Jemena Electricity Networks (Vic) Ltd

Flemington Electricity Supply

RIT-D Stage 1: Non-Network Options Report

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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.
Constraint	Refers to a constraint on network power transfers that affects customer service.
Continuous rating	The permissible maximum demand to which a conductor or cable may be loaded on a continuous basis.
Jemena Electricity Networks (JEN)	One of five licensed electricity distribution networks in Victoria, the JEN is 100% owned by Jemena and services over 319,000 customers via an 11,000 kilometre distribution system covering north-west greater Melbourne.
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.
Probability of exceedance (POE)	The likelihood that a given level of maximum demand forecast will be met or exceeded in any given year.
Regulatory Investment Test for Distribution (RIT-D)	A test established and amended by the Australian Energy Regulator (AER) that establishes consistent, clear and efficient planning processes for distribution network investments over a certain limit ($5m), in the National Electricity Market (NEM).
Reliability of supply	The measure of the ability of the distribution system to provide supply to customers.
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.
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.
50% POE and 10% POE condition (winter)	50% POE and 10% POE condition (winter) are treated the same, referring to an average daily ambient temperature of 7ºC, with a typical maximum ambient temperature of 10ºC and an overnight ambient temperature of 4ºC.

ABBREVIATIONS

AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
JEN	Jemena Electricity Network
ES	Essendon Zone Substation
FT	Flemington Zone Substation
MD	Maximum Demand
NEM	National Electricity Market
NER	National Electricity Rules
NPV	Net Present Value
NS	North Essendon Zone Substation
POE	Probability of Exceedance
RIT-D	Regulatory Investment Test for Distribution
VCR	Value of Customer Reliability
WMTS	West Melbourne Terminal Station

OVERVIEW

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 a reliable electricity network service at the lowest possible cost. To do this, we must choose the most efficient solution to address emerging network issues. This means choosing the solution that maximises net benefits. In some cases, non-network solutions – such as embedded generation or demand management – may be more efficient than investing in network assets with long asset lives. Effective engagement with non-network proponents is essential in order for us to identify and assess credible non-network options.

The purpose of this non-network options report is to commence this engagement with non-network proponents in relation to the network issues associated with Flemington Zone Substation.

Identified need

Flemington (FT) Zone Substation is supplied by two 66 kV lines from West Melbourne Terminal Station and consists of two 66/11 kV 20/30 MVA transformers, two 11 kV buses and ten 11 kV feeders. It supplies approximately 15,000 domestic, commercial and industrial customers in the Flemington, Kensington, Ascot Vale and surrounding areas, with major customers including Flemington Race Course and the Melbourne Showgrounds.

The identified need arises because there is insufficient thermal capacity at FT Zone Substation to supply the forecast load, particularly under network outage conditions. In addition, the age and condition of the FT 11 kV switchboards is exposing customers to an increasing risk of asset failure and consequential loss of supply. The replacement of the existing switchboards has therefore been recognised as a Base Case cost.

The network issues at FT Zone Substation are exacerbated by limited transfer capability as a result of high levels of feeder utilisation and limited available support from the Essendon and North Essendon zone substations. These utilisation issues are likely to become progressively more challenging as load continues to grow, albeit at comparatively low annual rates. The risk of a prolonged supply interruption is heightened by the absence of a spare 66/11 kV transformer that is suitable for installation at FT Zone Substation. Current estimates indicate that the Base Case (or 'do nothing' option) would lead to unserved energy with a present value cost to customers of approximately $168 million.

This document presents an overview of the FT supply capacity risks, outlines possible options for economically mitigating these supply risks, and identifies the preferred network option to manage the risks into the future. The primary limitations associated with FT are identified as the thermal ratings of the 11 kV transformer cables and circuit breakers, along with the poor condition and limited additional connection capacity of the two existing 11 kV switchboards.

Options analysis results and preferred network option

The following credible network options to alleviate the issues at FT Zone Substation have been identified:

- Option 1 - Replace Flemington Zone Substation 11 kV assets by November 2017;
- Option 2 - Redevelop Flemington Zone Substation by November 2017;
- Option 3 - Establish a new zone substation by November 2017; and

- Option 4 – Install a third transformer at Flemington Zone Substation by November 2017.

Jemena has also identified embedded generation and demand management as potential credible non-network options.

Based on our provisional analysis, it appears that Option 1, which is to replace the FT Zone Substation 11 kV assets by November 2017 is the preferred network option. Our initial indicative estimate suggests that the network augmentation charge associated with this option would be approximately $480k per annum.

The purpose of this report is to identify credible non-network options that may provide a more cost effective solution than Option 1. To assist non-network proponents, we describe the technical characteristics of our network needs at FT Zone Substation. Importantly, however, this information is only intended to guide non-network proponents in developing credible non-network options. Jemena welcomes an open dialogue with non-network proponents to identify potential alternatives to the network options identified in this paper.

In light of submissions in response to this non-network options report, we will proceed to prepare a more detailed Draft Project Assessment Report. That report will apply the latest available information on demand forecasts, VCR estimates and project cost estimates to assess the network and non-network solutions to the identified need. Information on the next steps in the assessment process and our contact details are provided in Section 7 of this report.

1. INTRODUCTION

1.1 PURPOSE

Distribution businesses are required to go through a process (the Regulatory Investment Test for Distribution, or "RIT-D") to identify investment options which best address an identified need on the network. The RIT-D applies in circumstances where a network problem (an "identified need") exists and the estimated augmentation component capital cost of the most expensive potential credible option to address the identified need is more than $5 million. As part of the RIT-D process, distribution businesses must also consider non-network options when assessing credible options to address the identified need.

Under the RIT-D consultation procedures, distribution businesses are required to prepare and publish a non-network options report. This report helps distribution businesses to identify potential non-network options and be better informed on the costs and market benefits associated with a potential option. These arrangements provide an opportunity for third parties to consider how they could address the distributor's identified need on the network.

This document is Jemena's non-network options report for the Flemington Zone Substation area. In accordance with the requirements of the National Electricity Rules this report describes:

- the identified need in relation to the Flemington network;
- the potential credible network options that may address this need; and
- the technical characteristics of a credible non-network option.

1.2 OBJECTIVE

Jemena's objective is to ensure that reliable distribution services are delivered to its customers at the lowest sustainable cost. Non-network solutions have an important role to play in meeting this objective.

This report is an initial step in our engagement with non-network proponents in addressing the identified need in relation to the Flemington Zone Substation. Jemena welcomes an open dialogue with non-network proponents to ensure that the best solution is adopted, whether that solution is a network, non-network or combined project.

1.3 STRUCTURE OF THIS REPORT

The remainder of this report is structured as follows:

- Section 2 provides background information on the network location and assets;
- Section 3 describes the identified need that is to be addressed;
- Section 4 summarises the methodology and assumptions employed in assessing the credible options;
- Section 5 sets out the credible network options and provides an indicative assessment of their respective augmentation costs;

- Section 6 presents the technical characteristics of the identified need, which should guide non-network proponents in developing credible options; and
- Section 7 sets out our contact details, and provides a guide as to the information that non-network proponents should submit in response to this report. The section also outlines the next steps in the assessment process.

2. BACKGROUND

This section provides an overview of the network supply arrangements relating to the Flemington Zone Substation.

2.1 NETWORK SUPPLY ARRANGEMENTS

Flemington (FT) Zone Substation, is supplied by two 66 kV lines from West Melbourne Terminal Station (WMTS). FT Zone Substation consists of two 66/11 kV 20/30 MVA transformers, two 11 kV buses and ten 11 kV feeders. It supplies approximately 15,000 domestic, commercial and industrial customers in the Flemington, Kensington, Ascot Vale and surrounding areas, with major customers including Flemington Race Course and the Melbourne Showgrounds.

The 11 kV network supplied by FT Zone Substation is islanded from the surrounding networks to the west, south and east, which operate at 6.6 kV and 22 kV. FT Zone Substation makes up part of an 11 kV network with North Essendon (NS) Zone Substation and Essendon (ES) Zone Substation to the north and north-east of FT Zone Substation. Although some load transfer to NS Zone Substation and ES Zone Substation may be possible during network outage conditions, the load transfer capacity is minimal because the surrounding stations and their feeders are already heavily loaded.

FT Zone Substation is a two-level indoor zone substation that was originally commissioned in 1970. The top level of the building houses the 66 kV air insulated switchgear, which is insulator suspended from the ceiling of the building. The ground level houses the two 11 kV switchboards and the 66/11 kV transformers.

