

Service constraints at Clyde North (CLN) Zone Substation

RIT-D Stage 1: Non-network options report



Service constraints at CLN – Non-network options report

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1 Executive Summary

AusNet Services is a regulated Victorian Distribution Network Service Provider (DNSP) that supplies electrical distribution services to more than 745,000 customers. Our electricity distribution network covers eastern rural Victoria and the fringe of the northern and eastern Melbourne metropolitan area.

As expected by our customers and required by the various regulatory instruments that we operate under, AusNet Services aims to maintain service levels at the lowest possible cost to our customers. To achieve this, we develop forward looking plans that aim to maximise the present value of economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (NEM).

Our planning approach includes the application of a probabilistic planning methodology, under which conditions often exist where some of the load cannot be supplied under unlikely but possible conditions, such as during extreme demand conditions or with a network element out of service. Where relevant, we also prepare, publish, and consult on a regulatory investment test for distribution (RIT-D), which further helps ensure all credible options are identified and considered, and the best option is selected.

This non-network options report is stage one of the RIT-D consultation process to address the existing and emerging service level constraints in the Clyde North (CLN) Zone Substation supply area. The report has been prepared by AusNet Services in accordance with the requirements of clause 5.17 of the National Electricity Rules (NER).

1.1 Identified need

CLN consists of two 66/22 kV 20/33 MVA transformers supplying two 22 kV buses and seven 22 kV feeder circuits. The substation supplies approximately 30,000 residential, commercial, industrial and agricultural customers in Victoria's southeast growth corridor.

The supply area is surrounded by Cranbourne (CRE) and Hampton Park (HPK) Zone Substations in the west, Berwick North (BWN) Zone Substation in the north and Officer (OFR) Zone Substation in east.

CLN Zone Substation is a summer peaking substation with a forecast maximum demand growth rate averaging 3.6% per annum over the next 10-year period. The growth in demand is predominately driven by the significant expansion of residential and commercial development in Melbourne's southeast growth corridor.

The zone substation summer maximum demand recorded in 2019/20 was 73.4 MVA. The forecast summer maximum demand is given in Table 1.

Table 1: Forecast Summer Maximum Demand

Probability of Exceedance (POE)	Forecast Summer Maximum Demand 2020/21 (MVA)	Forecast Summer Maximum Demand 2024/25 (MVA)
50%	86.2	97.6
10%	92.5	104.3

The zone substation capacity, consisting of a nameplate rating of 66 MVA, and 'N' and 'N-1' cyclic ratings of 87.3 MVA and 43.5 MVA respectively, is insufficient to reliably supply the forecast maximum demand, meaning that the current level of supply to our customers is expected to diminish if some service level risk mitigation action is not undertaken.

In addition to the zone substation constraints, supply capacity is also limited at the feeder circuit level, where electricity demand growth is forecast to exceed the capacity of multiple

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feeder circuits, similarly resulting in a service level reduction unless some risk mitigation action is taken.

1.2 Credible options

The potentially credible options that AusNet Services believes may be capable of meeting the identified need include:

1. Do nothing (counterfactual);
2. Large customer demand management network support;
3. Residential battery network support;
4. Embedded generation network support;
5. Network reconfiguration;
6. Installation of a third transformer installation at CLN Zone Substation; and
7. Installation of a third transformer and third switchboard at CLN Zone Substation.

1.3 Submissions

AusNet Services invites written submissions on the matters set out in this non-network options report from Registered Participants, AEMO, interested parties, non-network providers and those registered on our demand side engagement register.

All submissions and enquiries should be directed to:

Fuji Dinh
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AusNet Services
Email: ritdconsultations@ausnetservices.com.au

Submissions are due on or before 27 August 2021.

Submissions will be published on AusNet Services' website. If you do not wish to have your submission published, please clearly stipulate this at the time of lodging your submission.

1.4 Next steps

Following conclusion of the non-network options report consultation period, AusNet Services will, having regard to any submissions received on this non-network options report, prepare and publish a draft project assessment report (DPAR). AusNet Services intends to publish the DPAR by Q3 2021.

2 Introduction

The RIT-D is an economic cost-benefit test used to assess and rank potential investments capable of meeting the identified need. The purpose of the RIT-D is to identify the credible option that maximises the present value of net economic benefit to all those who produce, consume and transport electricity in the NEM (the preferred option).

This non-network options report is the first stage of the RIT-D consultation process in relation to the existing and emerging service level constraints in the CLN supply area. This report has been prepared by AusNet Services in accordance with the requirements of clause 5.17 of the NER.

This report:

- Describes the identified need that AusNet Services is seeking to address, in relation to the service level constraints in the CLN Zone Substation supply area.
- Outlines the assumptions made in identifying the need.
- Describes the options that AusNet Services considers could potentially address the identified need.
- Outlines the technical characteristics that a non-network option would be required to deliver to meet the identified need.
- Invites registered participants, AEMO, interested parties, non-network providers and persons on AusNet Services' demand side engagement register to make a submission on this non-network options report.

3 Background

3.1 Existing network

CLN consists of two 66/22kV 20/33 MVA transformers supplying two 22 kV buses and seven 22 kV feeder circuits. The substation supplies approximately 30,000 residential, commercial, industrial and agricultural customers in Victoria's southeast growth corridor.

The supply area is surrounded by Cranbourne (CRE) and Hampton Park (HPK) Zone Substations in the west, Berwick North (BWN) Zone Substation in the north and Officer (OFR) Zone Substation in east, as shown in Figure 1. Electricity demand and population growth in the southeast growth corridor has been strong in recent years, which led to the establishment of CLN zone substation in 2004 to help manage growth by off-loading HPK and BWN zone substations and feeders.

In 2012, CRE zone substation was established to further off-load HPK zone substation and the feeders heading west and south, and CLN zone substation and the feeders heading west, north and south. Prior to establishing CLN zone substation, the areas shown in Figure 1 were supplied from the combination of BWN and HPK zone substations.

