Jemena Electricity Networks (Vic) Ltd

Flemington Zone Substation

RIT-D Stage 2: Draft Project Assessment Report

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Flemington Zone Substation

Authorisation

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History

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EXECUTIVE SUMMARY

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

Our customers expect us to deliver 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 the present value of net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (NEM).

The Draft Project Assessment Report (DPAR) presents the Flemington Zone Substation (FT) supply capacity risk and outlines how this risk has been quantified. It outlines possible options for economically mitigating supply risks, and identifies the proposed preferred option to manage the forecast supply risk in the area.

This FT Regulatory Investment Test for Distribution (RIT-D) Stage Two DPAR:

- Utilises Jemena Electricity Network's (JEN's) 2015 load demand forecasts;
- Incorporates detailed analysis undertaken as part of Stage One of the RIT-D, the non-network options report;
- Includes assessment of newly identified network, non-network and hybrid credible options identified during Jemena's Electricity Distribution Price Review (EDPR) submission and the non-network options report consultation process; and
- Considers preliminary design work and site investigations that have been undertaken since publishing the RIT-D Stage One non-network options report.

Identified need

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

Based on JEN's 2015 Load Demand Forecasts Report, the:

- 50% probability of exceedence (POE) summer maximum demand is forecast to increase from 34.2 MVA in 2015/16 to 36.9 MVA in 2020/21.
- 10% POE summer maximum demand is forecast to increase from 37.2 MVA in 2015/16 to 40.4 MVA in 2020/21.

The drivers of the identified investment need are:

- The thermal capacity of the zone substation 11 kV assets (30.5 MVA under system normal conditions and 23.9 MVA under N-1 conditions), which prevent full utilisation of the existing 66/11 kV transformers and thereby limit supply of the growing FT demand; and
- The connection capacity of the existing two 11 kV switchboards, on which all circuit breakers are already fully utilised by existing feeder lines and capacitor banks, thereby not allowing the connection of additional 11 kV feeders to supply the growing FT demand.

The primary driver for augmentation is the thermal capacity of the zone substation 11 kV assets. While there is also a need to replace deteriorating assets, primarily the 11 kV switchboards, this is a secondary driver when assessing the economic value of this constraint.

Non-network options report consultation submissions

On 21 October 2015, Jemena published Stage 1 of the Flemington Zone Substation RIT-D, the non-network options report. This report sought submissions from Registered Participants, interested parties, the Australian Energy Market Operator (AEMO) and non-network service providers to ensure the optimal solution was identified to mitigate or manage the Flemington Zone Substation thermal capacity limitations.

Jemena received two submissions to its non-network options report to address the FT thermal capacity constraints. Both submissions presented credible non-network options capable of mitigating or managing the identified thermal capacity limitation.

The submission from GreenSync presented a voluntary demand reduction solution to manage the identified supply risk prior to completing a network augmentation, while the other submission, from ZECO Energy, identified battery storage as a non-network solution to manage or mitigate the supply risk.

Hybrid network/non-network options have been included in the options assessed of this RIT-D Stage Two report based on the information provided in the two non-network options report submissions.

Proposed preferred option

The options analysis identifies that:

- Option 1b, upgrading the 11 kV transformer cables and switchboards, and installing a third 11 kV switchboard in the existing switch-room building by 2018, is the preferred network augmentation option;
- Engaging demand-side management services, either in the form of voluntary load reduction or a battery energy storage solution, does not defer the need for the preferred network augmentation; and
- Maintaining Jemena's existing supply risk management action of opening the 11 kV bus-tie circuit breaker at FT during peak demand periods, and supplementing this by engaging GreenSync for a voluntary load reduction demand management solution, provides positive net economic benefits for managing supply in advance to the network augmentation.

Following consultation of this DAPR, Jemena will proceed with the final stage of the RIT-D, the Final Project Assessment Report (FPAR), and proposes to implement the preferred network augmentation, Option 1b, by August 2018.

Table ES–1 shows the total project cost breakdown for Option 1b. Applying the discount rate of 6.37% per year, this preferred solution has a net economic benefit of $171.95 million (Real $2016) over the fourteen year assessment period.

Table ES–1: Proposed preferred solution cost estimate breakdown

	NPV project cost ($M Real 2016)
Network augmentation capital cost	6.35
Network augmentation operational cost (over the 2016-2020 period)	0.18
Total project expenditure (2016 – 2020)	**6.53**

Prior to commissioning the preferred network augmentation, there is a significant amount of load at risk which is predominately due to the forecast demand exceeding the system normal capacity of the zone substation. Rather than undertaking pre-contingent load shedding to manage a post contingent overload risk, Jemena currently manages this risk operationally by opening the 11 kV bus-tie circuit breaker at FT during peak demand periods (when FT demand exceeds 30 MVA). This operational arrangement effectively splits the zone substation into two electrically independent stations; each with one transformer, one bus, and five feeders.

While this 11 kV bus split arrangement allows each half of the zone substation to carry up to 23.9 MVA (transformer cable limit), for a total zone substation capacity of 47.8 MVA, the trade-off is an increased consequence if a network outage does occur. The zone substation effectively operates as two stations, and a sub-transmission line or transformer outage would therefore result in involuntary load shedding of half of the zone substation load. If an outage occurred at the time of peak demand in summer 2017, this would result in up to 18.9 MVA of customer load being shed.

Jemena will continue managing the existing supply risk by opening the 11 kV bus-tie circuit breaker at FT during peak demand periods until the preferred network augmentation in commissioned. We will also engage GreenSync to provide a firm offer for a voluntary load reduction demand management solution for 2017, with an option to extend that engagement to 2018 to secure against potential construction delays associated with the preferred network augmentation. Based on the residual load at risk and expected unserved energy with the bus-split arrangement in place, a demand management solution of up to $712k, and providing up to 5.2 MVA of day-ahead or up to 18.9 MVA of fast demand side management, in 2017 is expected provide a positive net economic benefit.

The estimated costs, in Real 2017 dollars, to manage the supply risk in advance of the network augmentation are shown in Table ES–2.

Table ES–2: Pre network augmentation supply risk management cost estimate breakdown

	NPV project cost ($M Real 2017)
Open 11 kV bus-tie circuit breaker at FT when zone substation demand exceeds 30 MVA	-
Demand management capital and operational cost	0.71
Total expenditure (2017)	**0.71**

Submission and next steps

Jemena invites written submissions on this report from Registered Participants, interested parties, AEMO and non-network providers.

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 31 January 2017.

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

Following our consideration of any submissions on this Draft Project Assessment Report, we will proceed to prepare a Final Project Assessment Report (FPAR). That report will include a summary of, and commentary on, the submissions to this report, and present the final preferred solution to address the Flemington Zone Substation thermal capacity constraint. Publishing the FPAR will be the third and final stage in the RIT-D process.

We intend to publish the Final Project Assessment Report by 10 February 2017.

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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 320,000 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

1. INTRODUCTION

This section outlines the purpose of the Regulatory Investment Test for Distribution, Jemena's objective in undertaken its network planning role, and the structure of this draft project assessment report (DAPR).

1.1 RIT-D PURPOSE AND PROCESS

Distribution businesses are required to go through the Regulatory Investment Test for Distribution (RIT-D) process to identify the investment option that best addresses an identified need on the network, that is the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (the preferred option).

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 identified need on the network.

Following completion of the non-network options report consultation period, distribution businesses are required to consider submissions, assess the market benefits of all credible options to address the identified need, and prepare a draft project assessment report outlining the proposed preferred option to address the identified need.

This document is Jemena's draft project assessment 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;
- submissions on the non-network options report;
- the credible options assessed that may address the identified need;
- the methodologies used to quantify market benefits;
- the net present value assessment results for the potential credible options assessed; and
- the technical characteristics of the proposed preferred credible option.

1.2 OBJECTIVE

Jemena's objective in planning its electricity distribution network is to ensure that reliable distribution services are delivered to its customers at the lowest sustainable cost.

This report is stage two of the RIT-D consultation process. It follows on from our non-network options report and considers additional network and hybrid network/non-network options based on submissions to that report and the Australian Energy Regulator's (AER) input to our Electricity Distribution Price Review (EDPR) submission.

2. BACKGROUND

This section provides an overview of the Flemington supply area, describes the general arrangement of Flemington Zone Substation (FT), and gives a brief overview of the network limitations.

The assessment is based on the 2015 Load Demand Forecasts Report.

2.1 NETWORK SUPPLY ARRANGEMENTS

Jemena is the licensed electricity distributor for the northwest of Melbourne's greater metropolitan area. The Jemena Electricity Networks (JEN) service area covers 950 square kilometres of northwest greater Melbourne and includes some major transport routes and the Melbourne International Airport, which is located at the approximate physical centre of the network. The network comprises over 6,000[1] kilometres of electricity distribution lines and cables, delivering approximately 4,400 GWh of energy to close to 330,000 homes and businesses for a number of energy retailers. 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.

FT, is supplied by two 66 kV lines from West Melbourne Terminal Station (WMTS). FT consists of two 66/11 kV 20/30 MVA transformers, two 11 kV buses and ten 11 kV feeders. It supplies close to 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 is electrically islanded from the surrounding networks to the west, south and east, which operate at 6.6 kV and 22 kV. FT makes up part of an 11 kV network with North Essendon Zone Substation (NS) and Essendon Zone Substation (ES) to the north and north-east of FT. Although some load transfer to NS and ES may be possible during network outage conditions, the load transfer capacity is minimal due to the heavy loading already existing on these surrounding stations and their feeders.

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

The primary driver limiting the station's capacity, during summer and winter peak demand periods, is the 11 kV buses, transformer circuit breakers and transformer cables. The full capacity of the two existing transformers cannot be fully utilised under system normal or network outage conditions. Some of the FT feeders, particularly those supplying the central, north and north-west areas of the zone substation supply area, are already heavily loaded, with some close to 100% utilisation. While the average utilisation across all feeders is approximately 69%, the lighter loaded feeders don't supply areas near the heavier loaded areas, and therefore can't be used to offload the heavily loaded feeders. There is also limited capability to connect new feeders at FT due to the rating of the existing 11 kV buses and the utilisation of all 11 kV circuit breakers.

Based on JEN's 2015 Load Demand Forecasts Report, the:

- 50% probability of exceedence (POE) summer maximum demand is forecast to increase from 34.2 MVA in 2015/16 to 36.9 MVA in 2020/21.

[1] Does not include low voltage services

- 10% POE summer maximum demand is forecast to increase from 37.2 MVA in 2015/16 to 40.4 MVA in 2020/21.

2.2 CONNECTIVITY AND ASSET INFORMATION

This section outlines planned and committed works that are currently underway to ensure that loading on the West Melbourne Terminal Station (WMTS) connection asset transformers doesn't limit the supply capacity to FT. It also outlines recently completed feeder line works that increased the load transfer capacity from FT to ES for supply backup following outage of an FT asset.

2.2.1 WEST MELBOURNE TERMINAL STATION CAPACITY

AusNet Services is currently planning 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 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 development plan, and is expected to be completed by 2019.

