Regulatory Investment Test for Distribution

Draft Project Assessment Report (DPAR)

Addressing reliability requirements in the Garbutt network area

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

Publication Date: **13th December 2019**

Consultation Period Starts: **13th December 2019**

Consultation Period Closes: **31st January 2019**

Disclaimer

While care was taken in preparation of the information in this ***Draft Project Assessment Report***, and it is provided in good faith, Ergon Energy Corporation Limited accepts no responsibility or liability for any loss or damage that may be incurred by any person acting in reliance on this information or assumptions drawn from it. This document has been prepared for the purpose of inviting information, comment and discussion from interested parties. The document has been prepared using information provided by a number of third parties. It contains assumptions regarding, among other things, economic growth and load forecasts which may or may not prove to be correct. All information should be independently verified to the extent possible before assessing any investment proposal

Executive Summary

Ergon Energy Corporation Limited (Ergon Energy) is responsible under its Distribution Authority D01/99 for electricity supply to the Townsville area in North Queensland.

Garbutt 132/66/11kV (T046) Substation (GARB) is a Powerlink Queensland (PLQ) / Ergon Energy (EE) shared site located in Townsville. GARB Substation was established in 1958 and progressively developed since to be a critical node within the Townsville sub transmission (66kV) network. GARB links two transmission feeders to seven zone substations (inclusive) and supplies 48,500 customers and 86MVA of load (directly and indirectly).

There is minimal forecast load growth at the substation however many assets are approaching or at the end of service life. Most notably the structures that support the 66kV air insulated busbar and bay equipment have been assessed to have insufficient structural integrity to safely provide support for the equipment. Some equipment and the majority of structures are 40-60 years old.

The deteriorated condition of the assets at Garbutt Substation poses significant safety risks to staff working in proximity to these assets and reliability of supply risks to customers supplied from Garbutt Substation.

The identified need for investment is to remediate the safety and reliability risks currently associated with the aged assets at Garbutt Substation in order to maintain a safe, reliable supply of electricity to customers in the Townsville region.

Ergon Energy originally published a notice of no non-network options relating to the above described identified need on 18th June 2018. This notice was revised and republished on 13th December 2019.

This is a Draft Project Assessment Report, where Ergon Energy provides both technical and economic information about possible solutions. Ergon Energy's proposed preferred network option to address the identified need is to replace the aged assets at Garbutt Substation with 66kV Gas Insulated Switchgear (GIS) located within the existing Garbutt Substation boundary.

For further information and inquiries please refer to the "Regulatory Investment Test for Distribution (RIT-D) Partner Portal".
https://www.ergon.com.au/network/network-management/

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1. Introduction

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

This report represents the second 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 at Garbutt Substation (GARB) in Townsville.

On the 18th June 2018, Ergon Energy (EE) published the first stage of the RIT-D, which was the release of the notice of no non-network options. This notice was revised and republished on the 13th December 2019.

This report:

- Identifies the need which Ergon Energy is seeking to address, together with the assumptions used in identifying and quantifying that need.
- Describes the credible options that are considered in this RIT-D assessment.
- Quantifies costs 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 possible future loads and development, Ergon Energy has, in good faith, included as much detail as possible while maintaining necessary customer confidentiality.

All submissions and queries should be lodged to Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". Submissions in writing (electronic preferably) are due by **31st January 2019**. The portal is available at:

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

For further information and inquiries please refer to the "Regulatory Investment Test for Distribution (RIT-D) Partner Portal"

2. Background

2.1. Geographic region

The geographic region covered by this RIT-D is Garbutt Substation and the connected substations through its 66kV Network. Garbutt Substation supplies approximately 48,500 customers and is located in the Townsville area of the Northern Region of Ergon Energy's Network.

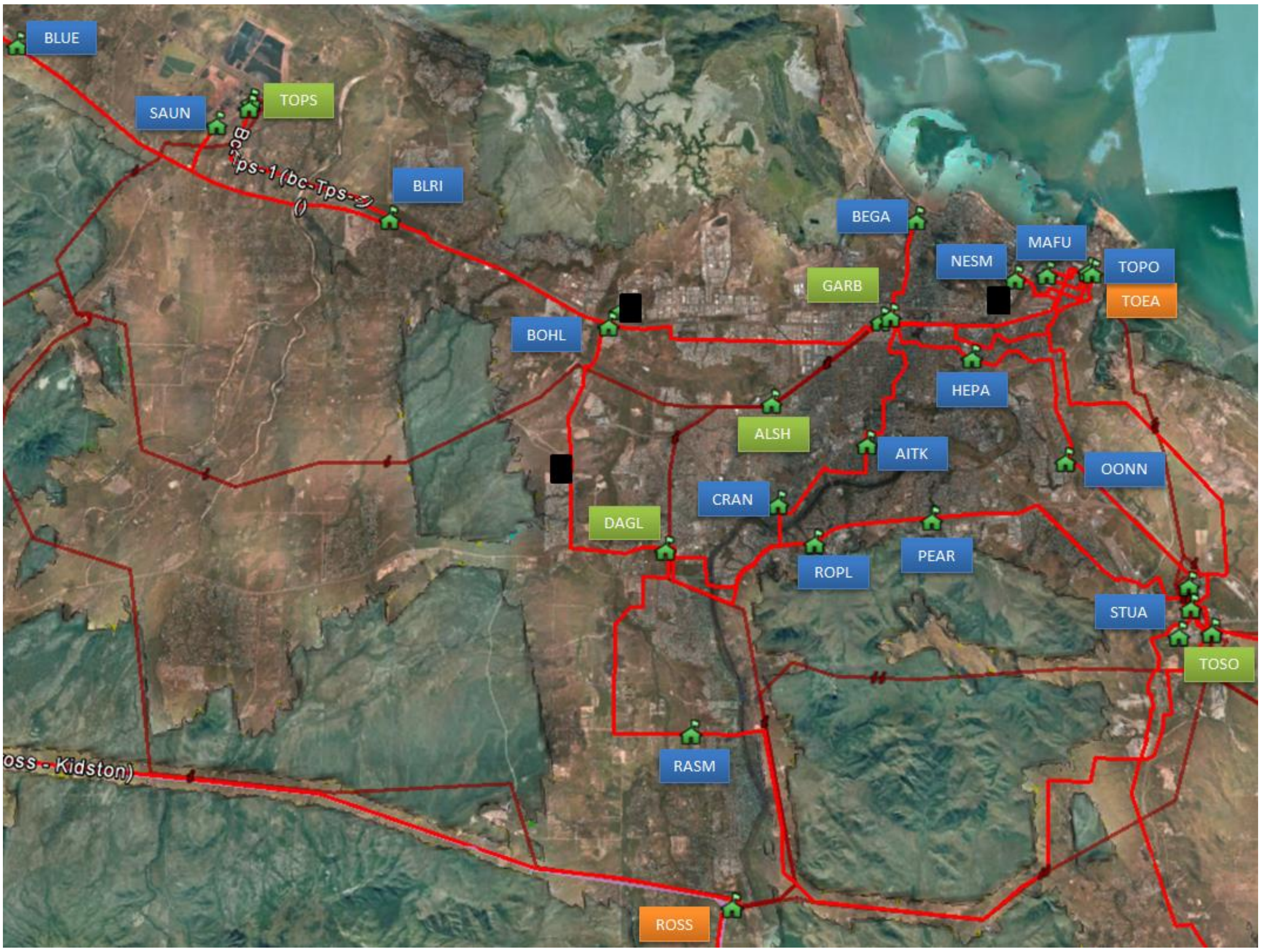


Figure 1: Townsville's 132 kV transmission and 66kV sub transmission Networks
(PLQ Sites Orange, PLQ/EE Sites Green, EE sites Blue)

2.2. Existing supply system

Garbutt 132/66/11kV Substation is supplied via a Powerlink Queensland (PLQ) owned double circuit transformer ended 132kV feeder from Alan Sherriff Substation. The PLQ-EE asset boundary at Garbutt Substation is the 66kV bushings on the 132/66kV transformers. Garbutt Substation has seven 66kV feeders that supply a number of zone substations in the Townsville area. Garbutt Substation has eleven outgoing 11kV feeders that supply approximately 1472 commercial/industrial customers and 4201 domestic customers.

