Regulatory Investment Test for Distribution

Final Project Assessment Report

Emerald 66kV Network

This document describes the *identified need* for investment at Emerald, including the preferred option to address the identified need.

Publication Date: **30 November 2016**

Executive Summary

Ergon Energy Corporation Limited (Ergon Energy) is responsible (under its Distribution Authority) for electricity supply to the Emerald area in Central Queensland.

The Emerald town and adjoining rural area is supplied from a 66kV line from H015 Lilyvale bulk supply substation, and a 66kV line from T032 Blackwater bulk supply substation. Emerald maximum demand is presently 39.7MVA and is forecast to grow by approximately 1.7% per annum for the next 10 years. The existing 66kV network does not have sufficient capability to supply the forecast increased load at Emerald under system normal conditions, and voltage constraints may start to occur within 5 years.

Ergon Energy has also received connection enquiries from two major customers in the Emerald area. Connection of either customer will bring forward the date voltage constraints may start to occur such that additional network capability will be required before connection can be offered. More significant network augmentation, or an alternate connection point, would be required to supply both major customers.

None of the two 66kV feeders have sufficient capability to alone supply the peak load at Emerald. An outage on either feeder may therefore result in loss of supply to a portion of the load at Emerald. The potential load shedding may be as high as 16MVA for loss of the Lilyvale – Emerald Feeder, due to the comparatively low capability of the Blackwater – Emerald Feeder. In the event of a permanent fault on the Lilyvale line at times of high demand at Emerald, Ergon Energy would be at risk of breaching the Service Safety Net Targets in the Distribution Authority.

Ergon Energy published a Non-Network Options Report relating to the above described network constraints on 1 July 2015. One submission was received by the closing date of 2 October 2015. The submission provider proposed an embedded diesel power station, which has been included as a component of Option C below.

Three potentially feasible options have been investigated:

- **Option A:** Install 11MVAr of additional reactive compensation at Emerald Zone Substation, and upgrade the Blackwater – Emerald Feeder by 2019/20.
- **Option B:** Construct a new 66kV feeder from Blackwater – Emerald by 2019/20, including feeder bays at both locations.
- **Option C:** Deferral of the capital works in Option A till 2022/23 through embedded diesel generation.

Ergon Energy published a Draft Project Assessment report on 31 May 2016, where Ergon Energy provided a technical and economic analysis of the above three solution options. Written submissions to the Draft Project Assessment Report were invited. No submissions were received by the closing date of 29 July 2016.

This is now a Final Project Assessment Report, where Ergon Energy presents the technical and economic analysis of the above three solutions options, and identifies the preferred solution. Ergon Energy's preferred solution is Option A – to install additional reactive compensation at Emerald and to upgrade the Blackwater line. For reasons described in this report, the preferred solution, including its timing, may change depending on progression of the abovementioned major customer connections. Ergon Energy will at all times follow due diligent processes to ascertain the most cost effective supplier.

For further information and inquiries relating to this Final Project Assessment Report, please refer to Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". The portal is available at:

https://www.ergon.com.au/network/network-management/network-infrastructure/regulatory-test-consultations

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Tables and Figures

1. Introduction

This Final Project Assessment Report has been prepared by Ergon Energy in accordance with the requirements of clause 5.17.4(o) of the National Electricity Rules (NER).

This report represents the third and final stage of the consultation process in relation to the application of the Regulatory Investment Test for Distribution (RIT-D) on potential credible options to address the identified need in the distribution network that supplies the Emerald area.

On 1 July 2015, Ergon Energy published the first stage of the RIT-D, which was the release of the Non-Network Options Report. This report sought information from Registered Participants and Interested Parties regarding alternative potential credible options, or variants to the potential credible options presented in that report. In response to the Non-Network Options Report, Ergon Energy received one submission, proposing embedded diesel generation.

Following the conclusion of the consultation on the Non-Network Options Report, Ergon Energy published the Draft Project Assessment Report on 31 May 2016. This report presented a technical and economic analysis of credible options that would address the identified need in the distribution network that supplies the Emerald area, and identified Ergon Energy's proposed preferred option.

This Final Project Assessment Report:

- Provides background information on the network capability limitations of the distribution network supplying the Emerald area.
- Identifies the need which Ergon Energy is seeking to address, together with the assumptions used in identifying and quantifying that need.
- Summarises and provides commentary on the submission(s) received on the Non-Network Options Report and the Draft Project Assessment Report.
- Describes the credible options that are considered in this RIT-D assessment.
- Quantifies costs (with a breakdown of capital and operational expenditure) and classes of material market benefits for each of the credible options.
- Describes the methods used in quantifying each class of market benefit.
- Provides details of classes of market benefits that are not considered material to this RIT-D assessment, and provides explanations to why these classes of market benefits are not considered material.
- Provides the results of Net Present Value (NPV) analysis of each credible option and accompanying explanatory statements regarding the results.
- Identifies the proposed preferred option, including detailed characteristics, estimated commissioning date, indicative costs, and noting that it satisfies the RIT-D.
- Provides contact details for queries on this RIT-D.

In preparing this RIT-D, Ergon Energy is required to consider reasonable future scenarios. With respect to major customer loads and generation, Ergon Energy has, in good faith, included as much detail as possible while maintaining necessary customer confidentiality. Potential large future connections that Ergon Energy is aware of are in different stages of progress and are subject to change (including outcomes where none or all proceed). These and other customer activity can occur over the consultation period and may change the timing and/or scope of any proposed solutions.

All queries on this RIT-D consultation should be lodged to Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". The portal is available at:

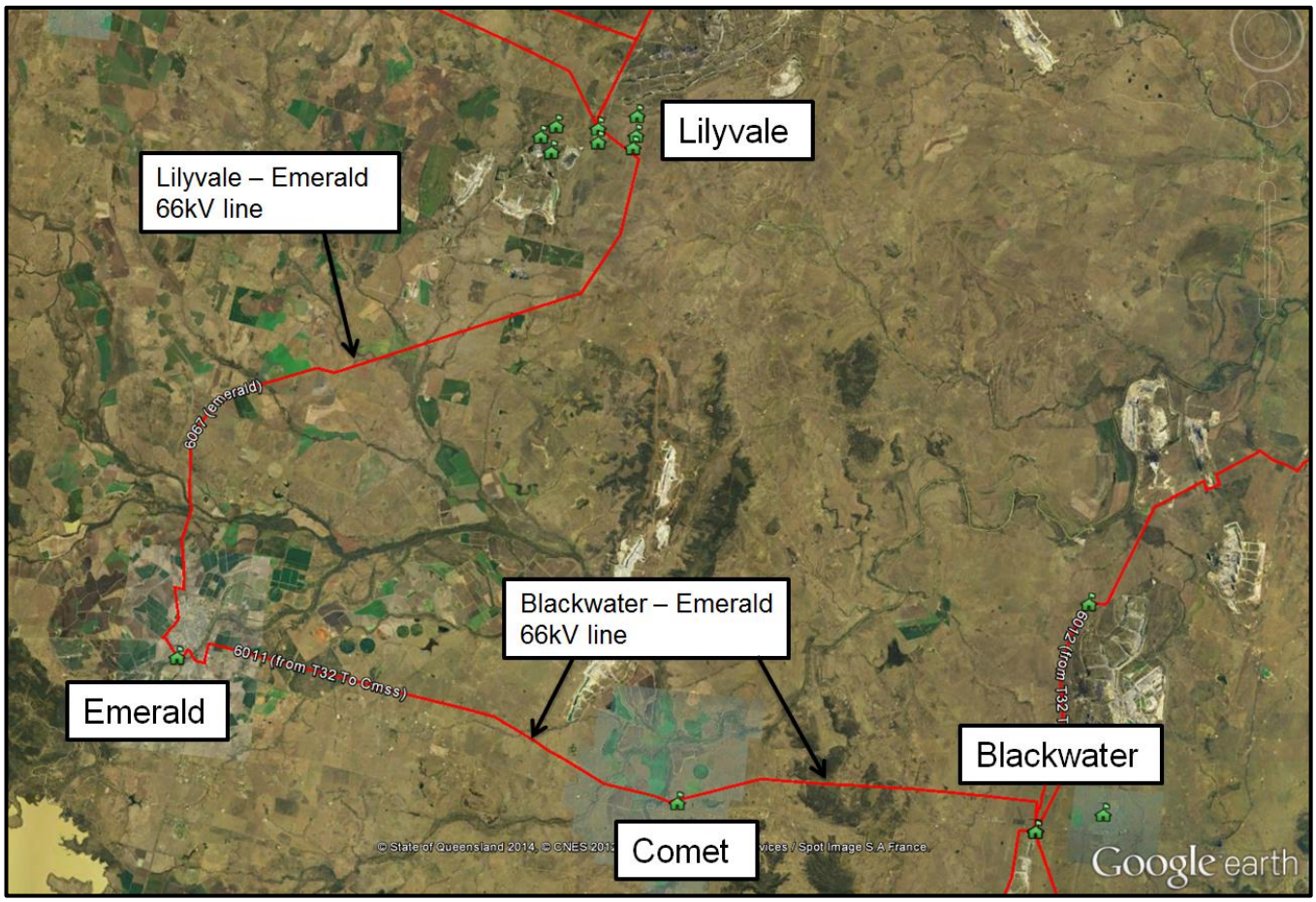
https://www.ergon.com.au/network/network-management/network-infrastructure/regulatory-test-consultations

2. Background

2.1 Geographic Region

The geographic region covered by this RIT-D is the Emerald town and surrounding rural areas. The town of Emerald is located 240km west of Rockhampton in central Queensland. The Google Earth image below shows the Emerald town and the subtransmission infrastructure in the area.

Figure 1 – Emerald Subtransmission System



2.2 Existing Supply System

The Emerald area, with approximately 8,700 electricity customers, is currently supplied from Ergon Energy's Emerald 66/22kV 3 x 20MVA Zone Substation. Emerald Zone Substation is supplied by two 66kV subtransmission lines, one from each of the Lilyvale and Blackwater bulk supply substations. The Blackwater line also supplies the Comet 5+2MVA Zone Substation via a tee-off.

There are currently two 5MVAr capacitor banks installed at Emerald Zone Substation to compensate for the reactive power demand in the downstream distribution network, and to provide voltage support on the 66kV network. The substation transformers have a tap range of +/-10%. Voltage set point on the distribution bus is 101%.

The demand on Emerald Zone Substation is a mixture of commercial, industrial and residential loads, and yearly peak loads generally occur in late summer afternoons. In summer of 2014/15 the load at Emerald peaked at 39.7MVA. Peak load at Comet Zone Substation is around 2.7MVA. The Comet load is largely driven by irrigation and has a relatively low coincidence with the load at Emerald (typically in the range of 50 – 70%).

