comparison of East Gippsland 66kV loop after establishing TGN-SLE/MFA 66kV line[12]



These works will result in the TGN to SLE section of the line will being constructed of 19/4.75 AAC conductor designed to a maximum conductor temperature of 100 degrees Celsius, rated to 881 A, and the section between the switching station and MFA remaining rated to 345 A. The works will:

- Increase the thermal capacity of the East Gippsland 66 kV network.
- Significantly increase the N-1 voltage collapse limits for outage of either the MWTS-SLE, MWTS-MFA or BDSS-SLE 66 kV lines.
- Reduce network losses.

There are several possible alternative routes for installing new 19/4.75AAC 66kV line between Traralgon and Sale, along the Princess Highway. Factors that may impact on route selection or the need for undergrounding segments include river, rail, and road crossings, the need to avoid multiple lines on a pole or the lines crossing.

The establishment of a new 66kV line will be in bushfire prone areas and a subsequently subject to stricter design and construction requirements. All new lines are to be constructed using concrete poles to mitigate the risk of bushfire hazards and are subject to stricter vegetation trimming requirements to maintain safe clearances.

This option delivers an NPV of $113.1 million, the third lowest reduction in residual risk relative to the base case. However, this option is more costly to implement relative to option 1 and option 2.

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

Option 4: Construct a 30MW/150MWh Battery Energy Storage System at Bairnsdale Switching Station (BDSS)

This option involves constructing a 30MW/150MWh battery at the existing 66kV switching station located at Bairnsdale (BDSS - Bairnsdale Switching Station) to provide support at a major load centre on the loop. This analysis assumes a battery life of 15-years. At battery end of life or loading increase beyond the 15-year forecasting period, it is expected the entire existing TGN-MFA 66kV line will need to be reconductored (approximately, existing 46.6 km, as per Option 1). These reconductoring works will replace all 6/4.72 7/1.57 ACSR conductor with 19/4.75 AAC and redesigning them to a maximum conductor temperature of 100 degrees celsius.

The battery will reduce the loading requirement on the loop by providing a temporary source close to the major load centre of Bairnsdale, reducing the current through major legs MWTS-SLE, MWTS-MFA and TGN-MFA. Support provided by the battery will significantly defer the requirement to reconductor TGN-MFA to beyond the forecasting period, however, this will still be required at either battery end of life or should load increase beyond the forecasting period. The battery has been sized to support the loop for 5 hours – based on historic peak load duration. The battery works will:

- Significantly increase the system normal planning limit and thermal capacity of the East Gippsland 66 kV network.
- Significantly increase the N-1 voltage collapse limits for outage of either the MWTS-SLE and MWTS-MFA lines.
- Reduce network losses.

This option delivers a positive NPV of $22.8 million, however, it is the most expensive option to implement at $180 million. While this option reduces residual risk from the base case, the quantum of the reduction is significantly less

[12] Note, this option only considers the TGN-MFA-SLE segment. "Connection Enablement: Morwell East Area" project is expected to upgrade the lines between MWTS -TGN.

than options 1, 2, and 3. Further, as the optimal timing for this option is not until 2037, it would mean that customers would face a greater risk of supply interruptions which is not consistent with customer expectations for AusNet to provide reliable electricity supply with minimal interruptions.

4.2.2. Non-credible options

Our analysis also identified the following options which deemed to be non-credible.

Demand management – does not address the identified need

There is limited ability for demand reductions to reduce peak demand on the East Gippsland 66kV network loop of the magnitude required to defer the need for augmentation. There is only one customer directly connected to the 66kV loop at Longford, which is radially supplied from Sale. This customer has indicated their intent to increase loading but has agreed to reduce load at peak loop times to avoid paying 66kV augmentation costs to run their increased load at peak times. Similarly, while there is the potential for 750kW of demand reduction on the 22kV networks this does not deliver the necessary load reduction required to address the identified need. This would total 0.5% of the expected coincident demand in 2024 under 50POE conditions which is insufficient to defer augmentation under AusNet's 50POE summer forecasts.