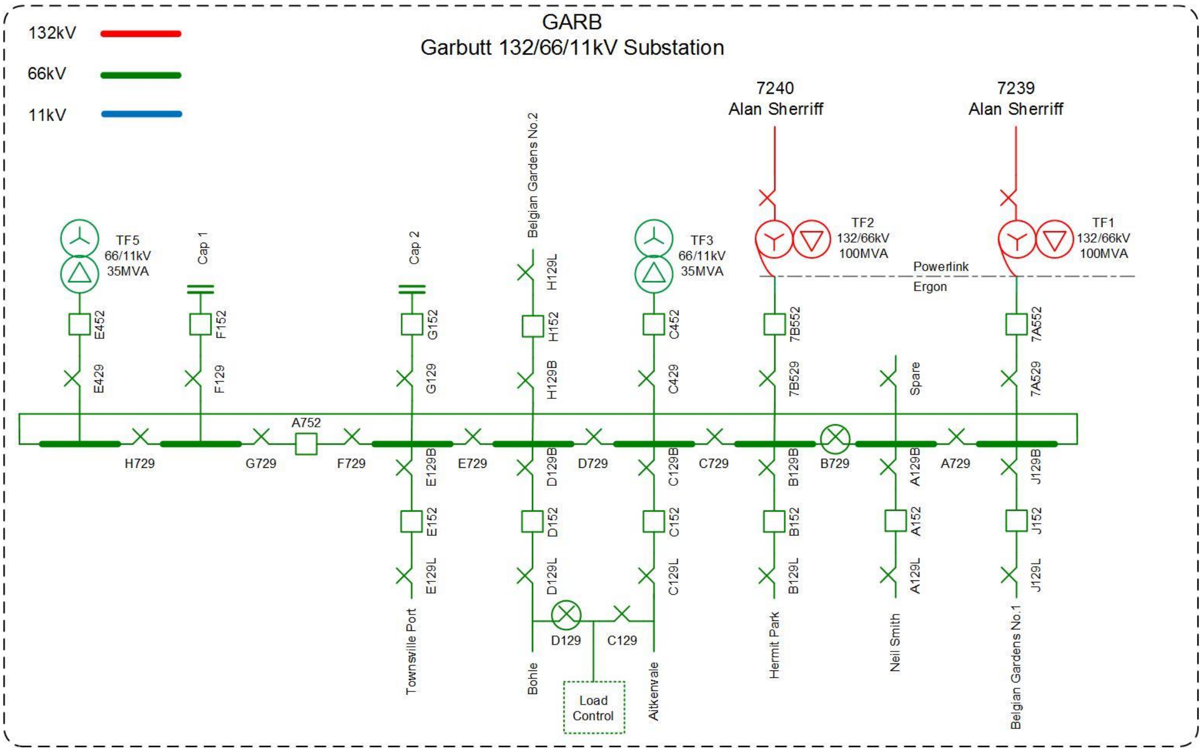


Figure 2 Single Line Diagram of the 66kV bus at Garbutt Substation

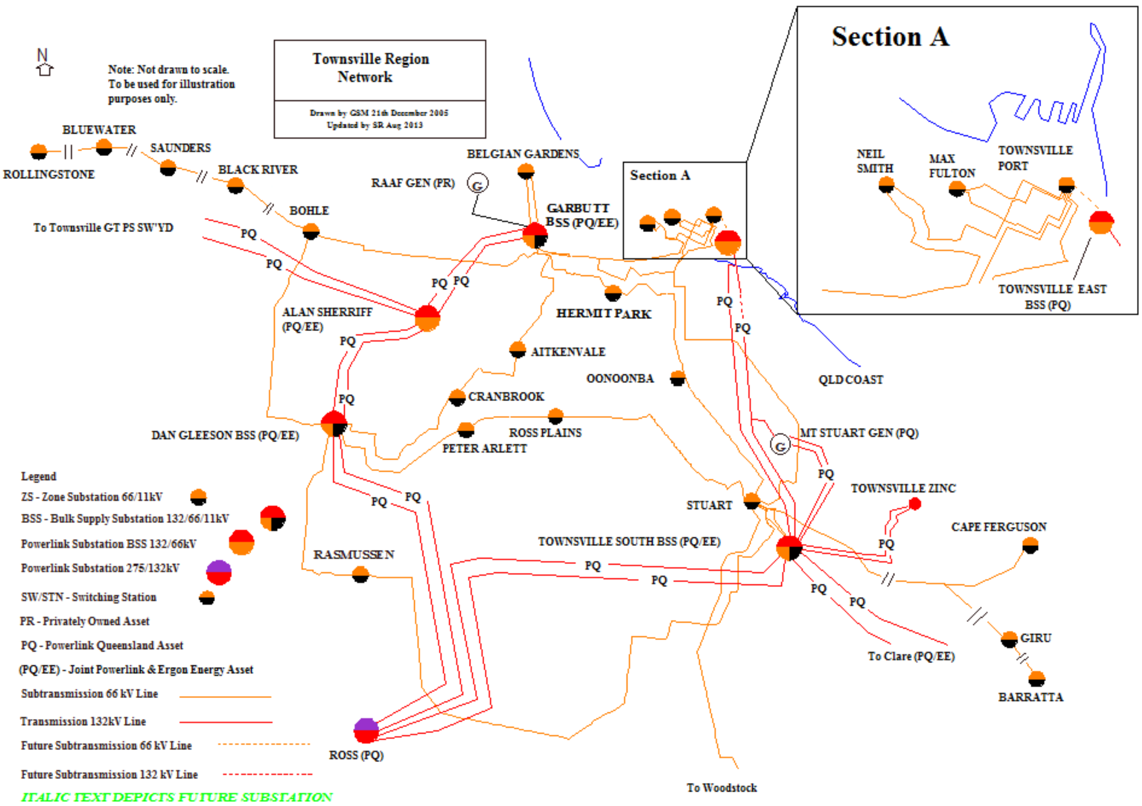


Figure 3 Existing Townsville Network Arrangement (Sub-transmission)

The Townsville 66kV network is supplied by four PLQ 132/66kV substations (T056 Townsville South, T094 Townsville East, T092 Dan Gleeson and T046 Garbutt) as shown in the diagram above. Garbutt Substation is a crucial node in the interconnected 66kV ring arrangement that supplies the 66/11kV zone substations in the Townsville urban area. The following Zone substations would be directly impacted for a Garbutt Substation 66kV bus outage:

- Garbutt 11kV network (complete outage of supply)
- Belgian Gardens (complete outage of supply)
- Bohle (supply maintained via Dan Gleeson – Bohle 66kV feeder)
- Black River (supply maintained via Dan Gleeson – Bohle 66kV feeder)
- Saunders (supply maintained via Dan Gleeson – Bohle 66kV feeder)
- Bluewater (supply maintained via Dan Gleeson – Bohle 66kV feeder)
- Rollingstone (supply maintained via Dan Gleeson – Bohle 66kV feeder)
- Neil Smith (supply maintained via Townsville Port – Neil Smith 66kV feeder)
- Aitkenvale (supply maintained via Dan Gleeson – Cranbrook 66kV feeder)
- Cranbrook (supply maintained via Dan Gleeson – Cranbrook 66kV feeder)
- Hermit Park (supply maintained via Stuart – Oonoonba 66kV feeder)
- Oonoonba (supply maintained via Stuart – Oonoonba 66kV feeder)

With the Townsville network configured in a normal state, an outage on both 66kV bus sections at Garbutt Substation should normally only result in an outage to customers supplied from the Garbutt Substation 11kV distribution network and the Belgian Gardens 11kV distribution network.

2.3. Load Forecast and Capacity

There is presently adequate capacity at Garbutt and Belgian Gardens Substations to service the forecast loads in compliance with the Safety Net targets.

	Normal Cyclic Capacity (NCC)	Emergency Cyclic Capacity (ECC)
Garbutt Substation 66kV	180MVA[1]	90MVA[2]
Garbutt Substation 11kV	53.8MVA	29.8MVA
Belgian Gardens Substation 11kV	73.9MVA	40.9MVA

Table 1 Garbutt and Belgian Garden Substation Capacities

The plots below show the historical maximum demands and the 50% Probability of Exceedance (50 PoE) forecast demands for the Garbutt Substation 66kV load, the Garbutt Substation 11kV load and the Belgian Gardens Substation 11kV load.

[1] Limited by the 66kV 800A isolators. Also dependant on the split of power flow through the 66kV rigid and aerial bus sections. The aerial bus section has a rating of approximately 485A.
[2] Dependant on the split of contingent power flows through the 66kV rigid and aerial bus sections. The aerial bus section has a rating of approximately 485A.

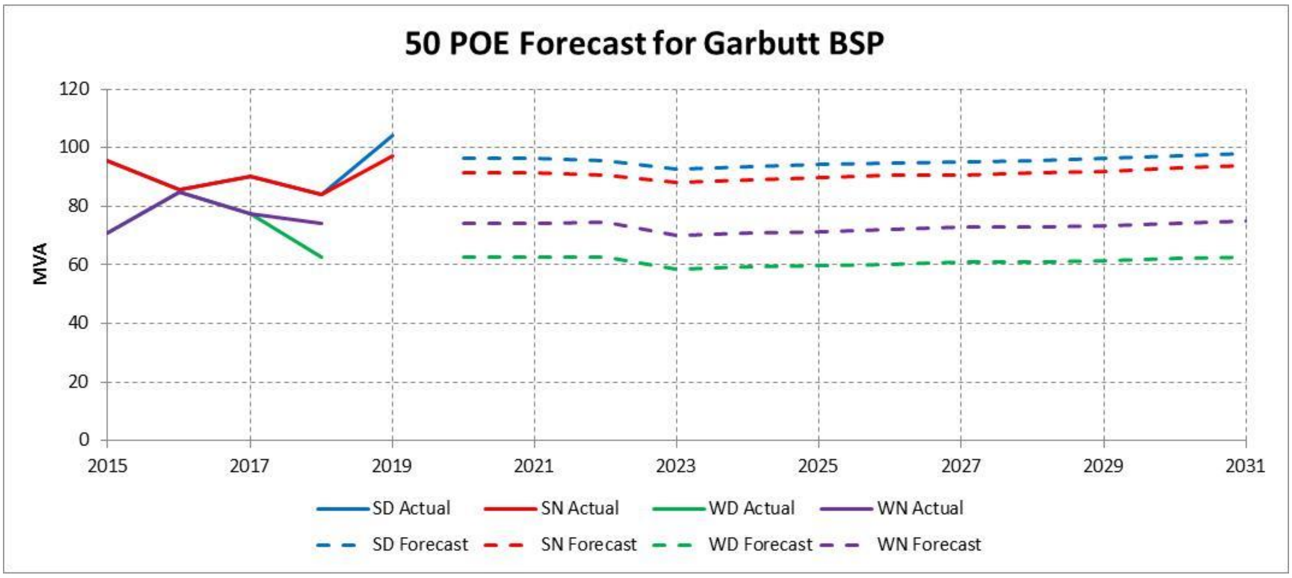


Figure 4 50 PoE Demand Forecast for the Garbutt Substation 66kV load

The 66kV network is highly meshed around Townsville and an outage to one of the 132/66kV transformers does not result in all 66kV load being carried on the remaining 132/66kV transformer due to the impedance change at Garbutt Substation. Therefore the loading shown in the forecast for Garbutt Substation 66kV load would normally not be applicable with one 132/66kV transformer out of service as some of this load would shift, based on the impedance changes, to adjacent bulk supply points in the Townsville 66kV network.

