Jemena Electricity Networks (Vic) Ltd

Comply with Bushfire Mitigation Obligations on JEN KLO 22kV Feeders

Network Development Strategy

Authorisation

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Glossary

Amperes (A)	Refers to a unit of measurement for the current flowing through an electrical circuit. Also referred to as Amps.
Capital expenditure (CAPEX)	Expenditure to buy fixed assets or to add to the value of existing fixed assets to create future benefits.
Constraint	Refers to a constraint on network power transfers that affects customer service.
Contingency condition (or event)	Refers to the loss or failure of part of the network. An event affecting the power system that is likely to involve the failure or removal from operational service of one or more generating units and/or network elements.
Contingency probability	The probability that a contingency condition (or event) will occur, and typically approximated by multiplying the number of times a contingency condition occurs (usually in a year) by its duration, normalised by the total available time (in this case, a year).
Energy-at-risk	The total energy at risk of not being supplied if a contingency occurs.
Expected unserved energy (EUSE)	Refers to an estimate of the long-term, probability weighted, average annual energy demanded (by customers) but not supplied. The EUSE measure is transformed into an economic value, suitable for cost-benefit analysis, using the value of customer reliability (VCR), which reflects the economic cost per unit of unserved energy.
Jemena Electricity Networks (JEN)	One of five licensed electricity distribution networks in Victoria, the JEN is 100% owned by Jemena and services over 360,000 customers via an 11,000 kilometre distribution system covering north-west greater Melbourne.
Limitation	Refers to a limitation on a network asset's capacity to transfer power.
Maximum demand (MD)	The highest amount of electrical power delivered (or forecast to be delivered) for a particular season (summer and/or winter) and year.
Megavolt ampere (MVA)	Refers to a unit of measurement for the apparent power in an electrical circuit. Also million volt-amperes.
Network	Refers to the physical assets required to transfer electricity to customers.
Network augmentation	An investment that increases network capacity to prudently and efficiently manage customer service levels and power quality requirements. Augmentation usually results from growing customer demand.
Network capacity	Refers to the network's ability to transfer electricity to customers.
Non-network	Refers to anything potentially affecting the transfer of electricity to customers that does not involve the network.
Non-network alternative	A response to growing customer demand that does not involve network augmentation.
Operating & Maintenance expenditure (O&M)	Expenditure (ongoing) for running a product, business or system.
Peak or maximum demand	The highest amount of electrical power delivered (or forecast to be delivered) for a particular period of time.
Probability of exceedance (POE)	The likelihood that a given level of maximum demand forecast will be met or exceeded in any given year:

10% POE condition (summer)	Refers to an average daily ambient temperature of 32.9ºC derived by NIEIR and adopted by JEN, with a typical maximum ambient temperature of 42ºC and an overnight ambient temperature of 23.8ºC.
50% POE condition (summer)	Refers to an average daily ambient temperature of 29.4ºC derived by NIEIR and adopted by JEN, with a typical maximum ambient temperature of 38.0ºC and an overnight ambient temperature of 20.8ºC.
Probabilistic method	A planning methodology applied to network types with the most significant constraints and associated augmentation costs. It involves estimating the cost of a network limitation with consideration of the likelihood and severity of network outages and operating conditions.
Rapid Earth Fault Current Limiter (REFCL)	Rapid Earth Fault Current Limiter or REFCL means any plant, equipment or technology (excluding neutral earthing resistor) which is: (a) designed to reduce the effect of distribution system faults and when operating as intended may lead to a REFCL condition; and approved by Energy Safe Victoria in an electricity safety management scheme or bushfire mitigation plan pursuant to the Electricity Safety Act 1998 (Vic).
Regulatory Investment Test for Distribution (RIT-D)	A test administered by the Australian Energy Regulator (AER) that establishes consistent, clear and efficient planning processes for distribution network investments in the National Electricity Market (NEM).
Reliability of supply	The measure of the ability of the distribution system to provide supply to customers.

Required Capacity	As prescribed by the Electricity Safety (Bushfire Mitigation Duties) Regulations 2017, means that in the event of a phase-to-ground fault on a polyphase electric line, then network must have the ability:
	• to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds; and
	• to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to:
	  • 1900 volts within 85 milliseconds; and
	  • 750 volts within 500 milliseconds; and
	  • 250 volts within 2 seconds; and
	• during diagnostic tests for high impedance faults, to limit:
	  • fault current to 0.5 amps or less; and
	  • the thermal energy on the electric line to a maximum I^2t value of 0.10;
	where:
	• high impedance faults means a resistance value in ohms that is equal to twice the nominal phase-to-ground network voltage in volts;

	• I^2t means a measure of the thermal energy associated with the current flow, where I is the current flow in amps and t is the duration of current flow in seconds; • low impedance faults means a resistance value in ohms that is equal to the nominal phase-to-ground network voltage in volts divided by 31.75; and • polyphase electric line means an electric line comprised of more than one phase of electricity with a nominal voltage between 1 kV and 22 kV.
REFCL condition	An operating condition on the 22kV distribution system arising from the proper operation of a REFCL which results in the neutral reference of the distribution system moving to allow the un-faulted Phase to Earth voltage magnitude to approach a value close to the Phase to Phase voltage magnitude. The term “operating condition on the 22kV distribution system‟ in this term extends up to, but not beyond any device or plant which is functionally equivalent to an isolating transformer.
System normal	The condition where no network assets are under maintenance or forced outage, and the network is operating according to normal daily network operation practices.
value of customer reliability (VCR)	Represents the dollar value customers place on a reliable electricity supply (and can also indicate customer willingness to pay for not having supply interrupted).
zone substation	Refers to the location of transformers, ancillary equipment and other supporting infrastructure that facilitate the electrical supply to a particular zone in the Jemena Electricity Network (JEN).

Abbreviations

Act	Electricity Safety Act 1998
ASC	Arc Suppression Coil
BD	Broadmeadows Zone Substation
Co	Network capacitive current
COO	Coolaroo Zone Substation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP	Department of Environment, Land, Water and Planning
ESV	Energy Safe Victoria
EUE	Expected Unserved Energy
GVE	Greenvale Zone Substation
HBRA	Hazardous Bushfire Risk Area
HV	High Voltage
JEN	Jemena Electricity Networks (Vic) Ltd
KLO	Kalkallo Zone Substation
kV	Kilo-Volts
LBRA	Low Bushfire Risk Area
MVA	Mega Volt Ampere
MVAr	Mega Volt Ampere Reactive
MW	Mega Watt
MWh	Megawatt hour
NEM	National Electricity Market
NPV	Net Present Value
O&M	Operations and Maintenance
REFCL	Rapid Earth Fault Current Limiters
Regulations	Electricity Safety (Bushfire Mitigation) Regulations 2013
ST	Somerton Zone Substation
VCR	Value of Customer Reliability
VEDC	Victorian Electricity Distribution Code

Executive Summary

Jemena is the licensed electricity distributor for the northwest of Melbourne's greater metropolitan area. The network service area ranges from Gisborne South, Clarkefield and Mickleham in the north to Williamstown and Footscray in the south and from Hillside, Sydenham and Brooklyn in the west to Yallambie and Heidelberg in the east.

Our customers expect us to deliver and maintain a reliable electricity supply at the lowest possible cost over the long-term. To do this, we must choose the most efficient solution to address emerging network issues. This means choosing the solution that maximises the present value of net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (**NEM**).

Identified need

Under the Electricity Safety Act 1998 (the **Act**) and the Electricity Safety (Bushfire Mitigation) Regulations 2013 (the **Regulations**), Jemena Electricity Networks (Vic) Ltd (**JEN**) is obliged to ensure all 22 kV feeders originating from its Coolaroo Zone Substation (**COO**) meet certain specified technical performance requirements by 1 May 2023, effectively requiring these feeders to be protected by Rapid Earth Fault Current Limiters (**REFCL**) or otherwise requiring these feeders to be the subject of exemptions under the Act and the Regulations. Additionally, JEN takes supply for three of its feeders in the nearby area from the Kalkallo Zone Substation (**KLO**), which is owned by AusNet Services, and JEN must also meet the Required Capacity for its KLO 22kV feeders by 1 May 2023.