The station capacity is limited, during summer and winter peak demand periods, by the 11 kV transformer cables and circuit breakers. As a consequence, the full capacity of the two existing transformers cannot be fully utilised. The FT feeders, particularly those supplying the central, north and north-east areas of the zone substation supply area are already heavily loaded, with the peak utilisation rate forecast to average approximately 67% across all feeders by the end of 2015. There is also limited capability to connect new feeders at FT due to the rating of the existing 11 kV buses and the full utilisation of 11 kV circuit breakers.

Figure 2-1 shows a map of the area supplied from FT Zone Substation (shaded in yellow).

Figure 2-1: Flemington Zone Substation supply area

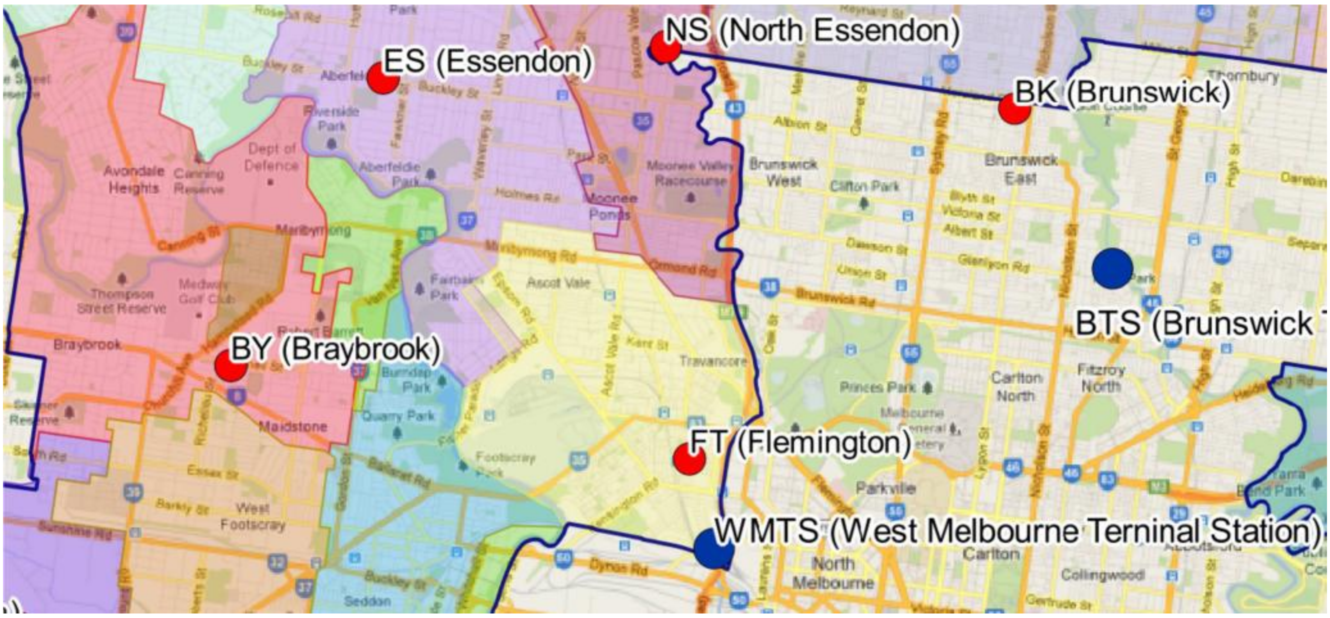
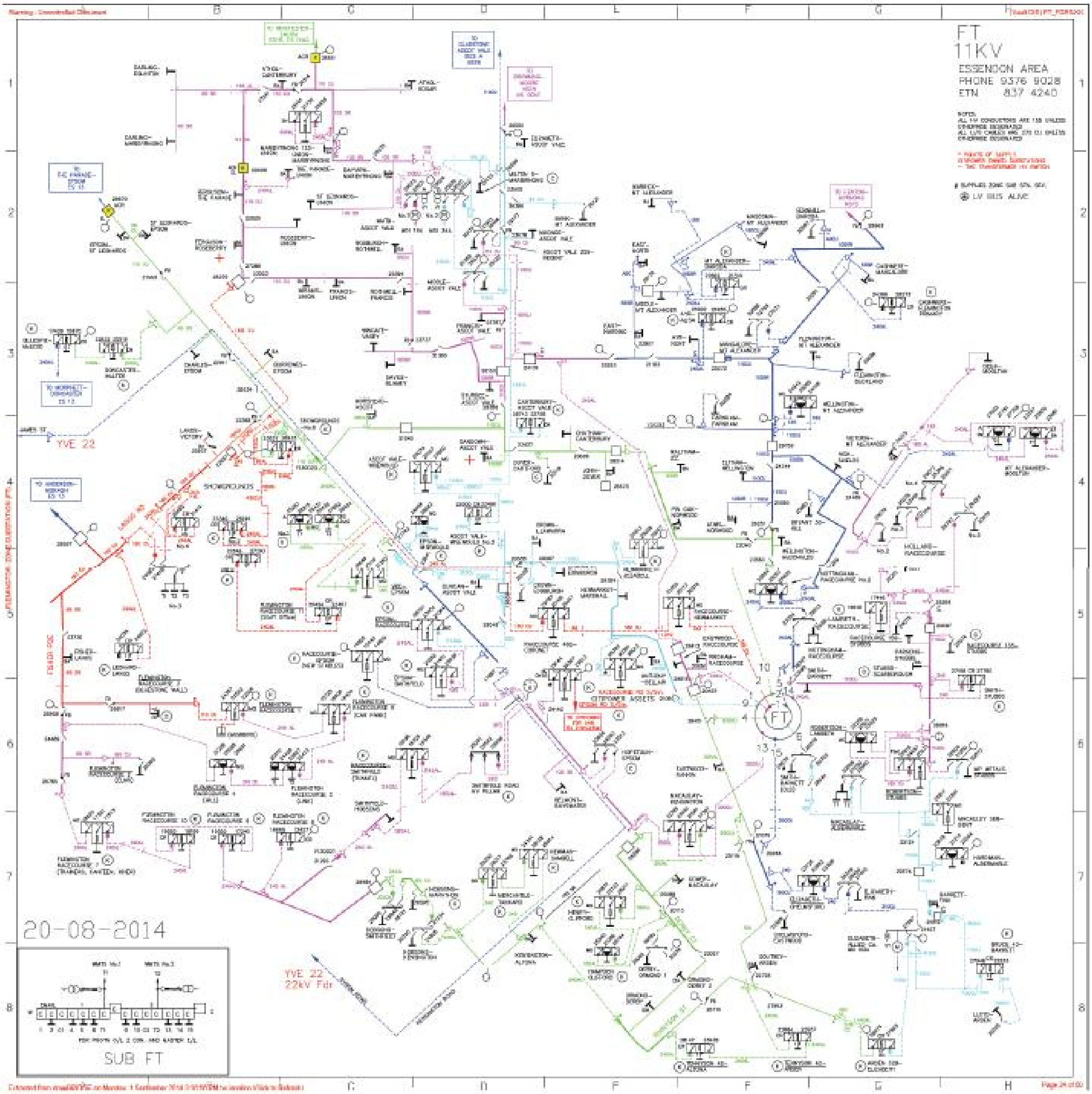


Figure 2-2 on the following page shows the supply area arrangement of the ten 11 kV feeders supplied from FT Zone Substation. It provides an indication of the area supplied by each of the FT feeders, and where they connect with the surrounding ES and NS zone substations via their feeders.

Figure 2-2: Flemington supply area arrangement



2.2 CONNECTIVITY AND ASSET INFORMATION

2.2.1 WEST MELBOURNE TERMINAL STATION CAPACITY

AusNet Services is currently commencing a rebuild of WMTS. This rebuild includes replacement of the four existing 150 MVA connection asset transformers with three 225 MVA transformers. Following the rebuild the system normal capacity of the station will increase from 600 MVA to 675 MVA, however the N-1 rating will remain at 450 MVA.

The WMTS rebuild is being undertaken as a separate project to any of the options identified in this report, and is expected to be completed by 2019.

2.2.2 11 KV FEEDER WORKS

Under a project titled Flemington Zone Substation Short Term Contingency Plan, Jemena will reconfigure the FT No.1 11 kV feeder line, FT-01, and construct a new 11 kV feeder from Essendon Zone Substation (ES), to be named ES-22. The new feeder installation and feeder reconfiguration works will provide approximately 6 MVA of additional transfer capacity during a single contingency event, which will be particularly beneficial in securing supply to FT prior to implementation of a long term thermal capacity solution.

The 11 kV feeder work is being undertaken as a separate project to any of the options identified in this report, and is expected to be completed by November 2015.

3. DESCRIPTION OF IDENTIFIED NEED

This section describes the investment need in relation to FT Zone Substation.