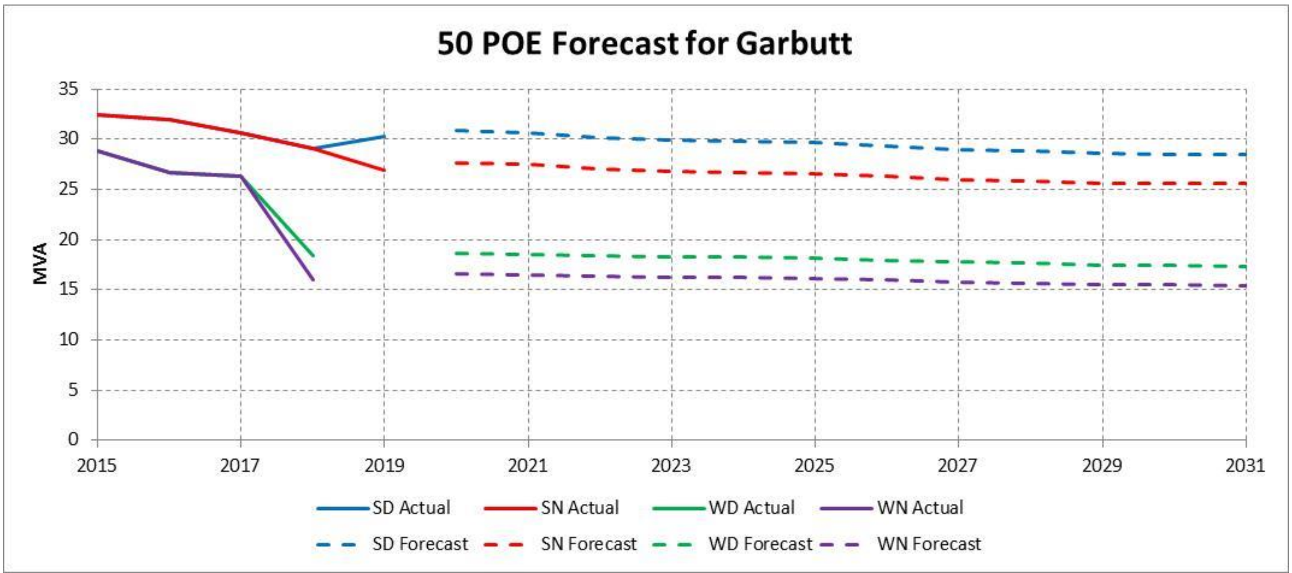


Figure 5 50 PoE Demand Forecast for the Garbutt Substation 11kV load

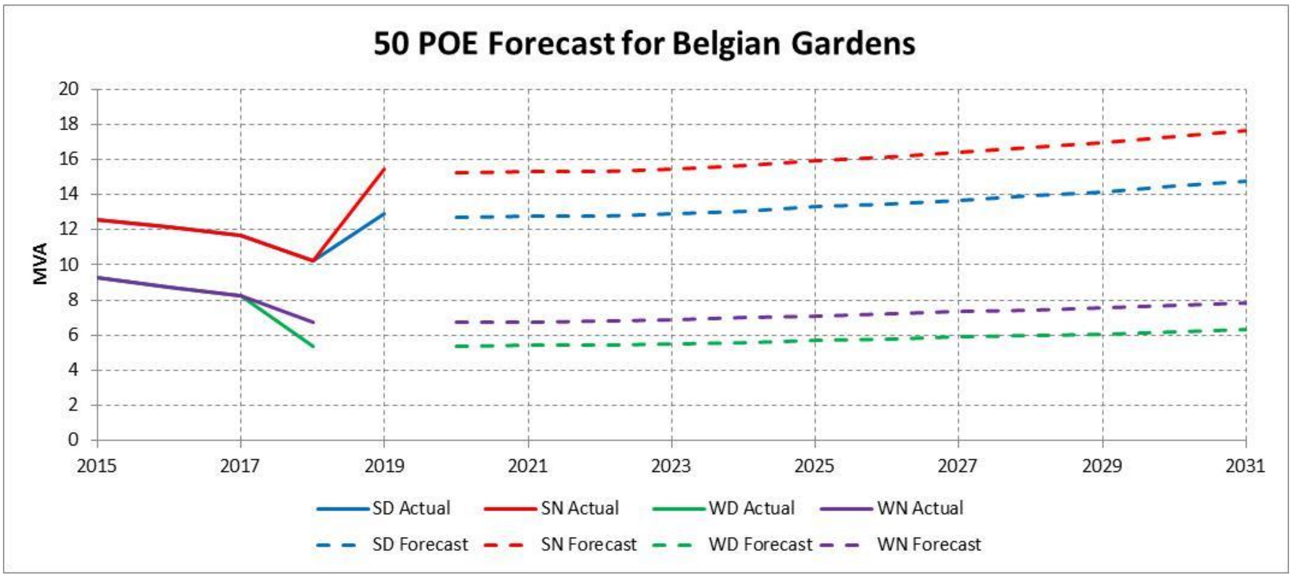


Figure 6 50 PoE Demand Forecast for the Belgian Gardens Substation 11kV load

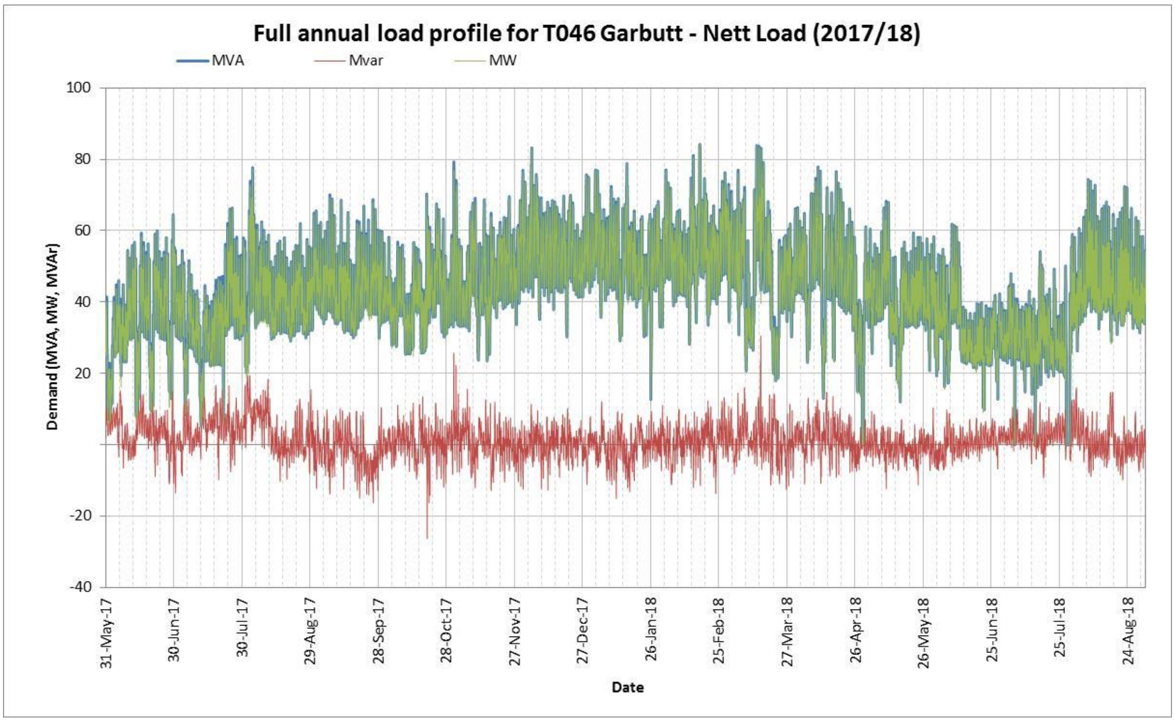


Figure 7 GARB 66kV load profile (2017/18)

The plot above shows the half hourly average daily load profile for Garbutt Substation 66kV load for the 2017/18 period. The plot shows that the Garbutt Substation 66kV load peaks during the summer period. Note that the configuration of the Townsville 66kV network and the status of local generation can influence the 66kV loading at Garbutt Substation.

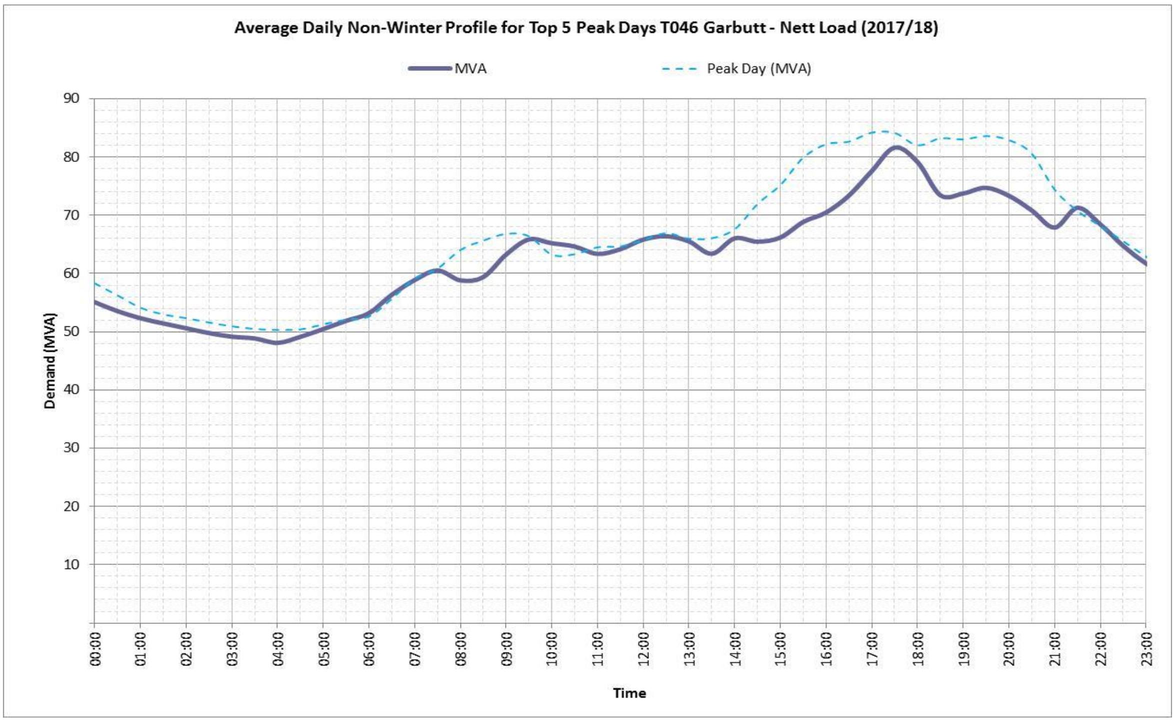


Figure 8 GARB 66kV load profile – Average of Top 5 Peak Days (2017/18)

The summer peak for the Garbutt Substation 66kV load typically occurs in the late afternoon early evening as shown in the plot above.

