REFCL Compliance Maintained Planning Report Belgrave (BGE) Zone Substation

AMS – Electricity Distribution Network

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Contents

1 Project overview

The Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016 came into effect on 1 May 2016 amending the *Electricity Safety (Bushfire Mitigation Regulations 2013* (the **Regulations**). The Regulations specify the Required Capacity for Rapid Earth Fault Current Limiter performance. The Regulations also specify the 22 zone substations on AusNet Services' network that must comply with the Regulations.

The *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (the **Act**) sets out the significant financial penalties enforceable for non-compliance. Refer to Appendix A for further information.

Belgrave (**BGE**) zone substation (**ZSS**) is included in Tranche 2 of the AusNet Services REFCL Program with compliance required to be achieved by 1 May 2021. This report investigates and seeks funding for the most prudent and efficient approach to maintain compliance with the Regulations at BGE during the 2022-26 regulatory control period.

By the Tranche 2 compliance deadline of 1 May 2021, BGE will have two standard Arc Suppression Coils (**ASCs**) installed which, for planning purposes, are assumed to have a total capacitive current limit of 218A (Bus 1 has an approximate limit of 111A and Bus 2 has an approximate limit 107A), beyond which it may not be able to achieve the Required Capacity. The zone substation demand is within the zone substation rating and the zone substation assets are in good condition. Hence, at this stage, the increasing capacitive current is driving the need to invest in BGE to ensure AusNet Services can maintain compliance with the Act and Regulations.

This report reviews various options considered by AusNet Services to manage the capacitance growth. The preferred option, which is the option found to be the most economically efficient and technically feasible, recommends a combination of installing a remote REFCL, feeder transfer and installation of isolation transformers.

The associated works for this option will include:

- Transfer 4A of capacitive current from BGE13 to BGE11 by opening BW16229 and closing BG201;
- Install a remote REFCL on BGE13 at an optimal location;
- Install four pole-top isolation transformers at the proposed location on BGE22. Minor amount of undergrounding of overhead line is required on BGE22.

The estimated cost for the works associated with this option is $9.9 million.

2 Background

2.1 Purpose of this report

This report investigates any constraints that are forecast to occur at BGE, identifies and assesses potential options, and seeks funding for the preferred option. BGE is included in Schedule 1 of the *Electricity Safety (Bushfire Mitigation) Regulations 2013*, and must meet the Required Capacity defined in the Regulations.

The constraints investigated include:

- Forecast demand;
- Network constraints; and
- Capacitive current and compliance with the Regulations.

The following sections of this report describe the compliance obligations, the technologies available to achieve those obligations, constraints at the zone substation and options to mitigate any issues.

2.2 Compliance obligations

The Victorian Government has mandated, through the Regulations, that electricity distribution companies increase safety standards on specific components of their networks to reduce bushfire risk. The Regulations set challenging performance standards (the **Required Capacity**) for 22 of AusNet Services' zone substations. The dates for compliance are separated into three tranches based on a prioritising points system, and occur on 1 May 2019, 1 May 2021 and 1 May 2023. In addition, the Victorian Government has enforced timely compliance of the Regulations by introducing significant financial penalties though the *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (the **Act**).

Distribution businesses have found that the Required Capacity can only be met by installing Rapid Earth Fault Current Limiters (**REFCLs**) in zone substations. In addition, the Victorian Government's Powerline Bushfire Safety Program also identified REFCLs as the preferred solution for meeting the Required Capacity[1].

The Act provides for the Governor-in Council to grant exemptions and for a Major Electricity Company to request the modification of due dates and periods.

Details of the Act, the Regulations and the penalties are in Appendix A.

2.3 REFCL technology

There are various types of technology that fall under the REFCL umbrella, however the only type of REFCL currently considered suitable by the Victorian Electric Supply Industry (VESI) for bushfire safety is known as the Ground Fault Neutraliser (GFN), a proprietary product by Swedish Neutral. Presently, the GFN is the only device that can meet the performance criteria of the Regulations. All references to REFCLs in the remainder of this document are referring to the GFN type.

REFCLs are comprised of the following key components:

- Arc Suppression Coil (**ASC**) – which is a large inductor that compensates for the capacitive current during an earth fault.

[1] REFCL fact sheet 2016 111216, Introducing best knowledge and technology, Powerline Bushfire Safety program, Dec 2016

- Residual Current Compensator (**RCC**) – also referred to as the inverter, which is located in the zone substation control building or switchroom. It is used to reduce fault current by compensating for the active current during an earth fault
- Control Panels and software, which control the equipment.

2.3.1 Remote REFCL

As conceived and implemented to date REFCL technology has been installed within the Zone Substation environment. This has been dictated by the requirement to access the neutral of the transformers supplying the network emanating from the station.

A Remote REFCL concept has been developed by AusNet Services to increase technical optionality of meeting and maintaining the Required Capacity. This concept endeavours to create a REFCL protected network within an individual distribution feeder (22 kV) when a zone substation reaches its ultimate REFCL capacity.

Remote REFCL consist of an Isolation transformer and REFCL (ASC+RCC) that creates a separate REFCL network downstream that is distinct and isolated from the supporting Zone Substation.

Through the use of the remote REFCL it is planned that expenditure to maintain the Required Capacity can be minimised.