2.2.1 Existing 66kV Network Capability

The capability of the existing 66kV network that supplies Emerald is presented in Table 1 below.

Table 1 – Emerald 66kV Network Capability Thresholds

Elements in Service	Thermal Capacity	Design Temperature	Voltage Constraint Threshold
Blackwater – Emerald 66kV Feeder	SD[1]: 31.7MVA (277A) SE[1]: 33.7MVA (295A)	65°C	23.5MVA[2] at Emerald + 1.5MVA at Comet (typical coincident load)
Lilyvale – Emerald 66kV Feeder	SD[1]: 69.5MVA (608A) SE[1]: 71.5MVA (629A)	75°C	36.0MVA[3] at Emerald
Both 66kV Feeders in Service	As above	As above	45.0MVA at Emerald + 2.5MVA at Comet (upper range coincident load)
Both 66kV Feeders in Service + One New Major Customer[4]	As above	As above	37.2MVA at Emerald + 2.5MVA at Comet (upper range coincident load)

2.2.2 Existing 66/22kV Zone Substation Capacity

Table 2 – Emerald 3x20MVA 66/22kV Zone Substation Capacity

Season	N Capacity (COR[5] of all three transformers)	N-1 Capacity (LTEC[5] rating of two lowest rated transformers)
Summer	67.8 MVA	51.8 MVA
Winter	75.6 MVA	59.8 MVA

[1] SD = Summer Day (9am – 5pm), SE = Summer Evening (5pm – 10pm)

[2] With Blackwater – Emerald line in service only. Threshold is revised from Non-Network Options report due to more detailed system modelling.

[3] With Lilyvale – Emerald line in service only. Comet cannot be supplied with the entire Blackwater – Emerald line out of service.

[4] See section 0

[5] COR = Cyclic Operational Rating, LTEC = Long Term Emergency Cyclic

3. Identified Need

The primary component of the identified need is the forecast shortfall of N capability on the 66kV network that supplies Emerald, i.e. inability to supply the full maximum demand at Emerald with all plant in service. In addition to this, the risk of breaching the Service Safety Net Targets needs to be managed.

3.1 Insufficient Future 66kV Network Capability

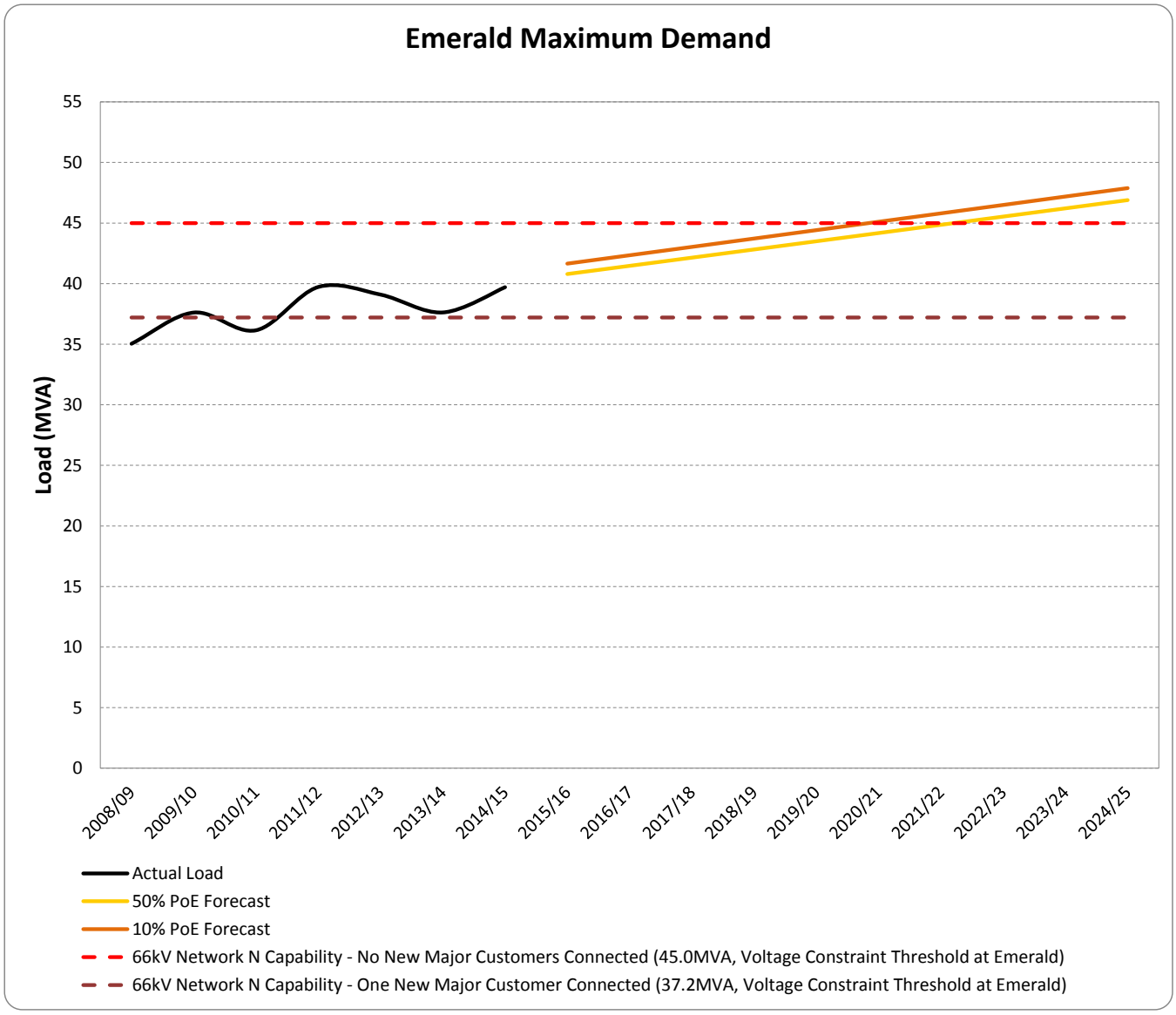
3.1.1 Description

The maximum demand at Emerald is presently 39.7MVA and is forecast to grow by approximately 1.7% per annum for the next 10 years. The existing 66kV network does not have sufficient capability to supply the forecast increased load at Emerald under system normal conditions (i.e. with all plant in service). Network modelling indicates that with the current level of reactive compensation, voltage constraints will begin to occur at Emerald Zone Substation when the Emerald load exceeds 45.0MVA (see Table 1, above).

Ergon Energy has also received recent connection enquiries for two major customers in the Emerald area, both of which would take supply from the 66kV network. Connection of either customer will reduce the maximum load that can be supplied to Emerald to 37.2MVA, resulting in immediate voltage constraints during times of maximum demand at Emerald. As such, additional network capability would be required before either connection could proceed.

To connect both of these major customers, more significant network augmentation, or an alternate connection point, would be required.

Figure 2 – Emerald Forecast Maximum Demand vs 66kV Network N Capability



- *PoE = Probability of Exceedance.*
- *50% PoE represents the forecast peak load during an "average" year. Used for contingency management planning.*
- *10% PoE represents a peak load that only has a 10% risk of being exceeded in any given year, e.g. during an unusually hot summer. Used when planning for N capability.*

Figure 2 above illustrates:

- The 10% PoE maximum demand at Emerald is expected to exceed the voltage constraint threshold of the 66kV network under system normal conditions in summer 2020/21 and onwards.
- With the connection of either one of the new major customer loads, the 66kV network that supplies Emerald will be at immediate risk of experiencing voltage constraints at times of high demand.

In other words, in the absence of any mitigation/solution to address the above issues:

- Ergon Energy will not be able to offer connection to any of the major customer loads from the Emerald 66kV network.
- Emerald Zone Substation, and hence also the entire underlying distribution network, may experience undervoltage issues in the event of a 10% PoE load (system normal) from summer 2020/21 and onwards.

3.1.2 Quantification

The forecast need for system N capability as discussed in section 3.1.1 is presented in Table 3 (no new major customers connected) and Table 4 (one new major customer connected) below.

The tables show:

- Forecast peak load above subtransmission network N capability (voltage constraint threshold at Emerald) under the 10% PoE maximum demand forecast.
- Energy above N capability, number of exceedances and exceedance total duration are likewise based on the 10% PoE forecast.
- It is expected that neither of the two major customers will require their full requested authorised demand before the 2018/19 financial year. Forecast figures prior to 2018/19 in Table 4 are therefore greyed out.

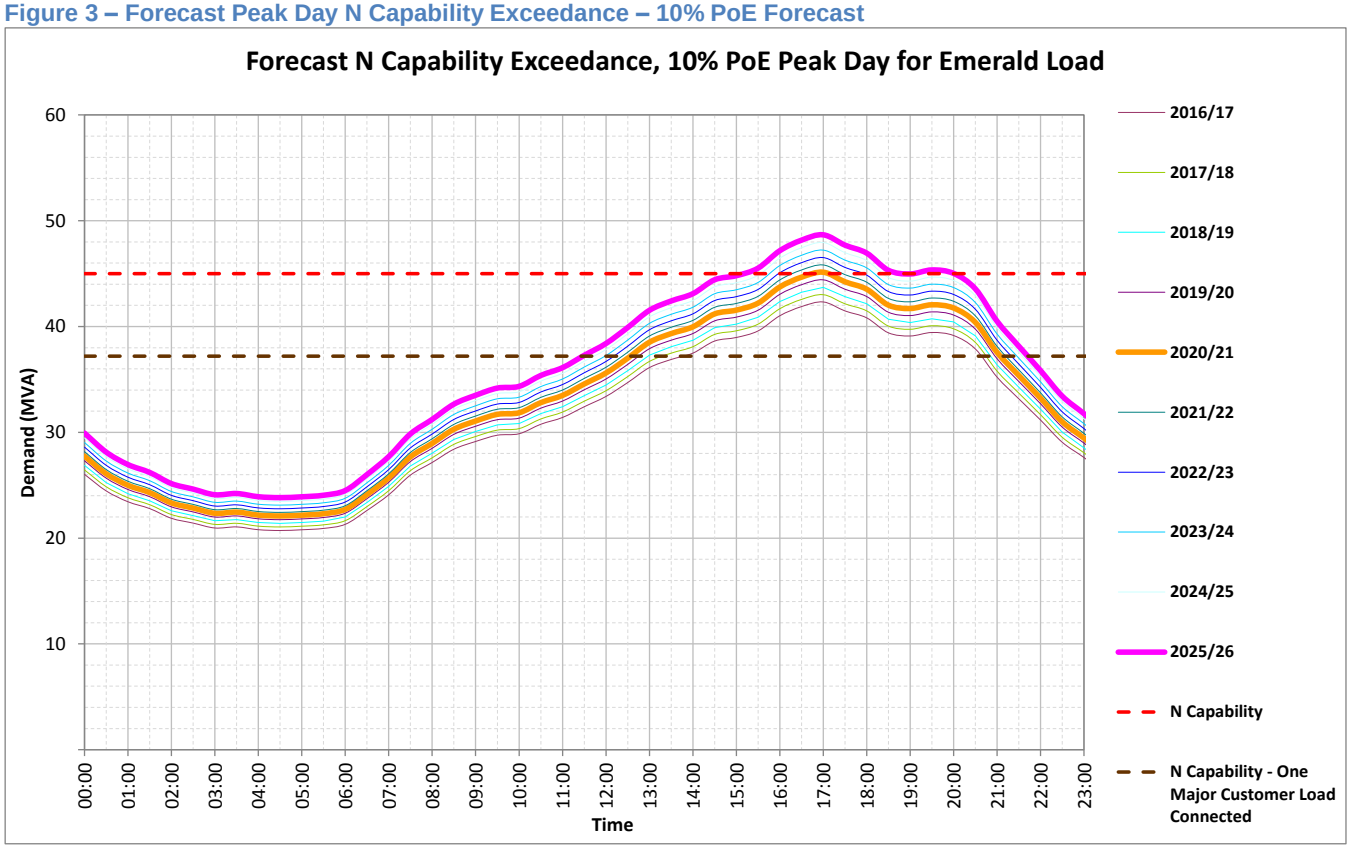
Table 3 – Forecast Network Limitation – System Normal Conditions – No New Major Customers Connected