Establishment of new Bairnsdale Terminal station – not economically viable

The establishment of a new Bairnsdale Terminal Station would entail extending the 220kV network from Morwell Terminal Station (MWTS) to a new Bairnsdale Terminal Station (BDTS) via approximately 130km of new 220kV line. While this option has several advantages such as increasing loop overload thresholds significantly, improving voltage constraints, and increasing generation capacity and reliability for the region it has been assessed as not currently economically viable and has been identified as having several technical challenges associated with EHV installations that need to be resolved.

4.3. Preferred option

Table 5 below provides a comparison of credible options. Based on our analysis of credible options Option 1 – Reconductor the MFA-TGN line has been identified as the preferred option for the following reasons:

- It has the highest NPV, relative to the other options assessed at $142.6 million.
- It is the least expensive option to implement, and the only option assessed as fully addressing all criteria.
- It addresses the identified need by significantly increasing the thermal capacity of the East Gippsland 66kV network, increases the N-1 voltage collapse limits for an outage on either the MWTS-SLE or MWTS-MFA lines on the network loop, and reduces network losses.
- This option provides the largest reduction in residual risk relative to the other options
- 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 5 – Comparison of credible options

ASSETMENT METRICS	COMPARISON OF OPTIONS				
	0	1	2	3	4
Capex ($m, real FY24)	N/A	$26.5	$50.7	$61.8	$180.0
NPV ($m, real FY24)	N/A	$142.6	$121.8	$113.1	$22.8
Residual risk ($m, real FY24)	$169.50	$3.3	$6.3	$8.7	$43.2
Optimal timing	N/A	2029	2031	2032	2037
Meets customer expectations	No	Yes	Partial	Partial	Partial
Aligns with asset management objectives	No	Yes	Partial	Partial	Partial

Table 6 below provides a detailed breakdown of costs and benefits associated with the preferred option. A high-level scope identifying undersized conductors on the TGN-MFA line to be reconductored is outlined in Appendix E.

Table 6: Expenditure overview ($m, real 2023-24)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Capex		$ 13.23	$ 13.23			$ 26.45	30 years
Opex			$ 0.26	$ 0.26	$ 0.26	$ 0.79	30 years
Benefits[13]	$ -	$ -	$ 1.94	$ 2.47	$ 3.16	$ 7.57	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.[14] 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.

[13] 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.
[14] See Appendix D for further details of sensitivity testing of credible options.

A. East Gippsland 66kV network loop characteristics

Table 7 – East Gippsland line characteristics

Line	Length (km)	Summer Rating (A)	Summer Rating (MVA)	Winter Rating (A)	Winter Rating (MVA)
MWTS-TGN No.1	19.1	345	39.4	390	44.6
MWTS-TGN No.2	18.3	800	91.5	800	91.5
MWTS-MFA	69.1	645	73.3	835	95.5
MWTS-SLE	67.3	790	90.3	960	109.7
TGN-MFA	46.6	345	39.4	380	43.4
MFA-SLE	19.6	435	49.7	535	61.2
MFA-BDSS No.1	61.8	345	39.4	390	44.6
MFA-BDSS No.2	56.4	300	34.3	300	34.3
SLE-BDSS	55.9	800	91.5	800	91.5
BDSS-BDL No.1	11.4	890	101.7	990	113.2
BDSS-BDL No.2	14.5	890	101.7	990	113.2
BDL-NLA	80.7	170	19.4	365	41.7
NLA-CNR	81.2	423	48.4	520	59.4

Due to the vast distances covered and the voltage regulation challenges that this brings, the sub-transmission network is supported by three 66 kV voltage regulators and the Bairnsdale Static Volt-Ampere-Reactive Compensator (SVC). The key characteristics of these assets are presented in below:

Table 8 - 66 kV line voltage regulator characteristics

Asset	Rating (MVA)	Number of Taps	Voltage Range (per unit)	Location
Maffra No.1 66 kV voltage regulator	40.0	19	0.788 to 1.061	BDSS-MFA No.1 66 kV line, approximately 3.5km from MFA.
Maffra No.2 66 kV voltage regulator	40.0	19	0.788 to 1.061	BDSS-MFA No.2 66 kV line, approximately 3.5km from MFA.
Bairnsdale 66 kV voltage regulator	20.0	9	0.894 to 1.061	BDL-NLA 66 kV line, at BDL.