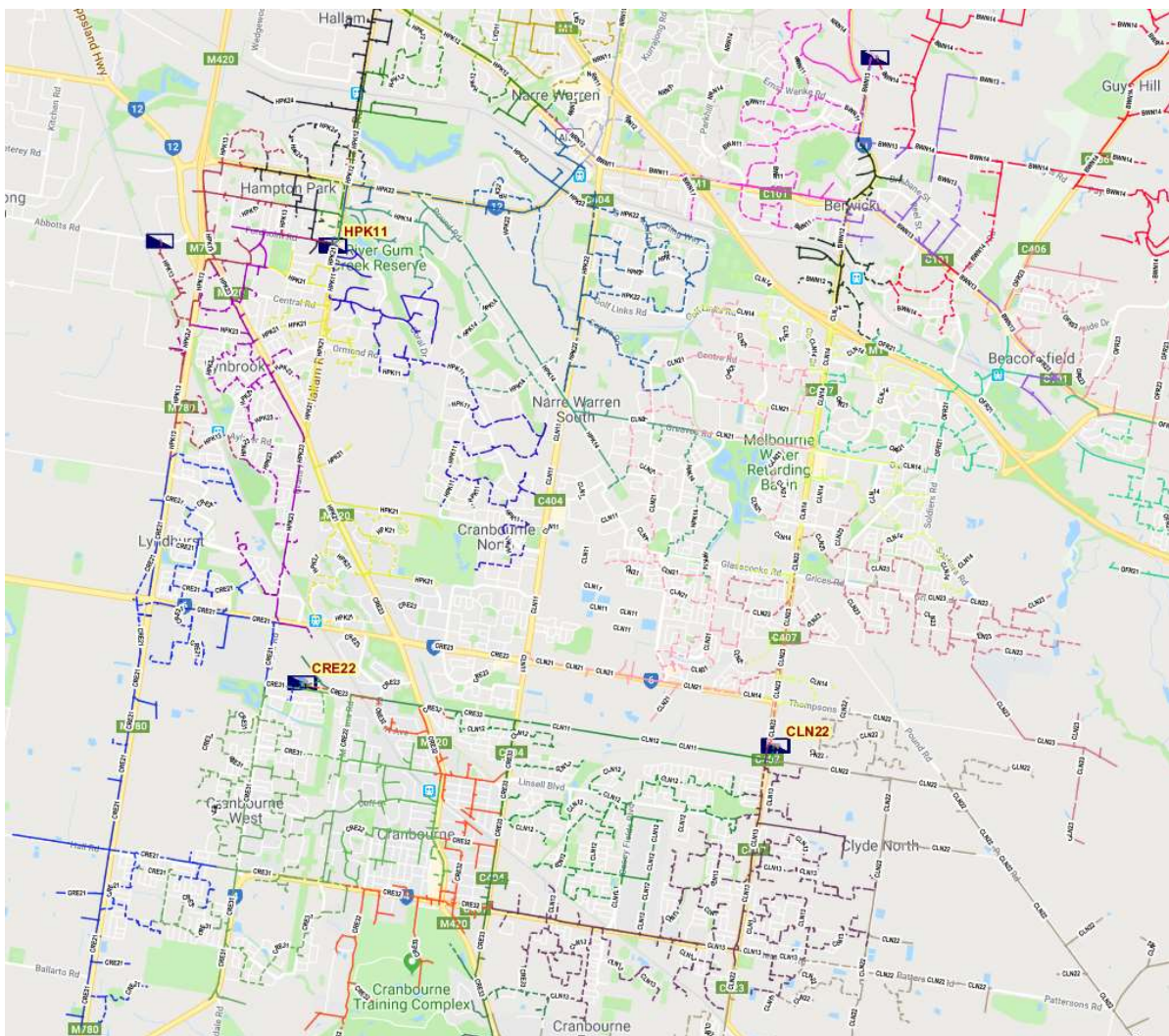


Figure 1: CLN and surrounding zone substation geographical feeder arrangements

The configuration of the primary electrical circuits within and surrounding CLN is as shown in the single line diagram of Figure 2.

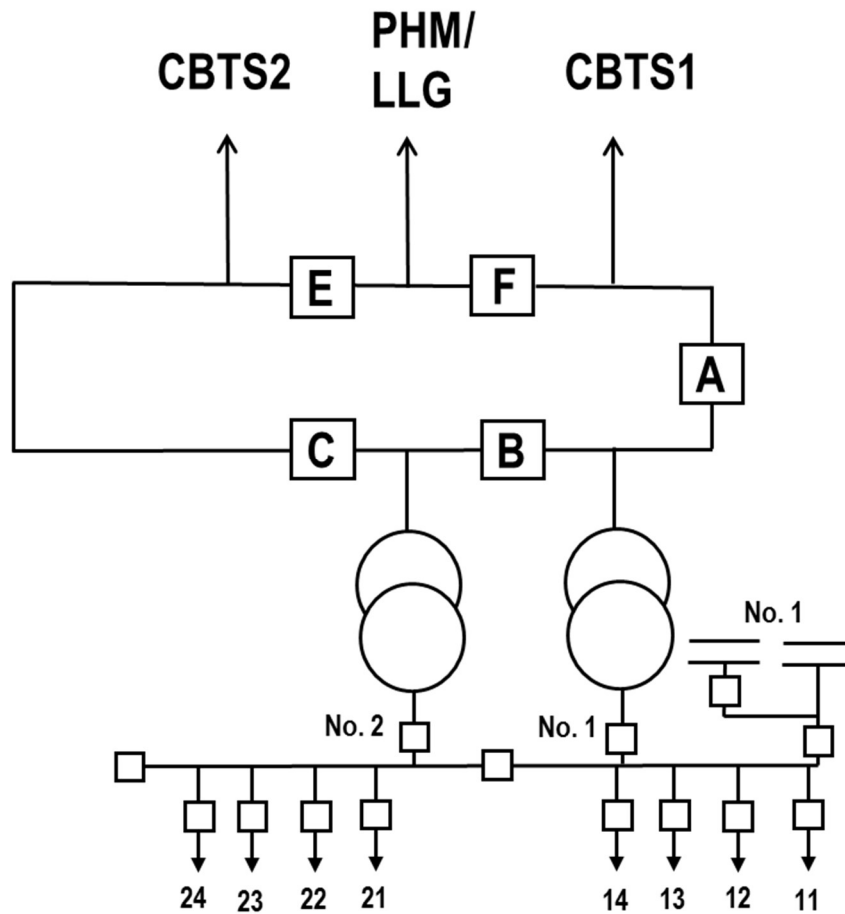


Figure 2: Existing Single Line Diagram of CLN

3.2 Customer Composition

CLN has seven 22 kV feeders supplying AusNet Services’ customers. Table 2 provides detail of the 22 kV supply feeders.

Table 2: CLN feeder information

Feeder	Feeder Length (km)	Feeder Description	Number of Customers	Customer Type
CLN11	20.8	Summer peaking, urban feeder	1,480	97.2% residential 1.6% commercial 0.4% industrial 0.7% farming
CLN12	29.1	Summer peaking, urban feeder	4,890	98.8% residential 1.2% commercial
CLN13	47.3	Summer peaking, rural short feeder	7,019	98.9% residential 1.1% commercial
CLN14	32.0	Summer peaking, urban feeder	4,382	97.7% residential 2.1% commercial 0.2% farming

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Feeder	Feeder Length (km)	Feeder Description	Number of Customers	Customer Type
CLN21	33.6	Summer peaking, urban feeder	5,636	98.4% residential 1.2% commercial 0.2% industrial 0.2% farming
CLN22	106.1	Summer peaking, rural short feeder	2,694	88.5% residential 3.2% commercial 0.3% industrial 7.9% farming
CLN23	31.2	Summer peaking, rural short feeder	4,100	99.2% residential 0.7% commercial 0.1% farming

4 Identified Need

Electricity demand supplied from CLN is forecast to grow an average of 3.6% per annum over the forward planning period to 2028. This growth in demand is predominately due to new housing and commercial developments in the southeast growth corridor.

AusNet Services' asset condition monitoring suggests the zone substation assets are generally in good or very good condition, and therefore have a low probability of failing and reducing the substation's supply capacity. Despite the low probability of failure, the loading on the zone substation already exceeds the substation's firm supply capacity and is forecast to exceed its system normal supply capacity by 2023.

In addition to the zone substation constraints, supply capacity is also limited at the feeder circuit level, where electricity demand growth is forecast to exceed the capacity of multiple feeder circuits, in the CLN and surrounding zone substation supply areas during the 2021 to 2026 regulatory period.

To provide the optimal balance of cost and reliability to our customers, action is required to manage the expected level of involuntary load shedding that would otherwise be required to maintain loading to within asset capabilities during both system normal and network asset outage conditions.