To meet its obligations relating to COO, JEN has assessed that the preferred solution to achieve compliance is to install a new single transformer REFCL protected Greenvale Zone Substation (**GVE**).[1] There is sufficient capacity at GVE zone substation to supply its area over the forward 10-year planning period under system normal conditions, however there is no redundant capacity in the event of an outage at GVE or the radial 66kV sub-transmission line which supplies it. There are, however, opportunities to mitigate the risks associated with the lack of redundant capacity at GVE through the works necessary to achieve compliance with the Act and Regulations in respect of our KLO feeders, thus being consistent with our customers' expectations that we should maintain the reliability of our services over the long-term.

This Network Development Strategy assesses options to ensure JEN can achieve and maintain compliance with the Act and Regulations for its KLO 22kV feeders. In the process of assessing and identifying viable options to provide the most economic and technically feasible solution to maintain the long-term compliance with the Act and Regulations, JEN has considered the customer reliability impacts (unserved energy) of various options (associated with the neighbouring single transformer GVE), technical limitations of the REFCL technology, the costs to High Voltage (**HV**) customers to upgrade their equipment (to enable them to continue to take supply safely from a REFCL protected feeder in accordance with Clause 16 (c)[2] of the Victorian Electricity Distribution Code (**VEDC**)), and the long-term load growth and associated network augmentation requirements where these are applicable.

Options Considered

Recognising the interrelationships between COO and KLO, in 2019, JEN and AusNet Services engaged the consultant WSP to assist in a joint planning exercise to examine a number of technical design options and determine the most efficient cost of meeting the requirements of the Act and Regulations across both COO and KLO supply areas over the long-term. This exercise identified 26 options. Through this process, we identified that there was only one option ('Option 15') which did not require any exemptions from the requirements of the Act

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[1] In addition to undertaking various bushfire mitigation activities to reduce the bushfire risk for those polyphase electric lines of an overhead construction within an urban environment (that remain supplied from COO) that pose some risk to a fire ignition that could propagate to a bushfire. For further details, refer to Network Development Strategy titled "Comply with Bushfire Mitigation Obligations at Coolaroo Zone Substation".

[2] Clause 16 (c) of VEDC states that "*A **business customer** must take reasonable precautions to minimise the risk of loss or damage to any equipment, premises or business of the **business customer** which may result from poor quality or reliability of electricity **supply** or the **distribution system** operating under the **REFCL condition** in accordance with clause 4.2.2A*"

and Regulations. However this option involved significantly higher expenditure than other options due to significant technical limitations of the REFCL technology.

For the reasons identified above, JEN and AusNet Services has investigated alternative solutions to the installation of a REFCL at KLO and proposed an approach which will result in a level of residual bushfire risk that we consider is commensurate with that which was originally intended by the Act and Regulations (referred to as a bushfire risk-neutral outcome), but at a lower cost to customers than if no exemptions to the Act or Regulations were granted. We considered that such alternative options would likely be more preferable in customers' long-term interests than Option 15 described above. JEN and AusNet Services also dismissed proposed solutions at KLO under Options 7 and 11 from the previous joint planning report[3] prepared by WSP in December 2019 (and published as part of JEN's regulatory proposal on 31 January 2020), as these two options entail higher expenditure than the alternative proposal undertaken by JEN since then.

The works undertaken by JEN since the publication of the joint planning report identified seven options:

- Base-case – Do Nothing;
- Option 1 – Part underground from KLO and transfer overhead sections to GVE;
- Option 2 – Install one remote REFCL at start of KLO22 feeder;
- Option 3 – Install two remote REFCLs at the start of KLO22 feeder;
- Option 4 – Fully Underground KLO22 feeder;
- Option 5a – Part underground from KLO plus remote REFCL in Mt Ridley Rd to serve downstream overhead;
- Option 5b – Part underground from KLO plus remote REFCL in Mickleham Rd to serve downstream overhead;
- Option 6 – Extend KLO-013 and KLO-021 plus remote REFCL; and
- Option 7 – Convert all 13.7km of open wire conductors to covered conductors.

A summary of the net economic benefit for each option is presented in Table ES–1-1.

Table ES–1-1: Summary of Net Economic Benefit of each option (real, $2020)

Option No.	NPV of Total Cost (Project cost and O&M) ($M)	NPV of net market benefits ($M)	Ranking
Base case	0	0	N/A
1	(6.2)	(9.5)	4
2	(7.5)	N/A	N/A
3	(13.8)	22.2	3
4	(20.7)	(20.7)	5
5a	(12.4)	23.5	1
5b	(12.4)	23.5	2
6	(11.8)	N/A	N/A
7	N/A	N/A	N/A

[3] Refer to "Economic Options to Maintain REFCL Compliance at Kalkallo and Coolaroo Zone Substations, Joint Planning Report, December 2019" report.

Preferred Option

The assessment shows that the preferred solution is Option 5a, which provides the highest net market benefits and is the option maximises the net economic benefit to all those who produce, consume and transport electricity in the NEM.

Option 5a comprises the following works:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA Ring Mains Unit (**RMU**) kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install new 4km underground cable section on KLO-022 along Hume Fwy from Patterson St to Mt Ridley Rd (corner Parkside Rise) – this would allow most of KLO22's underground network to remain as non-REFCL network[4];
  - Install two RMUs to facilitate underground connections;
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker- Hume kiosk – this new underground section to remain as non-REFCL network; and
  - Install remote REFCL on Mt Ridley Rd (corner Parkside Rise) to supply the overhead network (REFCL protected network) – all overhead sections to remain on remote REFCL supply.

Option 5a provides a bushfire risk-neutral outcome when compared to the installation of REFCL protection at KLO, as well as achieving the technical and compliance requirements and providing supply reliability outcomes which are consistent with our customers' long-term interests and expectations.

[4] JEN would rely on exemptions already granted under the Act and Regulations in respect of polyphase electric lines originating from KLO which are of a fully underground construction.

1. Introduction

1.1 Purpose

This document describes the network development strategy adopted by JEN to comply with Section 120M of the Electricity Safety Act 1998 together with sub-regulation 7(1)(ha) of the Electricity Safety (Bushfire Mitigation) Regulations 2013 for JEN's KLO 22kV feeders.

It describes our process of identifying viable options to provide the most economic and technically feasible solution to maintain the long-term compliance of JEN's KLO 22kV feeders with the Act and Regulations. It also considers the customer supply reliability impacts following the installation of a single transformer GVE[5] zone substation, REFCL technical limitations, the costs to HV customers to upgrade their equipment (to enable them to continue to take supply safely from a REFCL protected feeder in accordance with Clause 16 (c)[6] of VEDC, and the long-term load growth and associated network augmentation requirements where applicable.

1.2 Background

The Act and Regulations require JEN to ensure that all polyphase electric lines (22kV feeders) originating from COO zone substation meet specified technical performance requirements in regard to conductor voltage, current and thermal energy dissipation limits, referred to as "**Required Capacity**" by 1 May 2023. Additionally, JEN takes supply for three of its feeders in the nearby area from KLO, which is owned by AusNet Services, and JEN must also meet the Required Capacity on its KLO 22kV feeders by 1 May 2023.

In practical terms, generally, these performance requirements can be achieved through the installation of REFCLs at the zone substation.

However, there are inherent technical limitations of REFCL that prevent a simple REFCL installation at KLO, including:

- A limit of only one Arc Suppression Coil (**ASC**) per 22 kV bus;
- A limit of 100A of network capacitive current (**Co**) per ASC due to network damping ratios. This means that the Co for each 22 kV bus must not exceed 100A;
- A limit of 80A Co per 22 kV feeder; and
- A limit of two REFCLs per zone substation (i.e maximum zone substation Co of 200A).

KLO is a two-transformer zone substation, supplying four AusNet Services 22kV feeders and three JEN 22kV feeders, being KLO-013, KLO-021 and KLO-022. The network capacitance (Co) of each are as tabulated in Table 1-1.

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5 This document is based on output of the Network Development Strategy titled "Comply with Bushfire Mitigation Obligations at Coolaroo Zone Substation", which provided a pathway to achieving compliance for COO.