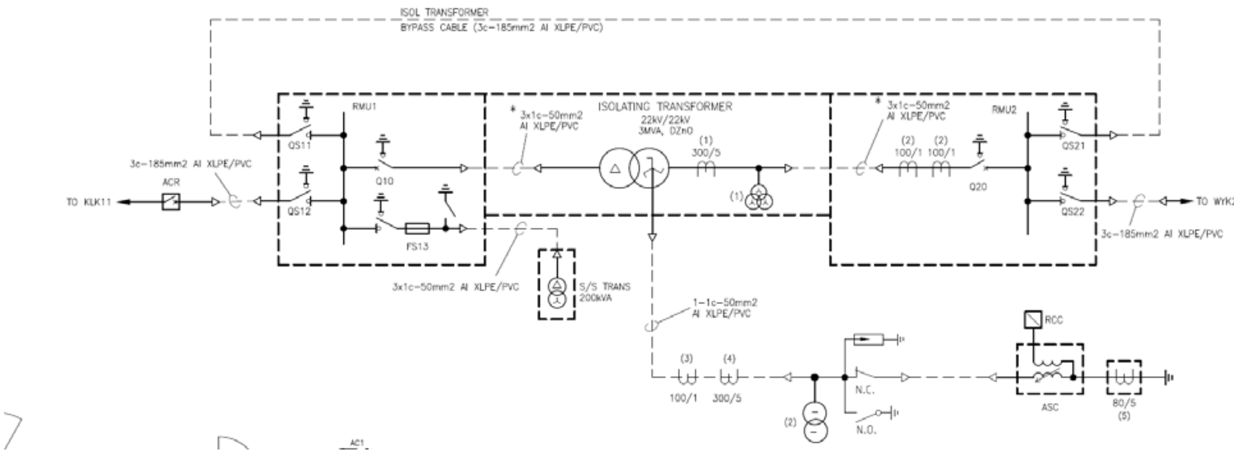


Figure 1 Remote REFCL Single Line Diagram

2.4 REFCL constraints

The REFCL's ability to successfully detect, manage and locate phase to earth (also referred to as ground) faults on the 22kV network[2] is dependent on a complex combination of network conditions which, when correctly managed, allow continued operation of the REFCL protection in compliance with the Required Capacity.

The following network conditions and physical constraints impact the continued correct operation of the REFCL and its ability to continue meeting the Required Capacity:

Network damping factor

The network damping factor is defined as the ratio of the resistive current losses to the capacitive current (I_R/I_C) measured across the zero-sequence network. A higher damping factor is undesirable as it limits the ability of the REFCL to detect a high impedance fault, and thus operate in the time required to comply with the Required Capacity. The higher the damping factor the lower the capacitive current limit of the ASC.

2 SWER, which operates at 12.7kV, is excluded from the Required Capacity and is subject to its own requirements.

Network topology

Most modern residential developments are constructed using underground cables which have a higher capacitance than overhead lines. As the 22kV network grows due to increased demand, new customer connections and overhead conductor to underground cable conversions, the additional cable installations will increase the total capacitive current on the network. If the network capacitive current exceeds the capacitive current limit of the ASC, network investment is required to maintain compliance with the Regulations.

Capacitive current limit of the ASC

There are two capacitive current limits:

- **Per ASC:** The typical configuration for REFCLs is one ASC per supply transformer switching zone, and therefore per bus. The limit of an ASC is dependent on the damping characteristics of the network. Currently, the actual damping characteristics specific to the network can only be measured once a GFN is operating. At locations where a GFN is not yet operational, an ASC planning limit of 100A is assumed to determine indicative, conservative, augmentation timing. At BGE, it has been determined that Bus 1 has an approximate limit of 111A and Bus 2 has an approximate limit of 107A. This is to be further confirmed by ongoing tests that AusNet Services is carrying out. For the purpose of this report, 111A and 107A have been respectively assumed for Bus 1 and Bus 2.
- **Per feeder:** To enable differentiation of the feeder experiencing a fault, the maximum capacitive current that is allowable per individual feeder is 80A.

Software limitations

Currently, Swedish Neutral (manufacturer of the GFN) has not deployed a software solution that will allow the use of three GFNs at one zone substation.

2.5 Prudent and efficient investment

AusNet Services has taken the approach of incremental funding requests to maintain compliance with the Regulation to ensure minimal long term cost to customers. This is prudent and efficient as it enables:

- Minimum works to be carried out just in time to maintain compliance with the Regulation until 2026.
- Planning to be based on the most up-to-date network growth and capacitive current information and
- Application of the latest development in REFCL technology in this rapidly developing field. For example, should Swedish Neutral deploy a software solution that enables the use of three REFCLs at a zone substation, it may enable deferral of the construction of a new zone substation.