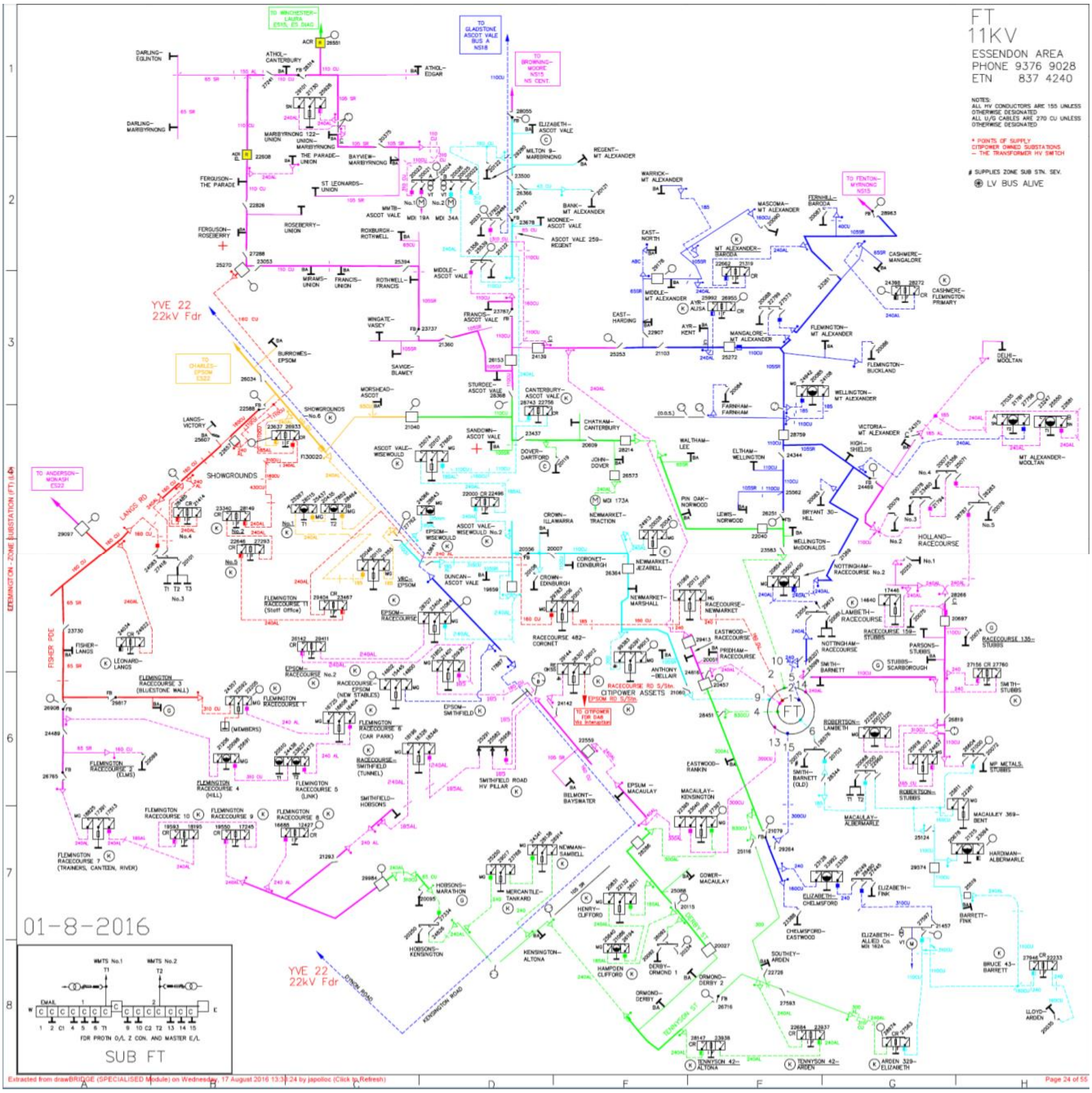
2.2.2 11 KV FEEDER WORKS

In December 2015 Jemena completed the installation of a new 11 kV feeder from Essendon Zone Substation (ES), named ES-22. This new feeder provides an additional 6 MVA of load transfer capacity to Flemington Zone Substation during single contingency events. The additional load transfer capacity provided by feeder ES-22 has been included in the network limitation risk assessments presented in this report.

2.3 GENERAL ARRANGEMENT

Figure 2–1 shows the supply area arrangement of the ten 11 kV feeders supplied from FT. It provides an indication of the area each of the FT feeders supply and where they connect with the surrounding zone substations ES and NS via their feeders.

Figure 2–1: Flemington supply area arrangement (1 August 2016)



3. IDENTIFIED NEED

Flemington Zone Substation (FT) supply capability is limited by insufficient thermal capacity to supply the forecast load under both system normal and network outage conditions. As demand is forecast to continue growing, so is the expected unserved energy demanded from FT.

Supply capability is also limited by the age and condition of the FT 11 kV switchboards which, based on condition monitoring results, are at risk of an increased number of failures or a catastrophic failure.

Despite the reliability risk of the switchboards, the primary driver of the identified need is the forecast demand and subsequent loading on the 11 kV transformer circuit breakers, buses and transformer cables. With the forecast demand on these assets exceeding their capacity under system normal and network outage conditions, the reliability performance of the FT assets is a secondary driver that has an insignificant impact in assessing the economic cost of this limitation.

In line with the purpose of the regulatory investment test for distribution (RIT-D), as outlined in Clause 5.17.1 (b) of the National Electricity Rules, the identified need to address the Flemington area supply limitation is an increase in the sum of customer and producer surplus in the National Electricity Market (NEM); that is an increase in the net economic benefit. This net economic benefit increase is driven by reducing the cost of expected unserved energy (predominately by a change in the amount of involuntary load shedding in this case) through augmentation, and balancing this benefit against each development option's cost to identify the optimal augmentation solution and timing.

This section summarises the station and feeder asset utilisation at FT, based on JEN's 2015 Load Demand Forecasts Report.

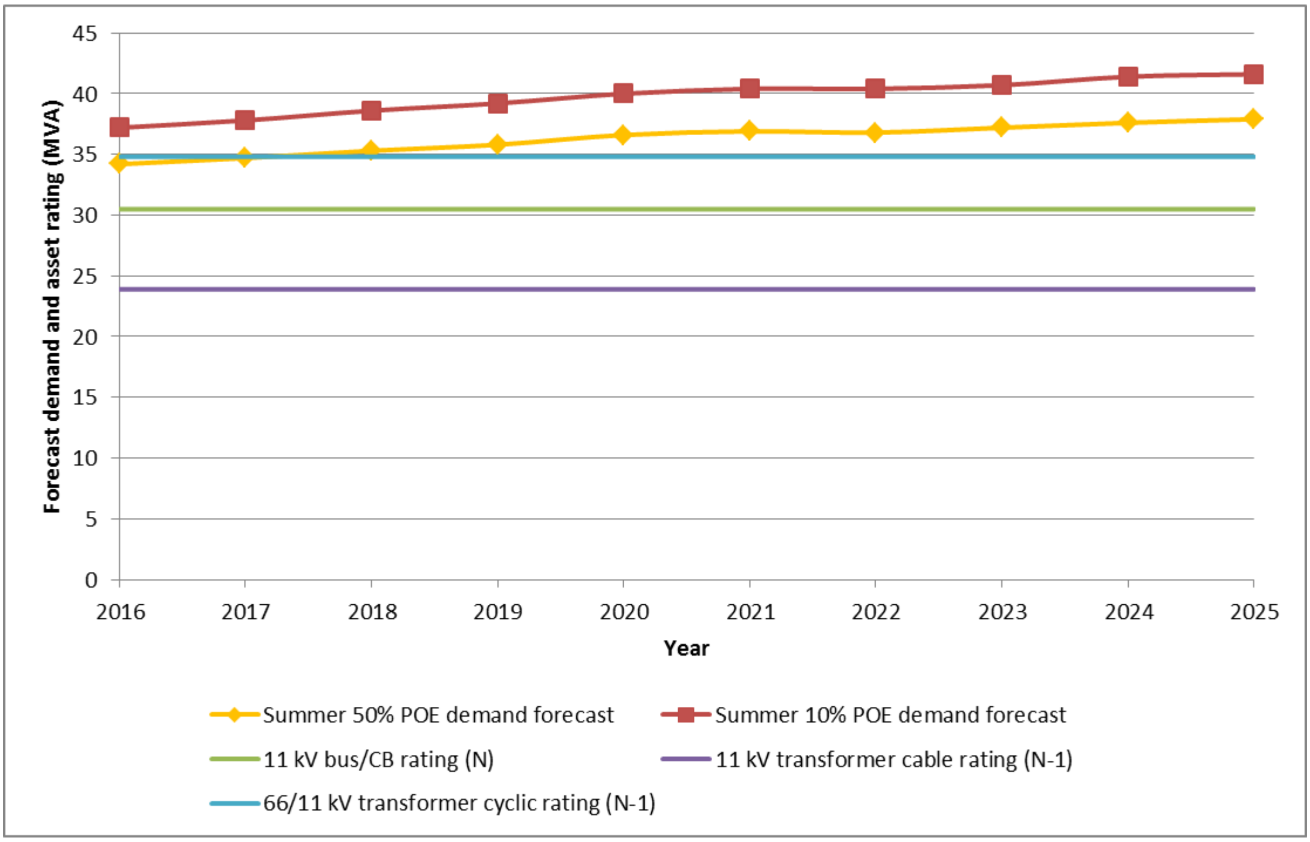
3.1 PRIMARY IDENTIFIED NEED

3.1.1 ZONE SUBSTATION ASSET UTILISATION

Figure 3–1 shows the forecast demand at FT, for 50% probability of exceedance (POE) and 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 buses and transformer circuit breakers under system normal conditions, and by the 11 kV transformer cables under network outage (N-1) conditions. Load shedding would be required to maintain network loading levels within the ratings of the buses, circuit breakers and transformer cables at times of peak demand.

It also shows that, even during outage conditions coincident with peak demand, the FT transformer cyclic ratings have sufficient transformer capacity to meet the 50% POE forecast maximum demand until 2017. Under 10% POE and 50% POE forecast demand conditions, the residual load at risk above the transformer N-1 cyclic rating is expected to be manageable beyond 2020 by utilising emergency load transfers to Essendon and North Essendon zone substations as required during network outage conditions.

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



3.2 SECONDARY IDENTIFIED NEED

3.2.1 11 KV FEEDER UTILISATION

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

As an assessment guideline applied by Jemena, feeders are identified for risk mitigation analysis when their system normal loading reaches 67% of the feeder's summer rating for 50% POE maximum demand conditions. Although augmentation might not necessarily be undertaken at this stage due to a lack of economic viability, Jemena considers the identification and investigation of risk mitigation appropriate at this level because loading feeders beyond 67% will typically expose customers to supply risks under outage conditions, due to the lack of available transfer capacity.

Insufficient load transfer capacity following a feeder outage will result in extended customer outages. This has increased societal (market) costs, which, as required under the National Electricity Rules (NER) and RIT-D, we aim to minimise through cost efficient augmentation. Extended customer outages also result in increased penalty costs to Jemena under the service target performance incentive scheme (STPIS), as outlined in Clause 6.6.2 of the NER.

Table 3–1 presents the forecast utilisation of FT 11 kV feeders, based on 50% POE summer peak demand conditions. It also shows the utilisation levels averaged across all FT feeders under 50% POE summer peak demand conditions. The utilisation figures are presented based on continuous summer feeder line ratings.