6 Clause 16 (c) of VEDC states that "*A **business customer** must take reasonable precautions to minimise the risk of loss or damage to any equipment, premises or business of the **business customer** which may result from poor quality or reliability of electricity **supply** or the **distribution system** operating under the **REFCL condition** in accordance with clause 4.2.2A*"

Table 1-1: 2019 Co of KLO Zone Substation 22 kV feeders

Feeder	Co (A)	Underground (km)	Overhead (km)	Network owner
KLO-011	0.5	0.13	0.003	AusNet Services
KLO-012	0	1.4	0.003	AusNet Services
KLO-013	83.5	22.3	0.17	JEN
KLO-014	75.6	29.0	248.8	AusNet Services
KLO-021	10.2	2.9	0	JEN
KLO-022	61.3	21.2	13.7	JEN
KLO-023	0	0	0	Spare
KLO-024	89.8	35.4	75.1	AusNet Services
TOTAL	**321**	**112.3**	**337.7**	

It is clear from Table 1-1 that the existing 321A of Co cannot be accommodated with a simple configuration of two REFCLs at KLO zone substation, without some form of network rearrangement and significant augmentation. Furthermore, the KLO supply area forms part of the Melbourne northern growth corridor, and network Co is forecast to increase to 424A by 2030 due to network growth, which will further exacerbate the high Co issue.

JEN and AusNet Services engaged the consultant WSP in 2019 to assist in a joint planning exercise to examine a number of technical design options and determine the most efficient cost of meeting the requirements of the Act and Regulations across both COO and KLO supply areas over the long-term. This exercise identified 26 options. Through this process, we identified that there was only one option (Option 15) which did not require any exemptions from the requirements of the Act and Regulations. However this option involved significantly higher expenditure than other options due to significant technical limitations of the REFCL technology.

For the reasons identified above, JEN and AusNet Services have investigated alternative solutions to the installation of a REFCL at KLO[7] and proposed an approach which will result in a level of residual bushfire risk that we consider is commensurate with that which was originally intended by the Act and Regulations, but at a lower cost to customers than if no exemptions to the Act or Regulations were granted. We considered that such alternative options would likely be more preferable in customers' long-term interests than Option 15 described above. JEN and AusNet Services also dismissed proposed solutions at KLO under Options 7 and 11 from the previous joint planning report[8] prepared by WSP in December 2019 (and published as part of JEN's regulatory proposal on 31 January 2020), as these two options entail higher expenditure than the alternative proposal undertaken by JEN since then.

In light of the exemptions already granted under the Act and Regulations in respect of polyphase electric lines originating from KLO which are of a fully underground construction, this document focuses on options to achieve compliance on KLO-022, as this feeder contains a significant amount of overhead conductor. For KLO-013, JEN has identified that the only efficient alternative is to underground the existing 170m of overhead conductors, thus making KLO-013 a fully underground feeder and allowing it to be covered by the exemptions from having Required Capacity. KLO-021 is already a fully underground construction, which does not require any augmentation work.

[7] For COO, JEN has assessed that the preferred solution to achieve compliance is to install a new single transformer REFCL protected GVE and undertake various bushfire mitigation activities to reduce the bushfire risk for those polyphase electric lines of an overhead construction within an urban environment (that remain supplied from COO) that pose some risk to a fire ignition that could propagate to a bushfire. For further details, refer to Network Development Strategy titled "Comply with Bushfire Mitigation Obligations at Coolaroo Zone Substation".

[8] Refer to "Economic Options to Maintain REFCL Compliance at Kalkallo and Coolaroo Zone Substations, Joint Planning Report, December 2019" report.

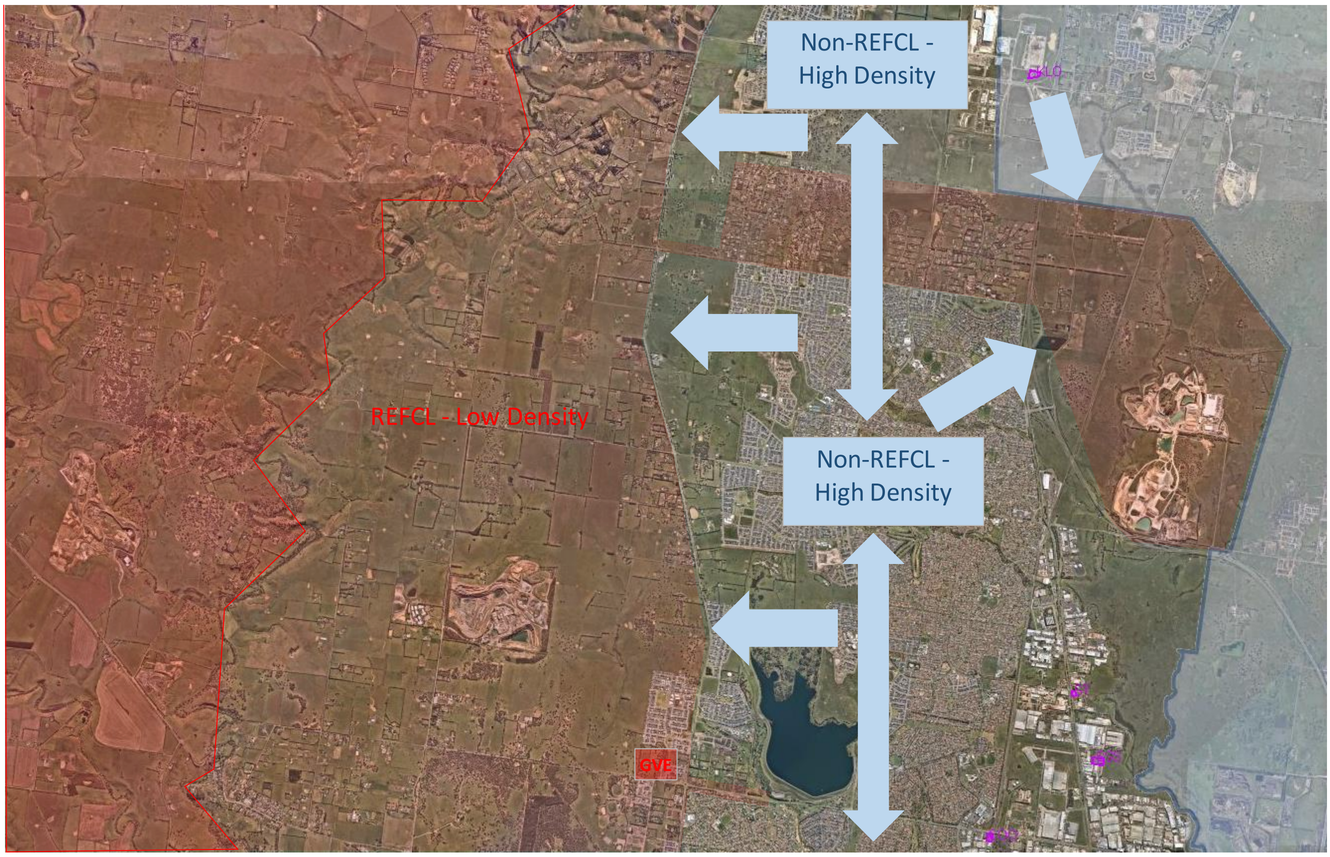
1.3 Network Overview

1.3.1 General Network Strategy

JEN has identified the areas of the KLO and neighbouring COO and Somerton Zone Substation (**ST**) supply network which are expected to experience urban growth in the near future. Meanwhile, other areas (including those to be supplied by GVE) are expected to remain rural and will experience low levels of growth in the short to medium term. These differences are highlighted in Figure 1-1, where the high density non-REFCL areas are indicated as pushing out in the direction of the blue arrows.

JEN's overall REFCL strategy must not inhibit this future network topology.