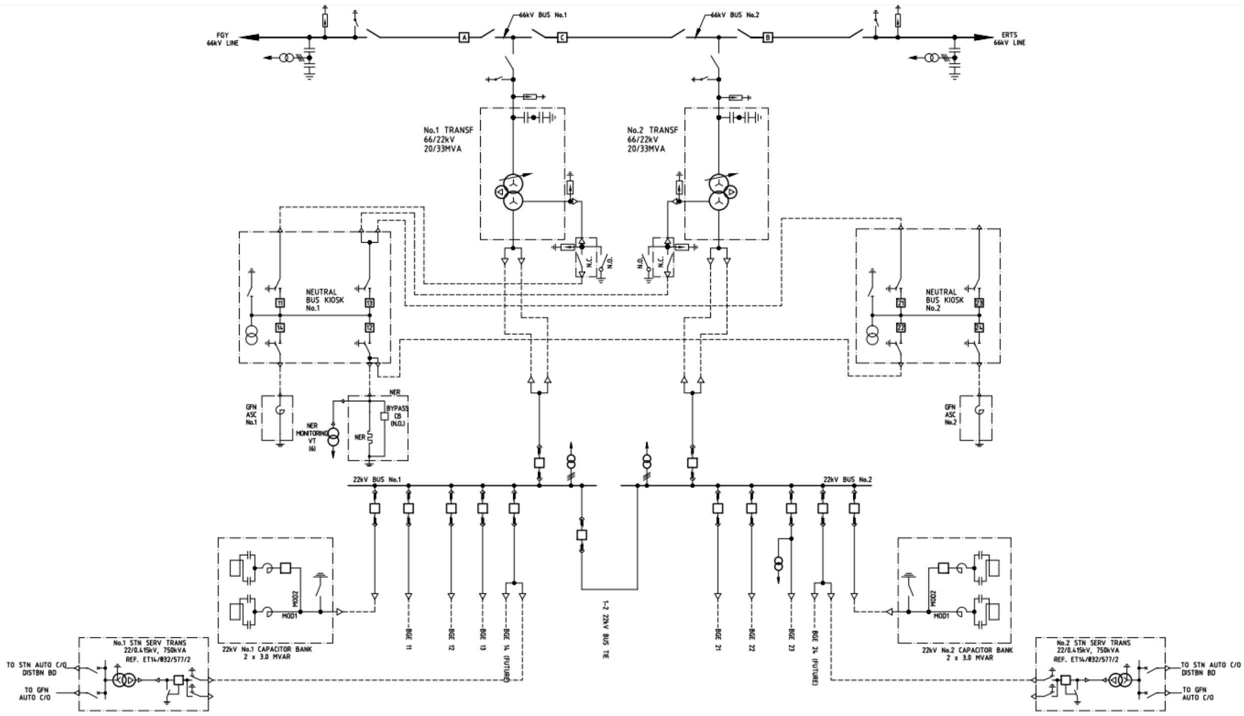
3 BGE zone substation overview

Belgrave (**BGE**) zone substation (**ZSS**) is located in the suburb of Belgrave South approximately 37km south east of Melbourne. Originally constructed in the early 1980s, it is now comprised of two transformers feeding two buses.

As shown in Figure 3.1, BGE consists of two 20/33 MVA transformers supplying two 22kV buses and six 22kV feeders.

Two REFCLs will be commissioned at BGE on neutral buses 1 and 2 by 31 May 2021 as part of Tranche 2 of the AusNet Services REFCL Program to achieve compliance with the Regulations. The future Single Line Diagram, showing the two REFCLs, is shown in Figure 3.1.

Figure 3.1 BGE ZSS Single Line Diagram



An aerial view of the 22kV feeders originating from Belgrave electricity distribution area is shown in

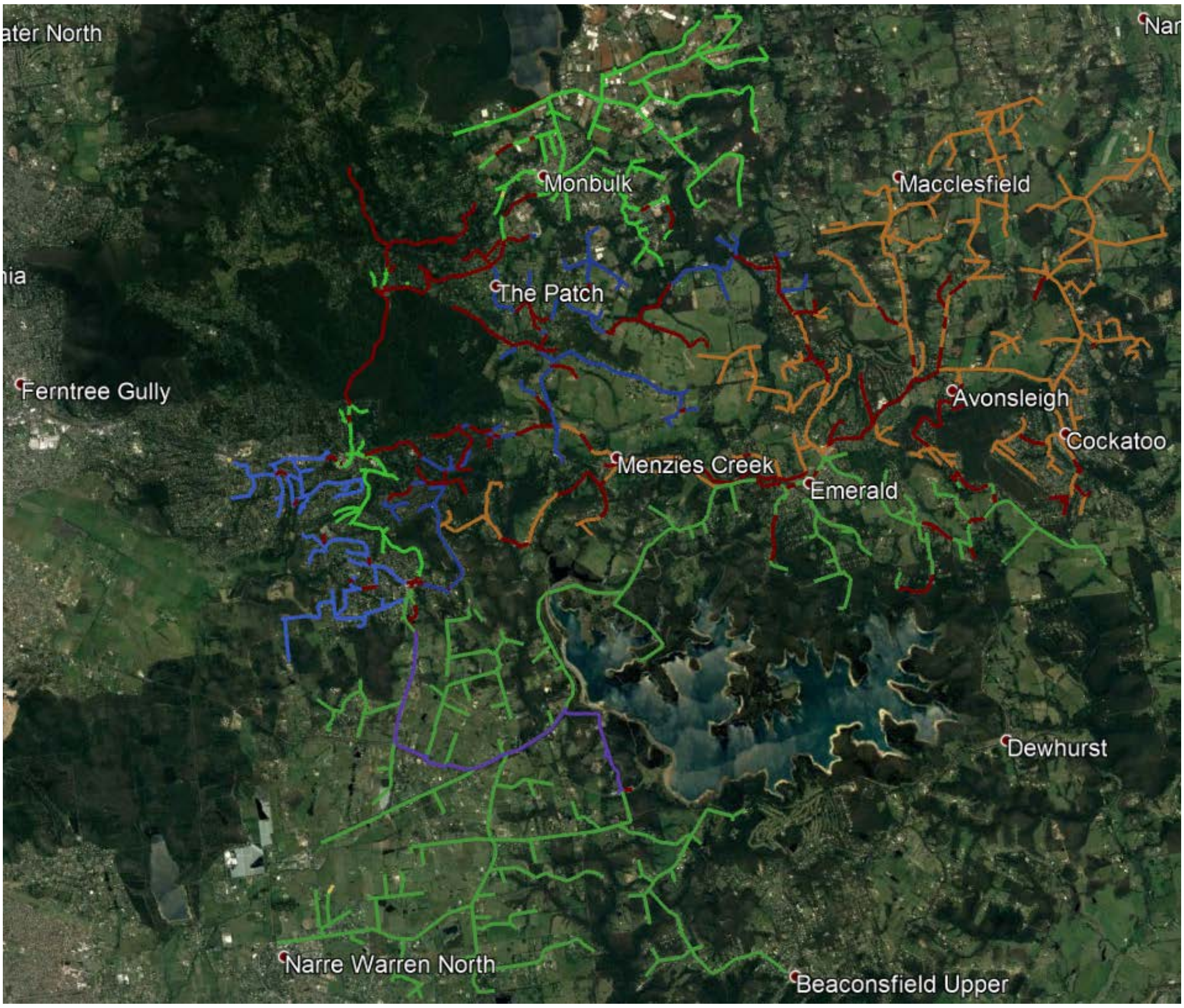
Figure 3.2. The distribution area includes the residential areas around Belgrave as well as semi-rural areas between Narre Warren North, Monbulk and Cockatoo. There are interconnections with Ferntree Gully zone substation to through to UWY, OFR, BWN and LYD. Connections exist though the 6.6kV network but do not have enough capacity to be considered for long term transfers.