It explains that FT Zone Substation supply capability is limited in two key respects:

- there is insufficient thermal capacity to supply the forecast load, under system normal and network outage conditions; and
- the age and condition of the FT 11 kV switchboards is exposing customers to an increasing risk of asset failure and subsequent supply interruption.

These limitations are exacerbated by:

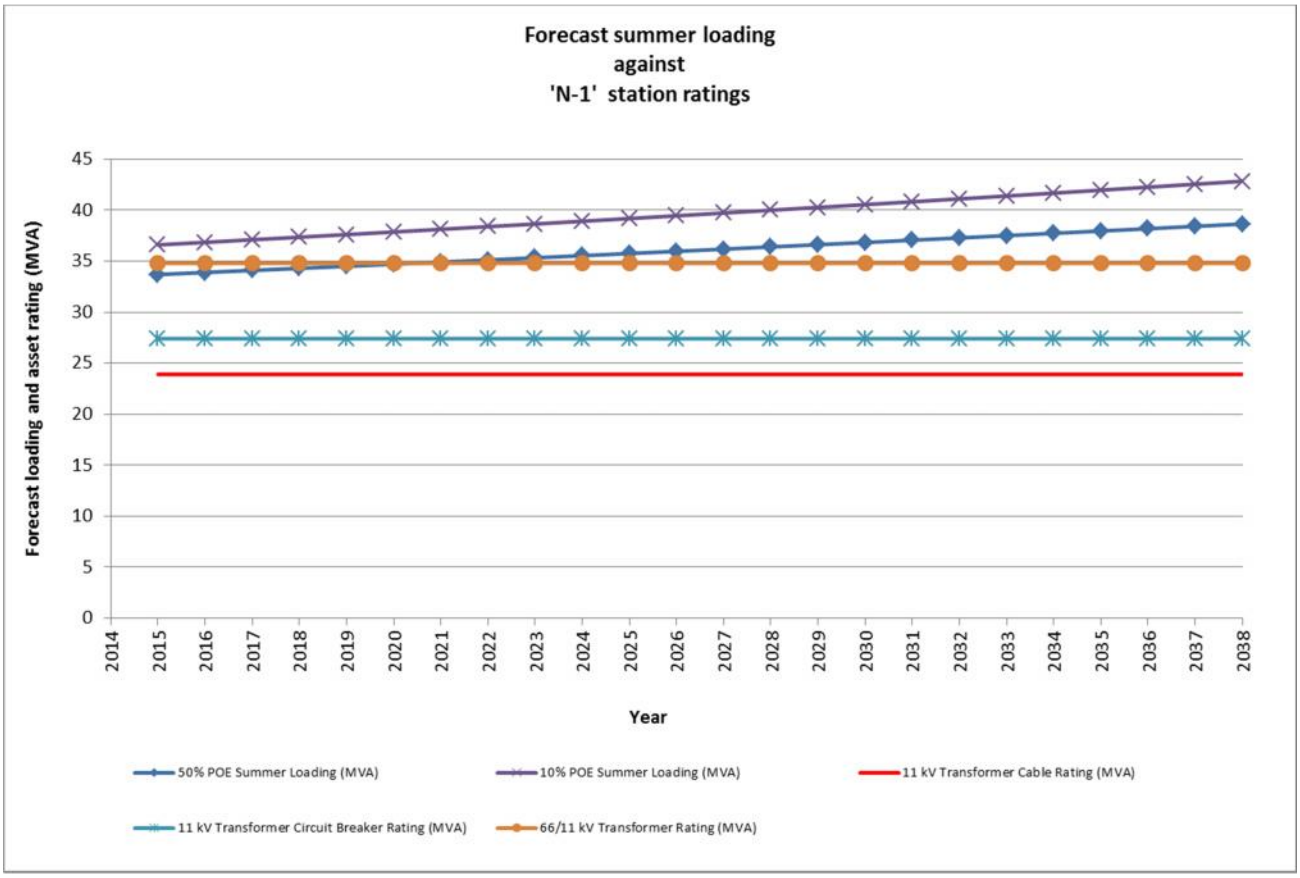
- limited transfer capacity as a result of feeder and station limitations at Essendon and North Essendon zone substations;
- the absence of a spare 66/11 kV transformer that is suitable for installation at FT Zone Substation, which increases the expected volume (and hence cost) of unserved energy; and
- increasing demand growth over the planning horizon.

3.1 ZONE SUBSTATION ASSET UTILISATION

Figure 3–1 shows the historical and forecast demand at FT Zone Substation, for 50% Probability of Exceedance (50% POE) and 10% Probability of Exceedance (10% POE) maximum demand conditions, compared to the ratings of key station assets. It shows that the station's capacity is limited by the 11 kV transformer cables and circuit breakers, and that under maximum demand conditions load shedding would be required to maintain network loading levels within the ratings of these cables and circuit breakers.

It also shows that, even during outage conditions coincident with peak demand, by utilising the transformer cyclic ratings FT Zone Substation has sufficient transformer capacity to meet the 50% POE forecast maximum demand until 2020. However, as noted in Section 2.1, the station capacity is limited by the 11 kV transformer cables and the 11 kV circuit breakers. As a consequence, the full capacity of the two existing transformers cannot be fully utilised.

Figure 3–1: Maximum demand against ratings for Flemington Zone Substation



If no action is taken to increase the supply capacity at FT Zone Substation, involuntary load shedding would be required to ensure that loading levels remain within asset ratings.

The impact of the limitation under the base case at the 50% POE demand forecast is presented in Table 3–1.

Table 3–1: Limitation impact under Base Case

Year	Energy at Risk (MWh)	Annual Hours at Risk (h)	Expected Unserved Energy (MWh)	Cost of Expected Unserved Energy ($k)
2016	1464	972	62	$2,400
2017	1720	1119	80	$3,070
2018	1858	1204	90	$3,470
2019	2147	1351	113	$4,340
2020	2661	1621	160	$6,150
2021	3201	1864	216	$8,300
2022	3810	2082	287	$11,030
2023	4703	2393	406	$15,580

3.2 11 KV FEEDER UTILISATION

In addition to the station asset loading limitations, the supply capacity from FT Zone Substation to its surrounding area is also limited by the number and capacity of 11 kV feeders connected to the zone substation.

Jemena conducts risk mitigation analysis when system normal loading reaches 67% of the feeder's summer rating for 50% POE maximum demand conditions. Although augmentation might not be warranted at this level of utilisation, loading feeders beyond 67% will typically expose customers to supply risks under outage conditions. Insufficient load transfer capacity following a feeder outage will result in extended customer outages.

Table 3–2 presents the forecast utilisation of FT 11 kV feeders, based on 50% POE summer peak demand conditions. It also shows the average utilisation across all FT feeders under 50% POE summer peak demand conditions. The utilisation figures are presented based on summer feeder line cyclic ratings.