Year	Maximum Demand 10%PoE (MVA)	Load above N Capability (45.0 MVA)	Annual Exceedance			Peak Day Exceedance	
			Number of Events	Total Duration (h)	Energy above N Capability (MWh)	Duration (h)	Energy above N Capability (MWh)
2016/17	42.3	0.0	0	0	0	0	0
2017/18	43.0	0.0	0	0	0	0	0
2018/19	43.7	0.0	0	0	0	0	0
2019/20	44.4	0.0	0	0	0	0	0
2020/21	45.1	0.1	1	1	0	1	0
2021/22	45.8	0.8	1	1	1	1	1
2022/23	46.5	1.5	2	4	2	2	2
2023/24	47.2	2.2	3	6	5	3	3
2024/25	47.9	2.9	3	8	10	3	5
2025/26	48.6	3.6	4	11	16	4	7

Table 4 – Forecast Network Limitation – System Normal Conditions – One New Major Customer Connected

Year	Maximum Demand 10%PoE (MVA)	Load above N Capability (37.2 MVA)	Annual Exceedance			Peak Day Exceedance	
			Number of Events	Total Duration (h)	Energy above N Capability (MWh)	Duration (h)	Energy above N Capability (MWh)
2016/17	42.3	5.1	8	24	47	7	18
2017/18	43.0	5.8	9	31	64	8	23
2018/19	43.7	6.5	11	38	85	8	28
2019/20	44.4	7.2	13	43	109	8	33
2020/21	45.1	7.9	16	54	139	9	38
2021/22	45.8	8.6	26	71	176	9	44
2022/23	46.5	9.3	34	97	225	9	50
2023/24	47.2	10.0	39	121	286	10	55
2024/25	47.9	10.7	44	147	363	10	62
2025/26	48.6	11.4	56	175	458	11	68

Figure 3 – Forecast Peak Day N Capability Exceedance – 10% PoE Forecast



3.2 Safety Net Compliance

For further information regarding the Safety Net and recent changes to reliability standards, please refer to Appendix A – Changes to Reliability Standards.

Under the revised reliability standards, Ergon Energy is no longer required to provide full N-1 security of supply on the 66kV network that supplies Emerald. Instead, a set of supply restoration targets, known as the 'Service Safety Net Targets' apply. The Safety Net targets seek to limit the severity (and thus the hardship experienced by Ergon Energy customers) following a "credible contingency" for loads up to the 50% PoE forecast.

Under Safety Net, Emerald is classified as a "Regional Centre" and has the following restoration targets. The load unsupplied must be[6]:

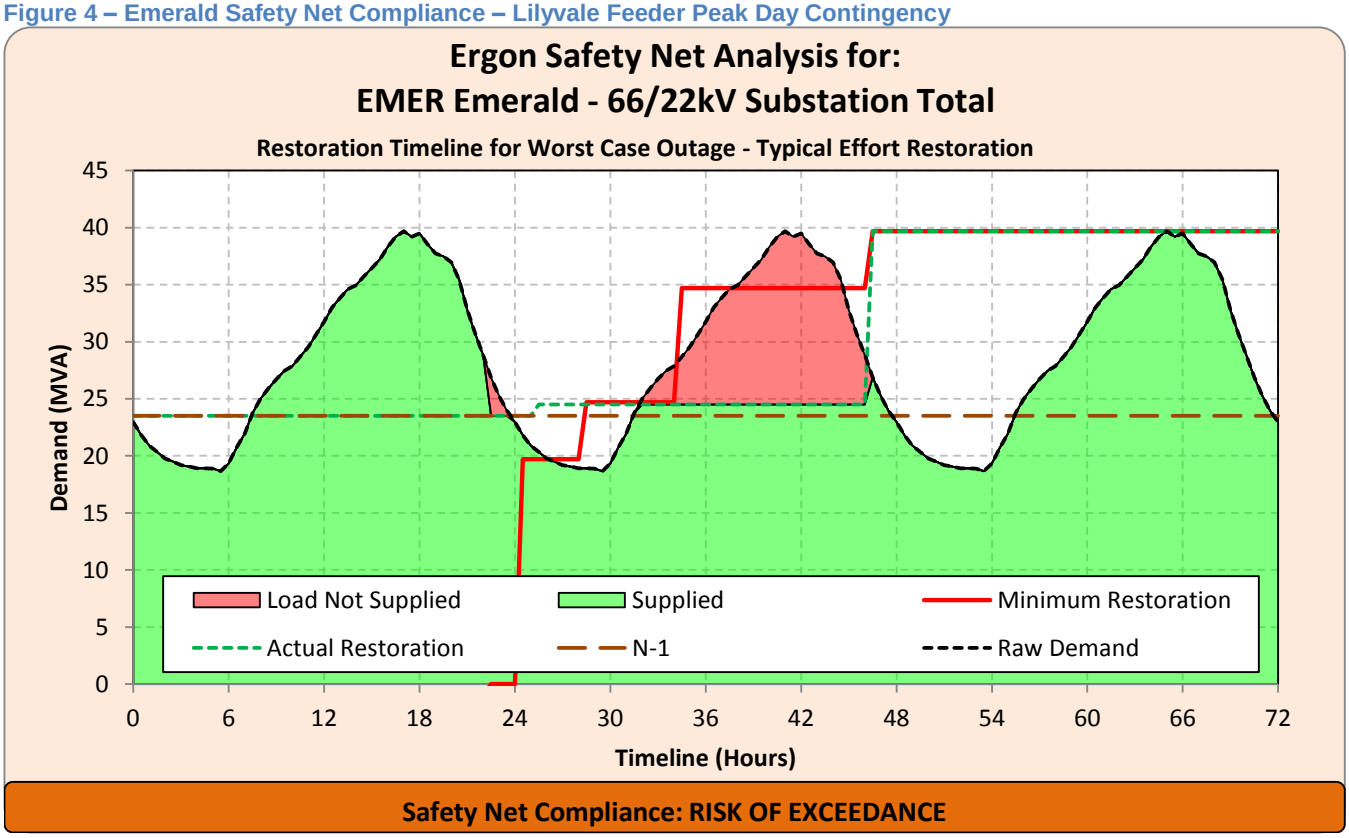
1. Less than 20 MVA after 1 hour
2. Less than 15 MVA after 6 hours
3. Less than 5 MVA after 12 hours
4. Fully restored within 24 hours

Since none of the 66kV feeders alone has sufficient capability to supply the peak load at Emerald, an outage on either 66kV line may result in loss of supply to a portion of the load at Emerald. This potential load shedding may be significant for a loss of the Lilyvale – Emerald line, due to the comparatively low capability of the Blackwater – Emerald line.

"Expected" vs "Target" supply restoration following a contingency on the Lilyvale – Emerald line on a peak day is shown in Figure 4. In a worst case scenario, it may take as long as 24h to return the line to service after a permanent fault. If this was to happen at a time when the load at Emerald is close to its annual maximum demand, as shown in Figure 4, Ergon Energy would be unable to meet the Safety Net restoration targets. It should be noted however that consideration needs to be given to the credibility of such an event occurring (i.e. both the permanent fault and the timing) before making decisions about the appropriate level of mitigation (including the option of none).

[6] Distribution Authority No. D01/99 issued to Ergon Energy Corporation Limited
Available at: https://www.dews.qld.gov.au/__data/assets/pdf_file/0004/219487/distribution-authority-d0199-ergon.pdf

Figure 4 – Emerald Safety Net Compliance – Lilyvale Feeder Peak Day Contingency



- *To have (effectively) zero risk of an outage that exceeds the Safety Net restoration targets, the green dashed line (actual restoration) needs to be at or above the red continuous line (minimum or "target" restoration).*

Load not supplied to either of the two potential new large customers following an outage as described above would typically not count against the Safety Net targets, as such events are covered under typical contractual terms negotiated prior to connection..

3.2.1 Tolerability of Non-Compliance

While there are periods of the year during which the load is high and if a fault was to occur during these periods, it is possible that the Safety Net targets may be exceeded (as shown in Figure 4), very detailed analysis was undertaken that considered:

- Annual load profile and forecast growth
- Extensive fault and supply loss scenario analysis to identify those combinations of factors that could result in exceedance of Safety Net restoration targets
- Mitigation opportunities/capabilities (existing and potential)
- Restoration options

When all of these factors were taken into account, the annual risk of Ergon Energy not meeting the Safety Net restoration targets at Emerald in any given year of the forecast period fell into the range of 1% to 0.1%. Risks in this range are not considered "intolerable" as per the usage found in the AS/NZS 31000 Risk Management standard and Ergon Energy's Network Risk Assessment Guidelines (NA000403R443). As such, the remaining risks should be managed to be "*As Low As Reasonably Practicable (ALARP)*". This should also include consideration of the time taken to provide a reasonable emergency response, the size (and thus achievability) of that response and the types of load that would be interrupted (e.g. critical vs. non-critical), and where residual risk remains, approval sought at the appropriate level of management.