Table 9 - Bairnsdale SVC characteristics

Asset	Range (MVAR)	Location
Bairnsdale SVC	±30.0	BDSS

B. AusNet's summer contingency plan

Should a short-term contingency (less than 24 hours) event occur, the following steps are enacted as per the existing summer contingency plans:

CONTINGENCY STEP	CONTINGENCY ACTION
1	If one of the main 66 kV lines supplying the East Gippsland loop fails during the peak time, to avoid risk of total voltage collapse, immediately load shed up to nearly 50% of the ZSs load across TGN, MFA, SLE and BDL ZSs. Once the loop voltage is secure, start progressively reinstate Out Of Service (OOS) feeders based on priority status of the each feeder. Further, following actions can be carried out.
2	Risk manage the line with dynamic ratings - based on the existing wind speed and ambient temperature. Risk manage the line up to 110% as per the procedure "Emergency Loading of 66kV OH Lines".
3	• Load transfers available to adjacent feeders are approximately 8 MVA as follows: • Use MWT32 tie with TGN11 to: • Close SW 814619 & Open "PASLEY CROSS ACR" TN039 (2MVA) • Use MWT32 tie with TGN12 to: • Close SW 844460 & TN067. • Open RC SW TN060 & RC SW TN073(6MVA)
4	Lower 22kV Bus voltage by 5% estimated reduction of 1.7MVA. Beware of voltage complaints due to voltage reduction it may need adjustment.
5	The assessment is carried out assuming no BPS/TGNSS generation available. If BPS generates a minimum of 40MW as a merchant generator, it will avoid voltage collapse and will reduce the overloads on the critical lines.

C. Cost breakdown of credible options

Option 1: Reconductor MFA-TGN line

Table 10: Reconductor MFA-TGN Line ($m, real 2023-24 dollars)

Metric	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)		$ 13.23	$ 13.23			$ 26.45	30 years
Opex ($m)			$ 0.26	$ 0.26	$ 0.26	$ 0.79	30 years

Source: AusNet analysis

Option 2: Construct new TGN-SLE 66kV line

Table 11 – New TGN-SLE line ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)			$ 16.91	$ 16.91	$ 16.91	$ 50.74	30 years
Opex ($m)					$ 0.51	$ 0.51	30 years

Source: AusNet analysis

Option 3: Establish a TGN-SLE/MFA 66kV line

Note: partial expenditure in the 2026-31 regulatory period, as the optimal timing of the project is 2032.

Table 12- TGN-SLE/MFA 66kV Line ($m, real 2023-24 dollars)

	FY27	FY28	FY29	FY30	FY31	Total FY27-31	Full assessment period
Cost ($m)				$ 20.61	$ 20.61	$ 41.22	30 years
Opex ($m)							30 years

Source: AusNet analysis

Option 4: Construct a 30MW/150MWh battery at Bairnsdale switching station

Note: no expenditure in the 2026-31 regulatory period.

Table 13 – 30MW/150MWH BESS ($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

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 98%, 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 of 50%, base case of 100% and high of 150%
- VCR sensitivity (Table 18) with base case of 39.45 $/MWh, QCV case (AusNet residential rate only – AER rate for Commercial/Industrial/Agricultural) of 52.49 $/MWh and QCV case (All AusNet customer rates) of $41.50