Table 3–2: Forecast utilisation of Flemington Zone Substation feeders

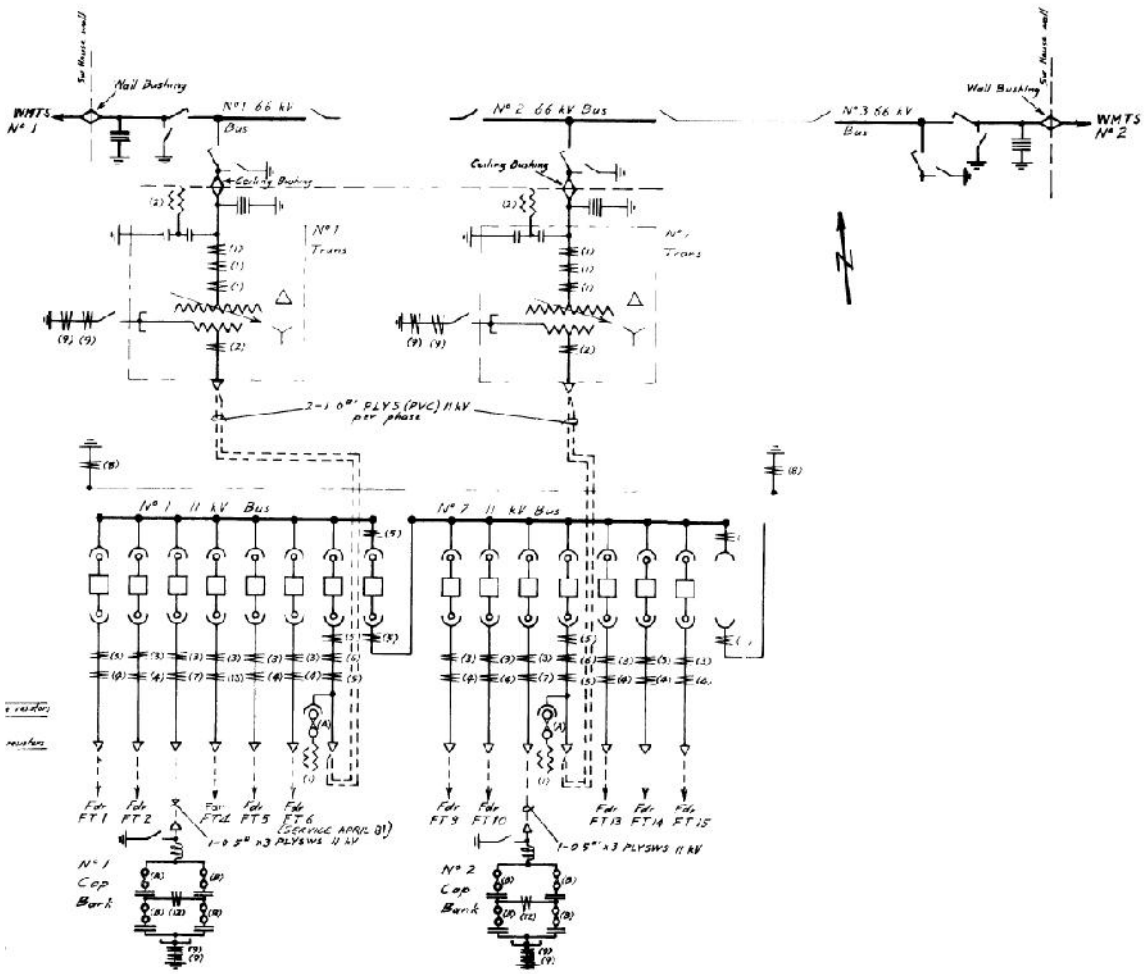
11 kV Feeder	Summer Rating (A)	Forecast Utilisation					
		2015	2016	2017	2018	2019	2020
FT01	375	86.7%	85.1%	84.0%	83.3%	83.0%	84.3%
FT02	260	79.2%	84.8%	103.3%	118.8%	134.2%	154.6%
FT04	590	43.0%	42.6%	42.0%	41.6%	41.5%	42.1%
FT05	345	64.6%	63.3%	62.5%	62.1%	62.0%	63.1%
FT06	180	58.2%	57.3%	56.6%	56.0%	56.0%	57.0%
FT09	300	90.9%	89.3%	88.3%	87.5%	87.1%	88.3%
FT10	375	65.3%	72.7%	79.9%	79.3%	79.0%	80.3%
FT13	375	64.3%	67.0%	66.5%	65.9%	65.7%	66.7%
FT14	375	62.8%	61.5%	60.7%	60.2%	60.1%	61.1%
FT15	345	45.6%	44.7%	44.1%	43.7%	43.7%	44.5%
Average feeder utilisation (%)		66.1%	66.8%	68.8%	69.9%	71.2%	74.2%

As shown in Table 3–2, many of the FT 11 kV feeders are already heavily utilised, and their loading levels are forecast to increase over the coming five year period. With the average utilisation forecast to exceed 74% by summer 2020, and some of the feeders supplying the central, north and north-east areas of the FT supply area being more heavily loaded, feeder reconfiguration, upgrade, and/or installation of a new 11 kV feeder will be required in the near future. The need for a new feeder from FT to supply the growing load in the Flemington supply area is the subject of a separate assessment.

As shown in the physical arrangement presented in Figure 3–2, the existing 11 kV switchboards at FT Zone Substation do not have any spare circuit breakers available. Additionally, the existing switchboards do not have sufficient space for installation of any new circuit breakers.

Establishing a new feeder capable of supplying the growing load would therefore require installation of a third 11 kV switchboard. Figure 3–2 also shows that there is provision at FT Zone Substation for a third transformer at the east side of the station, which would connect to the No.3 66 kV bus. However, as already noted in section 3.1, with exception of the 11 kV transformer cable and circuit breaker limitations, there is sufficient transformer capacity with the two existing transformers to meet the forecast demand in the medium term.

Figure 3–2: Flemington Zone Substation physical arrangement



3.3 LIMITED TRANSFER AND EMERGENCY BACKUP CAPACITY

Since the 11 kV area supplied by FT Zone Substation is largely isolated by the 6.6 kV and 22 kV networks surrounding the east, west and south, there is only limited opportunity to transfer load away from FT Zone Substation. Under outage conditions, some load could potentially be transferred off the feeders supplying the areas north and north-west of FT Zone Substation by extension of the feeders supplied from Essendon (ES) and North Essendon (NS) zone substations.

Jemena is currently undertaking works to provide additional backup supply from ES Zone Substation, as outlined in Section 2.2.2. However due to feeder and station limitations at ES and NS zone substations, this transfer capacity will be limited to approximately 6 MVA during peak demand periods at FT Zone Substation. This load transfer capacity will also decline as demand growth increases utilisation of the ES and NS feeders and zone substations.

Jemena does not currently have a spare 66/11 kV transformer that is suitable for installation at FT Zone Substation. Emergency backup capacity, in the case of a transformer outage, would therefore be limited to the remaining transformer's supply capacity until the faulted transformer could be repaired or replaced, or until supply could be reinstated by other support measures such as a temporary embedded generator installation.

3.4 ASSET CONDITION AND SAFETY

The switchgear at FT Zone Substation was manufactured in 1970 by Email (type J18), and is approaching the end of its service life, which has been accelerated due to insulation degradation identified through condition monitoring tests. The condition monitoring tests, conducted in 2010, involved measurement of the dielectric dissipation factor (DDF) of the insulating material, and were conducted on both 11 kV buses and six of the 11 kV circuit breakers at FT. Dielectric dissipation factor (DDF) is the ratio of the power dissipated in the major insulation to the power applied. A perfect insulator would have a DDF of zero, whereas a higher DDF indicates deterioration and/or moisture contamination of the insulation.

A DDF above 20 milliradian (2.0%), at an ambient temperature of 20°C, is commonly considered to be an operational hazard[1] due to the increased risk of insulation failure, which could result in catastrophic damage to the switchboard and loss of supply to customers. The condition monitoring test results show DDF measurements between 2.66% and 3.06% for the 11 kV bus tie circuit breaker, as high as 3.98% for the No.1 transformer circuit breaker, and between 1.52% and 3.29% for the other circuit breakers that were tested.

The condition monitoring test results indicate that the main insulating material of the 11 kV buses and circuit breakers at FT Zone Substation has degraded significantly from when the site was first commissioned. These results suggest that continuing to operate the station in this state increases the risk of asset failure.

In addition to the planned switchboard replacement works, ceiling strung switchgear, such as that used for the 66 kV bus switching at FT Zone Substation, is no longer commonly used due to the additional costly safety measures now required when maintaining or working on this equipment. Accordingly, at the time when any new 66 kV circuit breakers are required at FT, (e.g. installation of a third transformer), it is expected that the existing 66 kV switchgear will need to be replaced with modern standard equipment to minimise safety risks and avoid unnecessary maintenance costs.

[1] I.A.R Gray, “Dissipation Factor, Power Factor and Relative Permittivity (Dielectric Constant)”.

4. ASSESSMENT METHODOLOGY AND ASSUMPTIONS

This section provides a summary of the planning methodology applied in assessing the impact of network limitations, and in identifying and assessing the market benefits of credible options. It also outlines the assumptions applied in the initial assessment of credible options.

4.1 PROBABILISTIC PLANNING APPROACH

In accordance with clause 5.17.1(b) of the National Electricity Rules, Jemena'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 National Electricity Market.

To achieve this objective, Jemena applies a probabilistic planning methodology that considers the likelihood and severity of critical network outages. The methodology combines the expected impact of network outages on supply delivery with the value that customers place on their supply reliability, and compares this with the augmentation costs required to reduce the likelihood and/or impact of these supply outages.

To ensure the maximisation of net economic benefit, an augmentation will only be undertaken if the benefits, which are typically driven by a reduction in the cost of expected unserved energy, outweigh the cost of the proposed augmentation resulting in that reduction in unserved energy. Since an augmentation will not always be economically feasible, this planning methodology involves an inherent risk that under some possible but rare events - such as the occurrence of a network outage coincident with peak demand periods - there may be insufficient network capacity to meet all demand.

The planned replacement of the two existing 11 kV switchboards has been separated from the augmentation component of the credible options analysis. Any brought-forward costs associated with the switchboard replacements have been included in the capital cost of each proposed augmentation option.