As an objective test of achievement of an ALARP level of risk, assessment of the maximum foreseeable consequences (MFL) was undertaken. This figure was then multiplied by the probability of occurrence (calculated using the detailed analysis discussed above) to develop an annualised Value of Risk.

The change in the annualised Value of Risk of exceeding the Safety Net targets as a result of each option assessed (whether network or non-network) was quantified and included in the NPV analysis as a benefit (if the effect was positive) or a cost (if otherwise). An option that has the sole purpose of reducing or eliminating a marginally credible risk of breaching the Safety Net targets, need to have a lower annualised cost than the annual reduction in Value of Risk the solution brings. If not, the risk is already considered ALARP.

With the forecast level of load growth at Emerald, the annual risk of a Safety Net breach at Emerald will exceed 1% in 2021/22. A risk in this range is may be considered intolerable, and action may hence be required to reduce the risk to ALARP.

The worst case Safety Net exceedance, together with the quantified risk of breaching the Safety Net targets, are presented in Table 5 below.

The table shows:

- Forecast peak load above subtransmission network N-1 capability under the 50% PoE maximum demand forecast.
- N-1 capability of 23.5 MVA is with the Blackwater – Emerald line in service only, as this is the lowest capability line.
- At present, the only unsupplied load that can be restored before a 66kV line fault is repaired is approximately 1MVA which can be transferred to adjacent zone substations. It is assumed it will take around 3 hours to perform the necessary manual switching. Therefore:
    - There is no restoration capability in the “Within 1h” timeslot.
    - There is 1 MVA restoration capability in the “Within 6h” & “Within 12h” timeslots.
- In a worst case scenario, it may take up to 24 hours to repair a permanent line fault (noting that this is a very low probability event).
- Only the native load at Emerald, and not the two major customers that have enquired about connection to Ergon Energy’s network, count towards the required restoration targets.
- The annual risk of a Safety Net breach, together with the probability weighted value of that risk.

Table 5 – Forecast Safety Net Target Exceedance

Year	Maximum Demand 50%PoE (MVA)	Load above N-1 Capability (23.5 MVA)	Worst Case Safety Net Exceedance (MVA) Presently 1 MVA restoration after 3h available through distribution network transfers Line repaired within 24h			Risk of Breach	Value of Risk (Real $)
			Within 1h (<20 MVA Unserved)	Within 6h (<15 MVA Unserved)	Within 12h (<5 MVA Unserved)		
2016/17	41.5	18.0	0.0	2.0	12.0	0.70%	$53,935
2017/18	42.1	18.6	0.0	2.6	12.6	0.77%	$59,080
2018/19	42.8	19.3	0.0	3.3	13.3	0.84%	$64,350
2019/20	43.5	20.0	0.0	4.0	14.0	0.93%	$71,556
2020/21	44.2	20.7	0.7	4.7	14.7	0.99%	$76,221
2021/22	44.9	21.4	1.4	5.4	15.4	1.02%	$78,846
2022/23	45.5	22.0	2.0	6.0	16.0	1.08%	$83,533
2023/24	46.2	22.7	2.7	6.7	16.7	1.15%	$88,469
2024/25	46.9	23.4	3.4	7.4	17.4	1.21%	$93,050
2025/26	47.6	24.1	4.1	8.1	18.1	1.30%	$100,026

4. Load Profiles

The load at Emerald comprises a mix of residential, commercial and industrial customers. Daily peak loads generally occur in late afternoon and evening. The load is summer peaking, and annual peak loads are predominantly driven by air conditioning.