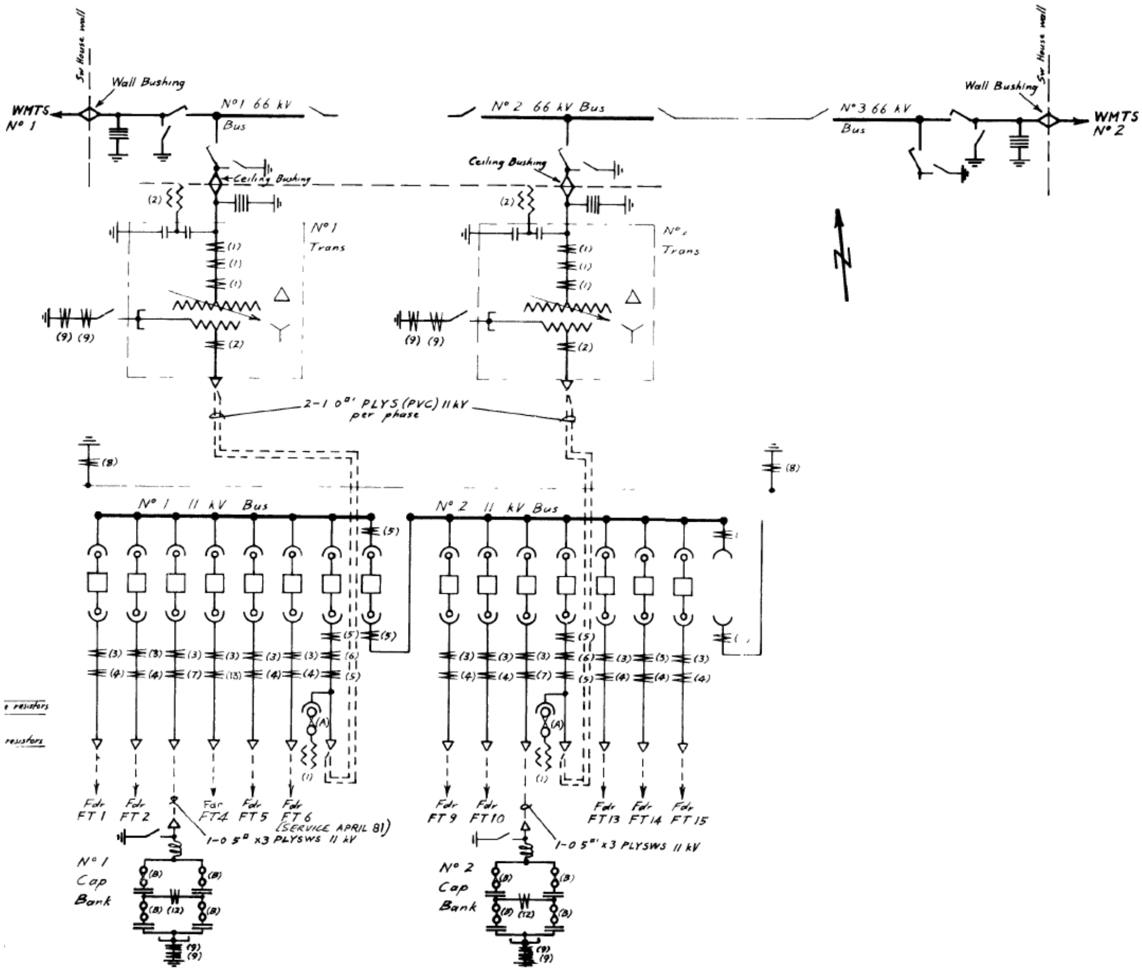
Table 3–1: Forecast utilisation of Flemington Zone Substation feeders

11 kV Feeder	Summer Rating (A)	Forecast Utilisation					
		2016	2017	2018	2019	2020	2021
FT01	375	83.5%	83.1%	82.5%	81.8%	81.6%	82.2%
FT02	260	74.7%	92.8%	112.2%	125.1%	150.3%	182.5%
FT04	590	41.5%	42.7%	43.8%	44.9%	46.1%	48.0%
FT05	345	55.5%	55.6%	56.0%	56.4%	56.7%	57.6%
FT06	180	61.5%	61.0%	60.6%	60.0%	59.9%	60.4%
FT09	300	74.4%	76.1%	82.1%	87.9%	87.7%	88.4%
FT10	375	99.4%	98.7%	97.9%	97.1%	96.9%	97.6%
FT13	375	90.7%	91.8%	92.7%	95.1%	98.0%	102.1%
FT14	375	58.0%	57.6%	57.2%	56.7%	56.6%	57.0%
FT15	345	47.5%	47.1%	46.8%	46.4%	46.2%	46.6%
Average feeder utilisation (%)		68.7%	70.7%	73.2%	75.1%	78.0%	82.2%

As presented in Table 3–1, many of the FT 11 kV feeders are already heavily utilised, and their loading levels are forecast to increase over the next five year period. With the average utilisation forecast to exceed 82% by summer 2020/21, and some of the feeders supplying the north-west areas of the FT supply area expected to exceed their capacity within the five year period, Jemena is planning to install a new 11 kV feeder at FT by summer 2017/18.

As shown in the physical arrangement presented in Figure 3–2, the existing 11 kV switchboards at FT don't have any spare circuit breakers available. Additionally, the existing switchboards do not have space provision to install any new circuit breakers. Although undesirable from a reliability and load balancing perspective, establishing the new feeder therefore requires significant temporary load rearrangement, pushing even more feeders to their limit, to free up an existing feeder circuit breaker for the new feeder. Figure 3–2 also shows that there is provision at FT for a third transformer at the east side of the station, which would connect to the No.3 66 kV bus. However, as mentioned in Section 3.1, if the 11 kV transformer cable, circuit breaker and bus limitations are addressed there is sufficient transformer capacity with the two existing transformers and available post-contingent load transfers to manage the forecast demand until 2021 or beyond.

Figure 3–2: Flemington Zone Substation physical arrangement



3.2.2 LIMITED TRANSFER AND EMERGENCY BACKUP CAPACITY

Since the 11 kV area supplied by FT is electrically separated from the 6.6 kV and 22 kV networks surrounding the east, west and south of FT, there is only limited opportunity to transfer load away from FT. During emergency outage conditions some load can be transferred off the feeders supplying the areas to the north and north-west of FT by extension of the Essendon Zone Substation (ES) and North Essendon Zone Substation (NS) feeders. Due to the additional risk it puts on the already heavily loaded sub-transmission lines, feeders and station assets at ES and NS, as described in our Distribution Annual Planning Report, the transfer capacity away from FT cannot be utilised to manage the system normal limitations. Utilising these transfers under system normal conditions may also limit Jemena's ability to maintain and operate the network in a secure manner because the available transfer capacity is required to take assets offline during lighter loaded periods.

Works to provide additional backup supply from ES, as outlined in Section 1.2.2, have been completed. The new ES-22 feeder added approximately 6 MVA of emergency transfer capacity, increasing the transfer capacity away from FT to approximately 8.7 MVA during peak demand periods.

Jemena does not currently have a spare 66/11 kV transformer anywhere within its network. 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.

3.2.3 ASSET CONDITION

The switchgear at FT was manufactured in 1970 by Email (type J18). These assets are approaching the end of their service life, which has been accelerated by 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 milliradians (2.0%) at 20°C is commonly considered to be an operational hazard[2] 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 have degraded significantly from when the site was first commissioned, and continuing to operate the station in this state increases the risk of asset failure.

2 I.A.R Gray, "Dissipation Factor, Power Factor and Relative Permittivity (Dielectric Constant)".

4. ASSUMPTIONS RELATING TO THE IDENTIFIED NEED

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 conditions and outages. The methodology compares the forecast cost to consumers of losing energy supply (e.g. when demand exceeds available capacity) against the proposed augmentation cost to mitigate the energy supply risk. The annual cost to consumers is calculated by multiplying the expected unserved energy (the expected energy not supplied based on the probability of the supply constraint occurring in a year) by the value of customer reliability (VCR). This is then compared with the annualised augmentation solution cost.

To ensure the net economic benefit is maximised, an augmentation will only be undertaken if the benefits, which are typically driven predominately by a reduction in the cost of expected unserved energy, outweigh the cost of the proposed augmentation resulting in that reduction in unserved energy. Augmentation is not always economically feasible and this planning methodology therefore carries an inherent risk of not being able to fully supply demand under some possible but rare events, such as a network outage coinciding with peak demand periods. The probabilistic planning methodology that we apply is further detailed in our Distribution Annual Planning Report.

The key assumptions that have been applied in quantifying the Flemington Zone Substation limitations are outlined in this section, and include:

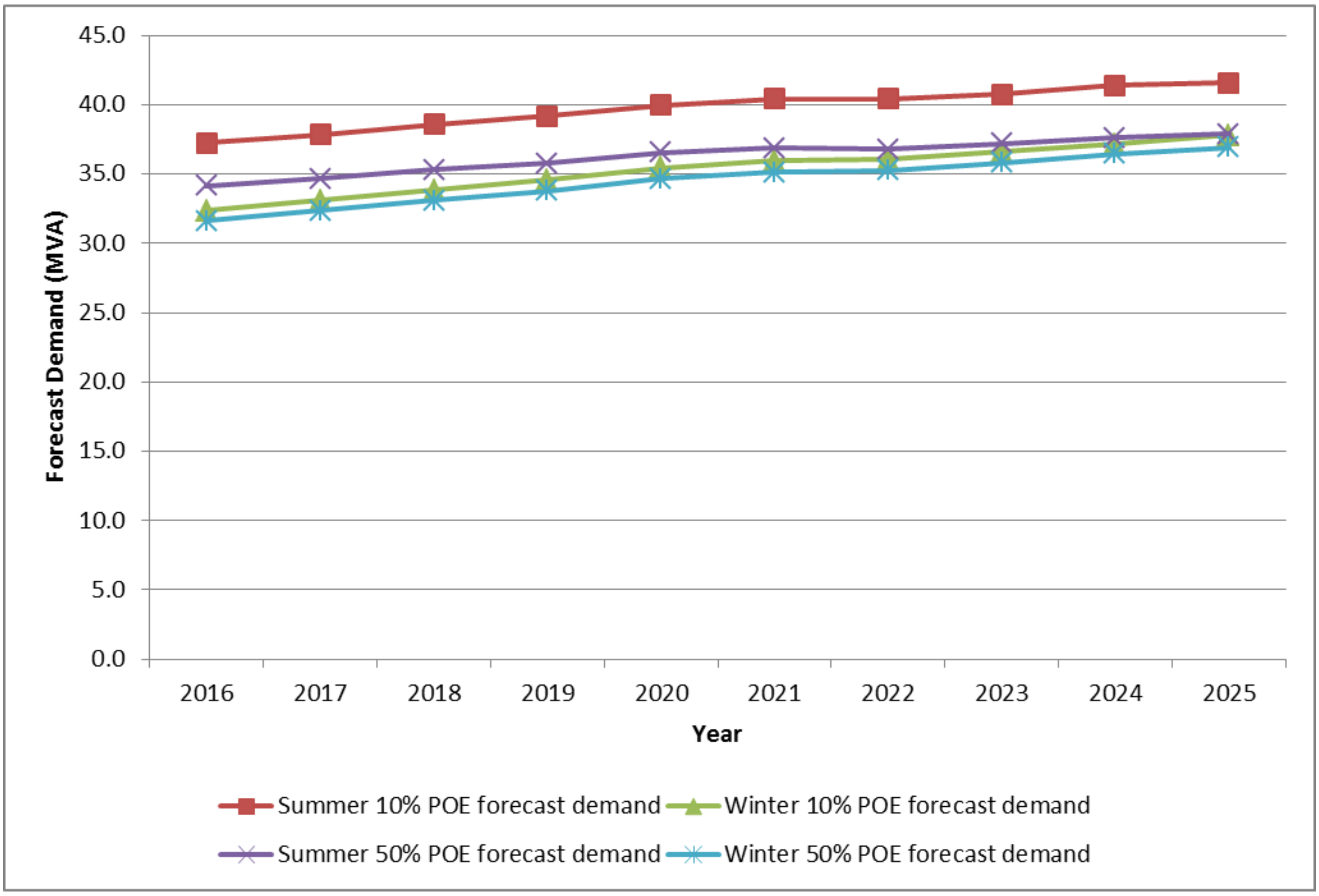
- Demand forecasts;
- Network asset ratings; and
- Network outage rates.