The image shows that the feeders are predominately overhead with the breakdown of overhead and underground conductors per feeder shown in Table 3.1. Overhead feeders contribute a lower amount of capacitive current compared to underground cables.

Table 3.1 Overhead and underground conductor lengths

Old Feeder Name	New Feeder Name	Overhead (km)	Underground (km)	Total length (km)
BGE11	BGE11	48.2	14.6	62.8
BGE23	BGE12	18.8	1.9	20.7
BGE24	BGE13	27.2	16.6	43.8
BGE21	BGE21	7.8	1.3	9.1
BGE22	BGE22	53.3	19.3	72.6
BGE12	BGE23	94.6	4.0	98.6
	Grand Total	**249.9**	**57.8**	**307.6**

Figure 3.2 BGE ZSS Aerial Layout (underground conductor shown in dark maroon)



3.1 Network forecast

This section discusses the demand and capacitive current forecasts to identify if either attribute is exceeding the capacity of the zone substation and when it is expected to occur. This will identify the need and drive the type and timing of any intervention or investment that may be required.

3.1.1 Demand forecast

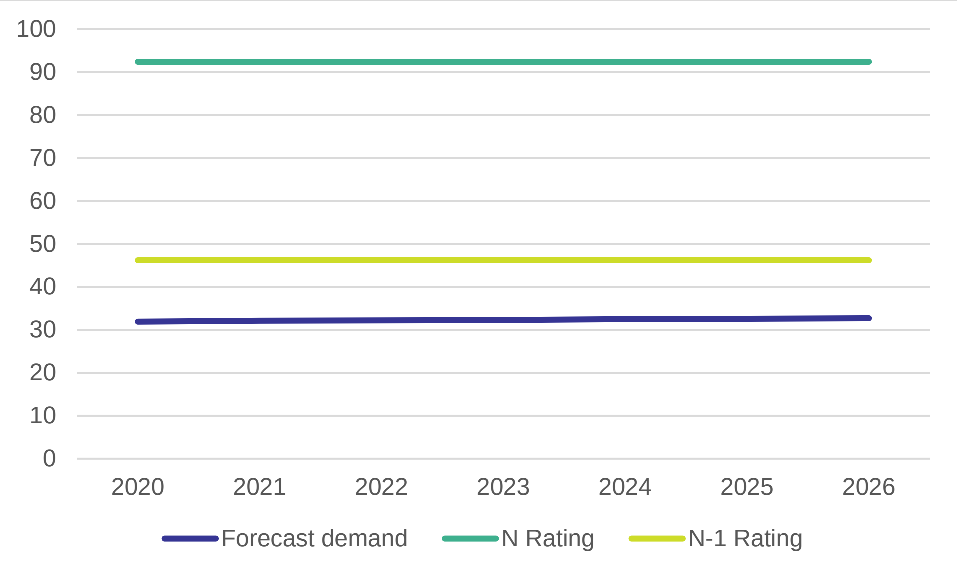
Table 3.2 shows the BGE maximum demand forecast (MVA) between 2020 and 2026. By 2026, the summer demand is expected to increase by approximately 1 MVA. Figure 3.3 shows that the forecast demand will not exceed the N-1 cyclic rating of the substation within the next regulatory period.