Figure 5 – Annual Load Profile

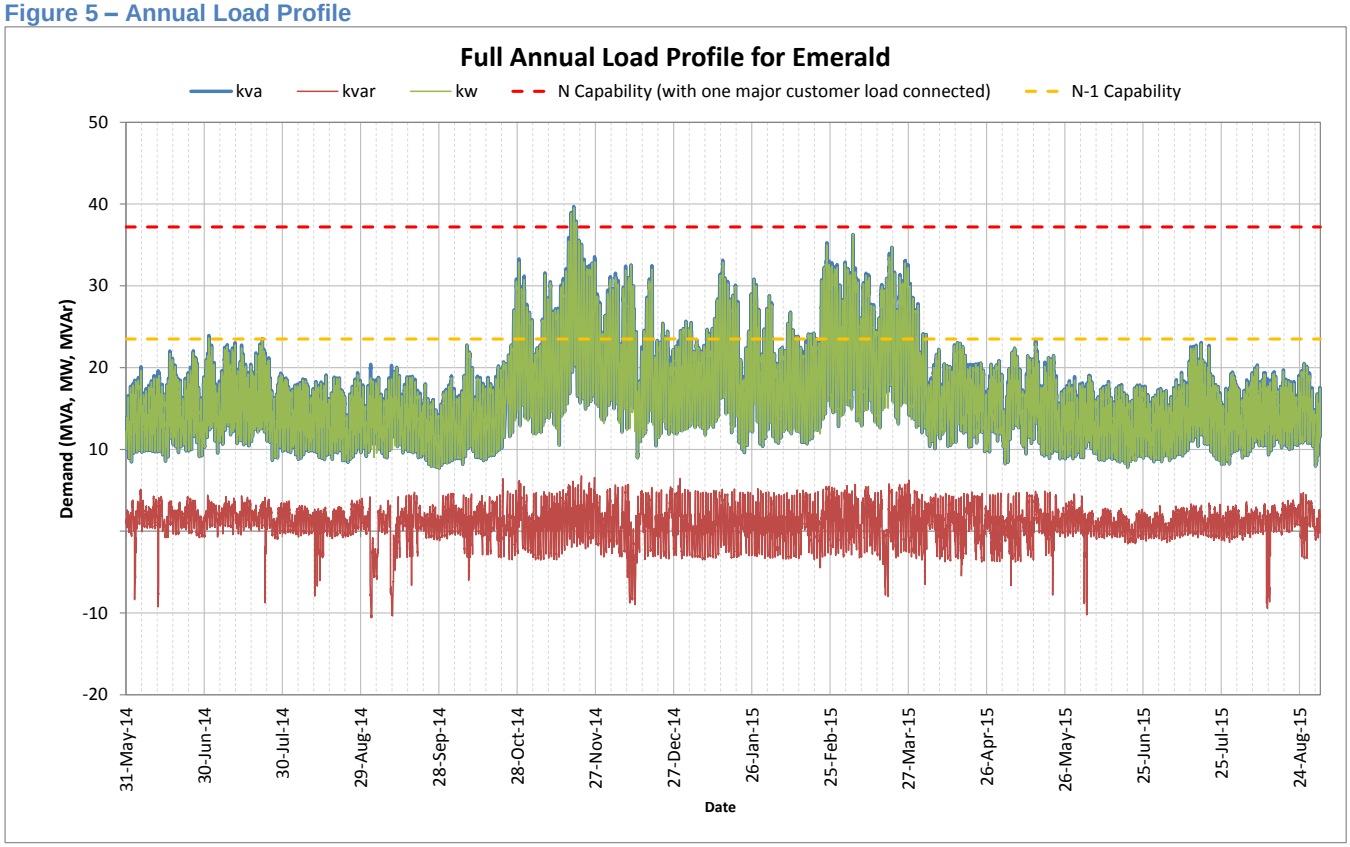


Figure 6 – Seasonal Peak Day Load Profiles

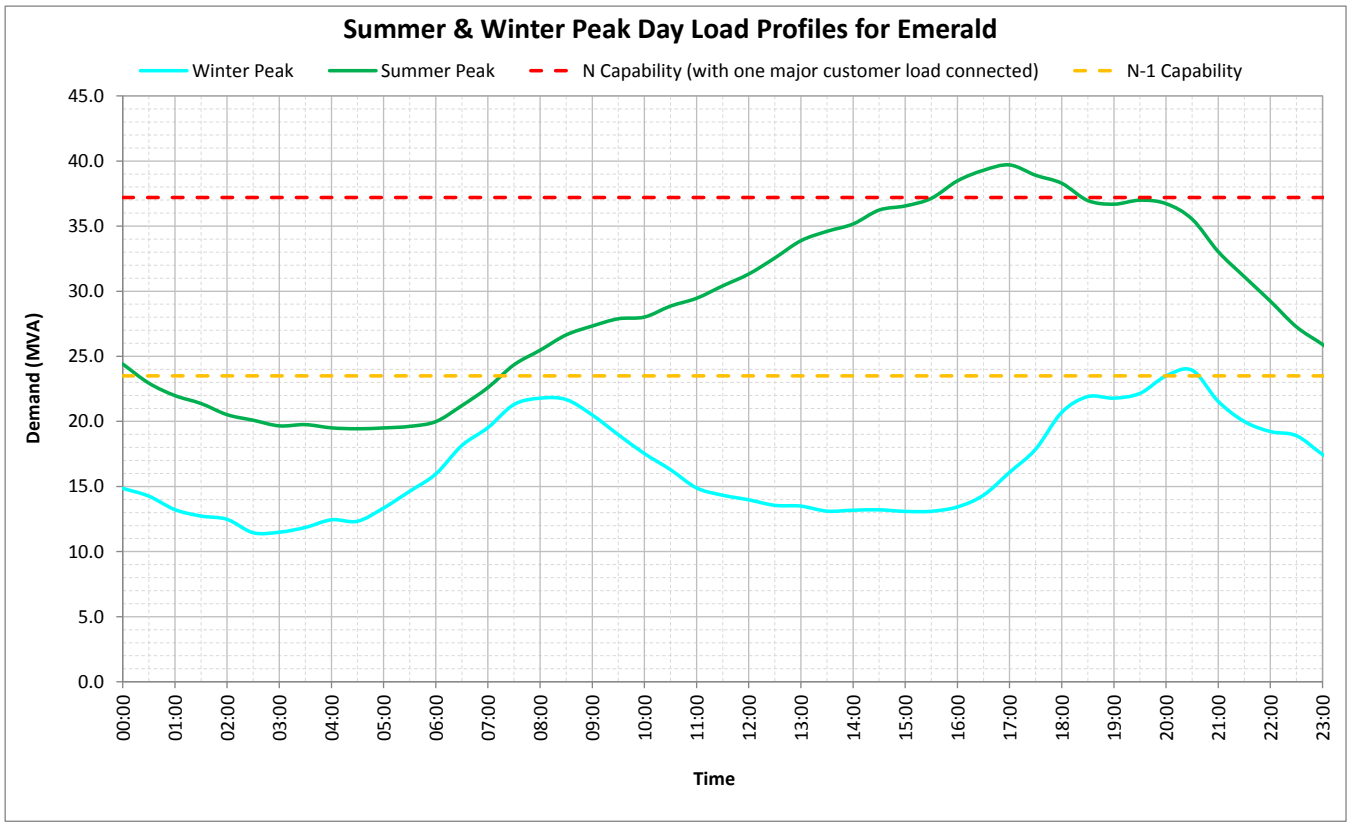
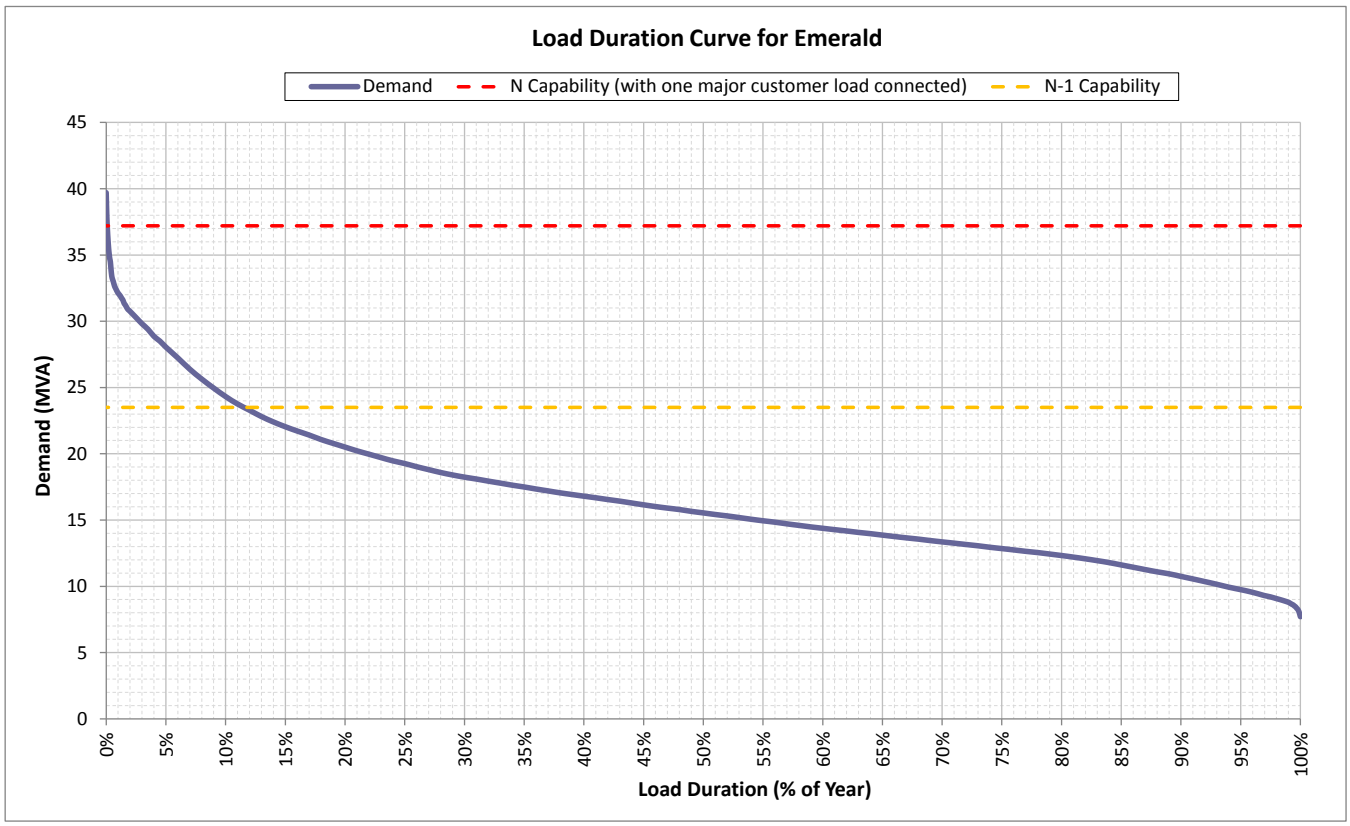


Figure 7 – Load Duration Curve



5. Key Assumptions in Relation to Identified Need

Below is a summary of key assumptions that have been made when the identified need has been analysed and quantified.

It is recognised that the below assumptions may prove to have various levels of correctness, and they merely represent a 'best endeavours' approach to predict the future identified need.

5.1 Forecast Maximum Demand

It has been assumed that peak demand at Emerald Zone Substation will grow as forecast.

Factors that have been taken into account when the load forecast has been developed include the following:

- load history
- known future developments (new major customers, network augmentation, etc.)
- temperature corrected start values (historical peak demands)
- forecast growth rates for organic growth

5.2 Load profile

Characteristic peak day load profiles shown in Figure 6 are unlikely to change significantly from year to year, i.e. the shape of the load profile will remain virtually the same with increasing maximum demand. This also implies that characteristic shape of the load duration curve (Figure 7) should remain unchanged.

5.3 System Capability

5.3.1 Voltage Constraints

Voltage constraints will occur at loading levels indicated by performed load flow modelling.

For modelled future peak loads, a lowest likely load power factor has been used as this will have the most adverse effect on system voltage drop. Lowest likely load power factor has been estimated based on observed correlation between real and reactive power for the Emerald load.

5.3.2 Line Ratings

The static thermal ratings of the subtransmission lines that supply Emerald have been calculated based on the main parameters listed in Table 6.

Table 6 – Line Rating Parameters

Parameter	Summer Day (9am – 5pm)	Summer Evening (5pm – 10pm)
Ambient Temperature	37°C	34°C
Wind Velocity	1.3 m/s	0.7 m/s
Wind Angle to Conductor Axis	45°	45°
Direct Solar Radiation	910 W/m^2	200 W/m^2
Diffuse Solar Radiation	210 W/m^2	20 W/m^2

5.4 66kV Network Reliability Performance

5.4.1 All Sustained Outages

Historical reliability performance of the 66kV feeders that supply Emerald is presented in Table 7 below. The figures in Table 7 have been used when market benefits resulting from changes in involuntary load shedding have been calculated (see section 9.1.1).

Table 7 – Historical Reliability Performance – Emerald 66kV Network

Element	Average No of Sustained Outages/Year	Average Duration/Outage	Average Outage Duration/Year
Blackwater – Emerald 66kV Feeder	1.46	3h 52 min.	5h 39 min
Lilyvale – Emerald 66kV Feeder	1.30	1h 03 min.	1h 22 min.

- *Sustained Outage: >1 min. duration. Only sustained outages count towards value of customer reliability.*
- *Transient Outage: <1 min. duration*

5.4.2 Permanent Faults

To evaluate the risk of breaching the Safety Net restoration targets, it has been assumed that the probability a permanent fault (i.e. that will require on site repairs) on the Lilyvale – Emerald Feeder is 4.74% per annum. This figure has been found by investigating fault occurrences and -durations on a total of 1,000km of 66kV feeders of similar construction to the Lilyvale – Emerald Feeder, and that run across similar areas, with the relative reliability performance of the Lilyvale – Emerald Feeder compared to the investigated feeders taken into account. The restoration time has been conservatively assumed to be 24h, whereas in most cases, the restoration time would be significantly shorter.

6. Summary of Submissions

On 1 July 2015, Ergon Energy published the Non-Network Options Report providing details on the identified need on the 66kV network that supplies Emerald. This report sought information from Registered Participants, AEMO and Interested Parties regarding alternative potential credible options or variants to the potential credible options presented by Ergon Energy.

In response to the Non-Network Options Report, Ergon Energy received one submission from a non-network service provider by 2 October 2015, which was the closing date for submissions to the Non-Network Options Report.

The submission provider proposed an embedded diesel standby power station of modular relocatable units, with an initial capacity of 5MVA, under a Build Own Operate arrangement. Under this proposal, Ergon Energy would need to sign a Network Support Agreement, which includes the payment of a monthly capacity charge. Contract terms proposed by the submission provider ranged from 10 to 40 years.

Following the conclusion of the consultation on the Non-Network Options Report, Ergon Energy published the Draft Project Assessment Report on 31 May 2016. The purpose of this report was to provide a technical and economic assessment of investigated solution options, one of which included the submission received in response to the Non-Network Option Report, and to present Ergon Energy's preferred solution option.

Registered participants and interested parties were invited to lodge submissions in response to the Draft Project Assessment report by 29 July 2016.

No submissions were received in response to the Draft Project Assessment Report.

7. Non-Network Solutions Considered

Ergon Energy presented two network options in the Non-Network Options Report, which was published on 1 July 2015. Out of these two options, the then preferred Option A was incomplete in the context that one of its intended components – 4MVA of generation – remained unexplored at the time of publication. The generation component was aimed at providing full compliance with the Safety Net restoration targets.

As detailed in section 3.2.1 Ergon Energy has since assessed the Value of Risk of breaching the Safety Net, with the conclusion that for the present Value of Risk, a non-network solution aimed solely at providing Safety Net compliance (or reduce the risk of non-compliance), will need to have a lower annualised cost than the reduction in Value of Risk it provides in order to be considered financially feasible.

The submission Ergon Energy received to the Non-Network Options Report has been investigated and assessed, as detailed in the following section.

7.1 5MVA Diesel Power Station – External Submission Provider

In response to the Non-Network Options Report, Ergon Energy received one submission from a non-network service provider. The submission provider proposed an embedded diesel standby power station of modular relocatable units, with an initial capacity of 5MVA, under a Build Own Operate arrangement. Under this proposal, Ergon Energy would need to sign a Network Support Agreement, which includes the payment of a monthly capacity charge. Contract terms proposed by the submission provider ranged from 10 to 40 years.

This option will (by itself or in conjunction with a network solution):

- Reduce the risk of breaching the Safety Net restoration targets in the event of a permanent fault on the Lilyvale – Emerald line.
- Have the potential to be utilised in the event of a 10% PoE load at Emerald to enable deferral of a network solution.

The cost of this option is $50,190/month ($602,280/year) for a 10 year contract term. For a 40 year contract term, the cost will be $42,830/month ($513,960/year).

This option has been included in Option C to explore a deferral of the proposed network solution in Option A.

8. Credible Options Included in this RIT-D

Details of the three credible options that have been investigated to address the identified need at Emerald are presented in the following sections.

8.1 Option A: 11MVAr of Compensation & Blackwater Line Upgrade

This option includes:

- Installing 3 x 3MVAr capacitor banks and a +/-2MVAr STATCOM at Emerald Zone Substation, for a total of 11MVAr of reactive compensation in addition to the already existing 2 x 5MVAr capacitor banks.
- Upgrade the Blackwater – Emerald 66kV feeder to a maximum operational temperature of 100°C by pole rebutting.