4.1 DEMAND FORECASTS

For the base (medium) scenario, demand forecasts have been based on the 2015 Load Demand Forecasts Report. Under this scenario, demand at FT is forecast to increase by approximately 1.5% per annum.

Figure 4–1 shows the forecast summer and winter maximum demand for the base scenario 10% POE and 50% POE conditions.

Figure 4–1: Forecast summer peak demand



4.2 NETWORK ASSET RATINGS

In planning our network, Jemena applies a summer and winter rating to its temperature sensitive assets, which provides some recognition of the difference in ambient temperature between the two seasons and the heating effect that the ambient temperature has on an asset's rating.

Jemena also applies a cyclic rating to its transformers. This allows the FT transformers to be loaded up to 116% of their normal summer rating for an extended period under emergency outage conditions.

The cyclic rating relies on the fact that asset loading is not constant over time, but that it cycles between the peak and some lesser loading level, allowing the assets time to dissipate heat and avoid long term heating overloads. Although cyclic ratings can be used for prolonged emergency periods, some loss of life occurs, and each twenty-four hour period that a transformer is loaded at its cyclic rating will result in a 0.03% reduction in the transformer's life expectancy.

The Flemington Zone Substation asset ratings are outlined in Table 4–1 through to Table 4–5.

Table 4–1: FT Zone Substation transformer ratings

Station asset	Continuous summer rating (MVA)	N-1 cyclic summer rating (MVA)	Continuous winter rating - (MVA)	N-1 cyclic winter rating (MVA)
No.1 66/11 kV transformer	30.0	34.8	30.0	34.8
No.2 66/11 kV transformer	30.0	34.8	30.0	34.8

Note: winter cyclic transformer ratings have been assumed equal to the summer ratings

Table 4–2: FT Zone Substation 11 kV transformer cable ratings

Station asset	Continuous summer rating (A)	Continuous summer rating (MVA)	N-1 short-term emergency overload rating (A)	N-1 short-term emergency overload rating (MVA)
No.1 11 kV transformer cable	1254	23.9	1668	31.8
No.2 11 kV transformer cable	1254	23.9	1668	31.8

Table 4–3: FT Zone Substation 11 kV bus ratings

Station asset	Summer rating (A)	Summer rating (MVA)
No.1 11 kV bus	1600	30.5
No.2 11 kV bus	1600	30.5

Table 4–4: FT Zone Substation circuit breaker ratings

Circuit Breaker (CB)	Continuous rating (A)	Continuous rating (MVA)
FT01 11 kV feeder CB	400	7.6
FT02 11 kV feeder CB	400	7.6
No.1 11 kV capacitor CB	600	11.4
FT04 11 kV feeder CB	800	15.2
FT05 11 kV feeder CB	400	7.6
FT06 11 kV feeder CB	400	7.6
No.1 11 kV transformer CB	1600	30.5
No.1-2 11 kV bus-tie CB	1200	22.9
FT09 11 kV feeder CB	400	7.6
FT10 11 kV feeder CB	400	7.6
No.2 11 kV capacitor bank CB	600	11.4
No.2 11 kV transformer CB	1600	30.5
FT13 11 kV feeder CB	400	7.6

Circuit Breaker (CB)	Continuous rating (A)	Continuous rating (MVA)
FT14 11 kV feeder CB	400	7.6
FT15 11 kV feeder CB	400	7.6

Table 4–5: FT Zone Substation 11 kV feeder ratings

Feeder	Summer rating (A)	Winter rating (A)	Summer rating (MVA)	Winter rating (MVA)
FT-01	375	375	7.1	7.1
FT-02	260	295	5.0	5.6
FT-04	590	590	11.2	11.2
FT-05	345	375	6.6	7.1
FT-06	180	255	3.4	4.9
FT-09	300	300	5.7	5.7
FT-10	375	375	7.1	7.1
FT-13	375	375	7.1	7.1
FT-14	375	375	7.1	7.1
FT-15	345	385	6.6	7.3

4.3 NETWORK OUTAGE RATES

In using a probabilistic economic planning methodology, the network outage rates applied in assessing limitation costs and benefits of augmentation can have a large impact on the optimal augmentation timing.

In assessing the cost of expected unserved energy due to the identified FT limitations, Jemena has considered the potential failure of the WMTS-FT 66 kV supply lines and the FT 66/11 kV transformers.

Supply line outage rates have been based on the number of sustained outages recorded over the seventeen year period between 1997 and 2013. During this period the two WMTS-FT 66 kV lines each suffered six sustained outages. The mean time to repair a sustained line outage is estimated at three hours per outage, which is based on the historical average time taken to repair a 66 kV line outage within the Jemena electricity network. Despite their inconvenience to Jemena and our customers, momentary outages were excluded from the limitation cost assessments due to their short duration and therefore limited impact on unserved energy.

66 kV line outages were included because, due to the station switching arrangement, a 66 kV line outage will also result in loss of a transformer, thereby limiting the station's supply capacity to its 'N-1' rating, which, due to the existing 11 kV transformer cable capacity limitations, is currently 23.9 MVA.

Transformer outages are much less common than line outages, and are therefore based on historical averages across the entire Jemena electricity network, rather than being based only on the two transformers at FT. This approach is supported by the fact that, despite being 45 years of age, condition monitoring tests suggest that the FT transformers are currently in very good condition. For this assessment, applying a higher, aged based, failure rate would not truly represent their expected failure rate, and would likely overestimate the network risk.

Historically, each transformer in Jemena's network is expected to fail once in every one hundred years. Due to procurement lead times and the typical work involved in repairing a transformer, the mean time to repair a transformer averages 2.6 months.

Despite the 11 kV switchboard condition tests showing significant insulation deterioration of the bus and circuit breakers (see Section 3.2.3), outage or failure of an 11 kV switchboard asset has been excluded from this assessment for the following reasons:

- Since the system normal and network outage capacity of FT is much lower than the zone substation's forecast demand, asset condition is not the primary driver of the need to augment the substation's capacity.
- An individual feeder circuit breaker outage is typically very short in duration and can often be managed by transferring load to adjacent feeders, and therefore won't alter selection of the option to address the zone substation capacity constraint.

Table 4–6 shows the network outage rates applied in calculating the expected unserved energy for the options analysis included in this report.

Table 4–6: Network outage rates

	Transformer	Supply line
Probability of failure	0.01	0.35
Mean time to repair (h)	1898	3
Number of assets	2	2
Unavailability rate	0.433%	0.024%
Combined unavailability per annum	0.457%	

5. SUMMARY OF SUBMISSIONS

On 23 October 2015 Jemena published Stage 1 of the Flemington Electricity Supply RIT-D, the non-network options report. The purpose of the non-network options reports was to commence engagement and encourage an open dialogue with non-network proponents in relation to the network capacity constraint associated with the Flemington Zone Substation electricity supply area, and to ensure the best solution is adopted to manage the network capacity constraints in the area, whether those solutions involve a network or non-network or hybrid solution.

As required under the National Electricity Rules (NER), the non-network options report was open for a consultation period of three months. Submissions closed on 29 January 2016.

Jemena received two submissions to the non-network options report; one from GreenSync, which outlined a voluntary load reduction demand side management proposal, the other from ZECO Energy, which provided indicative battery storage costs for a containerised battery energy storage solution at the street substation and/or zone substation level.

This section summarises the key aspects of the two non-network options report submissions.

5.1 GREENSYNC'S DEMAND MANANGEMENT PROPOSAL

GreenSync's submission proposes a partnered solution between Jemena and GreenSync to address the Flemington electricity supply constraint. The proposal includes two key components:

- Deployment of GreenSync's PortfolioCM™ technology, which is a platform designed to give Jemena control and visibility of portfolio enrolled demand side management (DSM); and
- Enrolment of a diverse DSM portfolio through engagement with company partners within the local Flemington area community.

5.1.1 CONSTRAINT MANAGEMENT PLATFORM

GreenSync's PortfolioCM™ is a cloud based software service designed to allow utilities to access and leverage DSM to smooth out network peaks, and increase long term network utilisation. Deploying the GreenSync PortfolioCM™ platform would give Jemena the capability to monitor constrained network elements to accurately predict when and where constraints exist, and dispatch DSM assets at minimum cost to maintain network security.

Once enrolled in the PortfolioCM™ platform, commercial and industrial (C&I), small business, utility and residential programs would create a holistic, integrated solution giving Jemena control and visibility of the DSM portfolio. The PortfolioCM™ technology allows the most economic dispatch of enrolled DSM assets weather via voluntary load reduction of enrolled C&I, water utility or residential customers, or demand response via battery systems enrolled in the portfolio.

GreenSync's proposal provides Jemena with the opportunity to manage the energy at risk until the network augmentation can be implemented, or to defer the proposed network augmentation. The proposal is flexible in duration and the level of load or batteries enrolled. It allows for additional DSM enrolment in the future by Jemena, GreenSync or a third party, and will allow the integration of a DSM solution with the proposed preferred network option to maximise the net market benefit.

For the purposes of project costing, GreenSync provided annual PortfolioCM™ licencing and other associated costs, which have been included in cost-benefit analysis but are not separately reported as they are commercial in confidence.

5.1.2 DSM PORTFOLIO

While their core business is around deployment, training and support of the PortfolioCM™ platform, as part of their RIT-D submission GreenSync has also engaged with solution partners, including AGL, Living Fundraisers, and the local Flemington community, to develop a diverse portfolio of DSM that could be enrolled within the Flemington Zone Substation supply area.

GreenSync identified four key client groups in the area; storage opportunities, small businesses, commercial and industrial, and residential groups. The portfolio of customers that expressed interest in participating in DSM, and that GreenSync considers as being either committed or that are expected to commit, include commercial and industrial load (C&I) and small to medium enterprises (SME). Based on their engagement, GreenSync has developed a committed and expected DSM portfolio that increases from 6.75 MW in 2016 to 7.25 MW in 2017, 2018 and beyond. The portfolio customer split is shown in Table 5–1.

Table 5–1: GreenSync committed and expected DSM Portfolio

Customer Category	Load Available by Year		
	2016	2017	2018 and beyond
C&I (Fast Response)	4,000	4,500	4,500
SME	250	250	250
C&I (Day Prior)	2,500	2,500	2,500
Total	**6,750**	**7,250**	**7,250**

As shown in Table 5–1, GreenSync's proposed portfolio includes both fast response and day prior C&I customers. Fast response typically utilises automation to control or trip off the DSM enrolled customer's assets, and would be contracted to operate within an hour. Fast response requires the installation of hardware at the customer's site, and can be useful for managing network loading immediately following a network contingency. Day prior response typically involves an automated messaging service directing the portfolio enrolled customer to ramp down or disconnect their load. It requires a twenty-four hour prior notification based on the day-ahead demand forecast, and is therefore more useful for managing system normal constraints where demand can accurately be predicted; typically where demand and ambient temperature are highly correlated.