Figure 1-1: Network Growth Strategy

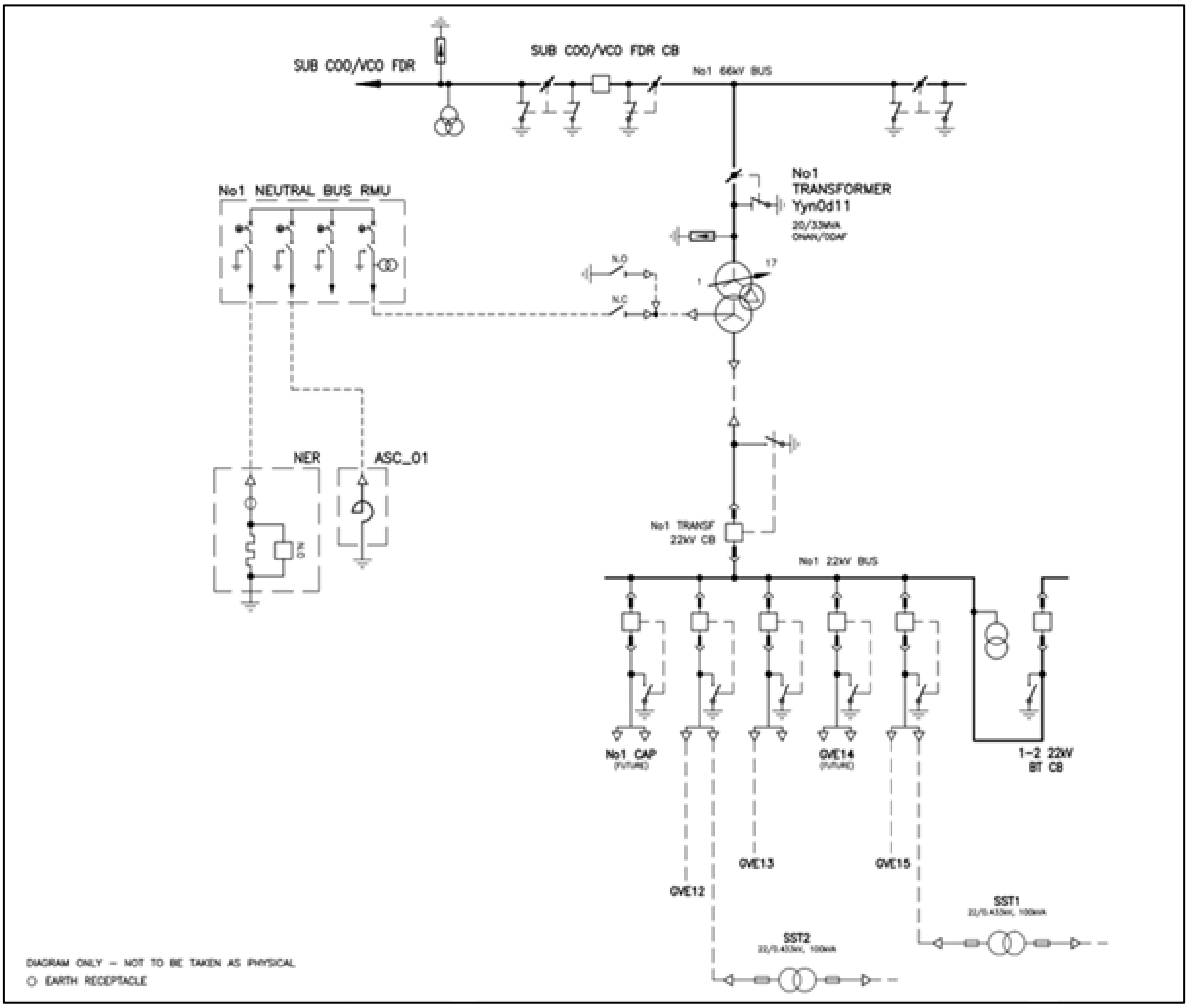


1.3.2 GVE Network

Single line diagram of the proposed GVE is provided below. The proposed GVE zone substation is fed from a single 66 kV incoming line and includes one 66/22 kV 20/33 MVA Yyn0d11 transformer, that supplies three JEN 22kV feeders (refer to Figure 1-2).

In line with the network growth strategy, the 22 kV network area to be fed by GVE is primarily overhead construction and incorporates all of the extant COO Hazardous Bushfire Risk Area (**HBRA**), having incorporated feeders COO-011 and the rural overhead portions of COO-021. This leaves the urban network in the area to continue to be served by COO (as non-REFCL), in line with expected network growth.

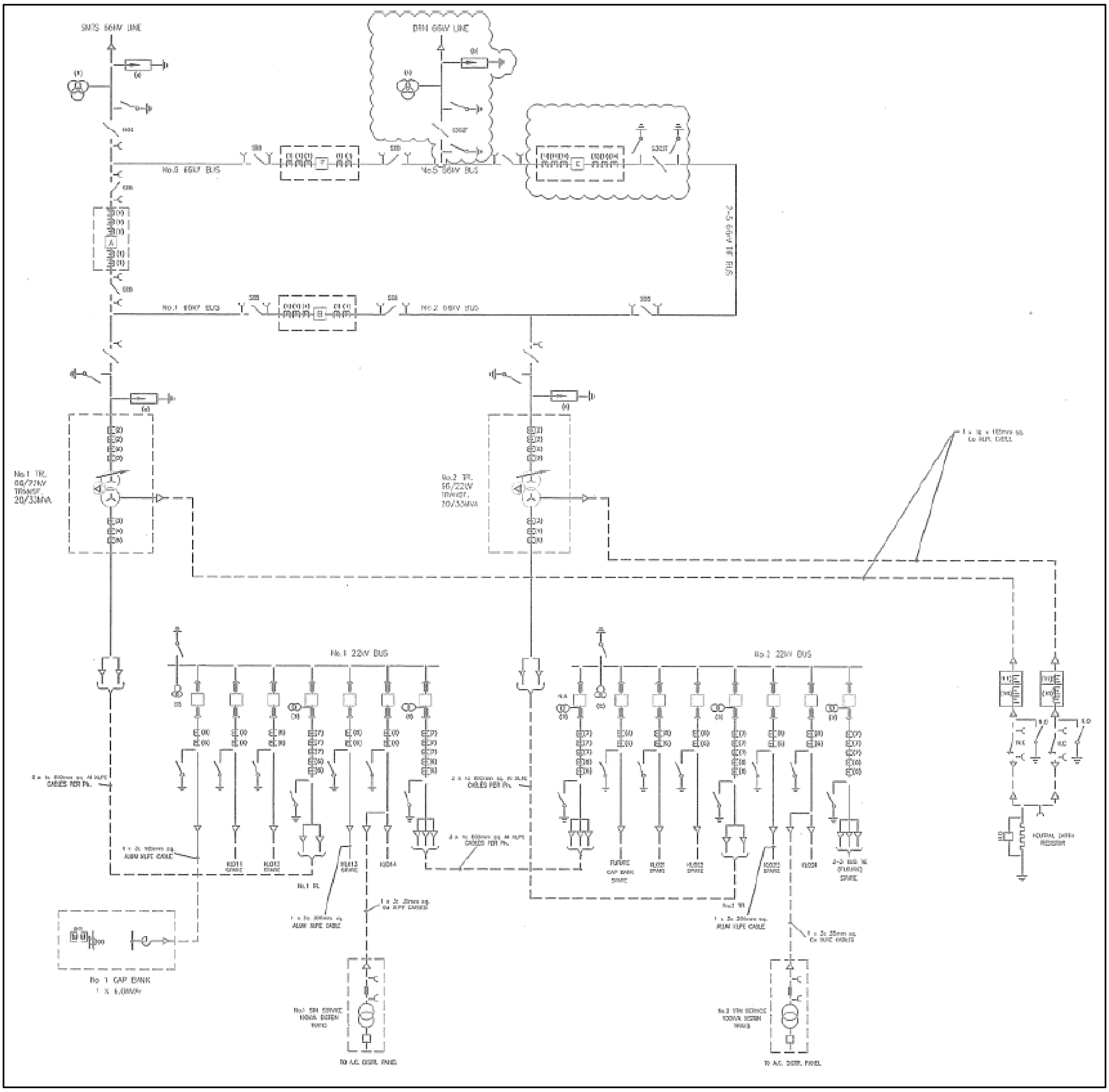
Figure 1-2: Proposed GVE Single Line Diagram



1.3.3 KLO Network

KLO is a 66/22 kV zone substation, owned by AusNet Services. It is supplied by two 66 kV incoming lines and contains two 66/22 kV 20/33 MVA transformers. KLO supplies four AusNet 22 kV feeders, and three JEN 22 kV feeders, KLO-012, KLO-013 and KLO-022 (refer to Figure 1-3).