5 Assumptions underpinning the identified need

The purpose of this chapter is to summarise the key input assumptions that underpin the identified need described in the previous chapter.

5.1 Regulatory Obligations

In addressing the identified need, we must satisfy our regulatory obligations, which we summarise below.

Clause 6.5.7 of the National Electricity Rules requires AusNet Services to only propose capital expenditure required in order to achieve each of the following:

- (1) *meet or manage the expected demand for standard control services over that period;*
- (2) *comply with all applicable regulatory obligations or requirements associated with the provision of standard control services;*
- (3) *to the extent that there is no applicable regulatory obligation or requirement in relation to:*
 - (i) *quality, reliability or security of supply of standard control services; or*
 - (ii) *the reliability or security of the distribution system through the supply of standard control services**to the relevant extent:*
 - (iii) *maintain the quality, reliability and security of supply of standard control services, and*
 - (iv) *maintain the reliability and security of the distribution system through the supply of standard control services; and*
- (4) *maintain the safety of the distribution system through the supply of standard control services.*

Section 98(a) of the Electricity Safety Act requires AusNet Services to:

design, construct, operate, maintain and decommission its supply network to minimise as far as practicable –

- (a) *the hazards and risks to the safety of any person arising from the supply network; and*
- (b) *the hazards and risks of damage to the property of any person arising from the supply network; and*
- (c) *the bushfire danger arising from the supply network.*

The Electricity Safety act defines 'practicable' to mean having regard to –

- (a) *severity of the hazard or risk in question; and*
- (b) *state of knowledge about the hazard or risk and any ways of removing or mitigating the hazard or risk; and*
- (c) *availability and suitability of ways to remove or mitigate the hazard or risk; and*
- (d) *cost of removing or mitigating the hazard or risk.*

Clause 3.1 of the Electricity Distribution Code requires AusNet Services to:

- (b) *develop and implement plans for the acquisition, creation, maintenance, operation, refurbishment, repair and disposal of its distribution system assets and plans for the establishment and augmentation of transmission connections:*

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- (i) to comply with the laws and other performance obligations which apply to the provision of distribution services including those contained in this Code;
- (ii) to minimise the risks associated with the failure or reduced performance of assets; and
- (iii) in a way which minimises costs to customers taking into account distribution losses.

Under clause 5.2 of the Electricity Distribution Code, AusNet Services:

must use best endeavours to meet targets required by the Price Determination and targets published under clause 5.1 and otherwise meet reasonable customer expectations of reliability of supply.

5.2 Asset Condition

To provide a consistent assessment of the condition of an asset, AusNet Services applies a common condition scoring methodology. This methodology uses the known condition details of each asset and grades that asset against common asset condition criteria.

Asset condition is measured with reference to an asset health index on a declining condition scale from C1 to C5, as outlined in Table 3.

AusNet Services' strategy and approach to monitoring the condition of assets is further described in *AMS 10-13 Condition Monitoring*.

Table 3: Asset condition scoring methodology

Condition Score	Condition	Condition Summary
C1	Very good	Initial service condition
C2	Good	Deterioration has minimal impact on asset performance. Minimal short term asset failure risk.
C3	Average	Functionally sound showing some wear with minor failures, but asset still functions safely at adequate level of service.
C4	Poor	Advanced deterioration – plant and components function but require a high level of maintenance to remain operational.
C5	Very Poor	Extreme deterioration approaching end of life with failure imminent.

Asset conditions are discussed in the Asset Health Reports for the key asset classes, namely power transformers, instrument transformers and circuit breakers, with information on asset condition rankings, recommended risk mitigation options and replacement timeframes.

A summary of the condition of key assets at CLN zone substation is provided in Table 4.

Table 4: CLN asset condition scores

Asset Type	Number of assets by Condition Score				
	C1	C2	C3	C4	C5
66 kV Circuit Breakers	5				
66 kV Current Transformers	12				
66 kV Voltage Transformers	11		2		
66/22 kV Power Transformers		2			
22 kV Circuit Breakers	15	1			
22 kV Current Transformers	22				
22 kV Voltage Transformers	4				

These conditions scores are then used to calculate the asset failure rates using the Weibull Hazard function, as presented in Equation 1.

Equation 1: Weibull Hazard Function

$$r(t) = \frac{\beta t^{\beta-1}}{\eta^{\beta}}$$

Where:

t = Time (condition based age)

η = Characteristic life (Eta)

β = Shape Parameter (Beta)

A Beta (β) value of 3.5 has been used to calculate the failure rates of all assets considered in the zone substation risk-cost model.

The condition based age (t) depends on the specific asset's condition and characteristic life (η). The characteristic life represents that average asset age at which 63% of the asset class population is expected to have failed. Table 5 gives the characteristic life values for each asset classes considered in the risk-cost model.

Table 5: Equipment Characteristic Life Values

Equipment	Characteristic Life (η) (years)
Power transformers	50
Circuit breakers	45
Voltage transformers	40
Current transformers	30

5.3 Zone Substation Supply Capacity

CLN is a summer peaking substation with a forecast maximum demand growth rate averaging 3.6% per annum over the next 10-year period. The growth in demand is predominately driven by the significant expansion of residential and commercial development in Melbourne's southeast growth corridor.

The zone substation summer maximum demand recorded in 2019/20 was 73.4 MVA. The forecast summer maximum demand is given in Table 6.

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Table 6: Forecast Summer Maximum Demand

Probability of Exceedance (POE)	Forecast Summer Maximum Demand 2020/21 (MVA)	Forecast Summer Maximum Demand 2024/25 (MVA)
50%	86.2	97.6
10%	92.5	104.3

Figure 3 shows the forecast maximum demand and supply capacities (cyclic ratings) of CLN zone substation. It is important to note that demand already exceeds the N-1 cyclic rating, which is the station’s supply capacity when one transformer out of service, and is forecast to exceed the station’s N rating, which is the station’s supply capacity with all assets in service, during the 2021-25 EDPR period.