Fast response customers would be paid a premium upfront capacity fee to incentivise participation. Day prior enrolled customers would be paid a lower upfront capacity fee, but receive higher energy curtailment (dispatch) fees if and when their load reduction services are called on. In their submission, GreenSync provided indicative capacity fees ($/kW) and dispatch fees ($/kWh) for each customer category. These costs have been applied in the cost-benefit analysis but are not separately reported as they are commercial in confidence.

In addition to the customer payments and the PortfolioCM™ licencing and management costs, GreenSync also provided an indicative, once off, project and portfolio establishment cost, which has also been included in the cost-benefit analysis.

As part of their submission, GreenSync engaged AGL and Living Fundraisers to increase the potential residential and small to medium enterprise portfolio recruitment and event participation during DSM events. In the submission, AGL noted its commitment to expanding its battery storage program to the Flemington area, which would involve installing 6 kWh battery storage devices at residential and small to medium enterprise premises, to be controlled by the GreenSync PortfolioCM™ platform. Living Fundraisers noted their commitment to engaging with and incentivising the community to promote DSM enrolment and participation during DSM events. No battery storage costs or committed and expected customer enrolment volumes were included in the submission.

GreenSync's submission demonstrated that their DSM proposal would provide a positive net market benefit relative to the do nothing scenario, and that enrolment prior to commissioning the preferred network augmentation option would maximise the net market benefit.

Based on portfolio and cost information provided in GreenSync's submission, Jemena has assessed DSM solutions, as presented in Section 8.

5.2 ZECO ENERGY'S BATTERY STORAGE PROPOSAL

ZECO Energy is an energy storage provider and distributor of Samsung's residential and commercial energy storage products.

ZECO Energy's submission, prepared jointly with turnkey project service provider BMC Group, broadly outlines two battery energy storage solutions (BESS) that may address the identified need:

- BESS kiosk cabinets – are designed to connect to the low voltage terminals of Jemena's substation kiosk transformers. Multiple kiosk cabinets could be located throughout the Flemington supply area to reduce localised loading throughout the supply area, thereby reducing the overall zone substation peak load.
- Containerised BESS – is designed as a larger capacity, larger footprint solution. Containers could be located within Flemington Zone Substation to reduce peak loading directly at the zone substation.

Each BESS is designed as a fully integrated system, with each cabinet or container housing the:

- power conversion system;
- Samsung SDI batteries;
- battery trays and racks;
- battery management system/s; and
- switchgear, cables and connectors

ZECO Energy's submission did not identify specific battery installation quantities or proposed specific connection locations, nor did it attempt to quantify market benefits of a battery storage solution.

While their submission did include battery technology information and indicative costs for supply and installation of their BESS kiosk cabinets and containers, ZECO Energy has requested that the bulk of their submission remain commercial in confidence. As such, much of the submission detail has been omitted from this assessment report.

Jemena has assessed battery storage market benefits based on information supplied in ZECO Energy's submission, battery technology information publically available on Samsung's website, and typical battery energy storage solution costs. Jemena's assessments are presented in Section 8.

6. OPTIONS CONSIDERED IN THE RIT-D

This section outlines the credible options that have been considered in the RIT-D, and outlines the proposed works associated with each credible option.

Since publishing the non-network options report we have undertaken preliminary design work to firm up the feasibility and deliverability of the identified network options. With this work we have expanded the network options presented in the Stage 1 report, and included the option of upgrading the existing 11 kV transformer cables in the existing cable conduits.

We have also included additional hybrid network/non-network options based on the proposals and information outlined in submissions to the non-network options report consultation.

The complete list of credible options considered in this RIT-D is:

- Option 1a - Upgrade 11 kV transformer cables and 11 kV switchboards, and install a third 11 kV switchboard (in new switch-room building) in 2018;
- Option 1b - Upgrade 11 kV transformer cables and 11 kV switchboards, and install a third 11 kV switchboard (in existing switch-room building) in 2018;
- Option 1c - Upgrade 11 kV transformer cables and 11 kV switchboards (in new switch-room building) in 2018;
- Option 1d - Upgrade 11 kV transformer cables and 11 kV switchboards (in existing switch-room building) in 2018;
- Option 2 - Rebuild Flemington Zone Substation in 2018;
- Option 3 - Establish a new zone substation to upgrade FT in 2018;
- Option 4 - Install a third 66/11 kV transformer (in existing switch-room building) in 2018;
- Option 5a - Enrol DSM of 7.25 MVA in 2018, with commissioning of network Option 1b delayed to 2019;
- Option 5b - Install 7.25 MVAh of battery storage in 2018, with commissioning of network Option 1b delayed to 2019;
- Option 6 - Upgrade 11 kV transformer cables (in existing switch-room building) in 2018; and
- Option 7 - Upgrade 11 kV transformer cables and 11 kV transformer circuit breakers (in existing switch-room building) in 2018.

The post augmentation capacities of the network options are summarised in Table 6–1.

Table 6–1: Post augmentation capacities of network options

Augmentation option	N summer capacity	N winter capacity	N-1 summer capacity	N-1 winter capacity
Base Case - Do Nothing	30.5	30.5	23.9	26.3
Option 1a - Upgrade 11 kV transformer cables and 11 kV switchboards and install a third 11 kV switchboard (in new switch-room building)	45.0	45.0	34.8	34.8
Option 1b - Upgrade 11 kV transformer cables and 11 kV switchboards and install a third 11 kV switchboard (in existing switch-room building)	45.0	45.0	34.8	34.8
Option 1c - Upgrade 11 kV transformer cables and 11 kV switchboards (in new switch-room building)	45.0	45.0	34.8	34.8
Option 1d - Upgrade 11 kV transformer cables and 11 kV switchboards (in existing switch-room building)	45.0	45.0	34.8	34.8
Option 2 - Rebuild Flemington Zone Substation	47.6	47.6	38.0	38.0
Option 3 - Establish a new zone substation to upgrade FT	47.6	47.6	38.0	38.0
Option 4 - Install a third 66/11 kV transformer (in existing switch-room building)	61.0	61.0	30.5	30.5
Option 6 - Upgrade 11 kV transformer cables (in existing switch-room building);	30.5	30.5	30.5	30.5
Option 7 - Upgrade 11 kV transformer cables and 11 kV transformer circuit breakers (in existing switch-room building);	30.5	30.5	30.5	30.5

The load reduction demand side management and battery energy storage solution for the Option 5 hybrid network/non-network solutions are summarised in Table 6–2. These capacities can effectively be considered as a reduction in the forecast demand, rather than an increase in the supply capacity.

Table 6–2: Post implementation DSM capacities of hybrid network/non-network options

Augmentation option	Demand reduction capacity (MVA)	Battery storage capacity (MVAh)	Power converter capacity (MVA)	Network capacity increase (MVA)
Option 5a - Enrol DSM of 7.25 MVA in 2018, with commissioning of network Option 1b delayed to 2019	7.25	-	-	As per Option 1b (delayed to 2019)
Option 5d - Install 7.25 MVAh of battery storage in 2018, with commissioning of network Option 1b delayed to 2019	-	7.25	7.25	As per Option 1b (delayed to 2019)

6.1 BASE CASE – DO NOTHING

The assessment of credible options is based on a cost-benefit analysis that considers the future expected unserved energy of each credible option compared with the base case, where no augmentation option is implemented.

Under this base case – Do Nothing option, the action required to ensure that loading levels remain within the capabilities of assets is involuntary load shedding of Jemena's customers. The cost of involuntary load shedding is calculated using the value of customer reliability (VCR) which, for the Jemena electricity network, is currently estimated at $39,463/MWh (Real $2016), as described in Section 7.3.1.1.

The 'Base Case – Do Nothing' option gives the basis for comparing the cost-benefit assessment of each credible option. The base case is presented as a do nothing option, where we would continue managing network asset loading through involuntary load shedding without initiating any augmentation project.

Since there is no augmentation associated with the 'Base Case - Do Nothing' option, this is a zero cost option.

6.2 OPTION 1 – NEW FLEMINGTON ZONE SUBSTATION 11 KV ASSETS

This option is to upgrade the thermally limited 11 kV assets at FT by installing new, higher capacity, 11 kV transformer cables and 11 kV switchboards.

Four alternative sub-options are considered under Option 1. The four options have the common works of upgrading the 11 kV transformer cables and two existing 11 kV switchboards, but differ as follows:

- Option 1a - is for the common works in a new switch-room building and also includes installing a third 11 kV switchboard, commissioned in 2018.
- Option 1b - is for the common works in the existing switch-room building and also includes installation of a third 11 kV switchboard, commissioned in 2018.
- Option 1c - is for the common works in a new switch-room building, commissioned in 2018.
- Option 1d - is for the common works in the existing switch-room building, commissioned in 2018.

6.3 OPTION 2 – REDEVELOP FLEMINGTON ZONE SUBSTATION

This option is to completely redevelop Flemington Zone Substation at the existing site, with commissioning in 2018.

The proposed scope of work for Option 2 includes redevelopment of FT with:

- Installation of a new indoor 11 kV switch-room building;
- Installation of three new 11 kV switchboards;
- Installation of two new 11 kV transformer cables;
- Installation of 66 kV gas insulated switchgear; and
- Installation of two new 20/33 MVA transformers.

6.4 OPTION 3 – ESTABLISH A NEW ZONE SUBSTATION

This option is to establish a new Flemington Zone Substation, commissioned in 2018, at an alternative site in the Flemington area and decommission, demolish, clean-up and sell the existing site. The proposed scope of work for Option 3 includes:

- Purchase land for a new zone substation in the Flemington area;
- 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;
- 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 existing protection and communication circuits to the new zone substation; and
- Demolish, clean-up and sell the existing FT site.

6.5 OPTION 4 – INSTALL A THIRD 66/11 KV TRANSFORMER

This option is to install a third 66/11 kV transformer in the existing switch-room building, with commissioning in 2018.

The proposed scope of works for Option 4 includes:

- Installation of a new 66/11 kV 20/33 MVA transformer;
- Installation of a third 11 kV switchboard; and
- Installation of two 66 kV bus-tie circuit breakers, and associated 66 kV works.

6.6 OPTION 5 – EMBEDDED GENERATION AND DEMAND SIDE MANAGEMENT

This option is to utilise embedded generation or establish demand side management to reduce peak demand on the 11 kV transformer circuit breakers and cables at Flemington Zone Substation.

Jemena currently has no significant embedded generators (>1 MW) connected to the Flemington, Essendon or North Essendon feeders or zone substations that could be used to defer the need for the proposed preferred solution. As such, the option of contracting embedded generation for network support during hours of peak demand is not considered to be a credible option.

Demand side management, such as voluntary load reduction or battery energy storage, can alleviate supply risks caused by network inadequacies by reducing and/or shifting the peak demand. The resulting reduction in peak demand can potentially defer the need for major network augmentation, or help to better manage the risk until a major network augmentation can be commissioned or is economically feasible.

Due to the limiting assets associated with the identified need, demand side management would need to be connected to, or downstream (demand side) of, FT’s 11 kV buses to effectively offload the 11 kV transformer circuit breakers and cables.

Based on the non-network options report submissions received from GreenSync and ZECO Energy, as outlined in Section 5, Jemena has assessed hybrid network/non-network options that include voluntary load reduction or battery energy storage solutions.

The two alternative sub-options considered under Option 5 include:

- Option 5a - deploy GreenSync's PortfolioCM™ platform and enrol DSM of 7.25 MVA in 2018, with commissioning of network Option 1b delayed to 2019.
- Option 5b - install a battery energy storage system (BESS) comprising 7.25 MVAh capacity of battery storage and a 7.25 MVA power converter in 2018, with commissioning of network Option 1b delayed to 2019.