Table 14: Discount rate sensitivity

Rate sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV	Optimal timing	NPV	Optimal timing	NPV
Option 1 – Reconductor the entire TGN-MFA 66kV line	2029	$142.61	2028	$188.22	2030	$108.96
Option 2 – Construct new TGN-SLE 66kV line	2031	$121.75	2031	$164.73	2032	$90.79
Option 3 – Establish a TGN-SLE/MFA 66kV line	2032	$113.09	2031	$154.43	2033	$83.45
Option 4 – Construct a 30MW/150MWh Battery	2037	$22.78	2037	$41.23	2037	$10.47
Max NPV	$142.61		$188.22		$108.96	
Highest NPV project	Option 1		Option 1		Option 1	

Source: AusNet analysis

Table 15 – Forecast sensitivity

Forecast sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV	Optimal timing	NPV	Optimal timing	NPV
Option 1 – Reconductor the entire TGN-MFA 66kV line	2029	$142.61	2030	$81.10	2028	$234.83
Option 2 – Construct new TGN-SLE 66kV line	2031	$121.75	2033	$61.99	2030	$212.86
Option 3 – Establish a TGN-SLE/MFA 66kV line	2032	$113.09	2034	$54.17	2031	$202.86
Option 4 – Construct a 30MW/150MWh Battery	2037	$22.78	Not viable	Not viable	2036	$101.19
Max NPV	$142.61		$81.10		$234.83	
Highest NPV project	Option 1		Option 1		Option 1	

Table 16 - Cost sensitivity

Cost of options sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV	Optimal timing	NPV	Optimal timing	NPV
Option 1 – Reconductor the entire TGN-MFA 66kV line	2029	$142.61	2028	$146.14	2029	$139.07
Option 2 – Construct new TGN-SLE 66kV line	2031	$121.75	2031	$127.96	2032	$116.00
Option 3 – Establish a TGN-SLE/MFA 66kV line	2032	$113.09	2032	$120.24	2033	$106.33
Option 4 – Construct a 30MW/150MWh Battery	2037	$22.78	2036	$41.35	2037	$7.25
Max NPV	$142.61		$146.14		$139.07	
Highest NPV project	Option 1		Option 1		Option 1	

Table 17 – Asset failure sensitivity

Asset failure sensitivity	Base Case		Low Case		High case	
	Optimal timing	NPV	Optimal timing	NPV	Optimal timing	NPV
Option 1 – Reconductor the entire TGN-MFA 66kV line	2029	$142.61	2029	$142.61	2029	$142.61
Option 2 – Construct new TGN-SLE 66kV line	2031	$121.75	2031	$121.75	2031	$121.75
Option 3 – Establish a TGN-SLE/MFA 66kV line	2032	$113.09	2032	$113.09	2032	$113.09
Option 4 – Construct a 30MW/150MWh Battery	2037	$22.78	2037	$22.78	2037	$22.78
Max NPV	$142.61		$142.61		$142.61	
Highest NPV project	Option 1		Option 1		Option 1	

Table 18 – VCR sensitivity

Asset failure sensitivity	Base Case (AER)		QCV (AusNet Resi only)		QCV (Full AusNet QCV analysis)	
	Optimal timing	NPV	Optimal timing	NPV	Optimal timing	NPV
Option 1 – Reconductor the entire TGN-MFA 66kV line	2029	$142.61	2028	$197.69	2029	$151.22
Option 2 – Construct new TGN-SLE 66kV line	2031	$121.75	2030	$175.63	2031	$130.20
Option 3 – Establish a TGN-SLE/MFA 66kV line	2032	$113.09	2031	$166.30	2032	$121.41
Option 4 – Construct a 30MW/150MWh Battery	2037	$22.78	2036	$69.36	2037	$29.32
Max NPV	$142.61		$197.69		$151.22	
Highest NPV project	Option 1		Option 1		Option 1	

E. High-level scope

High level scope of works (Option 1):

- Reconductor the entire TGN-MFA 66kV Line to replace any undersized conductor.
- Approximately 46km of line to be reconductored
- 19/4.75AAC (or similar conductor) to be used, thermally designed to 100 degrees to achieve a minimum summer cyclic rating of 881A.
- Conduct plant protection review.

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