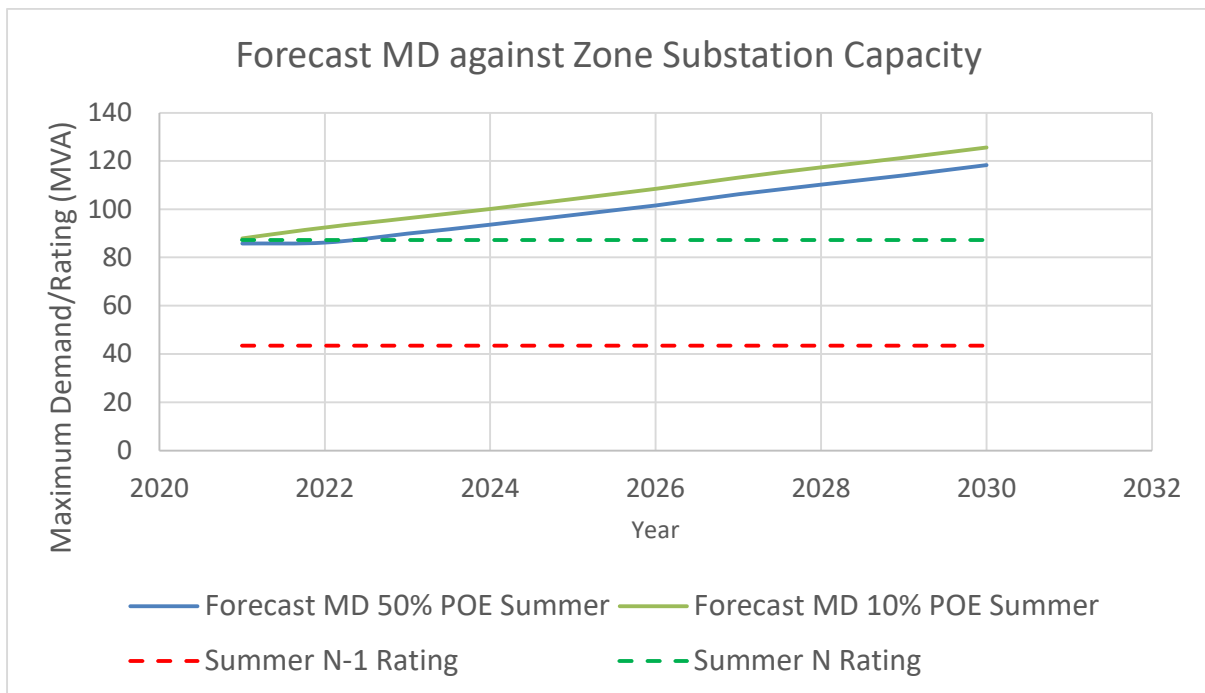


Figure 3: CLN Zone Substation forecast maximum demand and supply capacity

5.4 Load Duration Curves

The zone substation load duration curves that feed into the risk-cost assessment model are derived from historical actual demands between:

- 1 October 2019 and 31 March 2020 for the summer 50% probability of exceedance (POE) curves;
- 1 April 2020 and 30 September 2020 for the winter 50% POE curves;
- 1 October 2019 and 31 March 2020 for the summer 10% POE curves; and
- 1 April 2020 and 30 September 2020 for the winter 10% POE curves.

The historical hourly demands are separated by season and unitised based on the recorded maximum demand within that season (summer and winter) and time period. This allows the load duration curve to be scaled according to the seasonal forecast maximum demand for each year of the assessment period.

The 50% POE unitised load duration for CLN zone substation is presented in Figure 4, and the 10% POE unitised load duration for CLN zone substation is presented in Figure 5.

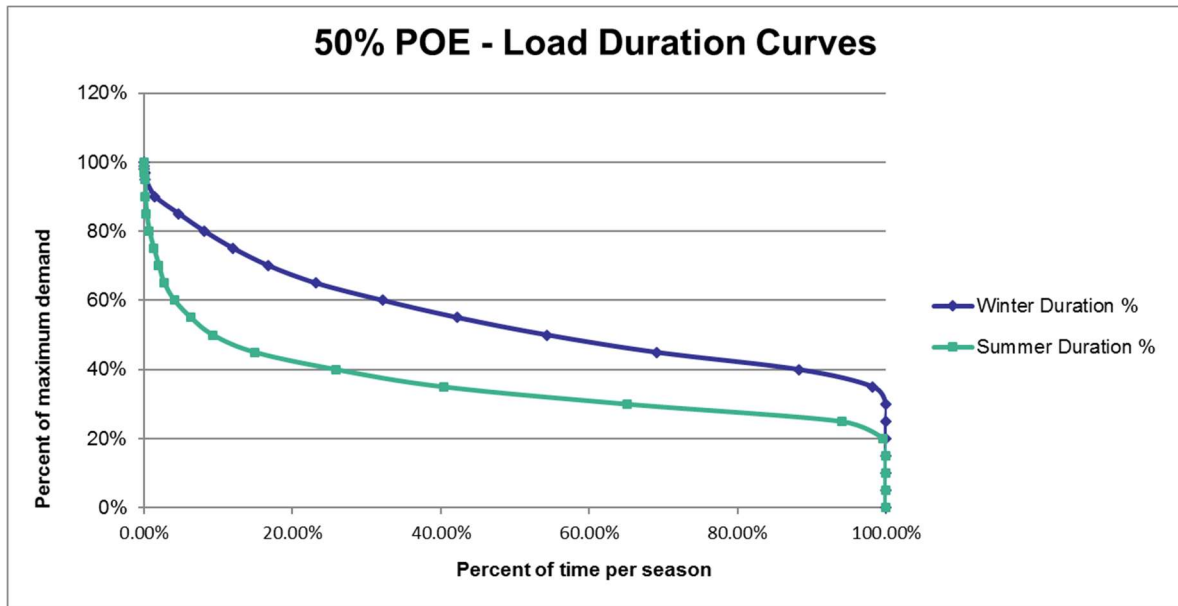


Figure 4: CLN Zone Substation 50% load duration curves

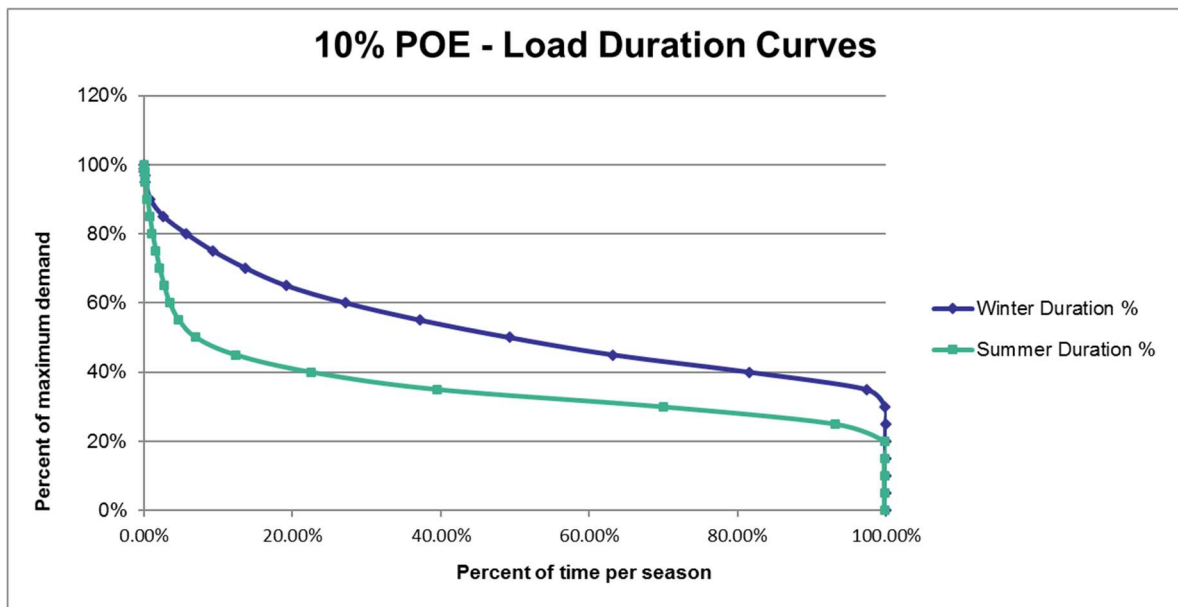


Figure 5: CLN Zone Substation 10% POE load duration curves

5.5 Feeder Circuit Supply Capacity

In addition to the zone substation constraints, supply capacity from CLN zone substation is also limited at the feeder circuit level, where electricity demand growth is forecast to exceed the capacity of two CLN feeder circuits during the 2021 to 2026 regulatory period.