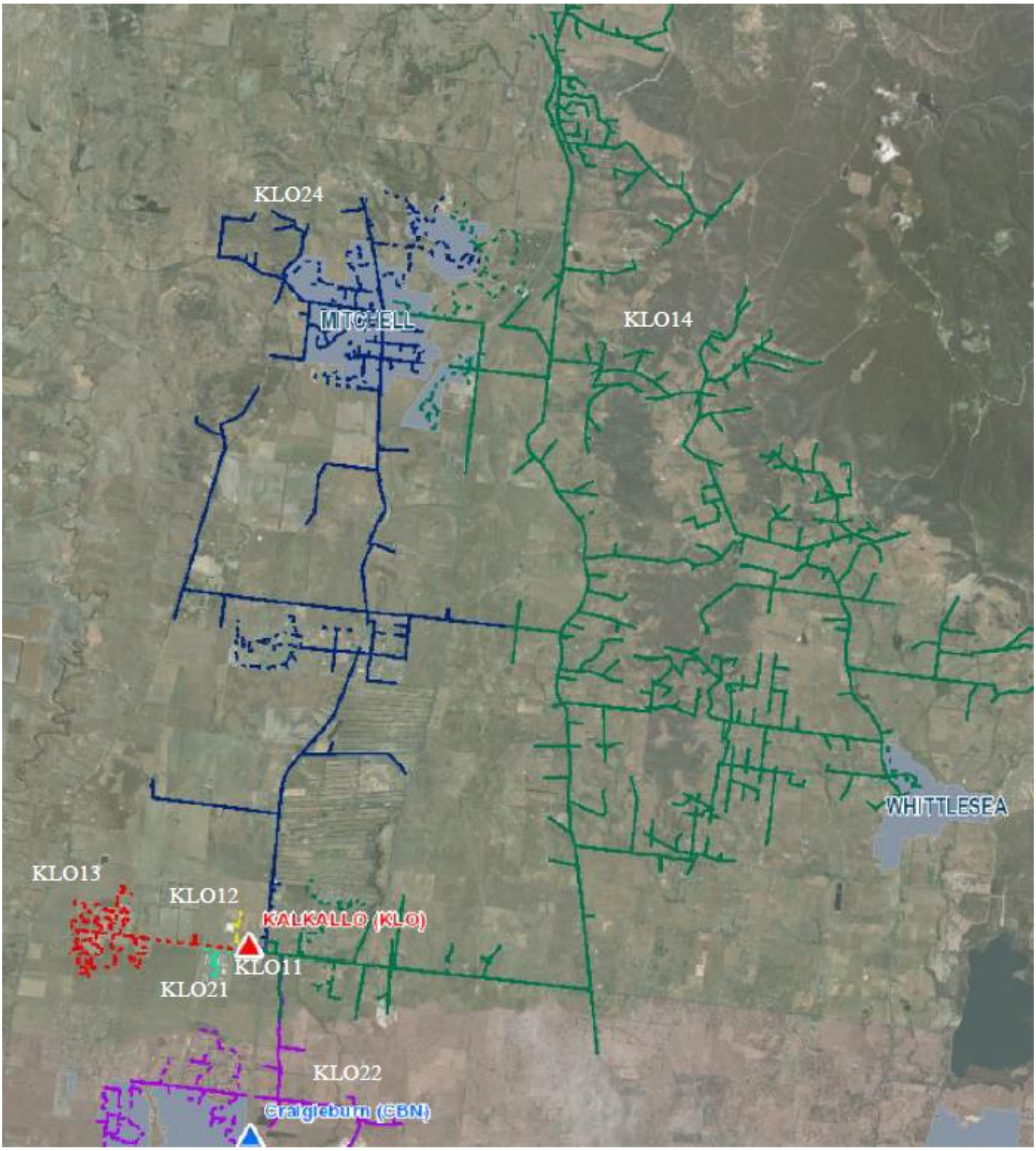
Figure 1-3 KLO Single Line Diagram



Source: "AusNet Services and Jemena Electricity Networks, Economic Options to Maintain REFCL Compliance at Kalkallo and Coolaroo Zone Substations, Joint Planning Report, December 2019" report

Figure 1-4 indicates the extant whole KLO network with the grey areas highlighting Low Bushfire Risk Area (**LBRA**). JEN's KLO feeders, KLO-013 and KLO-021 are almost entirely underground with one short overhead section (170m) on KLO-013. KLO-022 has a significant volume of overhead network and various underground sections.

Figure 1-4 KLO 22kV Network Area



Source: "AusNet Services and Jemena Electricity Networks, Economic Options to Maintain REFCL Compliance at Kalkallo and Coolaroo Zone Substations, Joint Planning Report, December 2019" report

2. Identified Need

As outlined in Section 1.2, the primary driver of this network development strategy is to comply with the Bushfire Mitigation Act and Regulations for JEN's KLO 22 kV feeders. Under section 120M of the Electricity Safety Act 1998 and Regulation 7(1)(ha) of the Electricity Safety (Bushfire Mitigation) Regulations 2013, JEN is obliged to ensure that its three 22 kV feeders originating from KLO have the Required Capacity by 1 May 2023, or to otherwise obtain exemptions in relation to these feeders.

In the process of identifying viable options to provide the most economic and technically feasible solution to maintain the long-term compliance of JEN KLO 22kV feeders, JEN is also obliged to consider the customer reliability impact following the installation of a single transformer GVE[9] zone substation, technical limitations of the REFCL technology, costs to HV customers to upgrade their equipment to continue to take supply safely, and the long-term load growth and associated network augmentation requirements where applicable.

9 This document is based on output of the Network Development Strategy titled "Comply with Bushfire Mitigation Obligations at Coolaroo Zone Substation", which provided a pathway to achieving compliance for COO.

3. Assessment Methodology and Assumptions

This section outlines the methodology that JEN applies in assessing its network supply risks and limitations for each of the feasible option that complies (or has the potential to comply) with the Act and Regulations. It presents key assumptions and input information applied to the assessments described in this document.

3.1 Probabilistic Economic Planning

In accordance with clause 5.17.1(b) of the National Electricity Rules, JEN's augmentation investment decisions aim to maximise the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM.

To achieve this objective, JEN applies a probabilistic planning methodology that considers the likelihood and severity of critical network conditions and outages. The methodology compares the forecast cost to consumers of losing energy supply against the proposed augmentation cost to mitigate the energy supply risk. Relevantly for the identified need, this assessment of the loss of energy supply to customers considers the impacts of a feeder or a single transformer GVE outage, either of which would not allow transfer to an adjacent feeder or neighbouring non-REFCL zone substation due to the REFCL technical limitations and the need to maintain Required Capacity on those feeders. The annual cost of these risks to customers is calculated by multiplying the expected unserved energy (the expected energy not supplied based on the probability of the supply constraint occurring in a year) by the value of customer reliability (**VCR**). This expected benefits provided by feasible options which seek to reduce or mitigate this risk are then compared with the costs of these options.

JEN's assessment of the total cost for each option covers the following:

- Project cost to comply with the Act and Regulations by 1 May 2023;
- Annual on-going operating and maintenance expenditure (**O&M**) to maintain compliance;
- Present value of the annual cost of expected unserved energy over 10-year period; and
- HV customer cost to comply with the Act and Regulations by 1 May 2023, although this is not applicable in this document.

As this strategy primarily focusses on the need to meet safety obligations, future network augmentation costs due to load growth under each option have not been specifically quantified. However, it should be noted that future costs of meeting load growth would not be materially different between options as all of the options considered have similar scope, and therefore this consideration would not alter the outcome of this options assessment.

All options considered would result in the same bushfire risk-neutral safety outcome. Therefore, the option that provides the highest net market benefits as quantified through this assessment would be considered to be the option that maximises the net economic benefit to all those who produce, consume and transport electricity in the NEM.