4.2 DEMAND FORECASTS

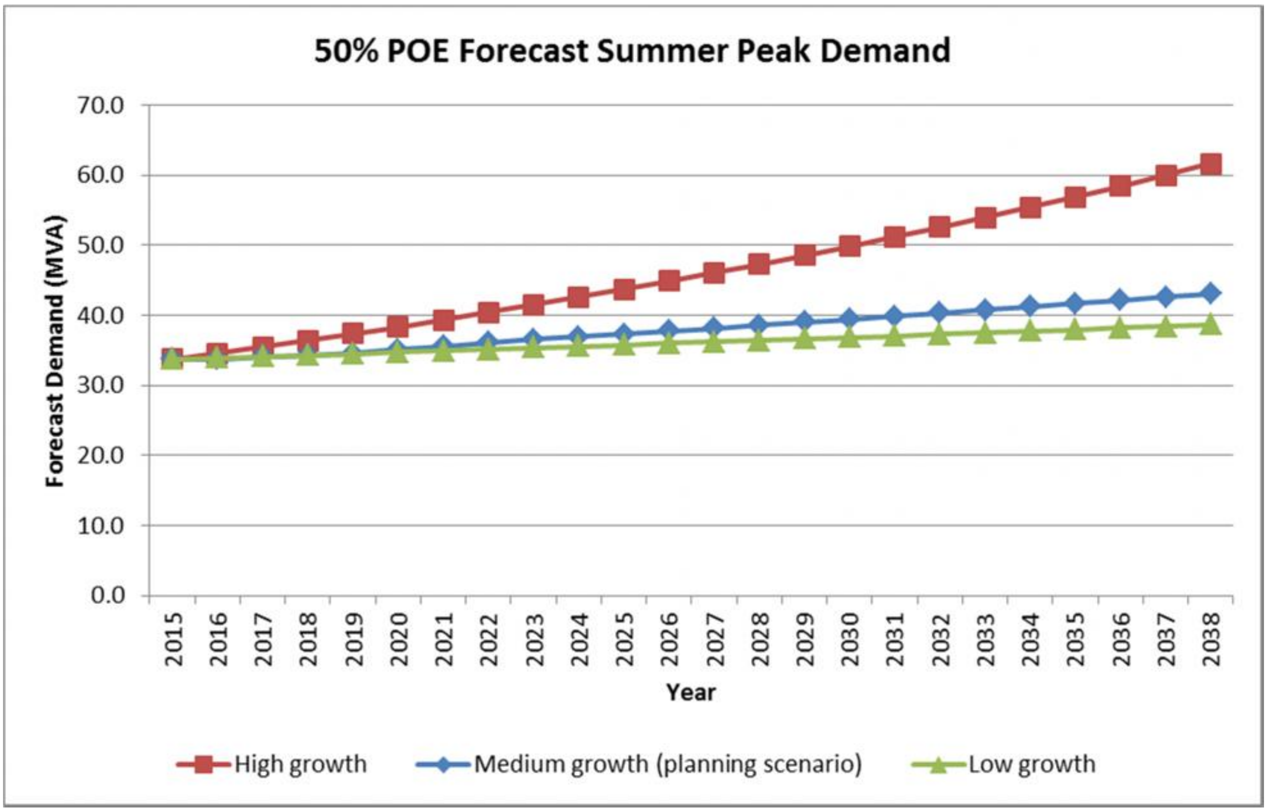
The demand forecasts used in the preparation of this report are those contained in Jemena's 2014 Distribution Annual Planning Report (DAPR). Updated demand forecasts will be published in Jemena's 2015 DAPR at the end of the year, and those forecasts will be used in the preparation of the Draft Project Assessment Report.

Our central forecast for demand at FT Zone Substation is an average increase of 1.1% per annum over the planning horizon. However, it is helpful to include a high and low case, recognising the considerable uncertainty regarding future demand. Jemena considers that there is greater potential upside in relation to higher demand growth rates, compared to the risk of lower than expected growth. In conducting the RIT-D, Jemena will undertake sensitivity analysis to examine the effects of different load growth forecasts. Jemena will provide details of the sensitivity analysis in the Draft Project Assessment Report, which will be published after we have considered submissions on this non-network options report[2].

Figure 4–1 shows the forecast summer peak demand for 50% POE conditions, under the medium demand forecast growth rate, along with the low and high demand sensitivity forecasts.

[2] Under clause 5.17.4(h) of the National Electricity Rules, we must provide at least 3 months for interested parties to lodge submissions on the non-network options report. Clause 5.17.4(i) requires us to publish a Draft Project Assessment Report within 12 months of the end of the consultation period on the non-network options report.

Figure 4–1: Forecast summer peak demand



4.3 VALUE OF CUSTOMER RELIABILITY

The cost of unserved energy is calculated using the value of customer reliability (VCR). This is an estimate of how much value electricity consumers place on a reliable electricity supply.

In assessing the credible options to alleviate the impact of constraints on its network, Jemena has applied VCR values based on the Australian Energy Market Operator's (AEMO) 2014 Value of Customer Reliability Review[3]. Applying the sector values developed by AEMO to Jemena's load composition of approximately 46% commercial, 31% residential and 23% industrial customers, Jemena has applied a VCR of $38,400/MWh in preparing this non-network options report. This 2014 VCR estimate will be updated to a 2015 value[4] for the purpose of preparing the Draft Project Assessment Report.

VCR sensitivity values will be applied when Jemena conducts its more detailed analysis of the credible options in its Draft Project Assessment Report.

3 AEMO. Available http://www.aemo.com.au/Electricity/Planning/Value-of-Customer-Reliability-review

4 The 2015 VCR estimate will be obtained by applying the escalation methodology set out in section 5 of AEMO's VCR Application Guide. The Application Guide is available from http://www.aemo.com.au/Electricity/Planning/Value-of-Customer-Reliability-review

4.4 DISCOUNT RATE

A discount rate of 6.5% real has been applied in undertaking the initial assessment of the network options presented in this report. However, further consideration of the discount rate and sensitivity analysis will be provided in the Draft Project Assessment Report.

4.5 COST ESTIMATES

The capital cost estimates for all network options are indicative costs only. They have been provided by Jemena's Works Delivery team, with consideration given to recent similar augmentation projects and typical unit costs based on industry experience. The capital cost estimates used for the purpose of this non-network options report are expressed in real 2014 dollars.

At this early stage of the assessment process, we have not developed detailed operating expenditure estimates for each credible network option. However, an indicative total annualised cost estimate for the preferred network option is provided.

Cost estimates will be further refined in the course of Jemena preparing the Draft Project Assessment Report.

5. SUMMARY OF POTENTIAL CREDIBLE OPTIONS

This section provides a summary of potential credible options, including network and non-network options that would address the identified need described in Section 3. It also identifies the preferred network option.

The analysis of options presented in this report is indicative only, and is subject to change when further detailed information is considered in the preparation of the Draft Project Assessment Report.

5.1 BASE CASE

The Base Case presents the forecast energy at risk assuming none of the potential credible options are implemented. It is used primarily as a comparison case, against which all of the credible options are compared to determine the option that maximises net benefits.

Although the Base Case option is essentially considered to be the ‘do nothing’ case, due to the age and condition of the existing 11 kV switchboards their replacement has been included in the Base Case. Where a credible option is proposed to be commissioned prior to the planned switchboard replacements, brought-forward replacement costs have been recognised. This allows for the earlier replacement of the existing 11 kV switchboards while still accounting for any additional costs of undertaking the replacement works prior to their planned replacement time.

The estimated cost of works required under the Base Case, to replace the two existing 11 kV switchboards in 2018, is $6.0 million ($ Real 2014). Applying the planning scenario discount rate of 6.5% over the forty-five year assumed asset life, this results in an indicative total annualised cost of $600k ($ Real 2014).

In addition to the cost of the asset replacement works, the Base Case includes a significant amount of expected unserved energy. Using the VCR described in Section 4.3, Jemena estimates the cost of unserved energy to be approximately $168 million in present value terms. Further information on the expected unserved energy is provided in Section 6.2.

5.2 CREDIBLE NETWORK OPTIONS

5.2.1 OPTION 1 - REPLACE FLEMINGTON ZONE SUBSTATION 11 KV ASSETS

This option involves replacing aged and thermally limited 11 kV assets at FT, and installing a third 11 kV switchboard to meet growing demand, and to allow connection of planned new feeders. The proposed scope of works for Option 1 includes:

- Installation of a new indoor 11 kV switch room;
- Installation of three new 11 kV switchboards, including two new 11 kV transformer circuit breakers and two new 11 kV bus tie circuit breakers; and
- Installation of two new 11 kV transformer cables.