6.7 OPTION 6 – UPGRADE 11 KV TRANSFORMER CABLES (IN EXISTING SWITCH-ROOM BUILDING)

This option is to upgrade the existing 11 kV transformers cables by removing the existing cables and installing higher capacity cables within the existing cable conduits, with commissioning in 2018.

This option was previously not considered in detail due to suspected safety and constructability issues with upgrading the existing 11 kV transformer cables in the existing switch-room building. Following additional assessment and preliminary design work undertaken since publishing the Stage 1 report, we have gained confidence that using the existing cable conduits and upgrading the 11 kV cables in the existing building is high-risk but possible.

To achieve the required thermal capacity, larger than standard cables would need to be installed in the existing, smaller than standard, cable conduits. While this poses installation challenges, it has been identified that there is a sufficiently large bending radius and sufficiently small pulling tension to install the required cables to achieve the desired capacities.

This option would not address the 11 kV transformer circuit breaker thermal limitation or the 11 kV bus thermal limitations.

6.8 OPTION 7 – UPGRADE 11 KV TRANSFORMER CABLES AND CIRCUIT BREAKERS (IN EXISTING SWITCH-ROOM BUILDING)

This option is to upgrade the existing 11 kV transformer cables and the existing 11 kV transformer circuit breakers without upgrading the entire 11 kV switchboards, with commissioning in 2018.

Jemena has obtained indicative cost estimates to upgrade the existing 1600 A transformer circuit breakers with 2000 A circuit breakers. While the cost estimates indicate that upgrading is likely viable, a network outage would be required to measure the location and fittings arrangement of the existing circuit breaker to ensure an upgrade is possible and to provide a firm cost estimate. It is also noted that space and heating constraints may prevent a higher capacity circuit breaker from being installed, however this cannot be confirmed without a network outage and detailed design work.

This option would not address the 11 kV bus thermal limitations.

7. MARKET BENEFIT ASSESSMENT METHODOLOGY

This section outlines the methodology that Jemena has applied in assessing market benefits associated with each of the credible options considered in this RIT-D. It describes how the classes of market benefits have been quantified, and outlines why particular classes of market benefits are considered inconsequential to the outcome of this RIT-D.

It also describes the reasonable scenarios considered in comparing the base case ‘state of the world’ to the credible options considered.

The RIT-D has been assessed over a fourteen year period. Market benefits were calculated for the first nine years (2017-2025), based on Jemena’s 2015 load demand forecasts, and the ninth year benefits were applied to each of the final five years (2026-2030) of the assessment period. This allows a longer assessment period without the need to develop longer term demand forecasts.

7.1 MARKET BENEFIT CLASSES QUANTIFIED FOR THIS RIT-D

This section outlines the classes of market benefits that Jemena considers will have a material impact on this RIT-D, and has therefore quantified.

The classes of market benefits quantified for this RIT-D include changes in:

- Involuntary load shedding and customer interruptions;
- Voluntary load curtailment; and
- Timing of the expenditure.

7.1.1 INVOLUNTARY LOAD SHEDDING AND CUSTOMER INTERRUPTIONS

Involuntary load shedding is where a customer’s load is interrupted (switched off or disconnected) from the network without their agreement or prior warning. Involuntary load shedding can occur unexpectedly, due to a network outage event, or pre-emptively, to maintain network loading to within asset capabilities. The aim of a credible option, such as demand side management or a network capacity augmentation, is to provide a change in the amount of involuntary load shedding expected.

A reduction in involuntary load shedding, relative to the Base Case, results in a positive contribution to the market benefits of the credible option being assessed. The involuntary load shedding cost of a credible option is derived by:

- The quantity (in MWh) of involuntary load shedding required assuming the credible option is completed, multiplied by
- The value of customer reliability (in $/MWh), which Jemena has calculated to be $39,436/MWh based on AEMO’s Value of Customer Reliability review[3].

Jemena forecasts and models hourly load for the forward planning period, and quantifies the expected unserved energy (involuntary load shedding) by comparing forecast load to network capabilities under system normal and network outage conditions.

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

Jemena has captured the reduction in involuntary load shedding as a market benefit of the credible options assessed in this RIT-D. The costs have been included in the net economic benefit assessments summarised in Section 8.

7.1.2 VOLUNTARY LOAD CURTAILMENT

Voluntary load curtailment is where a customer/s agrees to voluntarily curtail their electricity under certain circumstances, such as high network loading or during a network outage event. The customer will typically receive an agreed payment for making load available for curtailment, and for actually having it curtailed during a network event. A credible demand-side reduction option leads to a change in the amount of voluntary load curtailment.

An increase in voluntary load curtailment, compared to the Base Case, results in a negative contribution (a cost) to the market benefits of the credible option. This negative market benefit is derived by:

- The quantity (in MWh) of voluntary load shedding (demand side reduction) due to the credible option being assessed, multiplied by
- The payment (in $/MWh) made to the customer for voluntarily curtailing their load, plus
- Any availability fee (in $) made to the customer for making their load available for curtailment.

Jemena forecasts and models hourly load for the forward planning period and quantifies the expected voluntary load shedding by summating the available demand side reduction required to service that load under system normal and network outage conditions.

Despite being a market cost, voluntary load curtailment can form a credible option, having positive market benefits, by taking the place of higher priced involuntarily load curtailment.

Jemena has captured the expected voluntary load shedding and scheme management fees as operational costs of the demand side management programs assessed in this RIT-D. The operational costs are added to the capital cost to establish the scheme and enrol customers. These costs have been included in the net economic benefit assessments summarised in Section 8.

7.1.3 TIMING OF EXPENDITURE

The long term costs of credible options assessed in this RIT-D include all the major works at Flemington Zone Substation that are currently considered likely within the fourteen year period of 2017-2030. The costs used to rank credible options are the total lifecycle cost of each credible option, rather than just the immediate project works that this RIT-D is aiming to justify.

Depending on the scope of immediate project works, the timing of some future works vary between credible options. For example, under Option 1b it is proposed to install new 11 kV switchboards in 2018 to meet the thermal capacity requirements at Flemington Zone Substation. Option 4, however, addresses the thermal capacity constraint by installing a third 66/11 kV transformer, rather than new 11 kV transformer cables and switchboards. Since the 11 kV switchboards are expected to require replacement by 2021, due to their deteriorated condition, Option 4 includes the future replacement costs of the 11 kV switchboards in 2021, in addition to the immediate transformer installation cost in 2018.

By modelling the expected future costs under each credible option, Jemena has captured potential changes in expenditure timing between the various credible options. These market costs, and any associated benefits, are captured in the NPV analysis and applied to the credible option rankings outlined in Section 8.

7.2 MARKET BENEFIT CLASSES NOT RELEVANT TO THIS RIT-D

This section outlines the classes of market benefits that Jemena considers immaterial to this RIT-D assessment, and our reasoning for their omission in this RIT-D assessment.

The market benefits that Jemena considers will not materially impact the outcome of this RIT-D assessment include changes in:

- Costs to other parties;
- Load transfer capacity and embedded generators;
- Option value; and
- Electrical energy losses.

7.2.1 COSTS TO OTHER PARTIES

The FT capacity constraint is a localised thermal capacity limitation that radially supplies Flemington and its surrounding suburbs. The network limitations are downstream of the transmission network and neither the zone substation nor its high voltage feeders supply or connect to networks of other parties. As such, none of the credible options are expected to have a material impact on any surrounding areas or on the network development plans of any other network participants or other parties. Jemena has therefore not attempted to quantify any market benefits associated with costs to other parties.

7.2.2 CHANGES IN LOAD TRANSFER CAPACITY AND EMBEDDED GENERATORS

Load transfer capacity between Flemington, Essendon and North Essendon zone substations is predominately limited by the high voltage feeders that connect between the three zone substations. Options that address the capacity constraints directly at Flemington Zone Substation won't change feeder or load transfer capacities. Options that could result in a load transfer capacity change are those that address capacity limitations along, or downstream of, the high voltage feeders. This could include feeder augmentations or reconfigurations, demand side management or embedded generation.

As outlined in Section 6.6, Jemena currently has no significant embedded generators (>1 MW) connected to the Flemington, Essendon or North Essendon feeders or zone substations that could help address the identified need. Contracting embedded generation for network support is therefore not considered a credible option.

The identified need for this RIT-D is thermal limitations at Flemington Zone Substation. Jemena has not identified any credible high voltage feeder options that are capable of addressing the identified need.

For this RIT-D, the credible options that could result in a load transfer capacity change are those that include demand side reduction or distributed battery storage. Since constraint limitations at Essendon and North Essendon are currently insignificant compared to the Flemington Zone Substation constraints, any potential market benefit from increased load transfer capacities is likely to be immaterial to the options ranking for this RIT-D.

Additionally, Jemena's assessment of the market benefit for this RIT-D has been undertaken at the zone substation level. Assessing market benefits at the feeder level requires an added level of complexity that would likely exceed any potential additional benefit that may be identified. Jemena has therefore not attempted to quantify any market benefit associated with changes to the load transfer capacity or embedded generation.

7.2.3 OPTION VALUE

Jemena notes the AER's view that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the RIT-D proponent are sufficiently flexible to respond to that change.

We also note the AER's view that appropriate identification of credible options is capable of capturing any option value, thereby meeting the requirement to consider option value as a class of market benefit under the RIT-D.

In addition to appropriate identification of credible options, Jemena has undertaken sensitivity studies on the demand growth rate, value of customer reliability, discount rate, and credible option capital costs. Any calculation of option value benefit beyond this would require significant modelling, which is expected to be disproportionate to any additional option value benefit that may be identified. Jemena has therefore not attempted to estimate any additional option value market benefit for this RIT-D assessment.

7.2.4 ELECTRICAL ENERGY LOSSES

Reducing network utilisation, through network impedance or load changes, can result in a change in network losses.

The majority of the credible options considered in this RIT-D don't result in network impedance changes and are not expected to alter the forecast demand on Flemington Zone Substation. Most options are therefore not expected to result in any changes to the network losses. The credible options that can result in network loss changes are:

- Option 4, which involves installation of a third 66/11 kV transformer, and therefore is expected to result in a reduction in network losses.
- Options 5a and 5b, which involve in a reduction in the peak demand through demand side management.

To estimate any materiality of changes in network losses, Jemena calculated the network losses on the sub-transmission lines and the zone substation at the time of peak demand under the Do Nothing option, following installation of a third transformer, and following a peak demand reduction of 7 MW at Flemington Zone Substation. The network losses were calculated using PSSE load flow analysis with each of these three options modelled in turn.

Installing a third transformer at Flemington Zone Substation is expected to reduce the network losses by approximately 3.0% of the 2016 peak demand at FT (approximately 1 MW), compared to the Base Case network losses, whereas a 7 MW load reduction at Flemington Zone Substation is expected to reduce network losses by approximately 2.2% of the 2016 peak demand at FT (approximately 0.8 MW).

To estimate any market benefit of reducing network losses, the percentage change in network losses for each of the affected options can been multiplied by the change in expected unserved energy for that option and by the cost of network losses.

Since higher losses will result in additional generation dispatch to supply those loses, the cost of network losses is assumed to equal the average Victorian spot price for generation, which has been calculated at $50/MWh based on average Victorian spot price data from AEMO's website[4].