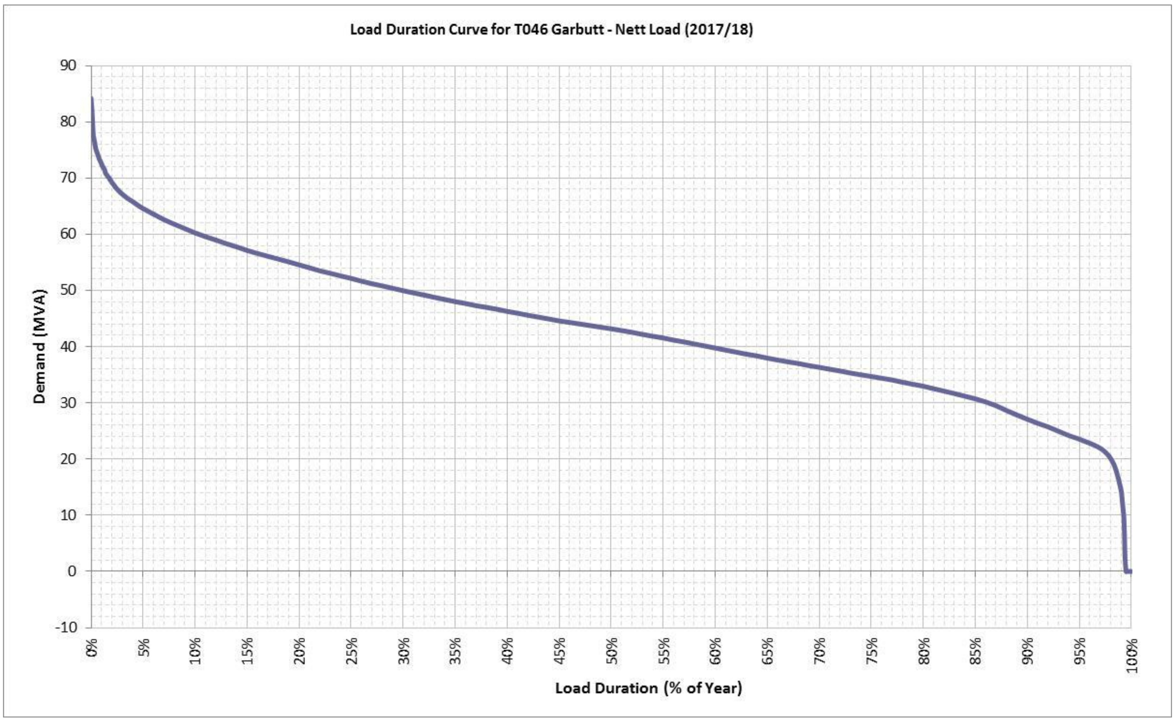


Figure 9 GARB 66kV Load Duration Curve (2017/18)

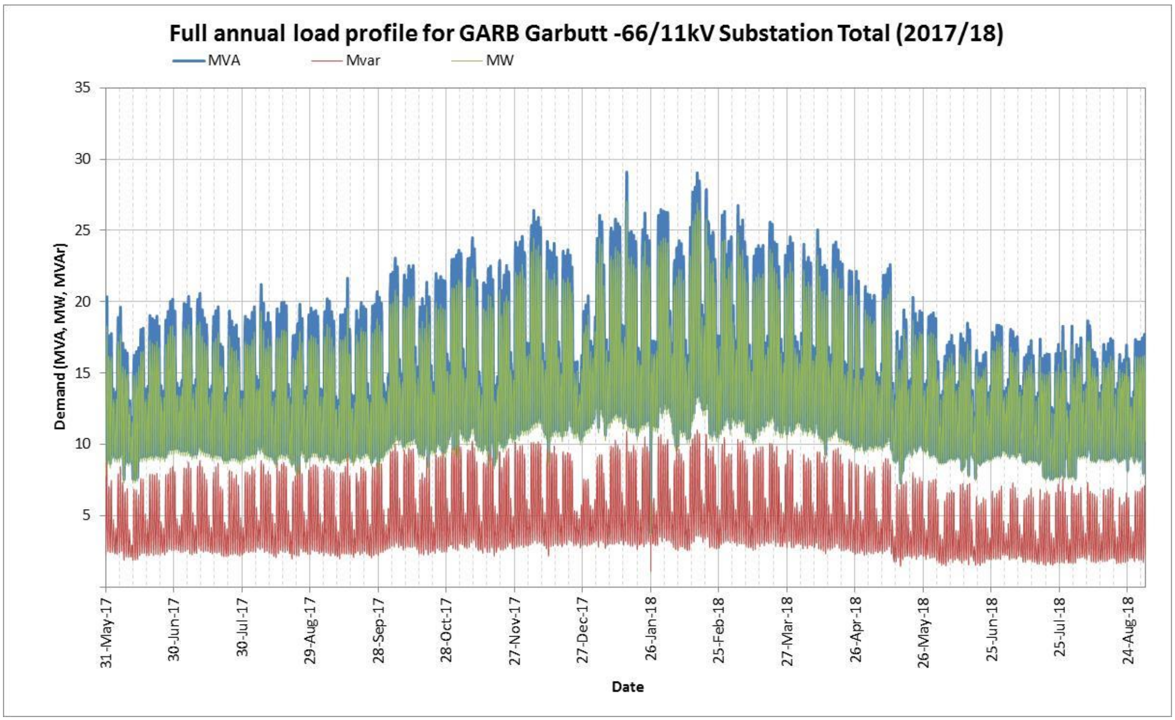


Figure 10 GARB 11kV load profile (2017/18)

The plot above shows the half hourly average daily load profile for Garbutt Substation 11kV load for the 2017/18 period. The plot shows that the Garbutt Substation 11kV load peaks during the summer period.

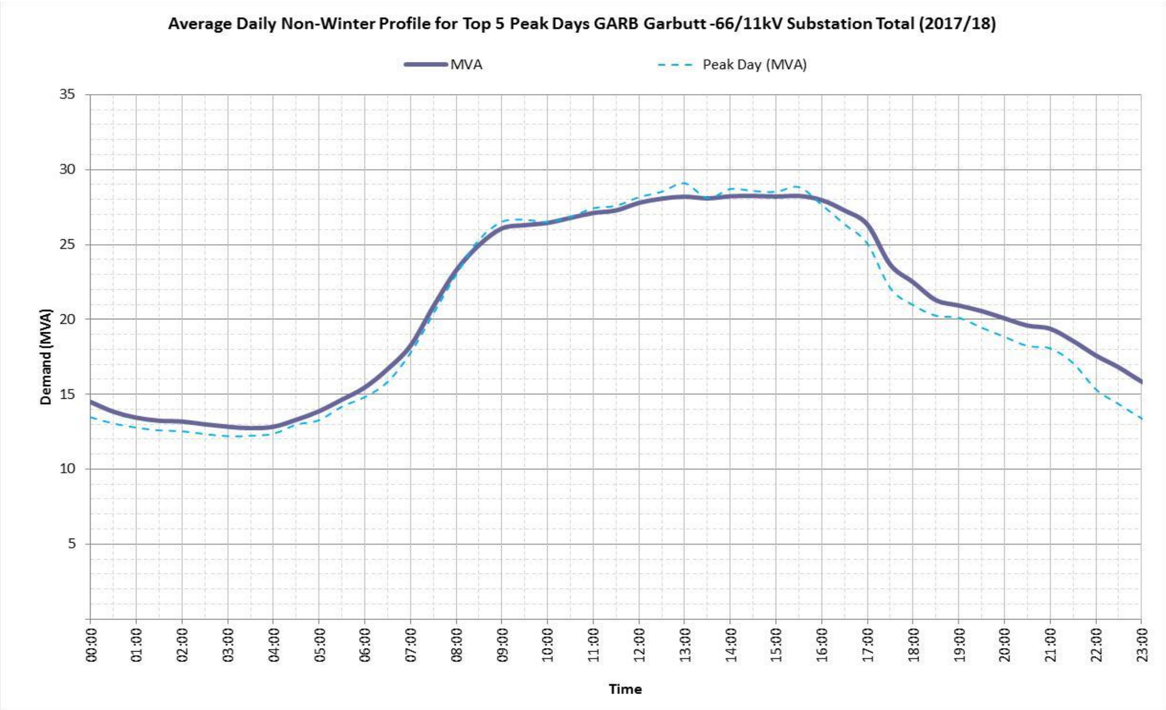


Figure 11 GARB 11kV load profile – Average of Top 5 Peak Days (2017/18)

The summer peak for the Garbutt Substation 11kV load typically occurs during the day as shown in the plot above. The Garbutt Substation 11kV distribution network supplies a large proportion of industrial / commercial customers that predominantly operate during normal business hours.

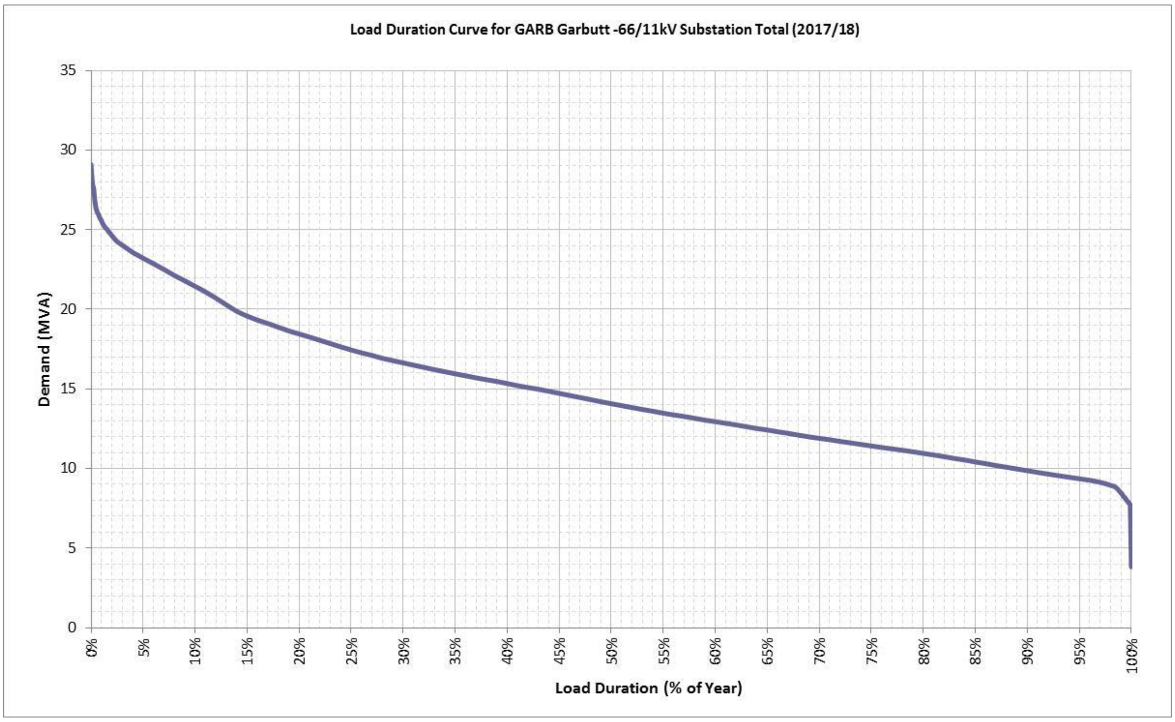


Figure 12 GARB 11kV Load Duration Curve (2017/18)