Table 7 presents the rating and annual forecast maximum demand of the 22 kV feeder circuits supplied from CLN zone substation. The ratings presented are the continuous summer feeder circuit ratings, and the forecast maximum demand levels represent a 50% probability of exceedance forecast. The shaded cells show when the feeder demand is forecast to exceed the feeder circuit rating.

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Table 7: Forecast utilisation of CLN Zone Substation feeders

Feeder	Rating (A)	Forecast Maximum Demand (A)						
		2021	2022	2023	2024	2025	2026	2027
CLN11	360	169	172	175	179	184	189	197
CLN12	335	302	308	312	317	323	329	337
CLN13	321	347	366	383	398	416	437	458
CLN14	325	296	305	311	319	327	335	346
CLN21	358	348	362	376	392	406	423	443
CLN22	375	340	370	401	430	457	484	513
CLN23	323	302	344	376	408	441	474	509

5.6 Load Transfer Capacity

CLN zone substation is surrounded by Cranbourne (CRE) and Hampton Park (HPK) zone substations in the west, Berwick North (BWN) Zone Substation in the North and Officer (OFR) Zone Substation in East.

CLN Zone Substation has multiple feeder interconnections with its neighbouring zone substations, as outlined in Table 8, which have potential to provide emergency load transfer during periods of limited or insufficient supply capacity.

Table 8: CLN feeder interconnections to adjacent zone substations

CLN Feeder	Adjacent Connecting Feeders	Connection Point Location relative to CLN Zone Substation
CLN11	CRE23, CRE33, HPK11	West
CLN12	CRE33, CRE32	West
CLN13	CRE33	South West
CLN14	OFR21, BWN12	North East
CLN21	HPK14, HPK22	North West
CLN22	CRE33	South West
CLN23	None	

Table 9 presents the rating and forecast maximum demand of feeder circuits supplied from zone substations adjacent to CLN zone substation, and that have normally open connection points to CLN feeders. The ratings presented are the continuous summer feeder circuit ratings, and the forecast maximum demand levels represent a 50% probability of exceedance forecast. The shaded cells show when the feeder demand is forecast to exceed the feeder circuit rating.

Table 9: Rating and demand of feeders connecting to CLN Zone Substation

Feeder	Rating (A)	Forecast Maximum Demand (A)						
		2021	2022	2023	2024	2025	2026	2027
BWN12	312	294	295	296	298	300	301	301
CRE23	360	229	232	233	234	236	239	243
CRE32	360	226	229	231	234	236	237	239
CRE33	335	245	256	263	271	277	281	285
HPK11	293	291	294	296	298	300	302	305

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Feeder	Rating (A)	Forecast Maximum Demand (A)						
		2021	2022	2023	2024	2025	2026	2027
HPK14	330	243	248	252	255	257	260	262
HPK22	311	262	265	268	272	276	278	281
OFR21	375	368	387	404	421	440	461	482

Based on the feeder circuit connections to adjacent zone substations, and other relevant limitations, the emergency load transfer capacity away from CLN zone substation is 30.1 MVA in 2020/21, reducing to 21.6 MVA by 2029/30, as presented in Table 10.

Table 9: Emergency load transfer capacity away from CLN Zone Substation

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Forecast emergency load transfer capacity (MVA)	30.1	29	28	26.9	26	25	24.1	23.2	22.4	21.6

5.7 Station Configuration Supply Risk

The configuration of CLN means that failure of some 22kV and 66kV circuit breakers will result in an immediate loss of supply from CLN zone substation until the failed equipment can be switched out, isolated and the station supplies restored. The resultant supply outage would be for an estimated duration of two hours, which is the time typically required by operators to travel to site and manually re-configure circuits to isolate the failed equipment and sequentially restore supply to customers.

Table 11 lists the estimated bus outage consequence factors for each major type of equipment based on the substation layout.

Table 10: CLN Bus Outage Consequence Factors

Equipment	Estimated Bus Outage Consequence
Transformer	0%
22 kV circuit breaker	50%
66 kV circuit breaker	50%
22 kV current transformer	50%
66 kV current transformer	50%
22 kV voltage transformer	0%
66 kV voltage transformer	0%

5.8 Investments Impacting Customer Supply Arrangements

This section outlines planned and committed investments that are expected to impact the customer supply arrangements in the area Clyde North supply area.

5.8.1 Zone Substation Feeder Works

AusNet Services has two new 22 kV feeder installations, connecting to CLN zone substation, that are currently in the construction stage. However, there is currently only one spare feeder exit circuit breaker available to accommodate the committed new feeders.

In the short term, AusNet Services will connect two feeder lines to a single feeder exit circuit breaker, in what is known as a piggy-back feeder arrangement. While this arrangement allows

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both new feeders to be established before existing feeders are loaded above their thermal capacity, piggy-back feeder connections are undesirable, and only ever done as a temporary arrangement, because they result in poorer reliability due to the increased consequence of an outage associated with the higher load and number of customers connected to the single feeder exit circuit breaker.

Maintaining long term customer reliability at the feeder level relies on the establishment of a third 22 kV switchboard at CLN zone substation in the near future.

5.8.2 Critical Peak Demand Tariff

In 2011, AusNet Services introduced the critical peak demand (CPD) tariff for large customers. This tariff is part of the standard tariff structure that applies to all large business customers, which is defined as those having an expected annual energy consumption of 160 MWh or more.

This tariff structure gives customers the opportunity to minimise electricity consumption, or seek alternative supply sources, between 3pm and 7pm Australian Eastern Daylight Time (AEDT) on the five CPD days nominated by AusNet Services between 1 December and 31 March each year.

For customers on this tariff, AusNet Services calculates their average peak demand across the five CPD days, and this forms the basis of the 'demand critical peak' component of their tariff for the next 12 months. By reducing their demand on the nominated CPD days, customers have the opportunity to reduce their energy costs while assisting AusNet Services to manage supply risks in the local area.

Demand reduction responses in the CLN zone substation supply area have proven relatively strong on CPD nominated days, suggesting there are customers in the area that are price responsive and may be willing to provide firm demand response action via a network support contract. There are 65 large customers supplied from CLN zone substation. However, it is estimated that up to 90% of the demand response achieved thus far has been delivered by only six customers, four of which are already engaged by AusNet Services to provide network support demand management services.

While large customers are available to offset the demand, particularly throughout the middle of day, their contribution to the zone substation peak, and therefore their ability to reduce the zone substation peak demand, is diminished because their demand requirements are typically somewhat reduced by the time the zone substation peak evening peak arrives. Further information on the average daily load profile at CLN is provided in Figure 6, Section 7.3 of this report.

5.8.3 Network Support Contracts

AusNet Services currently contracts 1,863 kW of demand management network support services in the CLN zone substation supply area. These network support services are provided by four large customers located on feeder CLN22. The contracts were established to help manage supply risks associated with feeder circuit loading levels on CLN22 and also contribute to reducing the zone substation loading at peak demand times.

Demand management network support services are renegotiated on an annual basis to ensure their continued need and contracted level of support is appropriate.

6 Credible options

6.1 Risk-Cost Model Overview

This section outlines the potential options that have been considered to address the identified need, and summarises the key works and costs associated with implementing these options.

It presents both the credible and non-credible options considered, and, where relevant, outlines why particular options are considered non-credible.

The following options were considered to address the identified need:

1. Do nothing (counterfactual);
2. Large customer demand management network support;
3. Residential battery network support;
4. Embedded generation network support;
5. Network reconfiguration;
6. Installation of a third transformer installation at CLN Zone Substation; and
7. Installation of a third transformer and third switchboard at CLN Zone Substation.

