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Regulatory Investment Test for Distribution

Non-Network Options Report

Ensuring Reliability of Electricity Supply and Managing Network Asset Risks in the Douglas Shire Area

This document describes the *identified need* for investment at Mossman. It includes description of the likely network options and to the extent possible, the characteristics of non-network options which may, either alone or in combination with network or other non-network options, represent a feasible solution for addressing the identified need.

Consultation Period Starts: **20th Aug 2019**

Consultation Period Closes: **3pm 29th Nov 2019**

Executive Summary

Ergon Energy Corporation Limited (Ergon Energy) is responsible (under its Distribution Authority) for electricity supply to the Douglas Shire and Northern Atherton Tablelands in North Queensland.

The Mossman 66/22kV Substation was constructed in 1964 and supplies some 3250 customers from the local 22kV distribution network in the Douglas Shire Council area from Mossman and north to the Daintree. Key customers supplied from the distribution network include the hospital, emergency services, aged care and retirement village, sugar mill, water and sewerage treatment plants, schools, communication sites, tourism facilities, resorts and businesses.

The Mossman Substation is supplied by two aged 66kV timber pole lines from Powerlink's Turkinje 132/66kV Substation via Mossman 1 (MOSS 1) and Mossman 2 (MOSS 2) feeders constructed in 1975 and 1958 respectively. The Mossman Substation comprises of two incoming 66 kV overhead feeders which supply the two outdoor 66 kV bus sections, four Circuit Breaker (CB) bays and isolators. Two 1963 vintage 10MVA 66/22kV transformers supply an outdoor 22kV yard supply comprising two 22 kV bus sections, seven 22 kV CBs, and thirteen isolators. Secondary systems, communication and protection equipment is housed in the Substation Control Building. The four Mossman 22kV feeders share intra-feeder ties and an inter-feeder tie with the adjacent 132/22kV Craiglie Substation 22kV distribution network which supplies approx. 4280 customers.

A substation condition assessment has highlighted the aged assets, reliability, safety and environmental risks at the Mossman Substation. The Mossman 66kV feeders which also supply the Mount Molloy Substation in the Northern Atherton Tableland area experience reliability issues and high maintenance costs reflecting late 1950s' design standards, assets reaching end of service life (e.g. 35km of 1958 vintage 7/0.104 HDBCC 66kV conductor) and exposure to adverse operating conditions (i.e. termites, bushfires, lightning activity, wet tropic rainforests and cyclones).

Ergon Energy has determined that network investment is essential in the Douglas Shire area in order for it to reliably and safely continue to provide electricity services and manage end of life asset risks. The primary drivers of this investment are reliability of the Mossman Substation and 66kV feeders, managing the 66kV and 22kV asset condition and safety concerns.

Ergon Energy's preferred internal solution at this stage is to:

- Convert Mossman to a 132/22 kV Substation supplied from a 132 kV tee-off a switched feeder at Yalkula and retire MOSS 1 and MOSS 2 66 kV feeders back to Mount Molloy.

This is a Non-Network Options Report, where Ergon Energy is seeking information about possible solutions to address the identified need, which may be able to be provided by parties other than Ergon Energy.

Submissions in writing (electronic preferably) are due by **3pm on 29 November 2019** and 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

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

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List of Figures and Tables

1. Introduction

This Non Network Options Report has been prepared by Ergon Energy in accordance with the requirements of clause 5.17.4(e) of the National Electricity Rules (NER).

This report represents the first 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 limitations in the distribution network that supplies the Mossman area.

This report:

- Provides background information on the network capability limitations of the distribution network supplying the Mossman area.
- 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 Ergon Energy currently considers may address the identified need, including for each:
    - Its technical definitions;
    - The estimated commissioning date; and
    - The total indicative cost (including capital and operating costs).
- Sets out the technical characteristics that a non-network option would be required to deliver in order to address the identified need.
- Is an invitation to registered participants and interested parties to make submissions on credible non-network options to address the identified need.