This option will remove the three most limiting constraints in supplying the Flemington area, being:

- Thermal capacity of the 11 kV transformer cables;
- Thermal capacity of the 11 kV transformer circuit breakers; and

- Thermal capacity, age, condition, and expansion capability of the existing 11 kV switchboards.

Removal of these three 11 kV constraints will increase the station's N summer rating from 30.5 MVA to 47.8 MVA and its N-1 summer rating from 23.9 MVA to a cyclic rating of 34.8 MVA. Following the proposed works, the station's supply capacity would be limited by the rating of the existing transformers, which have sufficient capacity to meet the forecast demand in the medium term.

Under this option, the work would be completed and commissioned by November 2017.

Jemena's indicative estimate of the capital cost of this option is $10.4 million in real 2014 dollars. The augmentation component is $4.8 million, consisting of $4.2 million in augmentation works and $600k in brought-forward asset replacement costs.

5.2.2 OPTION 2 - REDEVELOP FLEMINGTON ZONE SUBSTATION

This option is to completely redevelop FT Zone Substation at the existing site.

The proposed scope of works for Option 2 includes:

- Installation of a new indoor 11 kV switch room;
- Installation of three new 11 kV switchboards, including two new 11 kV transformer circuit breakers and two new 11 kV bus tie circuit breakers;
- Installation of two new 11 kV transformer cables; and
- Installation of 66 kV gas insulated switchgear and two new 20/33 MVA transformers.

This option will remove all existing limiting constraints in supplying the Flemington area, being:

- Thermal capacity of the 11 kV transformer cables;
- Thermal capacity of the 11 kV transformer circuit breakers;
- Thermal capacity, age, condition, and expansion capability of the existing 11 kV switchboards; and
- Thermal capacity of the 66/11 kV transformers.

With the new station assets planned to at least match the new transformers' cyclic ratings, the new zone substation's 'N' rating would be 66 MVA and its 'N-1' summer cyclic rating will be 49.5 MVA.

Under this option, the work would be completed and commissioned by November 2017.

Jemena's indicative estimate of the capital cost of this option is $16.8 million in real 2014 dollars. The augmentation component is $11.2 million, consisting of $10.6 million in augmentation works and $600k in brought-forward asset replacement costs.

5.2.3 OPTION 3 – ESTABLISH A NEW ZONE SUBSTATION

This option is to establish a new Flemington Zone Substation at an alternative site in the Flemington area by November 2017, and decommission, demolish, clean-up and sell the existing site.

The proposed scope of works for Option 3 includes:

- Purchase land for a new zone substation in the Flemington area, by late 2015;

- Construct a new 66/11 kV zone substation in the Flemington area, consisting of 66 kV gas insulated switchgear and two 20/33 MVA transformers, by November 2017;
- Reroute / extend and connect the existing WMTS-FT 66 kV lines to the new zone substation;
- Reroute / extend and connect the existing FT 11 kV feeders to the new zone substation;
- Reroute / extend and connect any existing protection and communication circuits to the new zone substation; and
- Demolish, clean-up and sell the existing FT site.

This option will remove all existing limiting constraints in supplying the Flemington area, being:

- Thermal capacity of the 11 kV transformer cables;
- Thermal capacity of the 11 kV transformer circuit breakers;
- Thermal capacity, age, condition, and expansion capability of the existing 11 kV switchboards; and
- Thermal capacity of the 66/11 kV transformers.

With the new station assets planned to at least match the new transformers' cyclic ratings, the new zone substation's N rating would be 66 MVA and its N-1 summer cyclic rating will be 49.5 MVA.

Jemena's indicative estimate of the capital cost of this option is $40.6 million in real 2014 dollars, consisting of approximately $35.2 million in zone substation works, and approximately $5.2 million in land purchase costs. The augmentation component is $35 million, consisting of $34.4 million in augmentation works and $600k in brought-forward asset replacement costs.

5.2.4 OPTION 4 – INSTALL A THIRD 66/11 KV TRANSFORMER AND THREE NEW 11 KV BUSES

This option is to install a third 66/11 kV transformer, a third 11 kV bus, and to replace aged 11 kV assets at FT.

The proposed scope of works for Option 4 includes:

- Installation of three new 11 kV switchboards in the existing building, including two new 11 kV transformer circuit breakers and two new bus tie circuit breakers;
- Installation of a new (third) 66/11 kV 20/33 MVA transformer; and
- Installation of two 66 kV bus-tie circuit breakers.

This option will address the thermal constraints in supplying the Flemington area without the need to replace the existing 11 kV transformer cables. This option will address the:

- Thermal capacity of the 11 kV transformer circuit breakers; and
- Thermal capacity, age, condition, and expansion capability limits of the existing 11 kV switchboards.

Removal of these 11 kV constraints and installation of the third transformer will increase FT Zone Substation's N rating from 30.5 MVA to 80.8 MVA and its N-1 summer rating from 23.9 MVA to a cyclic rating of 47.8 MVA. Following the proposed works, the station's N-1 supply capacity would be limited by the combined rating of the existing transformer cables, with the worst case outage being loss of the new transformer.

Under this option, the work would be completed and commissioned by November 2017.

Jemena's indicative estimate of the capital cost of this option is $15.9 million in real 2014 dollars. The augmentation component is $10.3 million, consisting of $9.7 million in augmentation works and $600k in brought-forward asset replacement costs.

5.3 PREFERRED NETWORK OPTION

The table below summarises the indicative capital cost estimates for each of the three credible network options.

Table 5-1: Indicative costs of network options

Option	Present value indicative cost ($M, real 2014)	
	Augmentation Component	Total
Option 1 – Replace Flemington Zone Substation 11 kV assets by November 2017	4.8	10.4
Option 2 - Redevelop Flemington Zone Substation by November 2017	11.2	16.8
Option 3 - Establish a new zone substation by November 2017	35.0	40.6
Option 4 - Install a third 66/11 kV transformer and three new 11 kV buses by November 2017	10.3	15.9

On the basis of the indicative capital cost estimates presented above, and the expected capacity benefits, Jemena has identified Option 1 as the preferred network option.

5.4 POTENTIAL CREDIBLE NON-NETWORK OPTIONS

Non-network alternatives, such as embedded generation or demand management can alleviate supply risks and potentially defer the need for major network augmentation. The embedded generation or demand management schemes for this project would need to be connected to, and supply into FT's 11 kV distribution network to effectively offload the 11 kV transformer cables and 11 kV feeders within the FT supply area.

Possible embedded generators could include:

- Gas turbine power stations;
- Co-generation from industrial processes; and
- Generation using renewable energy, such as solar, wind or land-fill powered generation.

A reduction of peak demand, using demand management, could be achieved by customers shifting their usage to off-peak periods, using high efficiency, low energy appliances, and by reducing energy wastage.

Demand management schemes could include:

- peak load usage shifting or lopping incentives; and
- Interruptible load at a reduced electricity tariff, which would be covered by a supply agreement that the load can be interrupted during network emergencies.

At the time of preparing this non-network options report there are no known proponents of embedded generation or demand management in the Flemington area. Non-network proponents are encouraged to express their interest to Jemena. Contact details and timeframes are set out in Section 7.1.

6. TECHNICAL CHARACTERISTICS OF NON-NETWORK OPTIONS

This section sets out the technical characteristics of our needs[5]. This information is provided to enable proponents of non-network solutions to understand the identified need, and to tailor their proposals accordingly.

Jemena wants to explore all potential non-network solutions with proponents in order to deliver the lowest-cost solution to our customers. We recognise that proponents may require additional specific information to develop their proposals. Accordingly, we encourage proponents to contact us as early as possible, to ensure that we can provide all the specific information that a proponent may require.

Further details on how to contact us are set out in Section 7.1.

6.1 SIZE AND LOCATION OF LOAD REDUCTION OR ADDITIONAL SUPPLY

Table 6-1 below outlines the estimated amount of load reduction, or additional generation in the FT supply area that would fully meet our identified need. While the table below defines our needs, it is conceivable that a non-network option may be preferred even if it does not fully address these requirements. The table should therefore be regarded as a guide. Jemena will consider each option on its merits, having regard to its expected performance in terms of addressing our needs, and the overall costs to our customers.

Table 6-1: Peak demand offsets required from non-network solutions

Year	N Load at risk (MVA)	N-1 Load at risk (MVA)
2016	0.2	6.8
2017	0.6	7.2
2018	0.8	7.4
2019	1.2	7.8
2020	1.8	8.4
2021	2.4	9.0
2022	2.8	9.4
2023	3.5	10.1

The above table is based on demand at 10% POE. The projected levels of load at risk take into account the available load transfer capability.

The FT supply area is shown in Figure 2-1 and Figure 2-2 in Section 2.1.