The purpose of this non-network options report is to provide an opportunity for non-network proponents to propose solutions. The options described in this section, therefore, should not be regarded as limiting the scope of potential non-network options.

6.2 Option 1 – Do nothing (counterfactual)

The Do Nothing (counterfactual) option assumes that AusNet Services would not undertake any investment, outside of the normal operational and maintenance processes. Under this option, increasing supply risk would be managed by increased levels of involuntary load reduction.

The Do Nothing (counterfactual) option establishes the base level of risk, and provides a basis for comparing potential options. Although the Do Nothing option has the lowest direct investment costs, it will typically involve much higher asset performance and supply risks compared to the other options.

6.3 Option 2 – Large customer demand reduction network support

This option is to contract large customers capable of providing demand management network support services, by reducing their load in response to an AusNet Services instruction.

In assessing the feasibility of engaging demand management services to address the identified service level risk, large customers in the supply area were identified, their historical response to critical peak demand (CPD) days was assessed, and how their load levels align to the zone substation daily and peak demand periods was considered. On that basis, this option assumes 3.0 MW of demand management network support is contracted to help mitigate the identified service level risks.

The network support costs applied in quantifying the costs and benefits associated with this option have been based on current fee rates of existing large customer demand management network support contracts.

The demand reduction available capacity (3.0 MW) is effectively modelled in the risk-cost model as a negative load, and is presented as an option cost by multiplying the available capacity (MW) by an annual capacity cost of \$10k/MW per annum.

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This availability cost is added to the energy curtailment (demand management activation) cost, which is monetised by multiplying the reduction in expected unserved energy (MWh) each year by an energy curtailment activation cost of \$5k/MWh.

Based on the 3 MW capacity and the forecast reduction in expected unserved energy delivered by this option, Table 12 presents the estimated costs of this option.

Table 11: Option 2 Demand Reduction Network Support Costs

	2021	2022	2023	2024	2025
Availability Cost (\$M)	0.030	0.030	0.030	0.030	0.030
Activation Cost (\$M)	0.001	0.002	0.00393	0.027	0.070
Total cost (\$M)	0.031	0.032	0.034	0.057	0.100

Importantly, however, a key purpose of this non-network options report is to engage with prospective service providers regarding the cost of non-network services. On that basis, the information presented above should be regarded as indicative only.

6.4 Option 3 – Residential battery network support

This option is to contract with a non-network aggregator for residential battery discharge, in response to an instruction from AusNet Services.

Although the physical support comes from customer installed batteries discharging into the network to offset demand, network support contracts would actually be between AusNet Services and network support aggregators, rather than directly with residential customers.

This option assumes 2.0 MW of residential battery network support contracts, which is optimistic compared to the level of customer installed batteries currently connected to AusNet Services' network.

The assessed level of network support is considered optimistic because AusNet Services is currently aware of approximately 400 customer battery installations, totalling approximately 3.8 MW of installed capacity, across the entire distribution network.

There are currently only sixteen known customer battery installations in the CLN zone substation supply area, totalling less than 100 kW of installed capacity. However, recently announced government incentives and any aggregator recruitment processes would likely increase uptake rates.

The battery available capacity (2.0 MW) is treated as a negative load in the risk-cost model and is presented as an option cost by multiplying the available capacity (MW) by an annual capacity cost of \$10k/MW per annum.

This availability cost is added to the battery discharge (activation) cost, which is monetised by multiplying the reduction in expected unserved energy (MWh) each year by the battery discharge activation fee of \$25k/MWh.

Based on the 2.0 MW capacity and the forecast reduction in expected unserved energy delivered by this option, Table 13 presents the estimated costs of this option.

Table 12: Option 3 Battery Discharge Network Support Costs

	2021	2022	2023	2024	2025
Availability Cost (\$M)	0.020	0.020	0.020	0.020	0.020
Activation Cost (\$M)	0.003	0.007	0.014	0.102	0.257
Total cost (\$M)	0.023	0.027	0.034	0.122	0.277

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As noted in relation to Option 2, the information provided is indicative only as AusNet Services is interested in hearing from prospective service providers regarding the costs of providing battery network support.

6.5 Option 4 – Embedded generation network support

This option is to contract with an embedded generator to provide network support services in response to an AusNet Services request.

The assessed network support capacity is 10 MW which, based on the average forecast growth in maximum demand over the period, could potentially delay a network solution by three to four years.

The embedded generator available capacity (10 MW) is effectively modelled in the risk-cost model as a negative load, and is presented as an option cost by multiplying the available capacity (MW) by an annual capacity fee of \$120k/MW. This availability cost is added to the dispatch (activation) cost, which is monetised by multiplying the reduction in expected unserved energy (MWh) each year by the generator dispatch activation cost of \$273/MWh.

Based on the 10 MW capacity and the forecast reduction in expected unserved energy delivered by this option, Table 14 presents the estimated costs of this option, noting that we are seeking information from prospective service providers regarding the costs of providing the required level of network support.

Table 13: Option 4 Embedded Generation Network Support Costs

	2021	2022	2023	2024	2025
Availability Cost (\$M)	1.200	1.200	1.200	1.200	1.200
Activation Cost (\$M)	0.000	0.000	0.000	0.002	0.007
Total cost (\$M)	1.200	1.200	1.200	1.202	1.207

6.6 Option 5 – Network reconfiguration

This option investigates the ability of the network to support load transfers from CLN Zone Substation to adjacent zone substations, in order to reduce the load on the CLN Zone Substation 66/22kV transformers. CLN Zone Substation has a number of feeder interconnections with its neighbouring zone substations, as outlined in Table 14.

Table 14: CLN feeder interconnections to adjacent zone substations

From Feeder	To Feeder	Connection Point location – Figure 1
CLN11	CRE23, CRE33 or HPK11	West
CLN12	CRE33 or CRE32	West
CLN13	CRE33	South West
CLN14	OFR21 or BWN12	North East
CLN21	HPK14 or HPK22	North West
CLN22	CRE33	South West
CLN23	None	

The forecast loading on the CLN feeders and neighbouring zone substation feeders are presented in Table 16.

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Table 16: Feeder summer 50% POE maximum demand forecasts

Feeder	Rating (A)	Forecast (A)						
		2021	2022	2023	2024	2025	2026	2027
BWN12	312	294	295	296	298	300	301	301
CLN11	360	169	172	175	179	184	189	197
CLN12	335	302	308	312	317	323	329	337
CLN13	321	347	366	383	398	416	437	458
CLN14	325	296	305	311	319	327	335	346
CLN21	358	348	362	376	392	406	423	443
CLN22	375	340	370	401	430	457	484	513
CLN23	323	302	344	376	408	441	474	509
CRE23	360	229	232	233	234	236	239	243
CRE32	360	226	229	231	234	236	237	239
CRE33	335	245	256	263	271	277	281	285
HPK11	293	291	294	296	298	300	302	305
HPK14	330	243	248	252	255	257	260	262
HPK22	311	262	265	268	272	276	278	281
OFR21	375	368	387	404	421	440	461	482

As per the feeder circuit maximum demand forecasts presented in Table, many of the feeders connecting CLN Zone Substation to its neighbouring zone substation are heavily loaded and, as detailed in the following sections, incapable of being reconfigured to permanently transfer sufficient load from CLN Zone Substation.