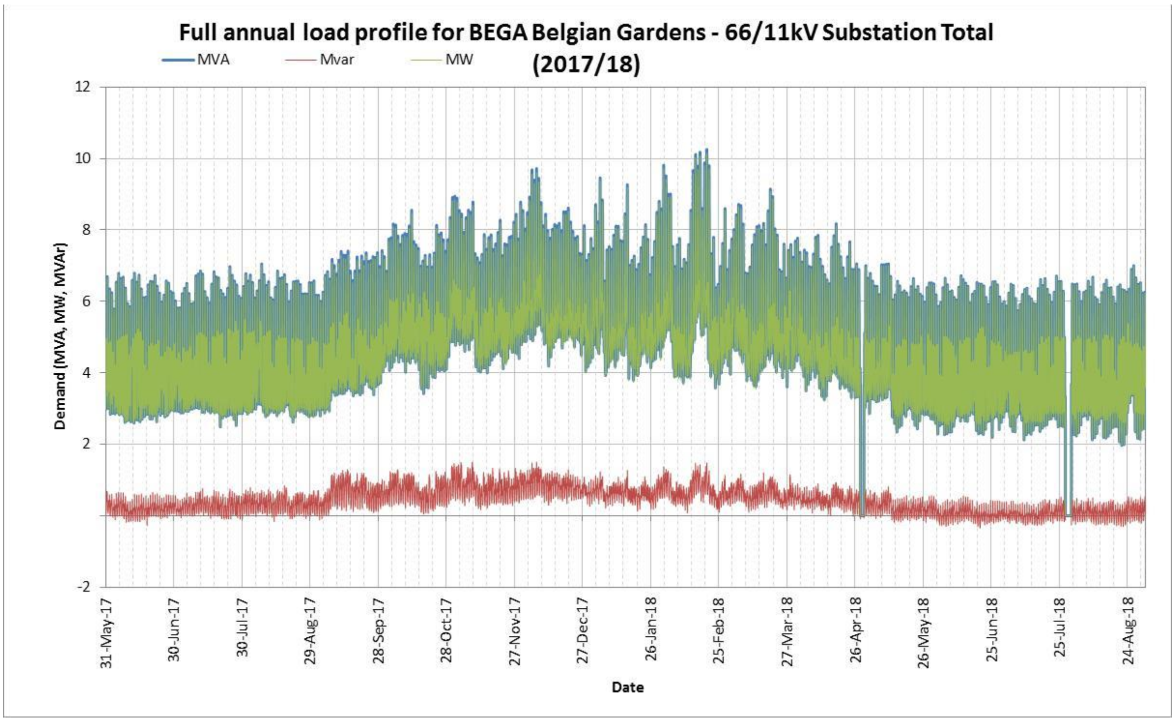


Figure 13 BEGA 11kV load profile (2017/18)

The plot above shows the half hourly average daily load profile for Belgian Gardens Substation 11kV load for the 2017/18 period. The plot shows that this substation load peaks during the summer period.

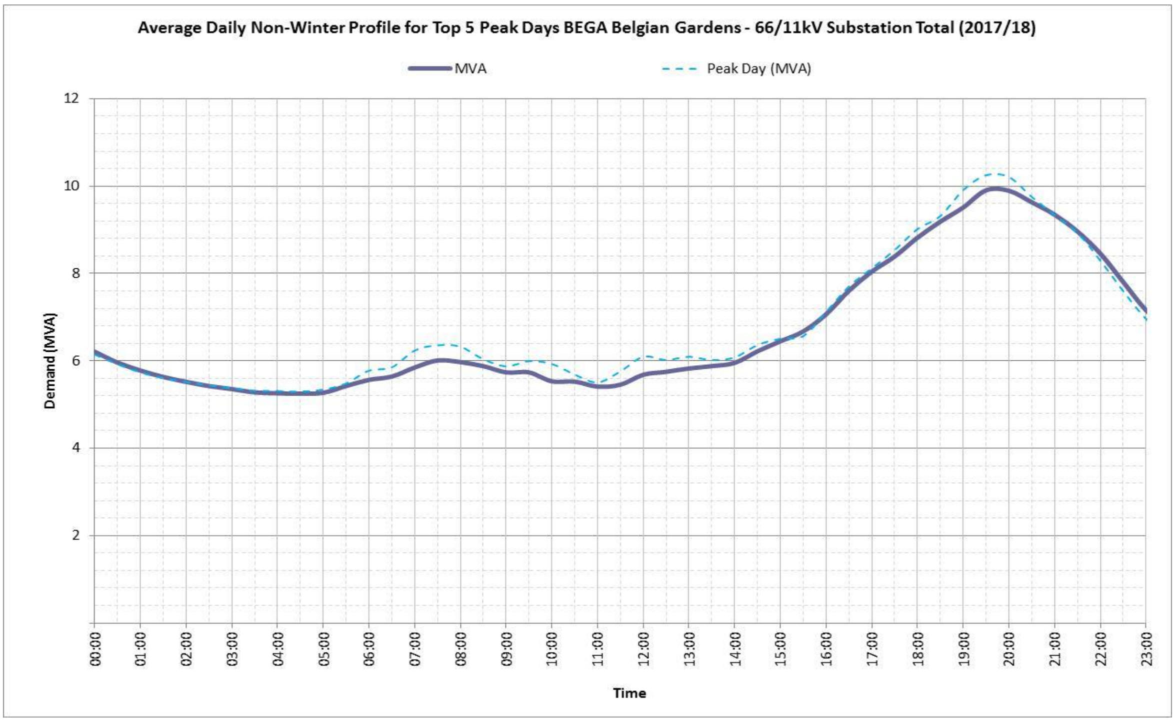


Figure 14 BEGA 11kV load profile – Average of Top 5 Peak Days (2017/18)

The summer peak for the Belgian Gardens Substation 11kV load typically occurs in the early evening as shown in the plot above. The Belgian Gardens Substation 11kV distribution network supplies a large proportion of residential customers resulting in an evening peak.

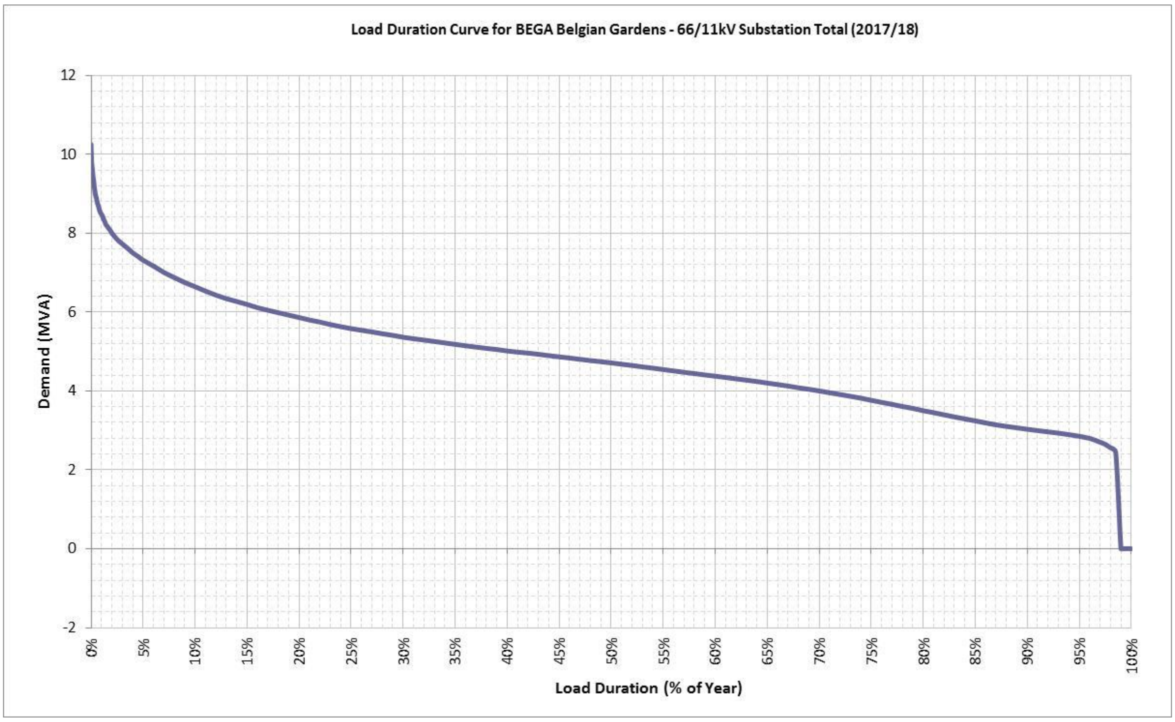


Figure 15 BEGA 11kV Load Duration Curve (2017/18)

2.4. Customer Statistics

Approximately 11,597 customers are directly supplied from Garbutt and Belgian Gardens Substations via the 11kV distribution network. 1,509 of these customers have inverter energy systems installed.

	Garbutt Substation 11kV network	Belgian Gardens Substation 11kV network
Total Customers	5673	5924
Residential	4201	5475
Non-Residential	1472	449
Annual Energy (kWh)	141,379,824	55,597,707
Energy Residential (kWh)	32,174,858	33,615,309
Energy Non-Residential (kWh)	109,204,967	21,982,399
Inverter Energy Systems		
IES Count Residential	615	715
IES Count Non-Residential	134	45
IES Capacity Residential	2544kVA	3224kVA
IES Capacity Non-Residential	2439kVA	736kVA

Table 2 Customer Statistics for the 2018/19 period

2.5. Substation Condition

2.5.1. Structures Condition Assessment

In 2016 a civil engineering assessment was undertaken to verify the integrity of the structures supporting the 66kV busbar and various primary plant items in the Garbutt Substation. The key observations on the pre 1980 concrete supports:

- due to the design, construction practices and quality of materials used, several concrete structures supporting the bus isolators and termination structures are deteriorating to the extent their structural integrity has been compromised
- all concrete structures supporting isolators on the low bus have a high risk of failure;
- all concrete structures supporting isolators on the high bus have a high risk of failure;
- all concrete line termination structures have a high risk of failure in the east west direction.

The assessment also made the following key observations about the risk that operators switching isolators mounted on these structures are exposed to:

- the majority of the bus isolators in the substation are becoming unsafe to operate due to their deteriorating condition
- there is a medium risk of failure of the structures supporting the A729, D729, B729 C729 and G729 isolators on the high bus. For the other isolators there is a low risk of failure;
- there is a medium risk of failure of the B129L line termination structure. For the other line termination structures the risk is low.

2.5.2. Substation Condition Assessment

A detailed Substation Condition Assessment Report (SCAR) was completed in early 2018. This assessment validated the recommendations presented in the 2016 civil engineering assessment of the structures and identified that a significant portion of the 66kV equipment was approaching end of life within the next 10 years.

The table below shows the assets that have been recommended for replacement based on the condition assessment.