Table 3.2 Maximum Demand (MVA) Forecast for BGE – 2020 to 2026

	2020	2021	2022	2023	2024	2025	2026
BGE Winter (50POE)	25.5	25.3	25.1	25.0	24.8	24.6	24.3
BGE Summer (50POE)	31.3	31.5	31.6	31.7	31.9	32.0	32.1
BGE Winter (10POE)	26.8	26.7	26.5	26.3	26.1	25.9	25.7
BGE Summer (10POE)	33.3	33.5	33.6	33.7	33.9	34.0	34.2

BGE Consolidated Forecast[3]	31.9	32.1	32.2	32.3	32.5	32.6	32.7

Figure 3.3 Demand forecast



3.1.2 Capacitance forecast

The network capacitance forecast was developed based on the characteristics of each zone substation supply area, the standard topology of cables installed for underground residential developments (**URDs**) and other known network augmentation.

Since the growth in capacitance is strongly related to the growth of URDs, the forecast was made in 5 year increments as the timing of growth on an annual basis is not certain. The growth is expected to be a step function of new URDs that are being established, rather than a smooth and gradual increase each year. However, the capacitive current growth has been extrapolated to create an indicative annual trend, as shown below, to provide indicative timing of when intervention is likely to be required.

As stated in section 2.4, the ASC limit is dependent on the damping characteristics of the network that individual zone substation supplies, including the effect of earth resistivity in the zone substation supply area and pollution (salt) on insulators. AusNet Services has attempted to model network damping to forecast ASC limits. The models were based on Tranche 1 zone substations so the outputs could be compared to measured data to test accuracy. The models developed to date have not accurately calculated the damping as measured in Tranche 1 and investigations are continuing. As a result, the actual damping characteristics specific to each network can only be measured once a REFCL installation is operating.

The ASC limit of 100A that is used for planning purposes is based on learnings from the Tranche 1 installations and consideration of differences with the Tranche 2 zone substation network supply areas. At BGE, it has been determined that Bus 1 has an approximate limit of 111A and Bus 2 has an approximate limit of 107A. This is to be further confirmed by ongoing tests that AusNet Services is carrying out. For the purpose of this report, 111A and 107A have been respectively assumed for Bus 1 and Bus 2.

AusNet Services is acting prudently to address the network capacitive limits at each Tranche 2 zone substation by deferring investment until the network damping can be accurately measured when the REFCL is brought online whilst working on refining network damping modelling. In the event the capacitance is identified to be greater than the ASC limit and compliance with the

[3] The forecast is the weighted sum of the summer forecasts, calculated as 30% of the 10POE summer forecast plus 70% of the 50POE summer forecast.

Regulatory obligations cannot be met, AusNet Services will utilise the time extension provisions in the Regulations to implement solutions to achieve the Required Capacity.

By 31 May 2021, BGE will have two standard ASCs installed which, for planning purposes, is assumed to provide a capacitive current limit of 218A. As shown in Table 3.3, this limit is forecast to be exceeded by 2021.

Table 3.3 BGE capacitive current forecast

	2020	2021	2022	2023	2024	2025	2026
BGE Capacitive Current	297	297	297	297	297	297	297
ASC Limit	N/A	218	218	218	218	218	218
Excess Capacitive Current		79	79	79	79	79	79