[4] AEMO: Average Victorian spot prices. Available http://www.aemo.com.au/Electricity/Data/Price-and-Demand/Average-Price-Tables

Due to the relatively small change in losses and the low cost of network losses compared to the expected unserved energy costs, changes in network losses are considered immaterial to the result of this RIT-D, and have therefore been excluded from the market benefit assessments summarised in Section 8.

7.3 VALUING MARKET BENEFITS

Clause 5.17.1 of the NER requires that the RIT-D assessment is based on a cost-benefit analysis that includes an assessment of reasonable scenarios of future supply and demand. Since this RIT-D is driven by electricity demand in a predominately radial network with minimal demand side generation, future supply developments are not expected to significantly impact the assessment results, preferred option or optimal timing.

For this RIT-D Jemena has elected to assess three alternative demand scenarios:

- No demand growth scenario;
- Base (planning) demand growth rate scenario; and
- High demand growth rate scenario.

The demand forecasts utilised for the base (planning) demand growth rate scenario are those of the 2015 Load Demand Forecasts Report. Under this scenario, demand at FT is forecast to grow at an average rate of approximately 1.5% per annum.

For the no demand growth scenario, Jemena has assumed no demand growth beyond the 2016 forecast demand.

For the high demand growth rate scenario, an annual growth rate of 3.0% has been applied.

In each of the three alternative demand scenarios, the summer and winter peak demand has been forecast for 10% POE and 50% POE conditions. In valuing market benefits for this RIT-D, the demand forecasts have been weighted 30% for the 10% POE demand forecasts and 70% for the 50% POE demand forecasts. The complete set of demand forecasts are tabulated in Appendix A.

7.3.1 SENSITIVITY ANALYSIS

There are three key inputs that could potentially vary the optimal timing or preferred option for mitigating the Flemington Zone Substation thermal capacity constraints. Sensitivity studies to these key inputs have been assessed under each of the reasonable scenarios outlined in Section 7.3. The preferred option is the one that maximises the present value of net economic benefit in the majority of reasonable scenarios and sensitivity studies.

The key variables applied in valuing the Flemington area limitations and economic benefits are outlined in this section, and include:

- value of customer reliability (VCR);
- discount rate; and
- project costs.

7.3.1.1 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 applies VCR values based on the Australian Energy Market Operator's (AEMO) 2014 Value of Customer Reliability Review[5]. Applying the sectorial values developed by AEMO to Jemena's load composition of approximately 47% commercial, 31% residential and 22% industrial customers, Jemena determined a VCR of $39,436/MWh (in 2016 Australian dollars), which includes an escalation factor of 1.33% to account for CPI from AEMO's 2014 to 2015 value, and 1.25% to account for CPI from the 2015 to 2016 value. This VCR of $39,436/MWh has been applied as the base VCR.

Sensitivities to this VCR of ±20% have been considered, resulting in a low VCR sensitivity of $31,549/MWh and a high VCR of $47,323/MWh.

7.3.1.2 Discount rate

A discount rate of 6.37% has been applied in undertaking the Net Present Value (NPV) assessment of credible options.

Although lower than Jemena considers appropriate for the analysis of a private enterprise investment in the electricity sector, this discount rate is based on the AER's approved weighted average cost of capital (WACC) for Jemena's electricity network in 2016.

Jemena has applied a sensitivity discount rate of 8.26%. This is in line with the rate proposed in Jemena's revised 2016-2020 electricity distribution price review (EDPR) submission. This sensitivity also accounts for uncertainty surrounding annual changes to the AER approved WACC.

7.3.1.3 Project costs

The network project capital costs have been estimated by Jemena's internal estimation teams. Consideration has been given to recent similar augmentation projects and expected costs based on site specific construction complexities and industry experience. These project estimates have been prepared for planning purposes and are therefore subject to an estimate range of ±30%, which has therefore been applied to the sensitivity studies for this RIT-D.

Operational costs for the network projects are estimated at 1.5% of capital cost per annum, and a

The program establishment capital costs and operational costs of the non-network options are based on information provided in the non-network options report submissions and industry available information. While estimate accuracy ranges for the non-network submissions were not provided, sensitivities of ±30% have also been applied to these costs for consistency with the network option sensitivity studies.

Project costs are generally presented in real $2015 or real $2016, as noted throughout the report. A consumer price index (CPI) rate of 2.5% per annum has been applied to the project works planned in later years.

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

8. OPTIONS ANALYSIS

This section presents the base case limitation and summarises the augmentation analysis results of potential options. The annualised Base Case (Do Nothing) limitation cost for the next nine year period is presented, as is the net economic benefit calculated for each potential option. The net economic benefit analysis has been assessed considering the network risk and expected augmentation costs for the fourteen year period from 2017 to 2030.

An emergency load transfer capacity away from FT, to neighbouring zone substations Essendon (ES) and North Essendon (NS), of 8.7 MVA is included in the expected unserved energy and cost of expected unserved energy values presented. While the load transfers can offload much of the expected unserved energy under emergency outage conditions, the assessment assumes these load transfers are not available to offload the system normal expected unserved energy. This assumption is made due to the additional risk that system normal load transfers would put on the adjacent zone substations and feeders, thereby only shifting the supply risk to another location within the network as opposed to actually mitigating it.

Each potential augmentation option has been ranked according to its net economic benefit, being the difference between the market benefit and the total lifecycle cost of expected augmentations within the fourteen year assessment period.

Appendix B includes the load at risk and economic assessment spreadsheets.

8.1 EXISTING NETWORK LIMITATIONS

This section presents the existing annualised thermal limitation cost for the next ten year period, due to the 11 kV transformer cable, bus and circuit breaker limitations.

8.1.1 BASE CASE

If no action is taken to increase the supply capacity or to voluntarily reduce the demand on Flemington Zone Substation (FT), involuntary load shedding would be required to ensure that loading levels remain within asset ratings under system normal and network outage conditions.

The impact of the limitation under the base case is presented in Table 8–1.

Table 8–1: Limitation impact under Base Case

Year	Max load at risk under system normal conditions (MVA)	Annual hours at risk under system normal conditions (h)	Weighted expected unserved energy (MWh)	Cost of weighted expected unserved energy ($k)
2017	7.3	115	99.9	$3,941
2018	8.1	160	149.1	$5,882
2019	8.7	220	215.3	$8,491
2020	9.5	303	342.5	$13,508
2021	9.9	360	429.6	$16,945
2022	9.9	371	442.7	$17,459
2023	10.2	436	566.4	$22,339

Year	Max load at risk under system normal conditions (MVA)	Annual hours at risk under system normal conditions (h)	Weighted expected unserved energy (MWh)	Cost of weighted expected unserved energy ($k)
2024	10.9	519	734.7	$28,977
2025	11.1	617	898.2	$35,427

8.2 EXISTING SUPPLY RISK MANAGEMENT

As presented in Table 8–1, there a significant amount of load at risk from 2017. This risk, and the resultant expected unserved energy, is predominately due to the forecast demand exceeding the system normal capacity of the zone substation. Rather than undertaking pre-contingent load shedding to manage a post contingent overload risk, Jemena currently manages this risk operationally by opening the 11 kV bus-tie circuit breaker at FT during peak demand periods (when demand exceeds 30 MVA). This operational arrangement effectively splits the zone substation into two electrically independent stations; each with one transformer, one bus, and five feeders.

While this 11 kV bus split arrangement allows each half of the zone substation to carry up to 23.9 MVA (transformer cable limit), for a total zone substation capacity of 47.8 MVA, the trade-off is an increased consequence if a network outage does occur. The zone substation effectively operates as two stations, and a sub-transmission line or transformer outage would therefore result in involuntary load shedding of half of the zone substation load. If an outage occurred at the time of peak demand in summer 2017, this would result in up to 18.9 MVA of customer load being shed.

Due to the additional post-contingent risk associated with the bus split, this operational arrangement is used as a temporary measure to manage risk until a permanent supply capacity solution can be economically justified and implemented. The reduction in expected unserved energy resulting from the bus split arrangement has therefore been omitted from the expected unserved energy calculations presented in Table 8–1 and the economic benefit calculations presented in Table 8–2.

The benefit of the bus split arrangement has been assessed in the detailed 2017 risk management assessment, and compared with the benefits of, and available expenditure on, demand management for managing the residual 2017 supply risk, as presented in Table 8–3.

8.3 ECONOMIC BENEFITS

Net economic benefits are the market benefits less the cost (negative benefit) to implement the credible option being considered.

Table 8–2 shows the proposed expenditure within the 2016-2020 period for each potential option, which is the direct project cost that this RIT-D is aiming to justify. It also presents the total lifecycle cost of each credible option, which is the expected expenditure over the 2016-2030 assessment period. Depending on works included in the 2016-2020 project, the 2016-2030 total lifecycle cost of each option includes the cost of future works such as new 11 kV switchboards in 2021 and replacement transformers in 2030. Using the total lifecycle cost to calculate the net economic benefit allows selection of the best longer-term network development plan, rather than just considering the short-term costs and benefits of the immediately required works.

The feasible options have been ranked based on their present value of net economic benefit, which is the total benefit provided over the 2016-2030 period, minus the total lifecycle cost (2016-2030) to implement and operate the credible option being considered.

Table 8–2: Market benefits of augmentation options relative to the base case

Augmentation option	2016-2020 project cost ($M, direct)	Total lifecycle project cost (2016-2030) ($M, direct)	NPV of net economic benefit ($M)	Project ranking
Base Case - Do Nothing	0.00	0.00	0.00	10
Option 1a - Upgrade 11 kV transformer cables and 11 kV switchboards and install a third 11 kV switchboard (in new switch-room building) in 2018	10.23	16.71	167.84	5
Option 1b - Upgrade 11 kV transformer cables and 11 kV switchboards and install a third 11 kV switchboard (in existing switch-room building) in 2018	6.53	12.60	171.95	1
Option 1c - Upgrade 11 kV transformer cables and 11 kV switchboards (in new switch-room building) in 2018	8.60	16.95	167.60	6
Option 1d - Upgrade 11 kV transformer cables and 11 kV switchboards (in existing switch-room building) in 2018	4.96	12.91	171.65	2
Option 2 - Rebuild Flemington Zone Substation in 2018	15.91	19.73	164.82	7
Option 3 - Establish a new zone substation to upgrade FT in 2018	41.03	45.59	138.96	9
Option 4 - Install a third 66/11 kV transformer (in existing switch-room building) in 2018	6.33	16.48	168.06	4
Option 5a - Enrol DSM of 7.25 MVA in 2018, with commissioning of network Option 1b delayed to 2019	7.79	13.86	170.68	3
Option 5b - Install 7.25 MVAh of battery storage in 2018, with commissioning of network Option 1b delayed to 2019	12.94	19.01	162.83	8
Option 6 - Upgrade 11 kV transformer cables (in existing switch-room building) in 2018	1.17	12.80	-12.65	11
Option 7 - Upgrade 11 kV transformer cables and 11 kV transformer circuit breakers (in existing switch-room building) in 2018	1.49	13.16	-13.01	12

The options analysis identifies that:

- Option 1b, upgrading the 11 kV transformer cables and switchboards, and installing a third 11 kV switchboard in the existing switch-room building, is the preferred network augmentation option; and
- As presented in Option 5a and Option 5b, engaging demand-side management services, either in the form of voluntary load reduction or a battery energy storage solution, does not defer the need for the preferred network augmentation.

Results of the detailed RIT-D and sensitivity analysis are included in Appendix B.