5 In accordance with Clause 5.17.4(e)(4) of the Rules.

6.2 POTENTIAL DEFERRED AUGMENTATION CHARGE

As explained in Section 5.1, the Base Case would result in a significant amount of unserved energy. The impact of the network limitations under the base case (in which no action is taken to augment capacity) is shown in Table 6-2.

Table 6-2: Limitation impact under base case

Year	Energy at Risk (MWh) Annual	Hours at Risk (h)	Expected Unserved Energy (MWh)	Cost of Expected Unserved Energy ($k)
2016	1464	972	62	$2,400
2017	1720	1119	80	$3,070
2018	1858	1204	90	$3,470
2019	2147	1351	113	$4,340
2020	2661	1621	160	$6,150
2021	3201	1864	216	$8,300
2022	3810	2082	287	$11,030
2023	4703	2393	406	$15,580

The table shows the total expected benefit that will be achieved if all energy at risk is eliminated.

In order to be selected as the preferred solution, however, a non-network solution would need to maximise the net benefits compared to other available options, including the preferred network solution. As already noted in Section 5.2.1, the augmentation and brought-forward replacement costs for Option 1 are approximately $4.8 million, which equates to an annualised total charge of approximately $480k per annum. On the basis that a non-network option delivers exactly the same performance as the preferred network solution, the deferred costs of $480k per annum represent the upper bound that would be available as an annualised network support payment.

As already indicated, it is conceivable that a non-network solution would offer a lower level of performance compared to the network option. In such a case, the network support payments would need to be scaled back in order for the non-network solution to maximise the net benefit.

6.3 TIMING OF REQUIREMENTS

The data in Table 6-2 indicates the potential value of a non-network option that removes load at risk from 2016 onwards.

As noted in section 5.2.1, the target commissioning date of our preferred network option is November 2017. Ideally, a non-network option would be operational from November 2016. Although a later commissioning date would be considered, Jemena would be concerned if the proposed timing of a non-network solution extended beyond that of the preferred network option, which is immediately prior to the summer of 2017-18.

6.4 OPERATING PROFILE

The annual profile of load supplied from FT is shown in Figure 6-1 below.

Figure 6-1: Flemington Zone Substation annual load profile

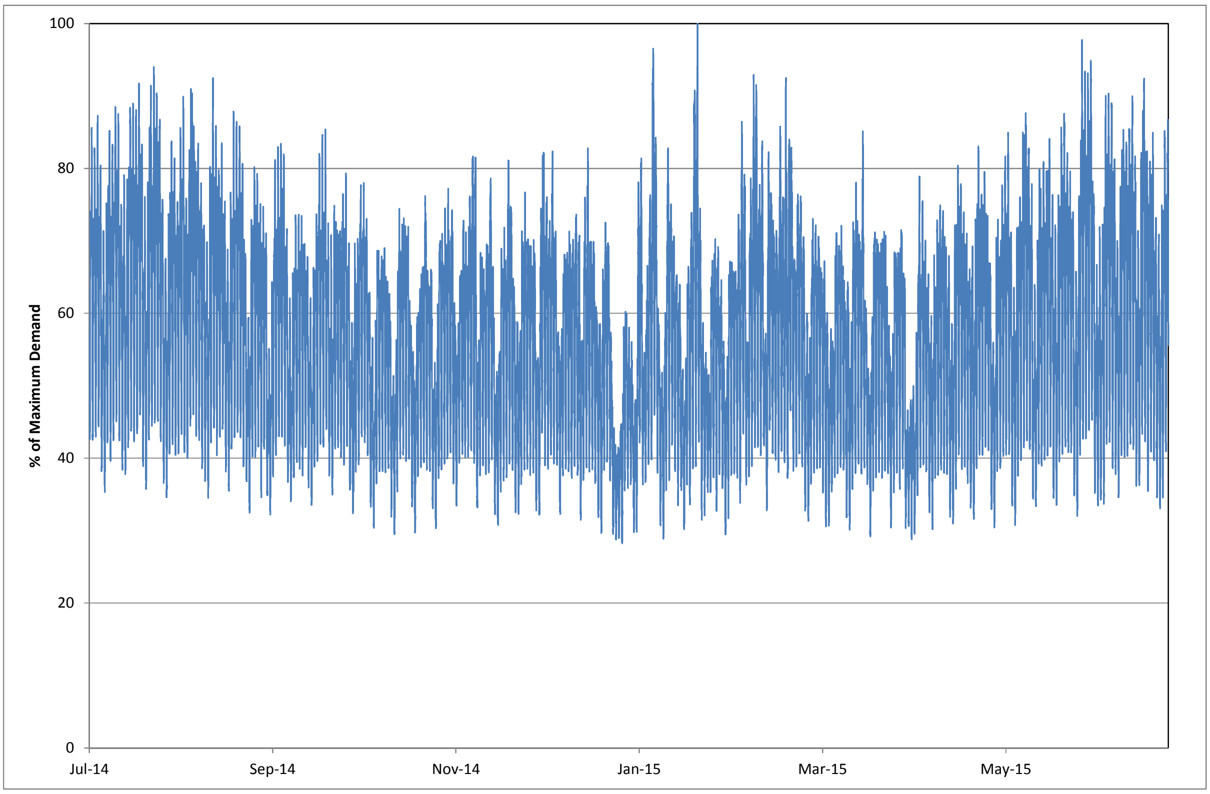
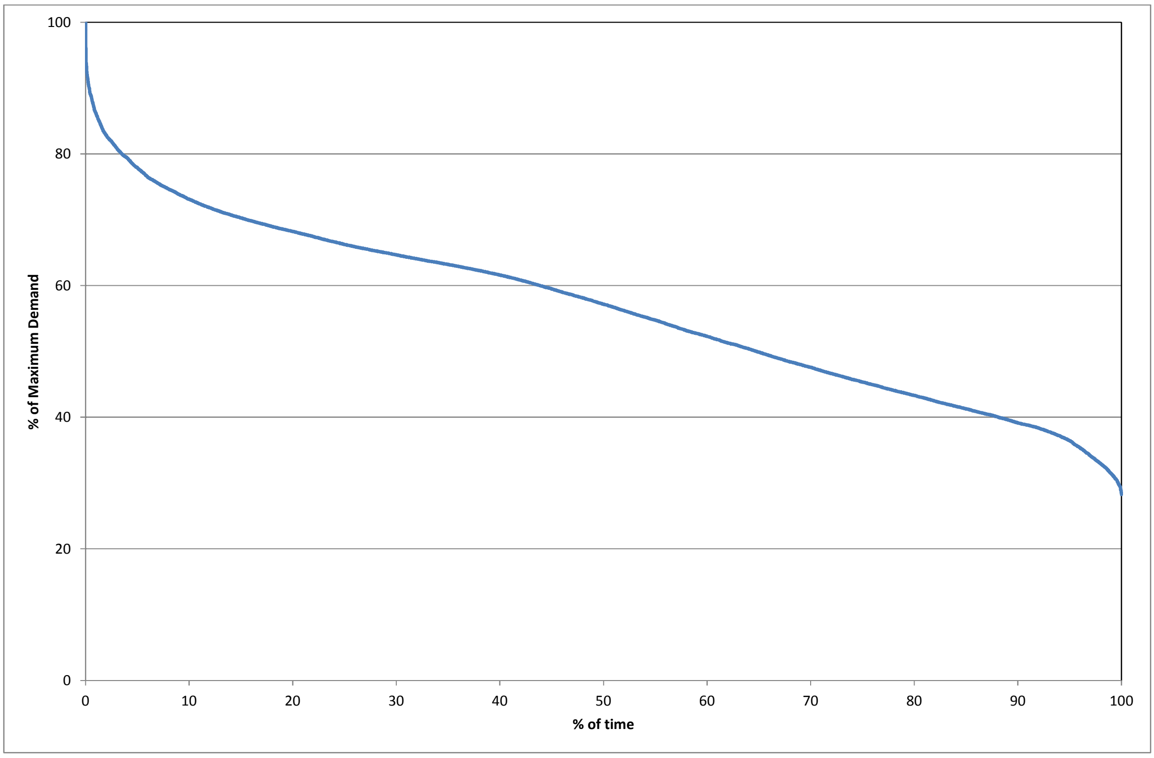


Figure 6-1 shows that peak loading on the station occurs in both the Summer (October to March) and Winter (April to September). Therefore, a non-network solution would be required to be available over both of these periods to reduce demand or increase local generation to avoid supply interruptions. Table 6-2 showed that the hours per year that load is at risk ranges from 972 in 2016 up to 2393 in 2023.

The load duration curve of FT for 2014-15 is shown in Figure 6-2 below.