Figure 3.4 Capacitive Current Forecast for BGE – 2020 to 2026

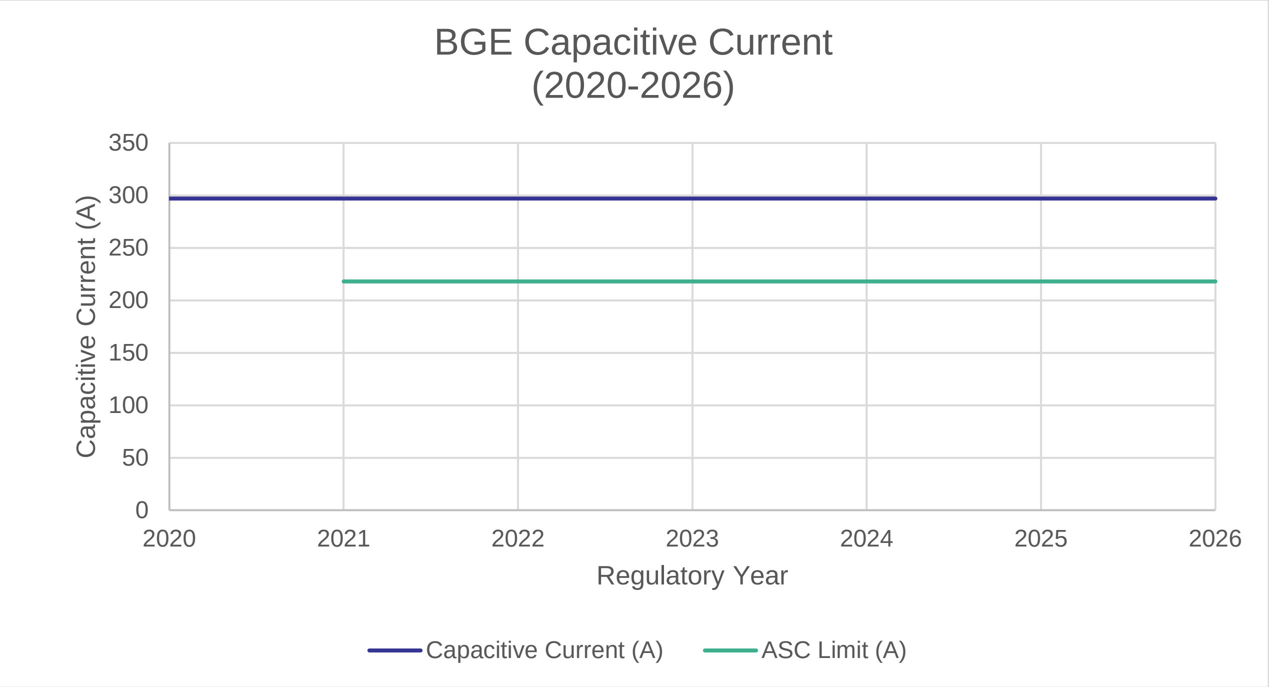


Table 3.4 estimates the capacitive current (I_{CO}) per feeder and per bus. This identifies if any feeders are expected to exceed the individual feeder limit of 80A and also where the greatest capacitive current reduction can be achieved. Importantly, the table shows:

- The I_{CO} at BGE is forecast to exceed the planning limit of the combined two REFCLs.
- The I_{CO} is not spread evenly across the feeders with Bus 1 forecast to reach 167A and Bus 2 forecast to reach 130A by 2026. Both buses are forecast to exceed the 111A and 107A planning limits respectively.
- Feeders BGE13 and BGE22 are forecast to be exceed the individual feeder limit of 80A.

Mitigation measures to address this are discussed in section 4.

Table 3.4 Estimated Capacitive Current contribution per feeder

Old Feeder Name	New Feeder Name	Forecast I_{CO} (A) 2026
BGE11	BGE11	75
BGE23	BGE12	10
BGE24	BGE13	82
	Total Bus 1	**167**

Old Feeder Name	New Feeder Name	Forecast I_{CO} (A) 2026
BGE21	BGE21	6
BGE22	BGE22	90
BGE12	BGE23	34
	Total Bus 2	**130**
	Grand Total	**297**

3.2 Identified need

As shown in section 3.1, due to expected network growth in AusNet Services' network, additional works will be required to maintain compliance with the Required Capacity in the 2022-2026 regulatory control period.

The forecast continued residential growth and network augmentation in the BGE supply area, particularly URDs which increase the capacitive current on the network, means that the capacitive current capacity of the REFCL at BGE may be exceeded in 2021:

- The zone substation may exceed its overall planning limit of 218A (two REFCLs installed);
- Both Bus 1 and Bus 2 are forecast to exceed the individual planning limits of 111A and 107A respectively; and
- Feeders BGE13 and BGE22 are forecast to be exceed the individual feeder limit of 80A.

As the demand growth and asset condition are not identified to be constraints for the zone substation, AusNet Services needs to identify the most economic option to address the capacitive current constraints that will affect compliance with the Regulations by 2021.

4 Options analysis

The options identified below are based on the best knowledge currently available on the network, including ASC limit and forecast capacitive current growth.

AusNet Services has identified eight options that could maintain compliance with the Regulations. These are summarised in Table 4.1.

Initial assessment of the seven options found that five were non-credible on a technical or cost basis. The reasons for this assessment are set out in in Table 4.1.

Two of the options (option 4 and 7) were found to be credible and are discussed in further detail in sections 4.2 to 4.1.

Table 4.1 Options Reviewed

Option	Discussion	Credible
Option 1 - Business as Usual	The Business as Usual option maintains the status quo at BGE which will entail no additional investment at BGE to manage the impact of the capacitive current. With a capacitive current forecast exceeding the thresholds used for forecasting purposes, BGE may become non-compliant with the Regulations, the community served by the BGE zone substation would be exposed to increased risk of fire starts from 22kV phase-to-earth faults, and AusNet Services will be subject to penalties under the Act. On this basis, Option 1 is not a credible option.	N
Option 2 – Capacitance/Load Transfer	As part of the REFCL Program and other capital works programs, capacity and capacitive current management projects are being undertaken. Ferntree Gully (FGY) is an	N

Option	Discussion	Credible
	adjacent zone substation to BGE and is also a Scheduled zone substation. A new zone substation is being constructed at Rowville (RVE) with load and capacitive current from three underground residential estates to be transferred from FGY to RVE. This transfer will create spare capacity at FGY. However, review of the network connections and conditions did not find suitable options to transfer enough capacitance amount from BGE to FGY to consider this option credible.	
Option 3 – Install isolation transformer on entire feeder	This option proposes to install an Isolation Transformer to isolate an entire feeder. Use of Isolation Transformers requires that all conductors downstream of the isolation transformer are underground cables. The BGE network is comprised of large rural feeders with overhead and underground sections. Hence, significant undergrounding of lines would be required for this option. Capacitance on both buses need be reduced to below the planning limits, therefore, one feeder on each bus will need to be considered. BGE13 and BGE22 are the most suitable feeders with a combined total overhead length of approximately 81km. Undergrounding 81km of overhead line will cost approximately $56 million. Therefore, this option does not present cost effective isolation opportunities and is not considered as a credible option.	N
Option 4 - Remote REFCL, load transfer and isolation transformers	The remote REFCL solution is currently under development by AusNet Services. It isolates part of a feeder and protects that isolated section with its own REFCL. The remote REFCL can be located no closer than 100m to the zone substation due to earthing issues. This option, along with network augmentation and installation of small isolation transformers, is considered credible and is discussed further in section 4.1.	Y
Option 5 - Undergrounding Over Head line in High Bush Fire Risk Area	BGE is comprised of 250km of overhead line. The cost, including converting overhead distribution transformers and switches to underground assets, is estimated at $175 million and therefore is not a credible option.	N
Option 6 - Install third REFCL	As there are only two transformers and buses at BGE, a third REFCL is not practical without extensive station rebuild, therefore, a non-credible option.	N
Option 7 - New Zone Substation	Installing a new zone substation to reduce the capacitive current at BGE is a technically viable option. This option is considered credible and is discussed further in section 4.2.	Y

4.1 Option 4 – Remote REFCL, load transfer and isolation transformers

This option proposes a combined solution of installation of a Remote REFCL, network augmentation and isolation transformers to reduce the capacitive current experienced at BGE.