Assets recommended for replacement ASAP	
Asset Location	**Asset Types**
132/66kV tfmr No. 1 66kV bay	VT, ISO, busbars & supports, surge arresters
132/66kV tfmr No. 2 66kV bay	VT, ISO, busbars & supports, surge arresters
66kV Cap No. 1 bay	Unbalance CT, VT
66kV Cap No. 2 bay	CB, VT
66kV Neil Smith fdr bay	ISO
66kV Hermit Park fdr bay	ISO
66kV Aitkenvale fdr bay	ISO, CT
66kV Bohle fdr bay	ISO
66kV Rigid buses 2, 3, 4, 5, 6, 7	ISO
Between 66kV rigid buses 6 & 7	CT
66kV bus zone protection scheme	Complete scheme
66kV capacitor bank # 1 & # 2 protection & control relays	All protection and control relays
Assets recommended for replacement within 5 to 10 year window	
66/11kV tfmr No. 3 66kV bay	ISO c/w support structure
66kV Cap No. 1 bay	ES c/w support structure, CB, ISO
66kV Cap No. 1 bay	Reactor support structures, busbars and supports
66kV Cap No. 2 bay	ES c/w support structure; ISO c/w support structure
66kV Cap No. 2 bay	Busbars and supports
66kV Neil Smith fdr bay	Busbars & cable termination support structures
66kV Hermit Park fdr bay	Busbars & cable termination support structures
66kV Aitkenvale fdr bay	Busbars support structures, surge arresters
66kV Spare bay located between 132/66kV tfmr bays	All assets in the bay
66kV Rigid buses 2, 3, 4, 5, 6, 7	All bus support structures
66kV Strung bus 1	Bus support structures
PLQ owned 415V AC board	Complete board
66kV GARB-HEPA protection schemes	Pilot wire protection scheme and pilot wire
11kV Protection schemes	All feeder protection schemes
Protection & Control Panels	Remove old tunnel board
ALFC system components	AFLC controller, coupling cell and transmitter
RTUs	RTUs 1 & 2
Communications assets	All pilot wire protection cables emanating from GARB Substation
Substation duct covers	Replace missing lids & repair cracked concrete ducts
Lightnining masts	Replace those on pre-1980 concrete structures

Table 3 Garbutt Substation Assets recommended for replacement in the SCAR within a 10 year timeframe

3. Description of the identified need

Garbutt 132/66/11kV (T046) Substation (GARB) is a Powerlink Queensland (PLQ) / Ergon Energy (EE) shared site with outdoor 132 kV and 66kV assets and indoor 11kV assets, which supplies 48,500 customers and 86MVA of load (directly and indirectly). Development of the substation commenced in 1958 with upgrades and augmentations in subsequent years. Garbutt Substation is now an integral node within the Townsville sub transmission (66kV) network with seven 66kV feeders supplying a number of zone substations. There is minimal forecast load growth at the substation however many assets are approaching or at the end of service life, with some equipment and the majority of structures 40-60 years old.

Figure 16 Aerial image of Garbutt Substation

A Civil Engineering Condition Assessment of the Garbutt Substation in 2016 made the following key observations about the pre 1980 concrete supports:

- All concrete structures supporting isolators on the low bus have a high risk of failure;
- All concrete structures supporting isolators on the high bus have a high risk of failure;
- All concrete line termination structures have a high risk of failure in the east-west direction.

The report also included the following key observations about the risk that operators switching isolators mounted on these structures are exposed to:

- There is a medium risk of failure of the structures supporting the A729, D729, B729 C729 and G729 isolators on the high bus. For the other isolators there is a low risk of failure;
- There is a medium risk of failure of the B129L line termination structure. For the other line termination structures, the risk is low.

In January 2018 a segmented porcelain insulator supporting a 66kV isolator failed catastrophically. Shards of porcelain were located up to 25m from the point of failure. This incident caused a significant supply interruption and triggered a reactive project to replace all segmented porcelain insulators in the Garbutt Substation yard.

Subsequent to this incident a Substation Condition Assessment Report (SCAR) was completed for Garbutt Substation which identified the assets nearing or at end of life and requiring replacement. The predominant primary system assets identified for replacement were the 66kV outdoor switchgear including; circuit breakers, voltage and current transformers, insulators stacks, isolators, the strung bus, the solid bus and all their supporting structures.

The deteriorated condition of the assets at Garbutt Substation poses significant safety risks to staff working in proximity to these assets and reliability of supply risks to customers supplied from Garbutt Substation.

Ergon Energy Corporation Limited (Ergon Energy) is responsible under its Distribution Authority D01/99 for electricity supply to the Townsville area in North Queensland. A fundamental requirement of Ergon Energy's Distribution Authority is to comply with the Minimum Service Standards and Safety Net Targets that seek to effectively mitigate the risk of low probability – high consequence network outages to avoid unexpected customer hardship and / or significant community or economic disruption. Details on Ergon Energy's Minimum Service Standards and Safety Net Targets are included in Appendix B.

A condition of Ergon Energy's Distribution Authority is to comply with all applicable legislation. Accordingly, clause 42 of the *Queensland Electricity Act 1994* requires the entity to operate, maintain (including repair and replace as necessary) and protect its supply network to ensure the adequate, economic, reliable and safe connection and supply of electricity to its customers.

The identified need for investment is to remediate the safety and reliability risks currently associated with the aged assets at Garbutt Substation in order to maintain a safe, reliable supply of electricity to customers in the Townsville region.

Changes to the National Electricity Rules (NER) in July 2017[3] have meant that replacement plans for network assets are now subject to RIT-D. Accordingly, Ergon Energy has initiated a RIT-D to address the identified need associated with the aged assets at Garbutt 132/66/11kV Substation.

3.1. Assumptions underpinning the identified need

The need to undertake action is predicated on the deteriorated condition of the assets at Garbutt Substation which pose significant safety risks to staff working in proximity to these assets and reliability of supply risks to customers supplied from Garbutt Substation.

The consequence of not addressing the condition based risks at Garbutt Substation is that the assets will continue to deteriorate and ultimately fail presenting safety and reliability risks.

This section summarises the key assumptions underpinning the identified need for this RIT-D. It is recognised that the assumptions may prove to have various levels of correctness, and they merely represent a 'best endeavours' approach to predict the future identified need.

[3] https://www.aemc.gov.au/rule-changes/replacement-expenditure-planning-arrangements

3.1.1. Forecast Load Growth and Daily Load Profiles

As shown in Figure 5 and Figure 6 the 50 PoE forecast demands for the GARB and BEGA 11kV loads are indicating minimal load growth over the next 10 years.

The average daily profiles for the GARB and BEGA 11kV loads shown in Figure 11 and Figure 14 are not expected to change significantly over the coming years. However the load profiles could potentially be influenced by changes to customer generation or usage patterns and the uptake of electric vehicles and battery storage in the area.

3.1.2. Reduced substation operational capability

The condition of the 66kV bus isolators and supporting structures limits operational flexibility at Garbutt Substation. A majority of the isolators are in poor condition with sticky contacts and some are inoperable. The isolator structures have an increased risk of failure during operation of the isolators due to the necessary force required to open and close the isolators.

Due to the proximity of the isolators to the aerial bus there are a number of isolators that cannot have maintenance performed on them without a complete 66kV bus outage at Garbutt Substation. The 66kV bus configuration does not provide the operational flexibility to de-energise both the aerial bus and the isolators on the rigid bus without a complete bus outage.

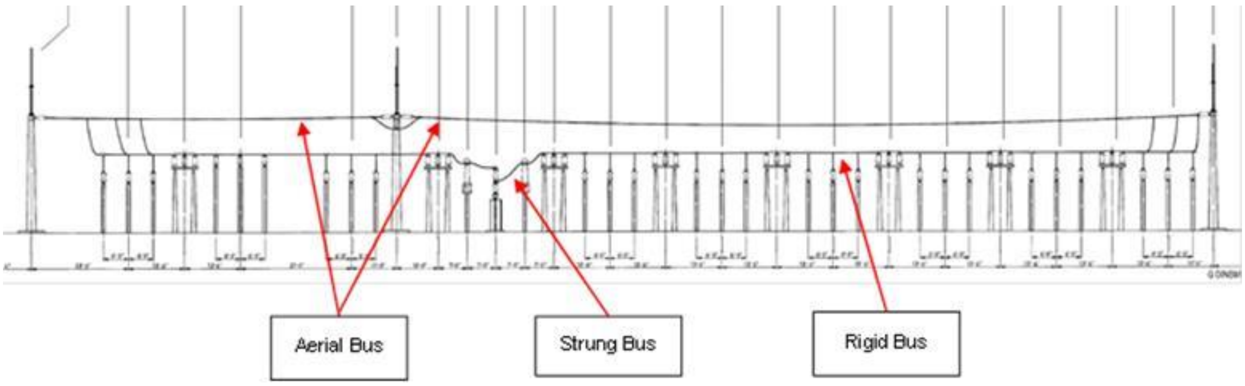


Figure 17 Garbutt Substation elevation diagram showing the 66kV bus configuration

Due to concerns associated with the integrity of the concrete support structures, switching operators assess the condition of each isolator prior to operating and consider the likelihood of structure failure or dislodgement of concrete pieces when subjected to the lateral forces during switching. The controls applied to maintain safety range from a safety observer to refusal to switch resulting in switching at adjacent devices. Switching at adjacent devices can be operationally inefficient and can result in wider network affected by the operation.

3.1.3. Increased risk of involuntary load shedding going forward

Townsville is located in a tropical environment and is subject to harsh atmospheric conditions including tropical cyclones[4]. The aged assets at Garbutt Substation, particularly the deteriorating concrete support structures, will become more susceptible to failure during periods of increased wind loading.

[4] http://www.bom.gov.au/cyclone/about/

With the Townsville network configured in a normal state, a credible contingency at Garbutt Substation is not expected to result in loss of supply to any customers as there is generally full N-1 backup capability available up to the Garbutt and Belgian Gardens Substation 11kV busbars.

A non-credible event such as an outage to both 66kV bus sections at Garbutt Substation would result in loss of supply to at least 10,000 customers. Although considered a non-credible event (or high consequence low probability event), due to the 66kV aerial bus arrangement at Garbutt Substation an aerial bus conductor failure or supporting structure failure is likely to result in an outage to both 66kV bus sections. As the Townsville 66kV network has a meshed arrangement, an outage on both 66kV bus sections should normally only result in an outage to customers supplied from the Garbutt Substation 11kV distribution network and the Belgian Gardens 11kV distribution network.

Figure 18 Photo showing the aerial bus spanning the bus tie circuit breaker

In the event of an extended 66kV bus outage at Garbutt Substation Ergon Energy will use 'best endeavours' to partially restore supply using 11kV feeder transfers and generation support. It has been assumed that for a majority of bus faults supply can typically be fully restored within 24 hours. The restoration times would generally be dependent on a number of factors including location of staff, time of fault, severity of the fault, asset accessibility, availability of suitable spares, weather conditions and would vary under extenuating circumstances such as a natural disaster scenario.

Based on the existing peak load profiles at GARB and BEGA the load at risk over a 24 hour period would be in the order of 630MWh which would reduce to around 430MWh after accounting for load transfers and generation support.

Based on Condition Based Risk Management (CBRM) analysis the probability of a 66kV primary plant or structural asset failure that would lead to a full 66kV bus outage could occur as infrequently as once in 20 years. The average annual probability of failure (PoF) is therefore 0.05 and the estimated unserved energy in the next 10 years is estimated at 215MWh.