CRE23

The spare capacity available in CRE23 is 131 A in summer 2021 and reduces to 117 A by summer 2027. However, due to the existing feeder geography and configuration majority of the CLN11 feeder has to be transferred to CRE23 and it is more than 120 A thus over-loading CRE23 feeder. Thus, it is not possible to off-load CLN11 to CRE23.

The three neighbouring feeders to CRE23 (CRE31, CRE32 and CRE33) are running close to their ratings and the spare capacity available in CRE23 will be required for contingencies in CRE feeders. This spare capacity will also be used in contingencies in heavily loaded CLN feeders.

CRE33

CRE33 has an average forecast growth of 10 A per year. The spare capacity available in CRE33 is 90 A in 2021 and is forecast to reduce to 50 A by 2027.

Lang Lang (LLG) zone substation is a single transformer and single 66 kV line substation. During outage events it is supplied from CRE zone substation, via CRE33, and other neighbouring zone substations. The spare capacity in CRE33 is therefore required to support LLG zone substation can cannot be utilised to permanently off-load CLN zone substation via feeder reconfigurations and load transfers.

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HPK11

HPK11 feeder is forecast to operate at the rating during next six-year period. The feeder will be risk managed during the six-year period, and therefore cannot be utilised to permanently off-load CLN zone substation via feeder reconfigurations and load transfers.

HPK14

The spare capacity available in HPK14 is 87 A in summer 2021 and is forecast to reduce to 68 A by summer 2027. Due to the existing HPK14 and CLN21 feeder configurations, the minimum load that could be transferred from CLN21 to HPK14 is greater than 120 A. Transferring this amount of load is not feasible because it would overload HPK14. It is therefore not feasible to off-load CLN21 to HPK14.

Additionally, the two neighbouring feeders to HPK14, HPK11 and HPK22, are operating close to their ratings and the spare capacity available in HPK14 is required to provide back-up supply to under contingencies conditions.

HPK22

HPK22 feeder is forecast to operate close to its rating during the next six-year period. It therefore has no spare capacity off-load CLN zone substation via feeder reconfigurations and load transfers.

OFR21

OFR21 is situated in the south east growth corridor and, as presented in Table, is forecast to be loaded above its rating by 2022. This feeder therefore has insufficient capacity available to permanently off-load CLN zone substation via feeder reconfigurations and load transfers.

6.7 Option 6 – Installation of a third transformer and third switchboard at CLN Zone Substation

This option is to install a third 66/22 kV 20/33 MVA transformer and a third 22 kV switchboard at CLN Zone Substation. Installation of a third transformer would increase the zone substation nameplate rating from 66 MVA to 99 MVA, the 'N' cyclic rating from 87.3 MVA to 130.1 MVA and the 'N-1' cyclic rating from 43.5 MVA to 87.3 MVA. This increased capacity would be sufficient to reliably supply the forecast maximum demand at the zone substation level.

With installation of a third 22 kV switchboard, this option would provide new 22 kV feeder exits from CLN Zone Substation and will thereby enable installation of the new CLN feeders planned during the 2021 to 2026 regulatory period.

This option has an estimated capital of \$7.4 million (Real, \$2018).

6.8 Option 7 – Installation of a third transformer at CLN Substation

This option is to install a third 66/22 kV 20/33 MVA transformer at CLN Zone Substation. Installation of a third transformer would increase the zone substation nameplate rating from 66 MVA to 99 MVA, the 'N' cyclic rating from 87.3 MVA to 130.1 MVA and the 'N-1' cyclic rating from 43.5 MVA to 87.3 MVA.

While this option would be sufficient to reliably supply the forecast maximum demand at the zone substation level, it does not allow piggy-backed feeders to be separated out and connected to individual feeder exit circuit breakers.

7 Requirements for non-network option

This section outlines:

- The technical characteristics that a non-network (network support generation, energy storage and/or demand management) option would be required to deliver; and
- The information that a non-network proponent should provide to AusNet Services to explore the potential provision of a non-network service.

The amount that AusNet Services would be willing to pay for a non-network service depends on the extent to which it will mitigate the risks described in the identified need. Key factors that influence the network support amount payable to proponents include availability, capacity, dispatch duration and firmness of response provided by the non-network solution.

7.1 Load reduction and location

As detailed in section 4, the identified need relates principally to security of supply risk. The table below sets out the load reductions that a non-network option would be required to deliver on a maximum demand day, in order to mitigate the identified risks at CLN to some extent, e.g. loss of one transformer.

Table 15: Load at risk and non-network support requirements

Year	Load at Risk (MVA)	Hours at Risk, POE50	Expected non-network support required during MD event	
			MW @ PF = 1	MWh
2021/22	13.7	50.4	13.7	39.7
2022/23	18.4	84.6	18.4	64.6
2023/24	23.2	115.4	23.2	96.0
2024/25	28.2	168.8	28.2	132.3
2025/26	33.2	240.1	33.2	171.9
2026/27	38.6	326.4	38.6	217.6
2027/28	43.6	405.1	43.6	260.5
2028/29	48.3	532.0	48.3	302.3
2029/30	53.2	654.0	53.2	347.2

If non-network options are able to reduce the load by more than this minimum amount under an N-1 scenario, then the level of risk mitigation is likely to be higher.

7.2 Power system security, reliability and fault levels

A non-network option must be capable of reliably meeting electricity demand under a range of conditions and scenarios. The non-network solution will contribute to system security and reliability to the extent that it addresses the risks arising from the identified need. The non-network option is not required to address any existing issues in relation to fault levels.

If the non-network option is a rotating or inverter-based generator operating in parallel with AusNet Services' network, the generator must comply with the requirements set out in

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document SOP 33-05 and other connection requirements which are set out in AusNet Services' embedded generator connections page on our website.¹

7.3 Timing and operating profile

A non-network option would need to be agreed by 30 June 2022 in order to defer the adoption of a network solution. AusNet Services' expectation is that a non-network solution would be required for a minimum of five (5) years, although the duration of the service would be subject to negotiation.

A non-network option must, as a minimum, be capable of reducing network loading or increasing network capacity in the CLN supply area during the months of December to March (summer period). For each day during this period, the network load reduction or increase in network capacity would be required over the evening period, typically 5 pm to 8 pm (AEST), as shown in Figure 6.