JEN has not considered any non-network alternatives in this paper as a non-network solution is unlikely to be considered sufficient to mitigate the bushfire risk.

3.2 Assessment Assumptions

In evaluating net economic benefits, the following assumptions are used to calculate the annualised value of expected unserved energy (**EUE**) for all the options analysed in this paper:

- Value of Customer Reliability of $41,738 per MWh;
- Load factor of 0.55 and power factor of 0.93 are assumed;

- Average demand is used to determine expected unserved energy at risk for GVE transformer, single 66kV circuit and GVE-011 feeder outages. In the event of any of these outages, load could not be transferred to adjacent zone substations or feeders due to REFCL technical limitations and the need to maintain the Required Capacity;
- NPV is calculated over 10 years, using a real discount rate of 2.5%;
- Single transformer GVE zone substation:
  - GVE maximum demand is forecast to be 15MVA;
  - Transformer outage probability, which is 1% reflecting an outage frequency of one outage per transformer every 100 years; and
  - Transformer outage duration of 2.6 months per outage.
- Single radial COO-VCO-GVE 66kV line:
  - Sub-transmission line outage frequency, which is 0.1 outages per kilometre of line length per year;
  - Sub-transmission line outage average duration of 6 hours per outage; and
  - With approximately 7km in circuit length, this equates to 0.7 outage per annum lasting an average duration of 6 hours (resulting in loss of all load at GVE for that time).
- GVE-011 feeder (abutting with KLO-022):
  - GVE-011 maximum demand is forecast to be 120A (or 4.6MVA);
  - Average GVE feeder outage rate is assumed to be 1 outage per annum; and
  - Average feeder outage repair time (or supply restoration time) is 4 hours.
- Remote REFCL:
  - Each remote REFCL comprises of one 7.5MVA isolation transformer and one arc suppression coil and associated equipment;
  - Remote REFCL Co limit is ranging from 60A to 100A depending on network damping;
  - Thermal capacity limit of one remote REFCL is 7.5MVA, which is limited by the isolation transformer rating of 7.5MVA;
  - Cost estimate for each remote REFCL is $6.3 M (real, $2020)
  - Cost estimate for remote REFCL land is $0.3 M (real, $2020)
  - O&M is estimated at $102k (real, $2020) per annum

4. Options Analysis

4.1 Options Description

This section provides a summary of the scope of works for the eight options (and a base case for comparison purposes) summarised in Table 4-1 below.

Table 4-1: KLO Options Summary

Option No.	Option Title	Objectives of option	Remote REFCL	Risks
0	Base Case: Do Nothing	Sets the reference point for comparison with all other options in terms of avoided cost of expected unserved energy for a single contingency event at GVE, its sub-transmission line, and GVE-011	0	Would result in JEN not being in compliance with the Act and Regulations. Would also entail significant supply reliability risks for GVE REFCL protected supply area. This option is non-feasible due to not meeting the identified need of compliance with the Act and Regulations, but is included for comparison purposes.
1	Part underground from KLO and transfer overhead sections to GVE	KLO-022 underground network remains as non-REFCL network KLO-022 overhead network (1MVA of load) transferred to GVE, and becomes REFCL protected Provide back up to non-REFCL supply areas such as KLO and ST	0	Minimal capital cost to comply with the Act and Regulations, however significant supply reliability risk on GVE network, as there is no redundancy under single contingency event.
2	Install one remote REFCL at start of KLO-022 feeder	KLO-22 becomes fully REFCL protected Provide backup to GVE, however extent of this backup capacity is constrained by remote REFCL's Co limit and feeder capacity to 7.5MVA	1	The feeder load is well above the REFCL rating of 7.5MVA therefore this option is not technically feasible. In addition the feeder Co is high which may compromise the performance of the REFCL therefore risking non-compliance.
3	Install two remote REFCLs at the start of KLO-022 feeder	KLO-022 becomes fully REFCL protected Provide backup to GVE	2	High capital cost In addition it may not accommodate Co increase from future underground network growth which may compromise the performance of the REFCL therefore risking non-compliance.
4	Fully Underground KLO-022 feeder	KLO-022 remains as non-REFCL network (to be covered by exemption) Provide back up to non-REFCL supply areas such as KLO and ST	0	High capital cost
5a	Part underground from KLO plus	KLO-022 becomes REFCL protected for overhead network,	1	-

	remote REFCL in Mt Ridley Rd to serve downstream overhead	and non-REFCL for underground network Provides back up to GVE and non-REFCL supply areas such as KLO and ST		
5b	Part underground from KLO plus remote REFCL in Mickleham Rd to serve downstream overhead	KLO-022 becomes REFCL protected for overhead network, and non-REFCL for underground network Provides back up to GVE and non-REFCL supply areas such as KLO and ST	1	-
6	Extend KLO-013 and KLO-021 plus remote REFCL	KLO-013 becomes REFCL protected for overhead network, and non-REFCL for underground network. KLO-022 is made redundant. Provides back up to GVE and non-REFCL supply areas such as KLO and ST	1	Not meeting technical requirement due to feeder KLO-013 will be overloaded, as KLO-022 is effectively made redundant.
7	Convert all 13.7km of open wire conductors to covered conductors	KLO-022 remains as non-REFCL network (aim to be covered by exemption) Provide back up to non-REFCL supply areas such as KLO and ST	0	Covered conductor performance is unknown, which carries high risk of other problems and detrimental impacts. Covered conductor effectiveness at mitigating bushfire ignition risk is unknown, and as such JEN considers it would unlikely be able to demonstrate to ESV that this option would provide a bushfire risk-neutral outcome (necessary in order to obtain exemptions from the Act and Regulations).

The scope of work for each option is provided below.

4.1.1 Base-case – Do Nothing

This option is non-feasible due to not meeting the identified need of compliance with the Act and Regulations, but is included for comparison purposes. It sets the reference point for comparison with all other options in terms of avoided cost of expected unserved energy for a single contingency event at GVE, its sub-transmission line, and GVE-011.

4.1.2 Option 1 – Part underground from KLO and transfer overhead sections to GVE

This option is technically feasible to achieve compliance with the Act and Regulations, and entails undergrounding work to separate JEN's KLO underground network (to remain supplied from KLO as non-REFCL network) from the overhead sections of KLO-022 (to be transferred to GVE as REFCL protected network).

This option reflects the minimum possible work on JEN's KLO 22 kV feeders that is necessary to comply with the Act and Regulations. However, it does not provide any backup to the GVE supply area, and as a result entails significant supply reliability risks for customers.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install new 4km underground cable section on KLO-022 along Hume Fwy from Patterson St to Mt Ridley Rd (corner Parkside Rise) – most of the KLO-022 underground network to remain a non-REFCL network;
  - Install two RMU to facilitate underground connections;
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker- Hume kiosk – this new underground section to remain on non-REFCL network; and
  - Transfer the overhead network on KLO-022 to GVE-011 (REFCL protected network) – all overhead sections to be supplied by GVE.

4.1.3 Option 2 – Install one remote REFCL at start of KLO-022 feeder

This option is not technically feasible to provide compliance requirements, due to the feeder's maximum demand projected to be higher than the REFCL limit (7.5MVA) and the likelihood that the Co limit may be exceeded. It entails installation of one remote REFCL at the start of KLO-022 to provide REFCL protection to the entire feeder.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install one remote REFCL at the start of KLO-022 (REFCL protected network).

4.1.4 Option 3 – Install two remote REFCLs at start of KLO-022 feeder

This option is technically feasible to provide compliance requirements in the short to medium term, however it may not accommodate the Co increase from future underground network growth as development continues within

Melbourne's northern growth corridor. It entails installation of two remote REFCLs at the start of KLO-022 to provide REFCL protection to the entire feeder.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install two remote REFCLs at the start of KLO-022 (REFCL protected network).