This option will:

- Increase the N capability of the 66kV network to allow a maximum of 53.2MVA to be supplied to Emerald under system normal conditions. This is sufficient to cater for a 10% PoE load throughout Ergon Energy's entire 10 year planning horizon.
- Allow a maximum of 49.2MVA to be supplied to Emerald under system normal conditions, with one of the major customer loads connected. This is sufficient to cater for a 10% PoE load throughout Ergon Energy's entire 10 year planning horizon.
- Increase the N-1 capability of the 66kV network to 29.5MVA, which is the maximum Emerald load the Blackwater – Emerald feeder will be able to supply with the Lilyvale – Emerald feeder out of service.
- Reduce the immediate annual risk of breaching the Safety Net to 0.26%. With the forecasted load growth, the annual risk of breaching the Safety Net at the end of the 10 year planning horizon will increase to 0.58%.

Important things to note:

- This option will not allow both major customers to connect to the Emerald 66kV network.
- With the proposed 11MVAr of additional reactive compensation at Emerald, modelling indicates that it is highly unlikely that the conductor temperature of the Blackwater – Emerald line will exceed 80°C during a worst case contingency on the Lilyvale – Emerald line.
- It is proposed to upgrade the Blackwater – Emerald line to 100°C operational temperature to maximise future N-1 capability of the network, in the event that more reactive compensation than what's proposed under this option will be installed in the future.

- Transmission Line Design Engineers that have been consulted have confirmed that it is permissible to operate the Blackwater – Emerald Feeder at 100°C on very rare occasions, provided minimum statutory ground clearance can be achieved.
- In relation to Safety Net:
    - The annual Value of Risk of a Safety Net breach is estimated to $20,000 (initial) - $45,000 (in 10 years) under this option.
    - The annual reduction in Value of Risk with 5MVA of embedded generation ranges from $18,000 (initial) - $38,000 (in 10 years).
    - At an annual cost of $602,280 (see section 7.1) for 5MVA of embedded generation, it is not considered financially feasible to implement the embedded generation for the sole purpose of reducing the risk of breaching the Safety Net.

The estimated capital cost of this option is $6.5M. Annual operating & maintenance costs of the reactive compensation are anticipated to be around 0.5% of the capital cost. For the refurbished Blackwater – Emerald line, it has been assumed that the pole rebutting will not increase the operating and maintenance costs of the line.

The estimated commissioning date will be within two years of Ergon Energy signing a connection agreement with one of the major customers that have enquired about 66kV connections in the Emerald area, although no later than in 2020. For the purpose of the financial analysis presented in section 10, a commissioning date in the 2019/20 financial year has been used.

8.2 Option B: New 66kV Feeder Blackwater – Emerald

This option includes:

- Construction of new 66kV feeder bays at Blackwater and Emerald substations.
- Construction of a new Single Circuit Concrete Pole (SCCP) 66kV feeder from Blackwater to Emerald, strung with Oxygen type conductor.

This option will:

- Provide sufficient N capability on the 66kV network to supply a 10% PoE load at Emerald throughout Ergon Energy's entire 10 year planning horizon.
- Increase the N-1 capability of the 66kV network to 45.0MVA (present N capability). This option will therefore provide nearly full N-1 security of supply to Emerald throughout Ergon Energy's entire 10 year planning horizon.
- Provide full compliance with the Safety Net for the 10 year planning horizon.
- Allow both major customers to take supply from the 66kV network that supplies Emerald, noting that it is considered unlikely for both these major connections to occur within the foreseeable future.

The estimated capital cost of this option is $39.5M. Annual operating & maintenance costs are anticipated to be around 0.5% of the capital cost.

The estimated commissioning date is in the 2019/20 financial year.

8.3 Option C: Deferral of Option A works through Embedded Generation

This option includes:

- Deferral of the capital works in Option A, by implementing the embedded generation specified in section 7.1 for a period of 10 years, which is the shortest contract term specified by the external generation provider.

This option will:

- In the absence of any of the major customers connecting to the Emerald 66kV network, enable deferral of the capital works in Option A till 2022/23, which is when the 50% PoE load is forecast to exceed the N capability of the 66kV network.
- Post implementation of the capital works, provide a further reduction in the risk of breaching the Safety Net compared to Option A.

Important things to note:

- The proposed deferral till 2022/23 is only achievable as long as none of the major customers connect to the Emerald 66kV network before that date.
- Running costs of the proposed diesel generators have not been specified by the generation provider.

The estimated commissioning date for the embedded generation is the 2019/20 financial year. Annual capacity charge payable to the external generation provider is $602,280 for the proposed 10 year contract term.

9. Market Modelling

The RIT-D requires market benefits to be calculated by comparing the 'state of the world' in the base case (where no action is undertaken by Ergon Energy) with the 'state of the world' with each of the credible options in place. The 'state of the world' means a reasonable and mutually consistent description of all the relevant supply and demand characteristics that may affect the calculation of the market benefits over the period of assessment. **Rather than using the wording 'state of the world', Ergon Energy has used the wording 'state of the system' in this RIT-D assessment.** The uncertainty associated with the future state of the system is addressed by considering a number of reasonable scenarios (see section 10).

The RIT-D assessment has been undertaken over a 20-year period. The modelling of the market benefits discussed in section 9.1.1 and 9.1.2 has been undertaken across a 10-year study horizon. The market benefits calculated in the final year of the modelling period (i.e. 2025/26) have been applied as the assumed annual market benefits that would continue to arise for a further 10 years. This approach of adopting an extended analysis period, based on continuation of an assumed end value has been adopted in similar assessments.[7]

9.1 Classes of Market Benefits Considered & Quantified

The purpose of the RIT-D is to identify the option that maximises the present value of net market benefits to all those who produce, consume and transport electricity in the National Electricity Market (NEM).

In order to measure the increase in net market benefit, Ergon Energy has analysed the classes of market benefits required to be considered by the RIT-D.

The following classes of market benefits are considered material, and have been included in this RIT-D assessment:

- Changes in involuntary load shedding.
- Changes in network losses

[7] AEMO: Regional Victorian Thermal Upgrade RIT-T – Project Assessment Draft Report, March 2013.
Available at: http://www.aemo.com.au/Electricity/Planning/Regulatory-Investment-Tests-for-Transmission/Regional-Victorian-Thermal-Capacity-Upgrade

9.1.1 Changes in Involuntary Load Shedding

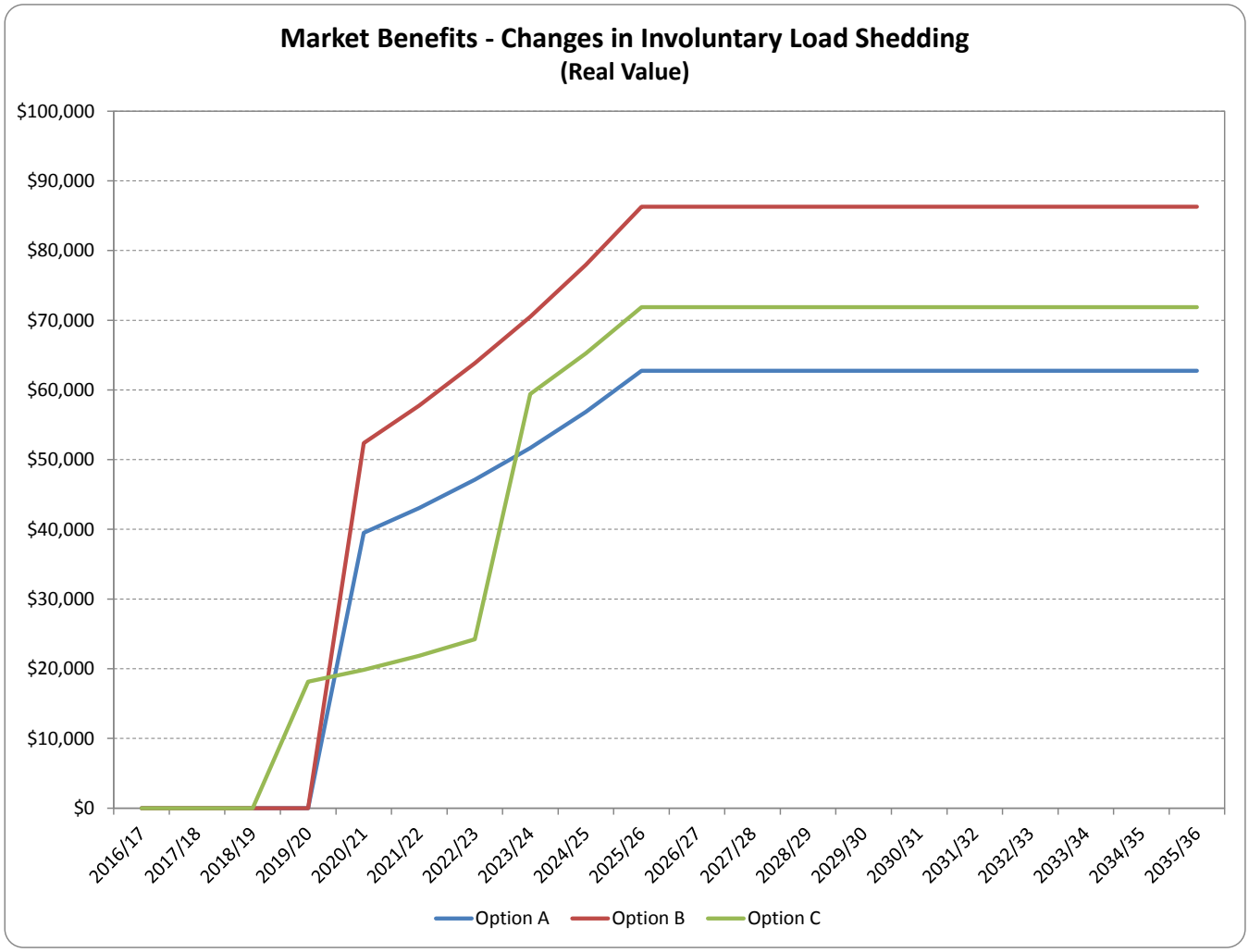
All credible options included in this RIT-D assessment will increase the supply capability to the Emerald area, once the capital works have been completed and the new plant is commissioned. In addition to providing the required N supply capability, the N-1 capability of the network will also increase. The latter will result in a reduction in involuntary load shedding as a result of outages on the 66kV feeders that supply Emerald.

The embedded generation included in Option C will have the capability to be dispatched in the event of an outage on the 66kV network, when the load at Emerald is above the N-1 capability of the network, which will also result in a reduction in involuntary load shedding.