4. Non-Network Solutions Considered

Ergon Energy considered a number of demand management technologies to determine their commercial and technical feasibility to assist with the identified need in the Garbutt network area.

The demand management options considered included:

- Customer Energy efficiency and power factor correction
- Demand Response (curtailment of load)
- Customer Solar Power / Energy Storage Systems
- Large Scale Customer Generation / Energy Storage

The internal investigations undertaken on the feasibility of the non-network solutions revealed that it is unlikely to find a complete non-network solution or a hybrid (combined network and non-network) solution to provide the magnitude of network support required in the Townsville area to address the identified need.

In addition, the available funding that can be used for a non-network solution to address the load-at-risk is around $18/kVA. Ergon Energy typically use a threshold cost of $40-100/kVA for screening demand response procurement for the Townsville area. Hence, it is anticipated that there would be no commercially viable non-network alternatives available to address the identified need.

Details of the demand management assessment are included in a separate notice released in accordance with 5.17.4(d) of the NER.

If during the course of the RIT-D process, a commercial and technical feasibility non-network solution emerges, then it will be assessed against the other credible options.

5. Credible Options Included in this RIT-D

Ergon Energy investigated a number of network options to address the identified need at Garbutt Substation. Construction works carried out in a live substation yard in proximity to the deteriorated structures presents an intolerable risk to staff safety and network supply interruption and therefore the option to replace like for like in-situ was not considered a credible option.

5.1. Option A: Replacement of the aged 66kV assets at Garbutt Substation with 66kV Gas Insulated Switchgear (GIS)

This option involves replacement of the aged 66kV assets at Garbutt Substation with 66kV Gas Insulated Switchgear (GIS) located within the existing Garbutt Substation boundary.

This option includes:

- A new building for the GIS switchgear and new control building for the protection and control equipment.
    - 66kV bus protection

  - 66kV feeder protection
  - Transformer 3 & 5 protection
- 15 x GIS Modular CB/Isolator/CT/VT(As required):
  - 4 x 66kV Transformer Bays (2 x Plink 132/66kV, 2 x EQ 66/11kV)
  - 8 x 66kV Feeder Bays (7 x existing feeders and 1 x Load control / Future Feeder)
  - 2 x 66kV Capacitor Bank Bays
  - 1 x 66kV Bus Tie Bay
- Connection of existing plant to the new GIS switchgear:
  - 66kV UG cables between the GIS switchgear and the transformers (x4), cap banks (x2), feeders (x7) and AFLC (x1).
  - 7 x 66kV Feeder Terminations
  - 2 x 66kV cable term poles (Aitkenvale and Bohle Feeders)
  - 5 x 66kV cable connections (Belgian Gardens 1 & 2, Neil Smith, Hermit Park, Townsville Port)
- Replacement of aged AFLC components; controller, transmitter and coupling cell
- Replacement of the pilot wire protection schemes on the Hermit Park and Townsville Port 66kV feeders including removal of the redundant pilot wires.
- Removal of all aged and redundant 66kV AIS bays and associated plant

The estimated capital cost of this option inclusive of interest, risk, contingencies and overheads is $30,867,660. Annual operating and maintenance costs are anticipated to be 0.5 percent of the capital cost. The estimated project delivery timeframe has design commencing in late 2019 and construction completed by late 2022.

-

5.1. Option B: Replacement of the aged 66kV assets at Garbutt Substation with 66kV Air Insulated Switchgear (AIS)

Option B is not recommended as it exposes the network and staff to undue risk. The condition assessment indicates that various support structures, multiple items of plant and protection relays are in poor condition which poses a number of risks.

Construction works carried out in a live substation yard in proximity to these structures presents an intolerable risk to staff safety and network supply interruption. This option, though presented and considered for options analysis does not apply sound, risk-based engineering judgement and is not considered feasible and as such not proposed to progress.

This option includes:

- replacement of the 66kV bus and structures with new rigid busbar in a staged manner to limit outages, rationalising the bus section isolators and removing the aerial / strung bus.
  - removal of the bus isolators A729, B729, C729, D729, E729 and H729

- rebuild feeder bays to replace defective structures and to replace identified end of life equipment;
    - rebuild existing 66kV bays connecting: CAP 1, CAP 2, TRANSF 3, AITK FDR, 2T, HEPA FDR, NESM FDR, 1T
- removal of the Belgian Gardens 2, Bohle 66kV and 66kV bus tie bays;
- expansion of the 66kV switchyard to allow optimal distribution of feeders and transformers across the bus sections;
    - establish two new outdoor 66kV feeder bays in the South East corner of the yard and rerouting/extension of Belgian Gardens 2 66kV UG feeder and Bohle OH 66kV feeder to the new bays
- repositioning of the 66kV bus tie bay and realignment of the capacitor banks, transformers and feeder bays providing redundancy in the bus arrangement
    - establish a new 66kV bus tie bay at the location adjacent to where the Bohle 66kV feeder bay was connected;
    - relocate CAP 2 to take supply from the existing 2T feeder bay
    - realign connection from 2T to existing CAP 2 feeder bay
- replacement of aged 66kV protection relays
- Replacement of the pilot wire protection schemes on the Hermit Park and Townsville Port 66kV feeders including removal of the redundant pilot wires.
- replacement of two aged RTUs
- replacement of aged AFLC components; controller, transmitter and coupling cell

The estimated capital cost of this option inclusive of interest, risk, contingencies and overheads is $35,434,450. Annual operating and maintenance costs are anticipated to be 0.5 percent of the capital cost. The estimated project delivery timeframe has design commencing in late 2019 and construction completed by late 2022.

Note: This option, though presented and considered for options analysis is not considered feasible due to the intolerable risks to staff safety and network supply interruption and the limited space available at GARB substation.

6. Market Benefits

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.

6.1. Classes of Market Benefits Considered & Quantified

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

- Changes in involuntary Load Shedding

6.1.1. Changes in Involuntary Load Shedding

Ergon Energy has calculated the impact of changes in involuntary load shedding caused by outages on the Garbutt Substation 66kV bus, by comparing the expected unserved energy under the base case (where no action is undertaken by Ergon Energy) with credible options in place.

Probability weighted values of expected unserved energy have been calculated based on the probability of the failure, the energy at risk and the estimated restoration time. The derived values of expected unserved energy have been converted to a dollar figure, which reflects the customer financial consequence of the unserved energy. Ergon Energy has applied a location specific VCR of $40,836/MWh, which has been derived from the 2014 AEMO VCR estimates as shown in Appendix C.

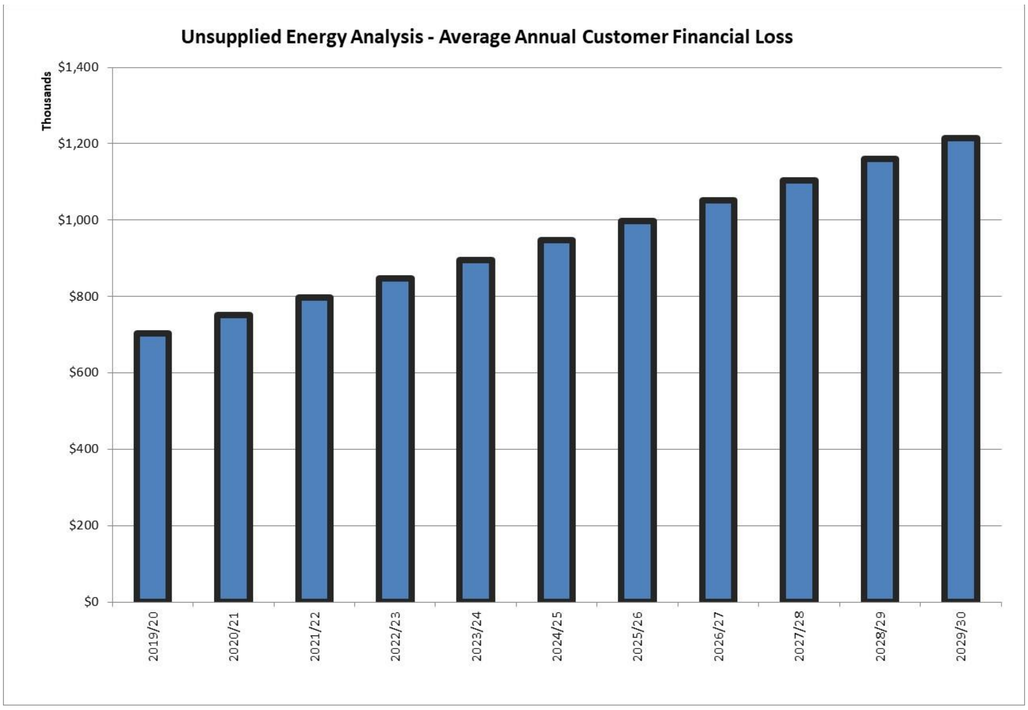


Figure 19 Assumed Average Annual Customer Financial Loss if no credible option is commissioned

The plot above shows the assumed average annual customer financial loss due to outages on the Garbutt Substation 66kV bus if no credible option is commissioned. The increase in financial loss over the 10 year period is based purely on the increase in probability of failure of existing assets and the CPI adjustments to VCR. The assessment has assumed minimal growth in maximum demand and energy over the 10 year period and minimal change in restoration times.

Under the proposed credible network option the risk of an outage on the Garbutt Substation 66kV bus is assumed to be small enough to be set to zero, therefore there is not expected to be any unserved energy with the proposed credible network option in place.

Based on these assumptions, the reduction in expected unserved energy due to outages on the Garbutt Substation 66kV bus that the credible option is expected to deliver would be as presented in Figure 19 and has been included as a material market benefit.

6.2. Classes of Market Benefits not Expected to be Material

The following classes of market benefits are not considered to be material in the options comparison for this RIT-D assessment to make a difference in the preferred network option:

- Changes in Voluntary Load Curtailment
- Changes in Costs to Other Parties
- Changes in Timing of Expenditure
- Changes in Load Transfer Capability
- Changes in Network Losses
- Option Value

6.2.1. 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 the Garbutt area at present, any market benefits associated with changes in voluntary load curtailment have not been considered.

6.2.2. 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.

6.2.3. 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.

6.2.4. Changes in Load Transfer Capability

None of the credible options included in this RIT-D assessment are expected to affect load transfer capability between substations in the Townsville area as the transfer capability is predominantly limited by the 66kV feeders. The proposed network option will improve plant rating capacity at Garbutt Substation however the market benefits from this are not considered to be material due to the feeder limitations.

6.2.5. Changes in Network Losses

Ergon Energy does not anticipate that any of the credible options included in this RIT-D assessment will lead to any significant change in network losses.

6.2.6. 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[5].