As per the capacitive forecast shown in section 3.1.2, Bus 1 is 56A over the 111A capacitive current planning limit for a bus. Also, BGE13 is forecast to have 82A of capacitive current by 2021, which is above the individual feeder limit of 80A. Investigation of the network found that 4A of capacitance can be transferred to BGE11 by opening BW16229 and closing BG201. This will ensure BGE13 is below the feeder limit. There are multiple suitable locations, broadly in two areas, for the installation of remote REFCL on the BGE13 feeder. Area 1 is closer to the zone substation; putting a remote REFCL here will remove most of the capacitance on BGE13 however, the new remote REFCL will be exposed to the same capacitive limits. Area 2 is further away from the substation (approximately half way down the feeder in terms of capacitance); putting a remote REFCL here will result in more capacitive margin. The optimal location requires further investigation when the network tune point can be determined.

The remote REFCL solution is currently under development by AusNet Services. It isolates part of a feeder and protects the isolated section with its own REFCL to ensure the Required Capacity can be achieved. The remote REFCL must be located no closer than 100m to the zone substation due to earthing issues. In addition to finalising suitable land to house the remote REFCL (at least 22m x 11m land size is required), the following risks/issues require further consideration:

- There will be a negative impact on the community through the installation of new large infrastructure in residential areas;
- The additional transformers create an additional maintenance item in the network;
- For the remote REFCL to achieve its purpose, the selected locations for the remote REFCLs assumes new development will be down stream of the remote REFCLs, however, locations of new development cannot be predicted; and
- The effectiveness of a remote REFCL to isolate capacitance from new development growth will be limited by feeder thermal constraints.

As per the capacitive forecast shown in section 3.1.2, Bus 2 is 23A over the 107A capacitive current planning limit for a bus. Also, BGE22 is forecast to have 90A of capacitive current by 2021, which is above the individual feeder limit of 80A. To address both these concerns, four pole-top isolation transformers are recommended in the following locations:

- 300kVA isolation transformer on pole 419165 (BGE22) – results in 1.6A capacitance reduction
- 300kVA isolation transformer on pole 2601638927 (BGE22) – results in 2.2A capacitance reduction
- 300kVA isolation transformer on pole 419247 (BGE22 Lawsons Rd spur) – results in 2.9A capacitance reduction
- 1MVA isolation transformer near the intersection of Upper Grieve Rd and Belgrave (BGE22) -Gembrook Rd - results in approximately 15A capacitance reduction. For this solution to work, 2km of overhead at the end of this section will need to be undergrounded.

The above isolations will reduce the capacitance on BGE22 to below 80A. And, reduce Bus 2 capacitance to 108A which is marginally above the bus limit. Further isolations are very likely to be found with more detailed assessment. The approximate cost for the four pole-top isolation transformers and underground works is $2 million.

The approximate cost for this complete solution, i.e. capacitance transfers, remote REFCL on BGE13, pole-top isolation transformers and undergrounding works, is expected to cost $9.9 million. This is the recommended solution and revised 2026 forecast is summarised in the following table.

Table 4.2 Estimated Capacitive Current contribution per feeder

New Feeder Name	Forecast I_{CO} (A) 2026	Capacitance Reduction	Revised Forecast I_{CO} (A) 2026
BGE11	75	+4	79
BGE12	10		10
BGE13	82	-4	78 (A portion of this will be eliminated with a remote REFCL)

New Feeder Name	Forecast I_{CO} (A) 2026	Capacitance Reduction	Revised Forecast I_{CO} (A) 2026
Total Bus 1	**167**		**To be determined after knowing the exact remote REFCL location. This is likely to be below the 111A planning limit**
BGE21	6		6
BGE22	90	-21.9	68.1
BGE23	34		34
Total Bus 2	**130**		**108**
Grand Total	**297**		

4.2 Option 7 – New zone substation

This option proposes to establish a new REFCL-protected zone substation, transfer load to the new zone substation and balance the load on the existing BGE buses. Installing a new zone substation is a technically viable option. However, this option has the following key disadvantages:

- Additional capacity (demand MW) is not required in the 2022-2026 regulatory control period based on current load forecast
- Ability to acquire land in an appropriate location and to obtain the necessary easements for the new lines. AusNet Services will attempt to utilise the existing overhead network within the road reserves to minimise this risk.
- High cost – approximately $22 million.
- Long lead time.

Although this option is considered credible, it is not recommended due to the highlighted key disadvantages.

4.3 Option comparison

The two viable options studied in this report are summarised below. The comparison of the options shows that Option 4 is the preferred option.