Figure 6-2: FT load duration curve for 2014-15



The load profiles for the days of Summer and Winter maximum demands are shown in Figure 6-3 below.

Figure 6-3: Load profile on days of summer and winter maximum demand at FT

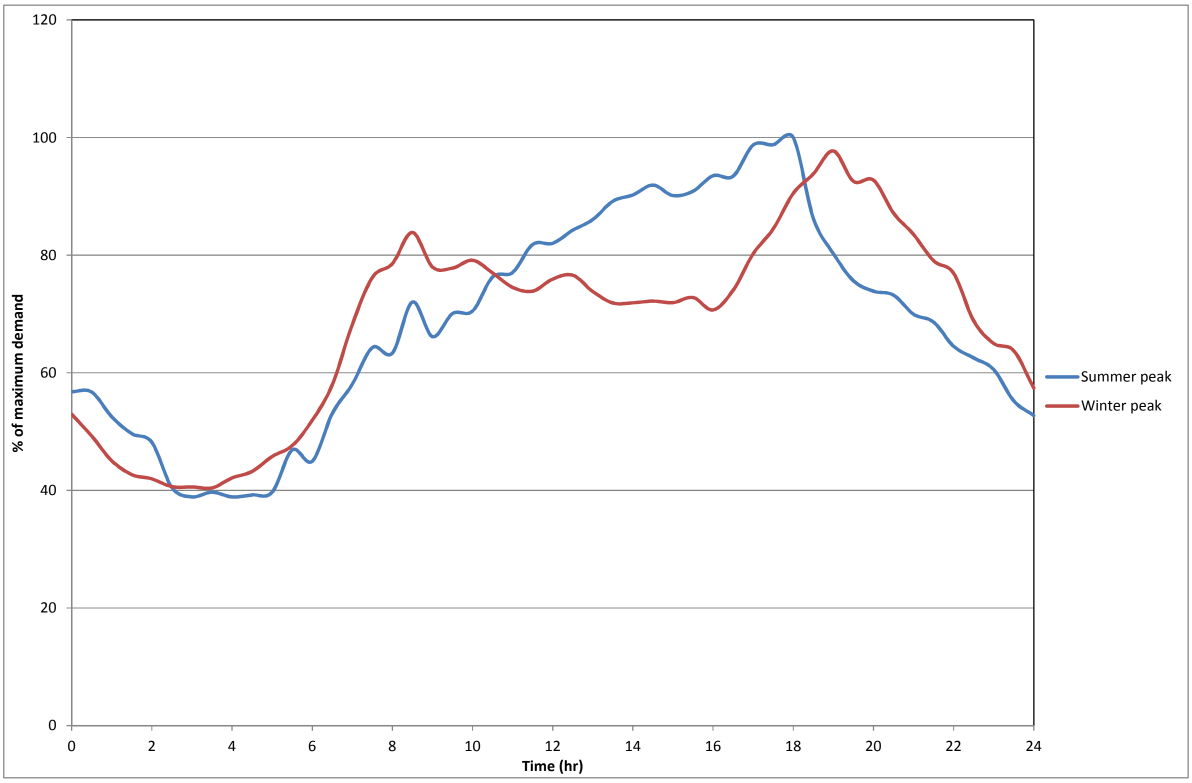


Figure 6-3 shows that for both Summer and Winter, the peak demand at FT occurs between 4.00 pm and 8:00 pm with the Winter peak about an hour later than the summer peak.

Ideally, a non-network solution would eliminate the load at risk at FT over the planning period. This level of performance would mean that the non-network option is comparable with the preferred network solution. However, a non-network solution may still be preferred providing that a lower level of performance is more than offset by lower costs (i.e. lower network support payments).

Jemena would be pleased to discuss this issue further with non-network proponents. Specifically, we would be pleased to discuss any proposed cost/performance combination that proponents considered to be more cost effective than the preferred network solution.

6.5 POWER SYSTEM SECURITY AND RELIABILITY

In order to substitute for traditional ‘poles and wires’ augmentation, proposed non-network options must be capable of reliably meeting the electricity demand under a range of conditions. As already noted, however, a potentially viable non-network option would not necessarily be required to provide a level of reliability that is identical to that provided by the preferred network solution. Rather, the value of a non-network option will reflect the reduction in expected unserved energy that the option is capable of delivering relative to the network option. The preferred option is the one that maximises net benefits.

If the non-network option is a generator connected to Jemena’s distribution network, the generator will be required to comply with the standards set out in our Embedded Generation Guidelines, which are available at:

https://jemena.com.au/about/document-centre/electrcitiy/embedded-generation-guidelines

The guidelines detail important requirements relating to:

- embedded generation access (connection) standards;
- embedded generation testing, commissioning and maintenance requirements; and
- operational constraints and standards.

Proponents of embedded generation solutions should familiarise themselves with these requirements.

6.6 FAULT LEVEL CONTRIBUTION

The installation of an embedded generator may raise the fault level of the network to which it is connected. It is important to ascertain that the resulting fault levels are not raised above the existing acceptable rated fault levels for circuit breakers, conductors, any auxiliary plant and fittings including earth grid, Distribution Code or design limits. We may need to carry out system fault level studies to assess these matters.

Under Section 7.8 of the Victorian Electricity Distribution Code, an embedded generator is required to design and operate its embedded generating unit so that it does not cause fault levels in the distribution system to exceed the levels specified in Table 6–3 below. The existing fault levels at FT are specified in Table 6-4.

Table 6–3: Victorian Electricity Distribution Code fault levels

Voltage Level kV	System Fault Level MVA	Short Circuit Level kA
66	2500	21.9
22	500	13.1
11	350	18.4
6.6	250	21.9
<1	36	50.0

Table 6-4: FT fault levels

Voltage level (kV)	Fault levels (kA)	
	3 phase	1 phase to ground
66	16.5	13.1
22	14.5	2.7

7. SUBMISSIONS FROM INTERESTED PARTIES

7.1 INVITATION FOR SUBMISSIONS

Jemena seeks submissions from interested parties, including proponents of non-network solutions.

As noted already, we are interested in exploring all potential non-network solutions with proponents. We recognise that some proponents may require information in addition to that provided in this report. If you do need further information, please contact us as early as possible, to ensure that sufficient time is available to fully assess feasible network and non-network potential solutions. It should be noted that parts of the network exhibit volatile load growth, usually due to economic and demographic factors that are difficult to foresee and model. It is essential that alternatives to network solutions are presented by proponents in sufficient time to allow for their thorough evaluation, planning and implementation.

All submissions and enquiries should be directed to:

Ashley Lloyd
Network Capacity Planning & Assessment Manager
Email: PlanningRequest@jemena.com.au
Phone: (03) 9173 8279

Submissions should be lodged with us on or before 29 January 2016.

All submissions will be published on Jemena's website. If you do not wish to have your submission published, please indicate this clearly.

7.2 INFORMATION FROM NON-NETWORK PROPONENTS

To assist in the assessment of non-network solutions, proponents are invited to make a detailed submission. That submission should be informed by earlier discussions with us (arranged through the contact officer noted above), and should include the following details about the proposal:

1. Proponent name and contact details;
2. Overview of the extent to which the proposal addresses the identified need;
3. A technical description of the proposal, including:

- location;
- size of the load reduction or additional supply;
- electrical layout schematics;
- network connection requirements, if needed;
- contribution to power system security or reliability;
- contribution to power system fault levels, load flows and stability studies (if applicable);
- the operating profile;
- reliability;

- how each of these matters is consistent with the applicable technical standards;

4. Timing of delivery of solution and its estimated lifespan;
5. Proposed operational and contractual commitments, including financier commitments;
6. Planning application information, where required;
7. Salvage and removal costs; and
8. An evaluation of potential risks associated with the proposal, including a comparison with the risks associated with the preferred network augmentation option, and any actions that can be taken to mitigate these risks. This assessment should address the risk of not meeting the demand requirement and the compensation arrangements that would apply in such circumstances.

We will review each non-network option and we may seek further information from the non-network proponent to better understand the design of the proposed solution and its implications on the network and other network users.

7.3 NEXT STEPS

As outlined in Section 1, this report is being prepared under the RIT-D consultation procedures, to help us and interested parties identify potential non-network options to address the identified need in the Flemington supply area.

Following our consideration of submissions on this non-network options report, we will proceed to prepare a Draft Project Assessment Report. That report will present a detailed assessment of all options to address the identified need, plus a summary of, and commentary on the submissions to this report. The Draft Project Assessment Report will apply the latest available information on demand forecasts, VCR estimates and project cost estimates.

We intend to publish the Draft Project Assessment Report by 30 June 2016. Further consultation, in accordance with the RIT-D process set out in the Rules, will then proceed.