4.1.5 Option 4 – Fully Underground KLO-022 feeder

This option is technically feasible as it would enable JEN to rely on existing exemptions from the compliance requirements.[10] It entails replacing all of JEN's KLO 22 kV feeders overhead conductors with underground cables and all pole mounted substations with kiosk substations. The main purpose of this option is to retain all of JEN's KLO 22 kV feeders as non-REFCL network and provide back-up to non-REFCL supply areas such as KLO and ST.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Replace approximately 13.7km of overhead conductors with underground cables; and
  - Replace 29 pole mounted substations with kiosk substations.

4.1.6 Option 5a – Part underground from KLO plus remote REFCL in Mt Ridley Rd to serve downstream overhead

This option is technically feasible to provide compliance requirements, and entails undergrounding work to separate JEN's KLO underground network (to remain supplied from KLO as non-REFCL network) from the overhead sections of KLO-022 (to be REFCL protected via an installation of a remote REFCL in Mt Ridley Rd).

This option provides the optimal supply arrangement that provides back up to GVE and non-REFCL supply areas such as KLO and ST.

10 An exemption from section 120W of the Act in respect of underground feeders was gazetted on 1 October 2020. Corresponding exemptions from the Regulations have also been granted by ESV.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install new 4.0 km underground cable section on KLO-022 along Hume Fwy from Patterson St to Mt Ridley Rd (corner Parkside Rise) – most of KLO-022 underground network to remain as a non-REFCL network;
  - Install two RMUs to facilitate underground connections;
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker-Hume kiosk – this new underground section to remain as non-REFCL network; and
  - Install remote REFCL on Mt Ridley Rd (corner Parkside Rise) to supply the overhead network (REFCL protected network) – all overhead sections to remain on remote REFCL supply.

4.1.7 Option 5b – Part underground from KLO plus remote REFCL in Mickleham Rd to serve downstream overhead

Similar to Option 5a, this option is technically feasible to provide compliance requirements, and entails undergrounding work to separate JEN KLO underground network, which remains supplied from KLO as non-REFCL network, and the overhead sections of KLO-022, which will be transferred to KLO-013 and REFCL protected via an installation of a remote REFCL in Mickleham Rd.

This option provides an alternative location for the remote REFCL compared to Option 5a, allowing for a network configuration which provides back up to GVE and non-REFCL supply areas such as KLO and ST. The supply arrangement under this option is less desirable from a supply reliability perspective than Option 5a, because a number of customers on the overhead sections of KLO-022 (to be transferred to KLO-013) would be placed on radial feed.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install new 4.0 km underground cable section on KLO-022 along Hume Fwy from Patterson St to Mt Ridley Rd (corner Parkside Rise) – most of the KLO-022 underground network to remain as a non-REFCL network;
  - Install two RMUs to facilitate underground connections;
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker- Hume kiosk – this new underground section to remain a non-REFCL network; and
  - Install remote REFCL on Mickleham Rd (corner Donnybrook Rd) to supply the overhead network (REFCL protected network) – all overhead sections to remain on remote REFCL supply.

4.1.8 Option 6 – Extend KLO-013 and KLO-021 plus remote REFCL

This option is not technically feasible to enable JEN to meet the compliance requirements, because the forecast maximum demand on KLO-013 would be significantly higher than its rating. It entails extending KLO-013 to pick up KLO-022 (where KLO-022 is effectively made redundant), and KLO-021 being extended to pick up 50% of the KLO-013 load. This option aims to provide REFCL protection for KLO overhead network and non REFCL for the KLO underground network.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation;
  - Replace existing 170m of overhead conductors with underground cable;
  - Extend KLO-013 with 2.1 km underground cable from Lokeport–Hurkett kiosk to Mt Ridley Rd, along Forrest Red Gum Drive and connect to Daybreak-Highland kiosk; and
  - Install remote REFCL on Mt Ridley Rd (corner Red Gum Drive) to supply KLO-022 overhead network (REFCL protected network) – all KLO-022 overhead sections will be transferred to KLO-013 and remain on remote REFCL supply.
- Feeder KLO-021
  - Extend KLO-021 with 1.5 km underground cable along Donnybrook Rd and cut into KLO-013 to pick up 50% of load.
- Feeder KLO-022:
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker-Hume kiosk – this new underground section to remain on non-REFCL network.

4.1.9 Option 7 – Convert all 13.7km of open wire conductors to covered conductors

This option is not technically feasible to provide compliance requirements due to risks associated with the use of covered conductors. The effectiveness of covered conductors in mitigating bushfire ignition risks is unknown. JEN engaged with the ESV in August 2020 on the potential granting of exemptions from the Act and Regulations in situations where covered conductors may be used to seek to achieve a bushfire risk-neutral outcome. ESV has indicated that JEN would need to demonstrate this technology provides a bushfire risk-neutral outcome in order to obtain exemptions to the Act and Regulations – JEN would not be able to fulfil this requirement.

This option entails replacing all of JEN KLO 22 kV feeders overhead conductors with covered conductors and seeking exemptions from the Act and Regulations, as JEN's KLO 22kV feeders would remain a non-REFCL network.

Scope of works by 2023

The high level scope of works required by JEN are:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Replace approximately 13.7km of overhead conductors with covered conductors; and
  - Replace all transformer droppers and associated connections with insulated covered types, and install animal proofing for all pole-mounted transformers to prevent faults from occurring.
- Seek exemptions from the Act and Regulations.

4.2 Load Forecast

This section presents the maximum demand forecast at the new GVE zone substation, GVE-011 and JEN KLO 22 kV feeders prior-to- and post- KLO REFCL augmentation work under each option and compares them to the feeder ratings.

This assessment supports us in determining the most efficient outcome in the long-term interests of JEN's customers.

Table 4-2 presents the ratings of new GVE zone substation – these ratings remain the same prior-to- and post-KLO REFCL augmentation work. Critically, this table shows that GVE would be unable to meet any demand under N-1 conditions, due to its single transformer arrangement.

Table 4-2: GVE Zone Substation Ratings

	Summer	Winter
Substation N Secure Rating (MVA)	33.0	33.0
Substation N-1 Rating (MVA)	0	0

Table 4-3 presents the maximum demand forecast for GVE zone substation for the forward 10-year planning period prior to REFCL augmentation at KLO feeders. Note GVE is planned to be commissioned prior to summer 2024.

Table 4-3: GVE Zone Substation Demand Forecast Prior to KLO REFCL Augmentation (Base Case – Do Nothing)

	2020 (actual)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Summer – 10% POE (MVA)	0	0	0	0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Summer – 50% POE (MVA)	0	0	0	0	13.1	13.1	13.0	13.1	13.1	13.1	13.1

Based on our forecast, there is sufficient capacity at GVE zone substation to supply its area over the forward 10-year planning period under system normal conditions, however there is no redundant capacity in the event of an outage at GVE or a radial 66kV sub-transmission line. There exists, however, opportunities to mitigate the risks associated with the lack of redundant capacity at GVE through our works to achieve compliance for our KLO feeders, and therefore our assessment of options for KLO has considered GVE supply reliability impacts.

Table 4-4 presents GVE-011 and the three JEN KLO feeders maximum demand forecast prior to KLO REFCL augmentation.

Table 4-4: GVE-011 and JEN KLO Feeders Demand Forecast Prior to KLO REFCL Augmentation (Summer 10POE, Base Case – Do Nothing)

Feeder	Rating	2020 (actual)	2021	2022	2023	2024	2025	2026	2027
GVE-011 (MVA)	11.4	0.0	0.0	0.0	0.0	4.6	4.6	4.6	4.6
KLO-013 (MVA)	15.0	5.3	8.9	11.9	14.2	15.5	17.0	18.7	20.4
KLO-021 (MVA)	15.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
KLO-022 (MVA)	15.0	6.8	9.7	11.0	12.1	12.9	13.7	14.6	15.4

4.2.1 Load Forecast for Option 1

Under Option 1, it is expected that there will be a net load transfer from KLO-022 to GVE-011 of approximately 1MVA from summer 2024 onwards. The maximum demand forecast for GVE zone substation, GVE-011 and KLO feeders are presented in Table 4-5 and Table 4-6.

Based on our forecast, this option places further supply reliability risk in the event of an unplanned outage at GVE or the radial 66kV sub-transmission line.