Ergon Energy has calculated the impact of changes in involuntary load shedding caused by outages on the 66kV network, by comparing the expected unserved energy under the base case (where no action is undertaken by Ergon Energy) with each of the credible options in place. Probability weighted values of expected unserved energy have been calculated based on historical reliability performance of the two 66kV feeders (see section 5.4.1), forecast load growth and load duration. The derived values of expected unserved energy have been converted to a dollar figure, which reflects the customer financial consequence of the unserved energy, by using the location specific unit rate for Emerald of $35,332/MWh.

The reduction in expected unserved energy due to outages on the 66kV network each option will bring has been included as a market benefit, and are presented in Figure 8.

Figure 8 – Market Benefits – Changes in Involuntary Load Shedding



Changes in involuntary load shedding each credible option brings as a result of increased N supply capability (i.e. no need to shed load under system normal conditions) have not been considered. This

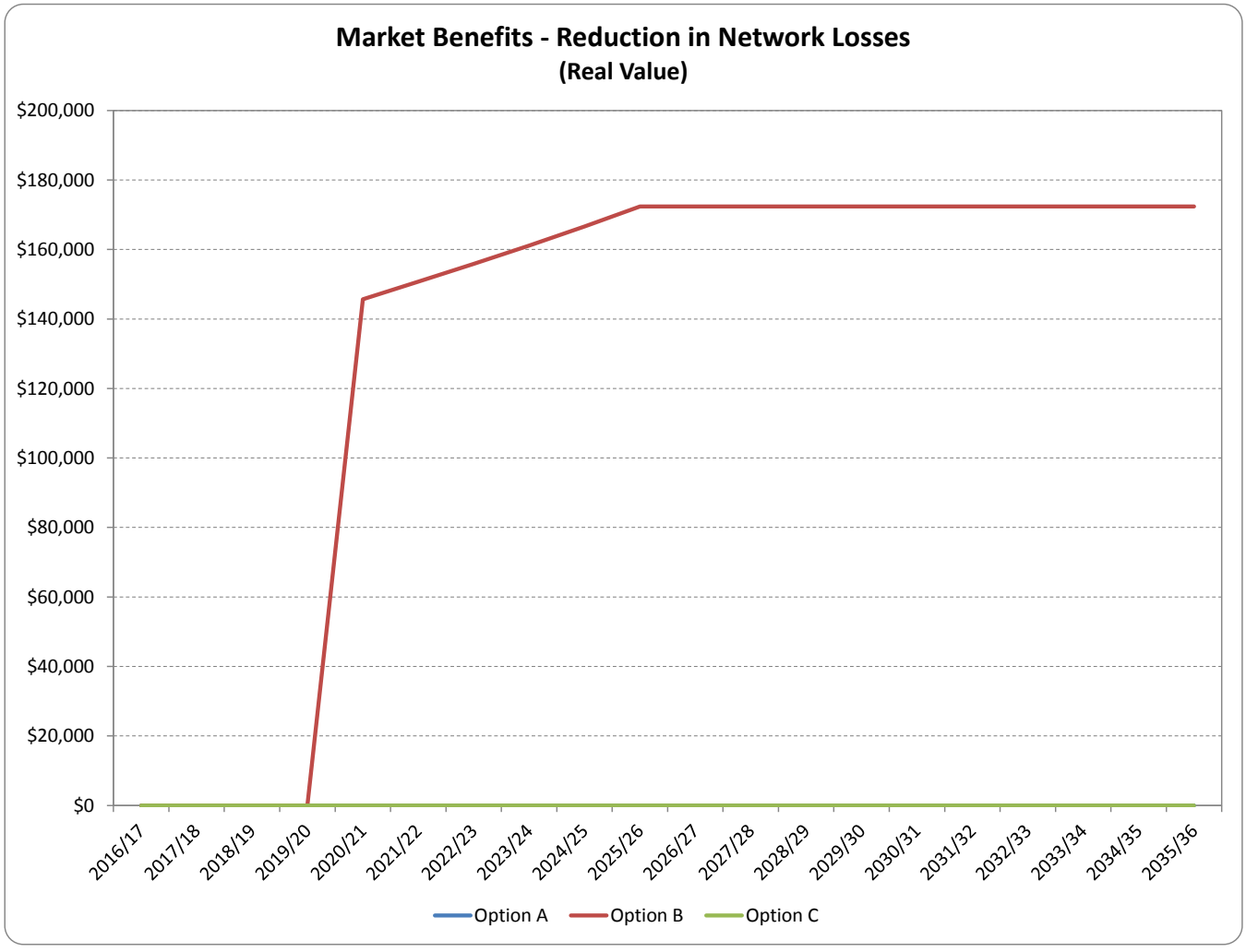
is because each credible option is for reliability corrective action, and as such, the NER only requires RIT-D proponents to quantify this market benefit insofar the credible option exceeds the minimum standard required for the reliability corrective action[8].

9.1.2 Changes in Network Losses

Market benefits associated with the change in network losses on the 66kV network have been quantified by a direct calculation of the likely MWh impact on the losses for each year of the modelling horizon. These MWh figures have been multiplied by the value of those losses, as measured by the average Queensland spot price for 2014/15 ($52.52/MWh).

The only option investigated in this RIT-D assessment that will bring a reduction in network losses is Option B – New 66kV feeder from Blackwater.

Figure 9 – Market Benefits – Reduction in Network Losses



9.2 Classes of Market Benefits not Expected to be Material

The following classes of market benefits are not considered to be material for this RIT-D assessment:

- Changes in voluntary load curtailment
- Changes in costs to other parties
- Changes in timing of expenditure

[8] NER version 79: clause 5.17.1 (c) (5)

- Changes in load transfer capability
- Option value

9.2.1 Changes in Voluntary Load Curtailment

Because none of the credible options include any voluntary load curtailment, and because there are no customers on voluntary load curtailment agreements in Emerald at present, any market benefits associated with changes in voluntary load curtailment have not been considered.

9.2.2 Changes in Costs to Other Parties

Ergon Energy does not anticipate that any of the credible options included in this RIT-D assessment will affect costs incurred by other parties.

Ergon Energy has transmission connection points at both Lilyvale and Blackwater (which is from where the Emerald 66kV feeders take supply), and network modelling indicates that implementation of the credible options will marginally alter the load sharing between the two 66kV feeders and hence also the load at the transmission connection points. This is however not expected to affect any transmission investments.

9.2.3 Changes in Timing of Expenditure

None of the credible options included in this RIT-D assessment is expected to affect the timing of other distribution investments for unrelated identified needs, as they exclusively address constraints on the 66kV network that supplies Emerald. A need may arise within the 10 year planning horizon to address constraints on the 22kV distribution network in the Emerald area, but none of the credible options is expected to have a material impact on the timing of investments to address any such constraints.

9.2.4 Changes in Load Transfer Capability

None of the credible options will have an impact on the load transfer capability between Emerald Zone Substation and adjacent zone substations.

9.2.5 Option Value

The AER's view is 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[9].

As discussed in section 10 there is a significant uncertainty regarding major customer connections in the Emerald area, and the investigated credible options have various abilities to provide sufficient network capability for different scenarios regarding the progression of these major customer connections. Rather than treating the ability of the credible options to provide adequate network capability for various scenarios as a market benefit, probability weighted costs of additional network augmentation that may be required for the options that don't provide sufficient network capability for all scenarios have been included in the sensitivity analysis presented in section 10.3.

9.3 Quantification of Costs for each Credible Option

The capital and operational costs for each credible option considered in this RIT-D assessment are summarised in Table 8.

[9] AER "Regulatory Investment Test for Distribution Application Guidelines", Section A6.

Available at: http://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/regulatory-investment-test-for-distribution-rit-d-and-application-guidelines

Table 8 – Summary of Project Costs

Option	Capital Cost (Excl. Ergon Overheads)	Operational Cost (Excl. Ergon Overheads)
Option A Additional reactive compensation at Emerald Blackwater – Emerald line upgrade	$6.5M	0.5% of capital cost per annum for reactive plant. No increased operational cost for Blackwater – Emerald line.
Option B New feeder Blackwater – Emerald	$39.5M	0.5% of capital cost per annum.
Option C 5MVA embedded generation Deferral of capital works in Option A	$6.5M	$602k per annum capacity charge payable to external generation provider. 0.5% of capital cost per annum for reactive plant. No increased operational cost for Blackwater – Emerald line.

10. Financial Analysis

10.1 Deriving Relevant States of the System

The principal set of scenarios that materially affect this RIT-D are around the proposed connection (or not) of two large customers. Both have sought Planning Reports, but at the time of writing neither had actually applied for connection. For the purposes of this report, the specific states of the system that have been examined are:

1. No new large customers
2. Only one new large customer
3. Two new large customers

10.1.1 Major Customer Connection Scenarios

As noted in section 8, the suitability of each of the options considered is highly dependent on what happens with the major customers. That is:

- Zero new major customers: all options are technically suitable
- One new major customer: Option C is not suitable
- Two new major customers: Options C and A are not suitable

Table 9 - Option suitability vs. major customer connections

	New Major Customers		
	0	1	2
Option A	✓	✓	✗
Option B	✓	✓	✓
Option C	✓	✗	✗

There is also an issue associated with timing, whereby, for example, Option C (embedded generation) is undertaken to delay implementation of capacitive support (Option A), and then one of the major customers decides to proceed with connection. At that point, construction of capacitive support would need to immediately be implemented, losing the benefit of the (already sunk costs of) deferral. Further, once undertaken, should the second customer decide to connect, the new 66kV line would need to be constructed, effectively stranding both previous investments. Note that this is an unlikely worst case.

10.2 Comparing Relevant States of the System

In order to address this large uncertainty, in the sensitivity analysis presented in section 10.3, each option was analysed by including the *probability weighted* costs and benefits of all expenditures that may need to be undertaken should that option be chosen. That is, in the case of Option C (deferral of Option A using embedded generation), the effective cost has been increased by the probability weighted cost of needing to construct capacitive support earlier than otherwise planned and also the probability weighted cost of building the new 66kV line. The benefits included in Option C have been similarly adjusted. This approach was also applied to Option A, with the costs (and benefits) increased by the probability weighted costs (and benefits) of the 66kV line. Finally, no adjustment was made to Option B (new 66kV line) since once constructed, there is no need for either of the other two options.

It should also be noted that Option C has an additional benefit in that it provides a delay in the need to make a decision, effectively reducing the risk of the wrong capital expenditure (Option A or B) being chosen (thereby resulting in higher expenditure than the minimum). Quantification of this benefit requires that estimates are made of the timing at which connection applications would be likely to be received. Considering that there is already large uncertainty about the probability of either major customer proceeding at all, estimating the timing adds a parameter to the already complex analysis that effectively doubles the complexity, without appreciably improving the outcome.