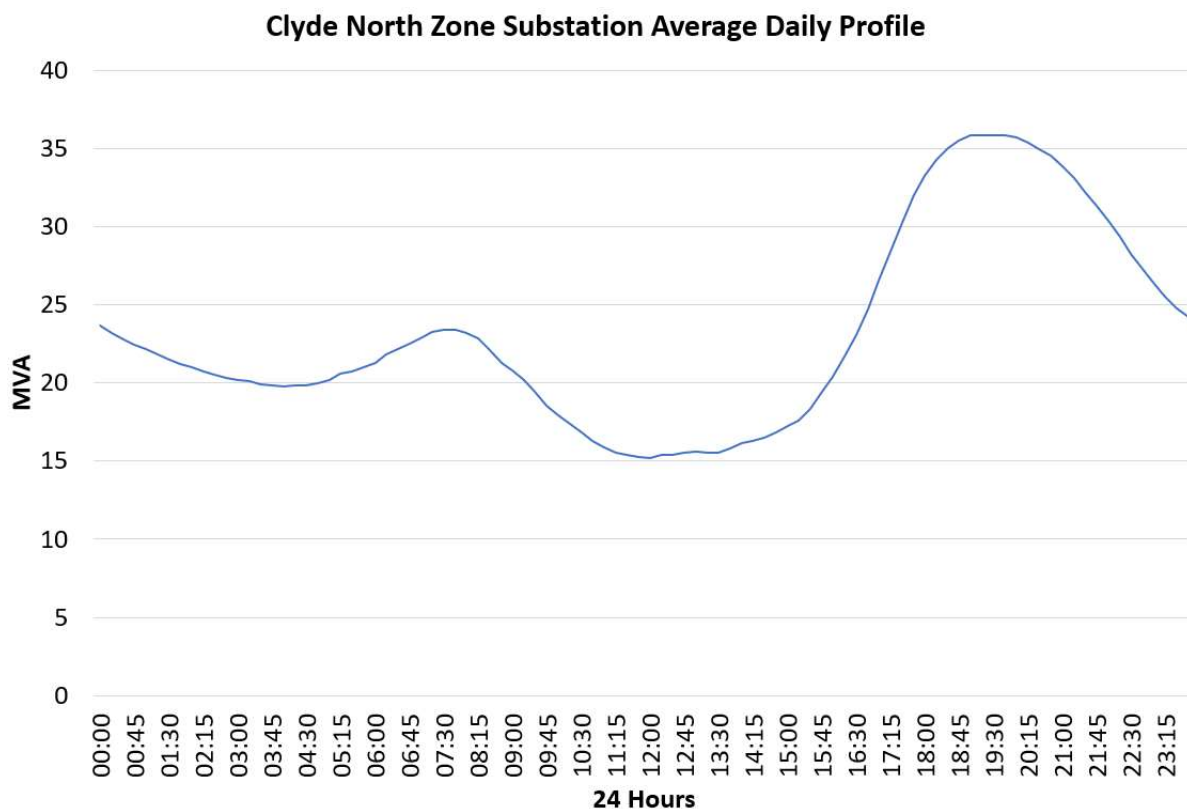


Figure 6: Average 24-hour Demand Profile, Showing Timing of Peak Demand

The maximum duration of non-network support required over a day can be up to four consecutive hours per day. The non-network solution will need to be capable of operating continuously during these periods on consecutive days, to cater to peak demands until the faulted asset is repaired or replaced, and full N-rated capacity is restored at the zone substation.

7.4 Guidance on potentially feasible options

The following non-network solutions are likely to be potentially feasible options to address the identified need:

¹ <https://www.ausnetservices.com.au/Electricity/Connections/Apply-for-Solar-and-Other-Generation/Embedded-Generation-Connections-Greater-than-5MW>

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- New embedded generation;
- Existing customer generation and load curtailment (firm demand management); and
- Embedded energy storage systems.

Without limiting the potential for non-network solutions, the following types of non-network options are unlikely to be feasible:

- Renewable generation not coupled with storage or dispatchable generation; and
- Unproven, experimental or undemonstrated technologies.

7.5 Data requirements from non-network service providers

Non-network service providers interested in alleviating the network constraints outlined above are advised to begin engagement with AusNet Services as soon as possible. A detailed proposal including the information listed below should be submitted by the requested date. Details required include:

- Name, address and contact details of the person making the submission.
- Name, address and contact details of the person responsible for non-network support (if different to above).
- A detailed description of the services to be provided, including:
 - Size and capacity (MW/MVA/MWh).
 - Location(s).
 - Frequency and duration.
 - Type of action or technology proposed, including response / ramp rate information, where applicable.
 - Proposed dispatching arrangement (e.g. telephone, web-based trigger, automated means via RTU).
 - Availability and reliability performance details.
 - Period of notice required to enable dispatch of non-network support (e.g. to allow time for charging of energy storage solutions or market-based limitations).
 - Proposed contract period and staging (if applicable).
 - Proposed timing for delivery (including timeline to plan and implement the proposal).
- High-level electrical layout of the proposed site (if applicable).
- Evidence and track record proving capability and previous experience in implementing and completing projects of the same type as the proposal.
- Preliminary assessment of the proposal's impact on the network.
- Breakdown of the lifecycle costs for providing the service, including:
 - Capital costs (if applicable).
 - Annual operating (i.e. set up and dispatch fees) and maintenance costs.

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- Other costs (e.g. availability, project establishment, etc.).
- Tariff assumptions.
- A method outlining measurement and quantification of the agreed service, including integration of the proposed solution with the network.
- A statement outlining that the non-network service provider is prepared to enter into a Network Support Agreement (NSA) (subject to agreeing terms and conditions).
- Letters of support from partner organisations.
- Any special conditions to be included in an NSA.

All proposals must satisfy the requirements of any applicable laws, rules, and the requirements of any relevant regulatory authority, including following the normal network connection processes where applicable. Any network reinforcement costs required to accommodate the non-network solution will typically be borne by the proponent of the non-network solution.

For further details on AusNet Services' process for engaging and consulting with non-network service providers, and for investigating, developing, assessing and reporting on non-network options as alternatives to network augmentation, please refer to the Non-Network Solutions and Demand Management webpages, which contain the Demand Side Engagement Strategy and other relevant demand management documentation:

<https://www.ausnetservices.com.au/Electricity>

7.6 Potential payments to non-network proponents

As already noted, the maximum amount that AusNet Services would be willing to pay for a non-network solution would depend on the value that it provides in terms of risk reduction. The actual payment to a non-network proponent will be subject to negotiation.

Provisional analysis indicates that Option 6 is the preferred network option. If this option could be deferred *entirely* by engaging a non-network solution, the total capital expenditure of approximately \$7.4 million could be deferred. The approximate maximum annual payment that would be available to a non-network proponent to defer this expenditure would be in the region of \$510 k per annum. This calculation assumes a 45 year asset life, an operating expenditure allowance of 1% of the avoided network capital expenditure, and a cost of capital of 5.9% (real).

It should be emphasised, however, that the actual payment for a non-network solution may be lower than this maximum available amount, due to the aforementioned factors of availability, capacity, dispatch duration and firmness of response provided by the non-network solution.

8 Next Steps

The assessment outlined in this report shows that in the absence of remedial action, involuntary load shedding will be required to maintain loading to within asset capabilities during both system normal and network asset outage conditions. AusNet Services considers that one of the credible options outlined in this report, or an alternative non-network option will be required to address the identified need.

8.1 Request for submissions

AusNet Services invites written submissions, on the matters set out in this non-network options report, from Registered Participants, AEMO, interested parties, non-network providers and those registered on our demand-side engagement register.

All submissions and enquiries should be directed to:

Fuji Dinh
Senior Engineer – Strategic Network Planning
AusNet Services
Email: ritdconsultations@ausnetservices.com.au

Submissions are due on or before 27 August 2021.

Submissions will be published on AusNet Services' website. If you do not wish to have your submission published, please clearly stipulate this at the time of lodging your submission.

8.2 Next stage of RIT-D process

Following conclusion of the non-network options report consultation period, AusNet Services will, having regard to any submissions received on this non-network options report, prepare and publish a draft project assessment report (DPAR) including:

- A summary of, and commentary on, any submissions on the non-network options report.
- A detailed market benefit assessment of the proposed credible options to address the identified need.
- Identification of the proposed preferred option to meet the identified need.

AusNet Services expects to publish the DPAR by Q3 2021.