Table 4.3 Feasible Options Comparison

Option	Technical feasibility	Estimated Cost (real $ 2020)	Regulatory feasibility	Social impact	Preferred
Option 4 – Remote REFCL, load transfer and isolation transformers	Yes, but further investigation is required about optimal location for remote REFCL	$9.9 M	Yes	Yes	Yes
Option 7 – New zone substation	Yes	$22 M	Yes	Yes	No

5 Recommendation

It is recommended that Option 4 (Remote REFCL, load transfer and isolation transformers) be approved.

In summary, following the approval, AusNet Services will complete the following works:

- Transfer 4A of capacitive current from BGE13 to BGE11 by opening BW16229 and closing BG201;
- Install a remote REFCL on BGE13 at an optimal location;
- Install four pole-top isolation transformers at the proposed location on BGE22. Minor amount of undergrounding of overhead line is required on BGE22.

The estimated cost for the works associated with this option is $9.9 million.

6 Appendix A

6.1 The Regulation stipulates the requirements

AusNet Services' network's geographical location means that it is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the risk of bushfires that may occur following earth faults on the distribution network.

The Victorian Bushfire Royal Commission, established in 2009, made several recommendations with respect to fires initiated from electricity distribution networks. Subsequently, the Victorian Government established the Powerline Bushfire Safety Taskforce (**PBST**) to investigate new cost efficient and effective technologies and operational practices to reduce catastrophic bushfire risk.

The PBST identified Rapid Earth Fault Current Limiters (**REFCLs**) installed in zone substations as an efficient and effective technology.

The *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* (**Amended Bushfire Mitigation Regulations**), which came into operation on 1 May 2016, set out new requirements for major electricity companies including the requirement for Polyphase Electric Lines (defined as multiphase distribution between 1 kV and 22 kV) at selected zone substations to have the following abilities:

- to reduce the voltage on the faulted conductor for high impedance faults to 250 volts within 2 seconds
- to reduce the voltage on the faulted conductor for low impedance faults to
  - i. 1900 volts within 85 milliseconds; and
  - ii. 750 volts within 500 milliseconds; and
  - iii. 250 volts within 2 seconds; and
- Demonstrate during diagnostic tests for high impedance faults to limit
  - i. Fault current to 0.5 amps or less; and
  - ii. The thermal energy on the electric line to that resulting from a maximum I^2t value of 0.10 A^2s;

The Amended Bushfire Mitigation Regulations define the low and high impedance faults as follows:

- High impedance = a resistance value in ohms that is twice the nominal phase-to-ground voltage. This is equal to 25.4 kilohms or a fault current of 0.5 amps on a 22 kV network.
- Low impedance = resistance value in Ohms that is the nominal phase-to-ground network voltage divided by 31.75. This is equal to 400 Ohms or a fault current of 31.75 Amps on a 22 kV network.

6.2 The Act stipulates non-compliance penalties

The penalties for not complying with the requirements set out in the Regulations are set out in the *Electricity Safety Act 1998* (the **Act**). The Act states that there will be a fine of up to $2 million for each point less than the prescribed number of points that must be achieved at each of the three specified dates and an ongoing fine of $5,500 per day that compliance is not achieved.

The detail of the fines is set out in Clause 120M (3) which states a major electricity company is liable to pay:

a *if subsection (1)(a) or (b) [(1)(a) - A major electricity company must ensure that for the initial period, a sufficient number of zone substations in its supply network are complying substations so that the total number of allocated substation points prescribed* *in respect of all of the complying substations is not less than 30 (the period 1 minimum points); and (1)(b) for the intermediate period, a sufficient number of zone substations I its supply network are complying substations so that the total number of allocated substation points prescribed in respect of all of the complying substation is not less than 55 (the period 2 minimum points)] is contravened, a pecuniary penalty not exceeding $2 000 000 for every point forming the difference between the total number of allocated substation points prescribed in respect of all of the complying substations and, as the case require:*

- i *the period 1 minimum points; or*
- ii *the period 2 minimum points; and*

b *if subsection (1)(c) [on or after 1 May 2023, of if Energy Safe Victoria specifies a later date under section 120X, that date, all zone substations in its supply network are complying substations] is contravened, a pecuniary penalty not exceeding $2 000 000 for every allocated substation point prescribed in respect of each zone substation that is not a complying substation; and*

c *if there is a continuing contravention of subsection (1)(a), (b) or (c), a pecuniary penalty that is a daily amount not exceeding $5500 for each day that contravention continues after service on the major electricity company by Energy Safe Victoria of notice of that contravention.*

6.3 Exemptions and time extensions

Electricity businesses can seek an exemption from both the Act and Regulations.

Exemption from the Act can be sought under section 120W of the Act from the requirements under section 120M of the Act. An exemption requires the Director of ESV to consult with the Minister for Energy, Environment & Climate Change and Governor in Council approval. The process can take up to 6 months.

Clause 13 of the Regulations allows for the electricity businesses to apply for exemptions from complying with the requirements of (7)(1)(ha) and (7)(1)(hb).

13 Exemptions

2 *Energy Safe Victoria may, in writing, exempt a specified operator or major electricity company from any of the requirements of these Regulations.*

3 *An exemption under subregulation (1) may specify conditions to which the exemption is subject.*

Time extension requests under S120X of the Act can be made to the Director of Energy Safe Victoria clearly stating the reasons for the request.