Ergon Energy does not consider that the identified need for the options included in this RIT-D would be affected by uncertain factors about which there may be more clarity in future.

7. Financial Analysis

7.1. Net Present Value

Net Present Values of the two credible options are presented in Table 4 below. The NPV analysis demonstrates that Option A has the lowest Net Present Cost.

Note that the figures in the table below are the discounted present values evaluated over a 20 year period. These direct costs are preliminary estimates which are subject to change as costs are refined, and do not include any interest, risk, contingencies or overheads, but does include residual life values at the end of the 20 year period. Operating and maintenance costs and market benefits are assumed to be similar for the two options (GIS vs AIS).

$ Millions	Option A	Option B
Capex	(10.30)	(11.94)
Opex	(1.41)	(1.41)
Direct Benefits	0.00	0.00
Commercial NPV	**(11.71)**	**(13.35)**
Ranking	*1*	*2*
Invol. Load Shed	11.91	11.91
Commercial + Risk	**0.20**	**(1.44)**
Ranking	*1*	*2*

Table 4 – Net Present Value Analysis

Note: The above NPV analysis does not include the monetised values of all the network risks as well as the quantified values of all the market benefits that are not significant enough to make a difference in the preferred option.

[5] 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

8. Proposed Preferred Option

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

The NER requires the Draft 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: Replacement of the aged 66kV assets at Garbutt Substation with 66kV Gas Insulated Switchgear (GIS).

This option satisfies the identified need for investment in compliance with RIT-D.

The total benefit, inclusive of operating costs and market benefits, is estimated at $0.2M in present value terms.

The technical characteristics of the preferred solution are presented below:

Replacement of the aged 66kV assets at Garbutt Substation with 66kV Gas Insulated Switchgear (GIS) located within the existing Garbutt Substation boundary.

9. Submission and Next Steps

9.1. Request for Submissions

Ergon Energy invites written submissions on this report from registered participants and interested parties.

Ergon Energy will not be legally bound in any way or otherwise obligated to any person who may receive this RIT-D report or to any person who may submit a proposal. At no time will Ergon Energy be liable for any costs incurred by a proponent in the assessment of this RIT-D report, any site visits, obtainment of further information from Ergon Energy or the preparation by a proponent of a proposal to address the identified need specified in this RIT-D report.

All submissions and queries should be lodged to Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". Submissions in writing are due by **31st January 2019**. Ergon Energy is not obliged to consider submissions after this date without prior agreement. The portal is available at:

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

9.2. Next Steps

Following Ergon Energy's consideration of the submissions, the preferred option, and a summary of and commentary on any submissions received in response to this report, will be included as part of the Final Project Assessment Report. The Final Project Assessment Report represents the final stage of the consultation process in relation to the application of the RIT-D.

Ergon Energy intends to publish the Final Project Assessment Report no later than 14th February 2020. Ergon Energy will use its reasonable endeavours to publish the Final Project Assessment Report by the above date. This may however not be achievable due to changing power system conditions or other circumstances beyond the control of Ergon Energy.

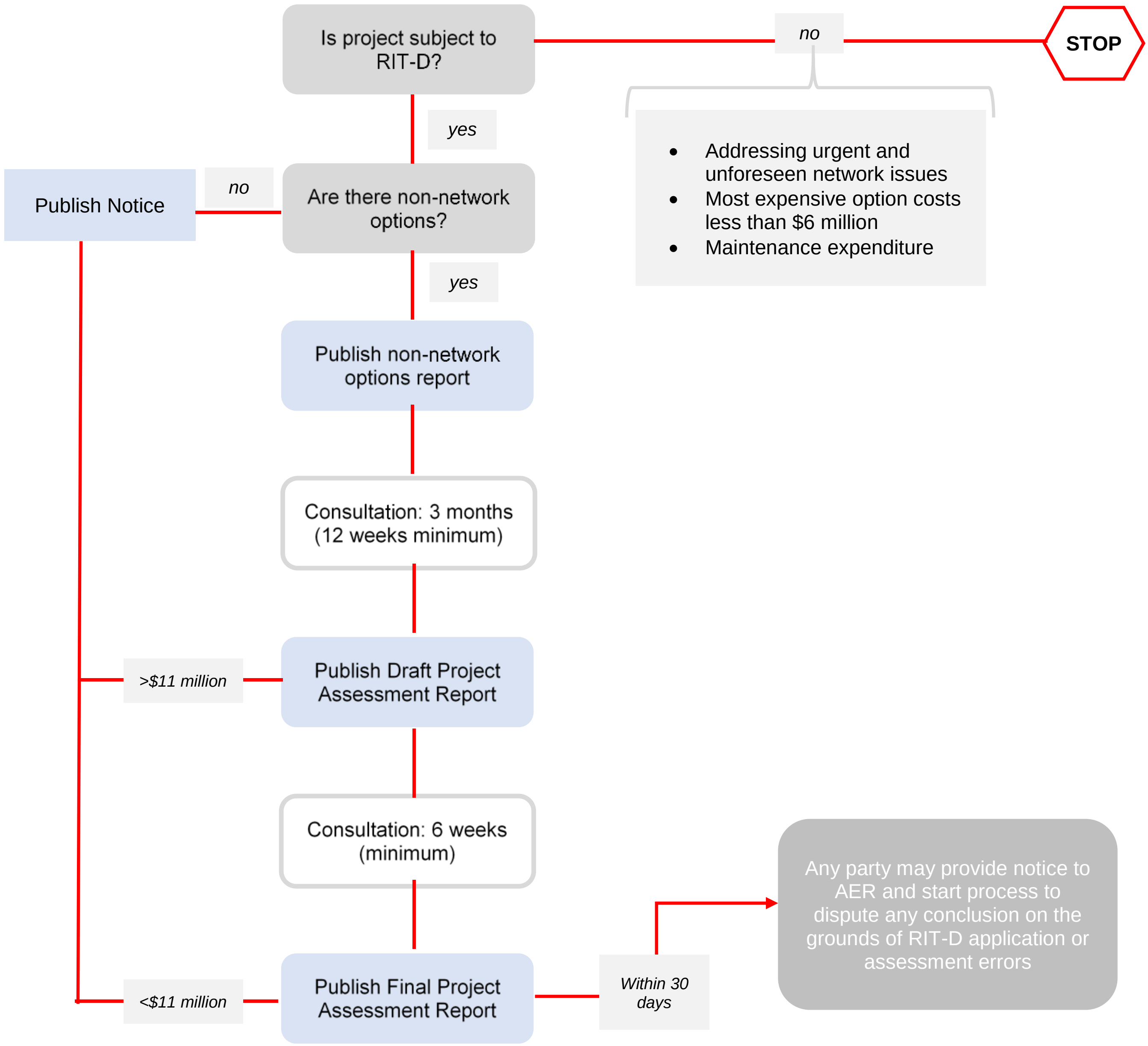
At the conclusion of the consultation process, Ergon Energy intends to take steps to progress the recommended solution(s) to ensure any statutory non-compliance is addressed and undertake appropriately justified network reliability improvement(s), as necessary.

9.3. Contact Details

Inquiries about this RIT-D may be sent to:

E: demandmanagement@ergon.com.au
P: 13 74 66

Appendix A. RIT-D Process



Appendix B. Ergon Energy's Minimum Service Standards and Safety Net Targets

The legislated System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) limits from Ergon Energy's Distribution Authority are detailed in Table 5.

Feeder Category	SAIDI MSS Limits	SAIFI MSS Limits
Urban	149	1.98
Short Rural	424	3.95
Long Rural	964	7.40

Table 5 SAIDI (minutes per customer) and SAIFI (interruptions per customer) limits

The legislated Safety Net Targets from Ergon Energy's Distribution Authority are provided in Table 6. Townsville is considered a 'Regional Centre'.

Area	Targets (for restoration of supply following an N-1 Event)
Regional Centre	Following an N-1 event, load not supplied must be: ○ Less than 20MVA after 1 hour; ○ Less than 15MVA after 6 hours; ○ Less than 5MVA after 12 hours; and ○ Fully restored within 24 hours.
Rural Areas	Following an N-1 event, load not supplied must be: ○ Less than 20MVA after 1 hour; ○ Less than 15MVA after 8 hours; ○ Less than 5MVA after 18 hours; and ○ Fully restored within 48 hours.
Note: All modelling and analysis will be benchmarked against 50 PoE loads and based on credible contingencies. 'Regional Centre' relates to larger centres with predominantly urban feeders. 'Rural Areas' relates to areas that are not Regional Centres.	

Table 6 Ergon Energy Service Safety Net Targets

Appendix C. VCR Value Analysis

The Value of Customer Reliability (VCR) values represent customers' willingness across the (NEM) to pay for reliable electricity supply. The VCR is used for estimating market benefits that relate to reliability, such as changes in involuntary and voluntary load curtailment.

Zone Substation	Domestic	Industrial	Domestic (kWh)	Industrial (kWh)	VCR ($/MWh)
Aitkenvale	5259	781	41,305,644	48,333,793	$38,232
Belgian Gardens	5475	449	33,615,309	21,982,399	$35,278
Black River	5968	278	49,552,650	17,438,233	$32,503
Bohle	5951	772	47,177,992	64,442,819	$39,015
Cranbrook	4346	408	31,805,850	46,252,069	$39,327
Garbutt	4201	1472	32,174,858	109,204,967	$43,022
Hermit Park	6099	938	35,150,228	43,879,877	$38,561
Neil Smith	2016	674	10,719,078	62,470,364	$44,689
Oonoonba	4905	325	30,565,134	23,814,994	$36,152
Total	**44220**	**6097**	**312,066,743**	**437,819,514**	**$39,149**

Table 7 Number of Customers Breakdown for Impacted Substations (2018/19 figures)

Zone Substation	Domestic	Industrial	Domestic (kWh)	Industrial (kWh)	VCR ($/MWh)
Belgian Gardens	5475	449	33,615,309	21,982,399	$35,278
Garbutt	4201	1472	32,174,858	109,204,967	$43,022
Total	9676	1921	65,790,166	131,187,365	$40,836

Table 8 Number of Customers Breakdown for only GARB & BEGA Substations (2018/19 figures)

Sector	$/kWh (2014)	$/kWh (2019) CPI Adjusted	$/MWh (2019) CPI Adjusted
Domestic	$25.42	$27.16	$27,156
Commercial	$44.72	$48.41	$48,411
Industrial	$44.06	$47.70	$47,697
Rural	$47.67	$51.60	$51,605

Table 9 AEMO VCR Values – CPI Adjusted (AEMO VCR Application Guide 2014[6])

$$VCR = \frac{(Domestic\ Customers\ Energy\ x\ VCR\ value) + (Industrial\ Customers\ Energy\ x\ VCR\ value)}{Total\ Energy}$$

[6] https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Value-of-Customer-Reliability-review