In addition to the long term options analysis presented in Table 8–2, a cost-benefit assessment for managing the supply risk prior to commissioning of the preferred network augmentation has also been undertaken. This assessment shows that continuing to open the 11 kV bus-tie circuit breaker during peak demand conditions maximises the net economic benefit and reduces the expected unserved energy in 2017 from $3.9 million to $712k. It also suggests that engaging load reduction demand side management up to a total expenditure of $712k, and providing up to 5.2 MVA of day ahead DSM or up to 18.9 MVA of fast DSM, in advance of the network augmentation and in addition to the bus split arrangement, can further reduce the residual expected unserved energy while providing a positive net economic benefit. Results of supply risk management option in advance of the network augmentation are presented in Table 8–3.

Table 8–3: Pre network augmentation supply risk management

Risk management option	Cost of weighted expected unserved energy ($)	Benefit ($)	Cost ($)	2017 net economic benefit ($)
Do Nothing	$3,941,365	-	-	-
Option 8a - Enrol DSM of 7.25 MVA in 2017	$4,540	$3,936,825	$1,735,075	$2,201,750
Option 8b - Open 11 kV bus-tie circuit breaker at FT when zone substation demand exceeds 30 MVA	$712,478	$3,228,887	-	$3,228,887

As a result of the options analysis, following consultation on this report Jemena will proceed with the final stage of the RIT-D, the Final Project Assessment Report (FPAR), and proposes to implement the preferred network augmentation, Option 1b, by August 2018.

To help manage the supply risk prior to commissioning the preferred network augmentation, Jemena will also:

- Continue its operational arrangement of opening the FT 11 kV bus-tie circuit breaker during peak demand conditions, which reduces the cost of expected unserved energy in 2017 from $3.9 million to $712k; and
- Engage GreenSync to provide a firm offer for a voluntary load reduction demand management solution to further manage the $712k of residual expected unserved energy in 2017, with an option to extend that engagement to 2018 to secure against potential construction delays associated with the proposed network augmentation. DSM expenditure of up to $712k, and providing up to 5.2 MVA of day ahead DSM or up to 18.9 MVA of fast DSM is expected to be beneficial.

Since the demand management solution will not defer the need for the preferred network augmentation, and will instead be designed to help manage the supply risk in advance of the network augmentation, Jemena intends to separate the demand management solution from further stages of this RIT-D, and will manage it as a stand-alone project. This will ensure the RIT-D can proceed in a timeframe that will allow commissioning of the preferred network augmentation by 2018, while providing Jemena and GreenSync sufficient time to work together on an appropriately sized and achievable demand management solution.

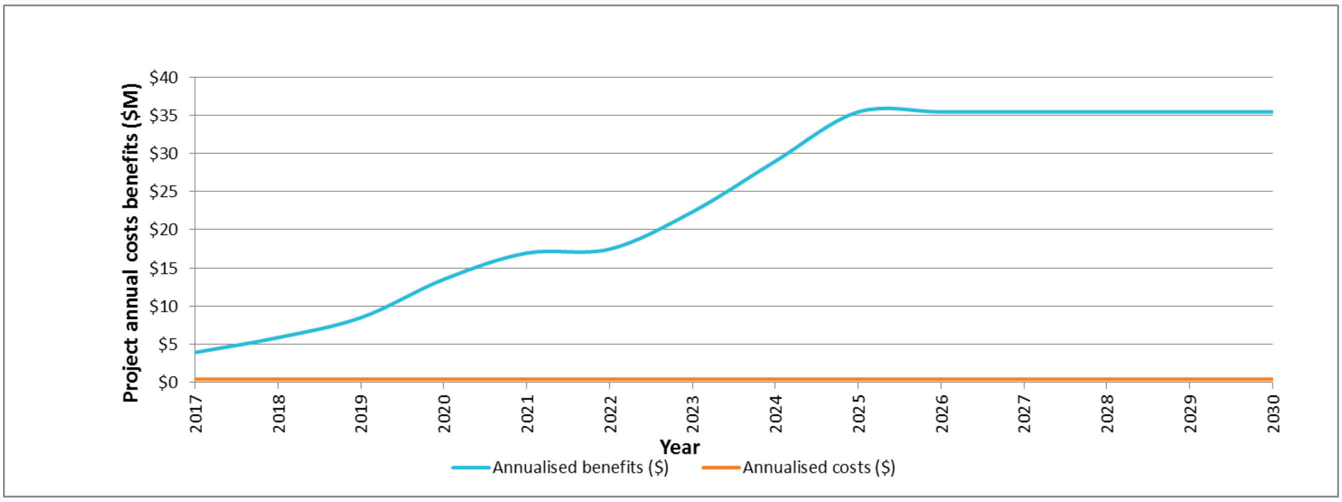
8.4 PREFERRED OPTION TIMING

The preferred timing for implementing Option 1b has been identified by taking the annualised augmentation market benefit (the change involuntary load shedding) associated with undertaking the proposed augmentation, and comparing this benefit to the annualised cost of establishing and operating the proposed network augmentation in 2018. The annualised capital cost of augmentation is calculated using the project costs within the 2016-2020 period, a project life of fifty years, and a discount rate of 6.37% per annum. The annualised cost calculation does not use the total lifecycle cost (2016-2030 costs) because this total lifecycle cost includes augmentation costs considered after the 2016-2020 period, which this RIT-D is not aiming to justify.

The annualised cost of the proposed preferred option, Option 1b, is $436k.

As shown in Figure 8–1, the annualised benefit exceeds the annualised costs and the optimal timing of the network augmentation is as soon as possible which, given project lead times, is expected to be by August 2018.

Figure 8–1: Annualised costs and benefits of Option 1a



9. CONCLUSION AND NEXT STEPS

The assessment outlined within this report shows that the primary limitations associated with Flemington Zone Substation (FT) is the thermal capability of the 11 kV transformer circuit breakers, 11 kV buses and the 11 kV transformer cables.

The condition of the 11 kV switchboards and 66/11 kV transformers are not considered to be primary drivers of the need to augment capacity at FT. The transformers are in very good condition for their age and are not showing any signs of insulation deterioration. While the switchboards have signs of deterioration, any additional augmentation benefits resulting from their condition are difficult to accurately quantify, and would be significantly outweighed by the demand driven risks and resulting benefits that have been assessed.

Following implementation of the proposed preferred solution, some residual risk will remain due to the thermal capacities of the existing transformers. However, based on the demand levels presented in the 2015 Load Demand Forecasts Report, this residual risk is considered to be economically manageable with the available load transfers until beyond 2021, at which stage the condition of the existing transformers will likely require review.

9.1 PREFERRED SOLUTION

The assessment shows that the preferred solution, Option 1b, is to upgrade the 11 kV transformer cables and 11 kV switchboards, and to install a third 11 kV switchboard, in the existing switch-room building by 2018.

Table 9–1 shows the total project cost breakdown for Option 1b. Applying the discount rate of 6.37% per year, this preferred solution has a net economic benefit of $171.95 million over the fourteen year assessment period.

Table 9–1: Option 1b - Cost estimate breakdown

	NPV project cost ($M Real2016)
Network augmentation capital cost	6.35
Network augmentation operational and maintenance cost	0.18
Total project expenditure (2016 – 2020)	**6.53**

Prior to commissioning the preferred solution, Jemena will continue managing the existing supply risk by opening the 11 kV bus-tie circuit breaker at Flemington Zone Substation. We will also engage GreenSync to provide a firm offer for a voluntary load reduction demand management solution for 2017, with an option to extend that engagement to 2018 to secure against potential construction delays associated with the proposed network augmentation. Based on the residual expected unserved energy, a demand management solution of up to $712k for the year is expected to provide a positive net economic benefit.

Table 9–2: 2017 supply risk management solution - Cost estimate breakdown

	NPV project cost ($M Real2017)
Open 11 kV bus-tie circuit breaker at FT when zone substation demand exceeds 30 MVA	-
Demand management capital and operational cost	0.71
Total expenditure (2017)	**0.71**

9.2 NEXT STEPS

Jemena invites written submission on this report from Registered Participants, interested parties, AEMO and non-network solution providers.

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 must be lodged with us on or before 31 January 2017.

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

Following our consideration of any submissions on this Draft Project Assessment Report, we will proceed to prepare a Final Project Assessment Report (FPAR). That report will include a summary of, and commentary on, any submissions to this report, and present the final preferred solution to address the Flemington Zone Substation thermal capacity constraint. Publishing the FPAR will be the third and final stage in the RIT-D process.

We intend to publish the Final Project Assessment Report by 10 February 2017.

APPENDIX A: MAXIMUM DEMAND FORECASTS

This Appendix A presents the maximum demand forecasts for Flemington Zone Substation. The base demand growth scenario has an average summer growth rate of 1.2% per annum and average winter growth rate of 1.7% per annum.

Table A–1: FT maximum demand forecasts (no demand growth scenario)

Year	Summer 50% POE demand (MVA)	Winter 50% POE demand (MVA)	Summer 10% POE demand (MVA)	Winter 10% POE demand (MVA)
2016	34.2	31.6	37.2	32.4
2017	34.2	31.6	37.2	32.4
2018	34.2	31.6	37.2	32.4
2019	34.2	31.6	37.2	32.4
2020	34.2	31.6	37.2	32.4
2021	34.2	31.6	37.2	32.4
2022	34.2	31.6	37.2	32.4
2023	34.2	31.6	37.2	32.4
2024	34.2	31.6	37.2	32.4
2025	34.2	31.6	37.2	32.4

Table A–2: FT maximum demand forecasts (base demand growth rate scenario)

Year	Summer 50% POE demand (MVA)	Winter 50% POE demand (MVA)	Summer 10% POE demand (MVA)	Winter 10% POE demand (MVA)
2016	34.2	31.6	37.2	32.4
2017	34.7	32.4	37.8	33.1
2018	35.3	33.1	38.6	33.8
2019	35.8	33.8	39.2	34.6
2020	36.6	34.7	40.0	35.4
2021	36.9	35.1	40.4	36.0
2022	36.8	35.2	40.4	36.1
2023	37.2	35.8	40.7	36.6
2024	37.6	36.4	41.4	37.1
2025	37.9	36.9	41.6	37.8

Table A–3: FT maximum demand forecasts (high demand growth rate scenario)

Year	Summer 50% POE demand (MVA)	Winter 50% POE demand (MVA)	Summer 10% POE demand (MVA)	Winter 10% POE demand (MVA)
2016	34.2	31.6	37.2	32.4
2017	35.2	32.6	38.4	33.3
2018	36.3	33.5	39.5	34.3
2019	37.3	34.5	40.7	35.4
2020	38.5	35.6	41.9	36.4
2021	39.6	36.6	43.2	37.5
2022	40.8	37.7	44.5	38.6
2023	42.0	38.9	45.8	39.8
2024	43.3	40.0	47.2	41.0
2025	44.6	41.2	48.6	42.2

APPENDIX B: ECONOMIC ASSESSMENT SPREADSHEETS

Load at risk assessments are included as Microsoft Excel spreadsheet attachments.

These spreadsheet attachments show the annual expected unserved energy, between 2017 and 2030, that would remain following implementation of each potential option considered, with the available 8.7 MVA emergency load transfer capacity included in the assessments.

The spreadsheet attachments include:

- RIT-D Cost-Benefit Assessment – Zero Growth Rate Scenario
- RIT-D Cost-Benefit Assessment – Medium Demand Growth Rate Scenario
- RIT-D Cost-Benefit Assessment – High Demand Growth Rate Scenario