10.3 Net Present Value & Sensitivity Analysis

Net Present Values of the three credible options are presented in Table 10 below. The NPV analysis demonstrates that Option A has the lowest Net Present Cost.

Table 10 – Net Present Value Analysis

$ Millions	Option A	Option B	Option C
Capex	(4.46)	(25.23)	(3.58)
Opex	(0.23)	(1.98)	(4.54)
Direct Benefits (Network Loss Reduction)	0.00	1.66	0.00
Commercial NPV	**(4.69)**	**(25.55)**	**(8.12)**
Ranking	*1*	*3*	*2*
Invol. Load Shed. & Safety Net Benefits	1.12	1.72	1.46
Cost/Benefit NPV	**(3.57)**	**(23.83)**	**(6.66)**
Ranking	*1*	*3*	*2*

As described in section 10.2, in order to address the uncertainty around the connection of two major customers, each option was analysed by including the *probability weighted* costs and benefits of all expenditures that may need to be undertaken should that option be chosen. In the majority of the investigated scenarios, a probability of proceeding of 50% has been applied to each major customer. Probabilities of 20% and 80% of each customer have been applied in the base scenario as well as for the high and low load growth scenarios. It has been assumed that if both major customer projects were to proceed, load growth at Emerald would be higher. It has likewise been assumed that the load growth would be lower in the scenario where none of the major customer projects are proceeding.

The sensitivity analysis presented in Table 11 clearly demonstrated that Option A has the lowest Net Present Cost in all scenarios.

The major reason why Option C has a significantly higher Net Present Cost compared to Option A, is because of the ongoing capacity charges ($50,190/month) Ergon Energy would have to pay the embedded generation provider throughout the entire proposed 10 year contract term. These capacity charges outweigh the deferral benefit of the proposed capital works, as well as the additional benefits of a further reduction in involuntary load shedding and reduction in risk of breaching the Safety Net the embedded generation would bring. To investigate whether the shortest practical contract term to provide the desired deferral of the capital works would yield a cost positive result for Option C, a variation in contract term has been included in the sensitivity analysis presented in Table 11. It can be seen that even for a (shortest practical) three year contract term, Option A still has a lower Net Present Cost.

Table 11 – Sensitivity Analysis

Option A	+11MVAr Reactive comp. at EMER, Upgrade BW line
Option B	New 66kV Feeder Blackwater - Emerald
Option C	Deferral of Option A works, 5MVA of embedded generation

Scenario		Major Customer Connections - Probability		Cost/Benefit Sensitivity Analysis Excl. Overheads ($M)			Weighting (probability of scenario)
				Option A	Option B	Option C	
Base Scenario		High 80% each	*Ranking*	(19.54) *1*	(23.83) *3*	(20.71) *2*	
		Medium **50% each**	*Ranking*	(9.81) *1*	(23.83) *3*	(12.46) *2*	
		Low 20% each	*Ranking*	(4.57) *1*	(23.83) *3*	(7.79) *2*	
Capex	High +30%	50% each	*Ranking*	(13.04) *1*	(31.40) *3*	(15.29) *2*	25%
	Low -30%	50% each	*Ranking*	(6.58) *1*	(16.26) *3*	(9.63) *2*	25%
Opex	High +20%	50% each	*Ranking*	(9.95) *1*	(24.23) *3*	(12.60) *2*	25%
	Low -20%	50% each	*Ranking*	(9.66) *1*	(23.43) *3*	(12.33) *2*	25%
Discount Rate	High 8.00%	50% each	*Ranking*	(9.98) *1*	(24.31) *3*	(12.23) *2*	25%
	Low 6.01%	50% each	*Ranking*	(9.69) *1*	(23.52) *3*	(12.51) *2*	25%
VCR Benchmark	High +30%	50% each	*Ranking*	(9.62) *1*	(23.60) *3*	(12.26) *2*	25%
	Low -30%	50% each	*Ranking*	(9.99) *1*	(24.06) *3*	(12.67) *2*	25%
Contract Term Embedded Generation in Option C	Extended 20 yrs total	50% each	*Ranking*	(9.81) *1*	(23.83) *3*	(13.88) *2*	25%
	Shortened 3 yrs total	50% each	*Ranking*	(9.81) *1*	(23.83) *3*	(9.85) *2*	25%
Load Growth	High +0.4%	80% each	*Ranking*	(19.17) *1*	(23.36) *3*	(20.34) *2*	25%
	Low -1.0%	20% each	*Ranking*	(4.83) *1*	(24.76) *3*	(7.41) *2*	25%
Weighted Average			***Ranking***	(9.99) ***1***	(23.86) ***3***	(12.52) ***2***	

11. Proposed Preferred Option

The previous section has presented the results of the NPV analysis conducted for this RIT-D assessment.

The NER requires the Final Project Assessment Report to include the preferred option under the RIT-D. This should be the option with the greatest net market benefit and which is therefore expected to

maximise the present value of the net market benefits to all those who produce, consume and transport electricity in the market.

This RIT-D assessment has clearly demonstrated that Option A maximises the present value of net market benefits under all reasonable scenarios considered. The preferred option is therefore Option A: Reactive compensation at Emerald Zone Substation and upgrade of the Blackwater – Emerald 66kV Feeder.

This option satisfies the RIT-D.

The total project cost, inclusive of operating costs and market benefits, is estimated at $3.57M in present value terms.

The technical characteristics of the preferred solution are presented below:

- Install 3 x 3MVAr capacitor banks and a +/-2MVAr STATCOM at Emerald Zone Substation, for a total of 11MVAr of reactive compensation in addition to the already existing 2 x 5MVAr capacitor banks.
- Upgrade the Blackwater – Emerald 66kV feeder to a maximum operational temperature of 100°C by pole rebutting.

12. Next Steps

This Final Project Assessment Report represents the final stage of the RIT-D process to address the identified need at Emerald.

In accordance with the provisions set out in clause 5.17.5(c) of the NER, Registered Participants or Interested Parties may, within 30 days after the publication of this report, dispute the conclusions made by Ergon Energy in this report with the Australian Energy Regulator. Accordingly, Registered Participants and Interested Parties who wish to dispute the analysis, conclusions, or recommendations outlined in this report must do so by **31 December 2016**. Any parties raising such a dispute are also required to notify Ergon Energy by using Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". The portal is available at:

https://www.ergon.com.au/network/network-management/network-infrastructure/regulatory-test-consultations

If no formal dispute is raised, Ergon Energy will proceed with more detailed investigations to further develop and refine the scope of the preferred solution and take it through to completion. This will involve a cost vs benefit analysis of various sources, amounts and configurations of the additional reactive support at Emerald, with 11MVAr being the minimum. Any change in scope compared to what's defined as the preferred solution in this report, will need to have a higher Net Present Value (lower Net Present Cost) in order to be chosen as the preferred solution. Ergon Energy will at all times follow due diligent processes to ascertain the most cost effective supply of the reactive support.

13. Appendix A – Changes to Reliability Standards

Ergon Energy was notified in March 2014 that the Queensland Government had made a decision to implement reforms to the electricity network reliability standards, consistent with the recommendations of the *Inter-Departmental Committee on Electricity Sector Reform* and the *Independent Review Panel on Network Costs*.

Specifically, from July 1 2014, these reforms:

1) Remove the requirement to comply with N-1 planning standards.
2) Require that Distributors take an 'economic' approach to building network for reliability purposes.
3) Retain the Minimum Service Standards (i.e. a set of target reliability performance indicators), while adding an additional set of "Safety Net" measures. The Safety Net measures provide an upper limit to the customer outage consequence for a single contingency, Low Probability, High Impact event on Ergon's network.

Along with changes to the transmission system requirements, these changes are forecast to save Queensland in the order of $2 Billion over the next 15 years, applying downward pressure on electricity network charges[10].

13.1 Service Safety Net Targets

Under Safety Net, Emerald is classified as a "Regional Centre" and the following restoration time targets apply for credible contingencies. The load unsupplied must be:

1. Less than 20 MVA after 1 hour
2. Less than 15 MVA after 6 hours
3. Less than 5 MVA after 12 hours
4. Fully restored within 24 hours

Important factors to note under Safety Net:

a) The magnitudes are calculated upon the maximum demand for a 50% PoE[11] forecast

b) The magnitudes and timelines are based on lapsed time after a credible contingency occurs. For example, no more than 20 MVA of load may be unserved 1 hour after a contingency, no more than 15 MVA is to be unserved after 6 hours, no more than 5 MVA is to be unserved after 12 hours, and supply must be fully restored after 24 hours.

c) During an actual outage, Ergon Energy will always endeavour to restore supply as early as can be safely achieved. The timelines above are "planned for" upper limits and as such, the actual customer interruption duration may be significantly less than the timeline (in many cases, no loss of supply would occur at all). For example, while 5 MVA can be "unsupplied" for 24 hours, due to the cyclic nature of network loading, in most locations supply to all customers would typically be restored during the evening/night (noting that the item of plant may not have yet been repaired/replaced). Occasionally, further loss of supply may occur during the high demand period on the following day, while the failed item of plant is still being repaired/replaced, however full supply is to be restored within 24 hours.

[10] http://www.dews.qld.gov.au/policies-initiatives/electricity-sector-reform/supply/electricity-network-reliability-standards

[11] Probability of Exceedance 50%: a forecast that has a 50% chance of being exceeded in any one year; i.e. an "average" year.

d) Large customers with an authorised demand above 1.5MVA, who have not paid for an N-1 supply, do not count against the Service Safety Net Targets and thus may remain unsupplied in some circumstances beyond the timelines given above.

For guidance as to what kind of events that may be considered as credible vs. non-credible contingencies, please refer to clause 4.2.3 of the National Electricity Rules.

13.2 Value of Customer Reliability

The Value of Customer Reliability (VCR) is a "*measure, or index, [that] indicates what different types of customers (residential, commercial and industrial) are prepared to pay to maintain reliable electricity supplies*."[12]

VCR forms the basis of the "economic" approach to planning for network reliability. Project costs for proposed network augmentations are compared against the improvement in network reliability they create; at the point where the benefit (i.e. the customer's willingness to pay for that reliability) exceeds the annualised cost of the augmentation, then the project is justified under this approach.

The significant difference between this approach and the previous "N-1" proscriptive standards is that there is no level of loading on a network element that automatically triggers an augmentation; the timing and form of a network reliability improvement is highly dependent of the price of the project and the benefits generated.

[12] http://www.aemo.com.au/Consultations/National-Electricity-Market/Open/~/media/Files/Other/consultations/nem/VCR_FACT_SHEET_NOVEMBER_20132_ELEC.ashx