Table 4-5: GVE Zone Substation Demand Forecast Post Augmentation (Option 1)

	2020 (actual)	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Summer – 10% POE (MVA)	0	0	0	0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
Summer – 50% POE (MVA)	0	0	0	0	14.1	14.1	14.0	14.1	14.1	14.1	14.1

Table 4-6: GVE-011 and JEN KLO Feeders Demand Forecast Post Augmentation (Summer 10POE, Option 1)

Feeder	Rating	2020 (actual)	2021	2022	2023	2024	2025	2026	2027
GVE-011 (MVA)	11.4	0.0	0.0	0.0	0.0	5.6	5.6	5.6	5.6
KLO-013 (MVA)	15.0	5.3	8.9	11.9	14.2	15.5	17.0	18.7	20.4
KLO-021 (MVA)	15.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1
KLO-022 (MVA)	15.0	6.8	9.7	11.0	12.1	11.9	12.7	13.6	14.4

4.2.2 Load Forecast for Options 2, 3, 4, 5a, 5b and 7

Under Options 2, 3, 4, 5a, 5b and 7, it is expected that the load forecasts for GVE, GVE-011 and KLO feeders remain unchanged. Refer to Table 4-3 and Table 4-4.

4.2.3 Load Forecast for Option 6

Under Option 6, it is expected that there will be a net load transfer from KLO-013 to KLO-021 of 7.8 MVA, and the entire feeder from KLO-022 to KLO-013 from summer 2024 onwards. There is no change to GVE or GVE-011.

As a result of the feeder load transfers, KLO-013 is expected to be significantly overloaded above its thermal limit, hence this is option is not technically acceptable.

Table 4-7 presents the maximum demand forecast for GVE-011 and JEN KLO feeders.

Table 4-7: GVE-011 and JEN KLO Feeders Demand Forecast Post Augmentation (Summer 10POE, Option 6)

Feeder	Rating	2020 (actual)	2021	2022	2023	2024	2025	2026	2027
GVE-011 (MVA)	11.4	0.0	0.0	0.0	0.0	4.6	4.6	4.6	4.6
KLO-013 (MVA)	15.0	5.3	8.9	11.9	14.2	20.7	22.9	25.5	28.1
KLO-021 (MVA)	15.0	1.0	1.0	1.0	1.0	8.8	8.8	8.8	8.8
KLO-022 (MVA)	15.0	6.8	9.7	11.0	12.1	0.0	0.0	0.0	0.0

4.3 Project and On-going Operational Costs

Based on the scope of works provided in Section 4.1, the project costs for each option is summarised in Table 4-8 below.

Table 4-8: Project Costs (real, $2020)

Option No.	1	2	3	4	5a	5b	6	7
Project capital cost ($M)	5.7	7.2	13.8	21.9	12.3	12.3	11.7	N/A
NPV of project capital cost ($M)	5.4	6.8	13.1	20.7	11.7	11.7	11.0	N/A

The on-going annual O&M expenditure of REFCL compliance testing for each option is estimated at $102 thousand per annum (real, $2020). Applying the real discount rate of 2.5% per year, this equates to a NPV of $0.7M over the ten-year assessment period.

As presented in Section 4.2, the load forecast of all the credible options have similar outcome such that it would not materially affect the future network augmentation scope, cost and timing under each option driven by load growth. As such, these ‘load growth’ related augmentation has not been considered further.

4.4 HV Customer Cost to Comply

JEN does not have any HV customer connections on KLO-013, KLO-021 and KLO-022, therefore there are no costs to consider in this category.

4.5 Expected Unserved Energy Assessment

The complexities and technical limitations associated with REFCL equipment can introduce a number of constraints during network operations—for example, by limiting our ability to undertake emergency load transfers between feeders—that may lead to significant supply interruptions under some circumstances. In the case of GVE, these risks are further heightened by the fact that this station has only a single transformer and is supplied only from a single 66kV line.

Based on the risk assessment, the cost of expected unserved energy is determined using the VCR and other assumptions listed in Section 3.2. The NPV of the cost of expected unserved energy over the 10-year period is determined for each option, and the results for each option are summarised in Table 4-9.

Table 4-9: NPV of Cost of Expected Unserved Energy ($M, real 2020)

Option No.	EUSE – Single Contingency Event			
	GVE zone substation	Single radial COO-VCO-GVE 66kV line	GVE-011	Total
Base Case	35.0	7.7	2.3	45.0
1	37.4	8.3	2.8	48.4
2	N/A – option not technically feasible			
3	7.4	1.6	0	9.1
4	35.0	7.7	2.3	45.0
5a	7.4	1.6	0	9.1
5b	7.4	1.6	0	9.1
6	N/A – option not technically feasible			
7	N/A – option not technically feasible			

4.6 Summary of Net Economic Benefit Analysis

A summary of the net economic benefit for each option is present in Table 4-10. This shows that Option 5a maximises the net economic benefit to all those who produce, consume and transport electricity in the NEM. As noted above, Options 2, 6 and 7 are not technically feasible, and all technically feasible options are expected to deliver an equivalent bushfire risk-neutral safety outcome.

Table 4-10: Net Economic Benefit of each option (real, $2020)

Option No.	NPV of Total Cost (Project cost and O&M) ($M)	NPV of net market benefits ($M) [1]	Ranking
Base Case	0	0	N/A
1	(6.2)	(9.5)	4
2	(7.5)	N/A	N/A
3	(13.8)	22.2	3
4	(20.7)	(20.7)	5
5a	(12.4)	23.5	1
5b	(12.4)	23.5	2
6	(11.8)	N/A	N/A
7	N/A	N/A	N/A

(1) Reflects total costs and expected unserved energy.

5. Recommendation and Next Steps

The assessment outlined within this document shows that the identified need associated with this strategy comprises:

- The compliance with the Act and Regulations for JEN's KLO 22 kV network area;
- The level of reliability in the GVE supply area must be considered and managed in light of the REFCL technical limitations and associated significant supply risks to customers; and
- Long-term load growth must be considered—in essence, the proposed solution needs to align with the network growth strategy.

5.1 Recommended Solution

In line with the assessment, the recommended solution is Option 5a, as this option maximises the net economic benefit to all those who produce, consume and transport electricity in the NEM. The results of this analysis are summarised in Table 4-10. This solution will deliver a bushfire risk-neutral outcome and is in the long-term interests of JEN's customers.

Option 5a comprises the following works:

- Feeder KLO-013:
  - Replace existing Walker-Donnybrook pole substation with a new 315kVA RMU kiosk substation; and
  - Replace existing 170m of overhead conductors with underground cable.
- Feeder KLO-022:
  - Install new 4km underground cable section on KLO-022 along Hume Fwy from Patterson St to Mt Ridley Rd (corner Parkside Rise) – most of KLO-022's underground network to remain a non-REFCL network[11];
  - Install two RMUs to facilitate underground connections;
  - Replace 120m of overhead conductors with 3C.240mm2 underground cable from pole A128561 to Homemaker- Hume kiosk – this new underground section to remain a non-REFCL network; and
  - Install remote REFCL on Mt Ridley Rd (corner Parkside Rise) to supply the overhead network (REFCL protected network) – all overhead sections to remain on remote REFCL supply.

Option 5a provides a bushfire risk-neutral outcome when compared to the installation of REFCL protection at KLO, as well as meeting technical and compliance requirements and mitigating significant supply reliability risks for customers (thus being consistent with our customers' expectations that we should maintain the reliability of our services over the long-term).

The JEN capital expenditure required for the recommended solution is $12.326M (real $2021, including overheads).

5.2 Next Steps

In accordance with Clause 5.17 of the National Electricity Rules and as per the process defined in the AER's RIT-D Application Guidelines, JEN will undertake a RIT-D for this project.

JEN is currently working through this process, however, a non-network solution is unlikely to be considered sufficient to address the identified need in relation to this project—namely to mitigate bushfire risk.

[11] JEN would rely on exemptions already granted under the Act and Regulations in respect of polyphase electric lines originating from KLO which are of a fully underground construction.

Given the compliance timeframes imposed by the Act and Regulations and the very low likelihood that a non-network alternative solution would address the identified need, JEN has initiated a land search activities for the proposed remote REFCL site.