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. At the time of writing, Ergon Energy considers the most probable future scenario to be that there will be future development in the Mossman area, and has developed this Non Network Options Report (including *Internal Options*) principally on this basis. It is noted that customer activity can occur over the consultation period and may change the timing and/or scope of any proposed solutions.

Submissions in writing (electronic preferably) are due by **3pm on 29 November 2019** and should be lodged to Ergon Energy's "Regulatory Investment Test for Distribution (RIT-D) Partner Portal". The portal is available at:

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2. Background

2.1. Geographic Region

The geographic region covered by this report is the area currently supplied by the Mossman Substation and Mount Molloy to Mossman 66kV feeders. The Mossman Substation, 22kV distribution network in the Douglas Shire area consists of approximately 3250 customers, with major customers including the local hospital, emergency services, aged care and retirement village, sugar mill, water and sewerage treatment plants, schools, communication sites, tourism facilities, resorts and businesses. See Figure 1 and Figure 2 for the geographical layout and single line diagram of the 132 and 66kV Ergon Energy Network.

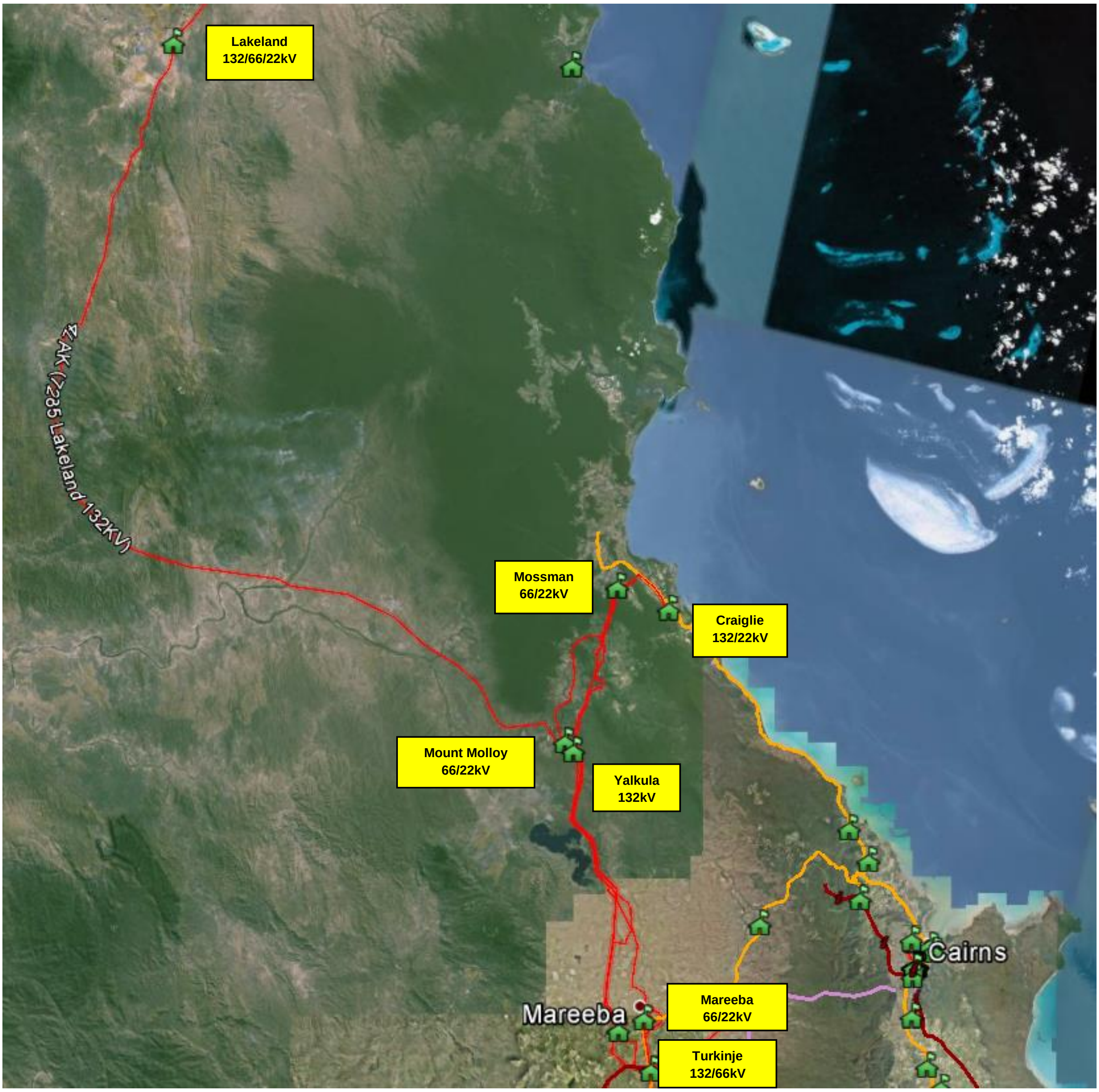


Figure 1 – Geographical Layout of the 132 and 66kV Network to the Douglas Shire Area

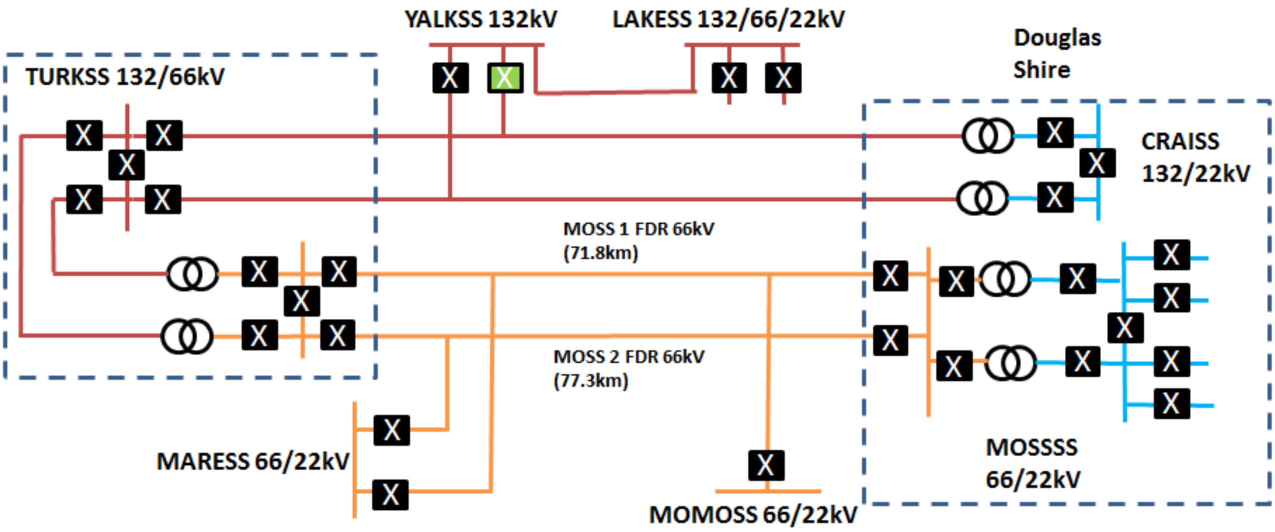


Figure 2 – Single Line Diagram (SLD) of the 132 and 66kV Network to the Douglas Shire Area

2.2. Existing Supply System

The Mossman Substation configuration can be seen in the SCADA screen capture below (Figure 3) comprising of two incoming 66kV overhead feeders which supply the two outdoor 66kV bus sections, four circuit breaker bays and isolators. The two 66/22kV transformers supply two outdoor 22kV bus sections, seven 22kV Circuit Breakers (CBs), a single station service transformer and thirteen isolators.

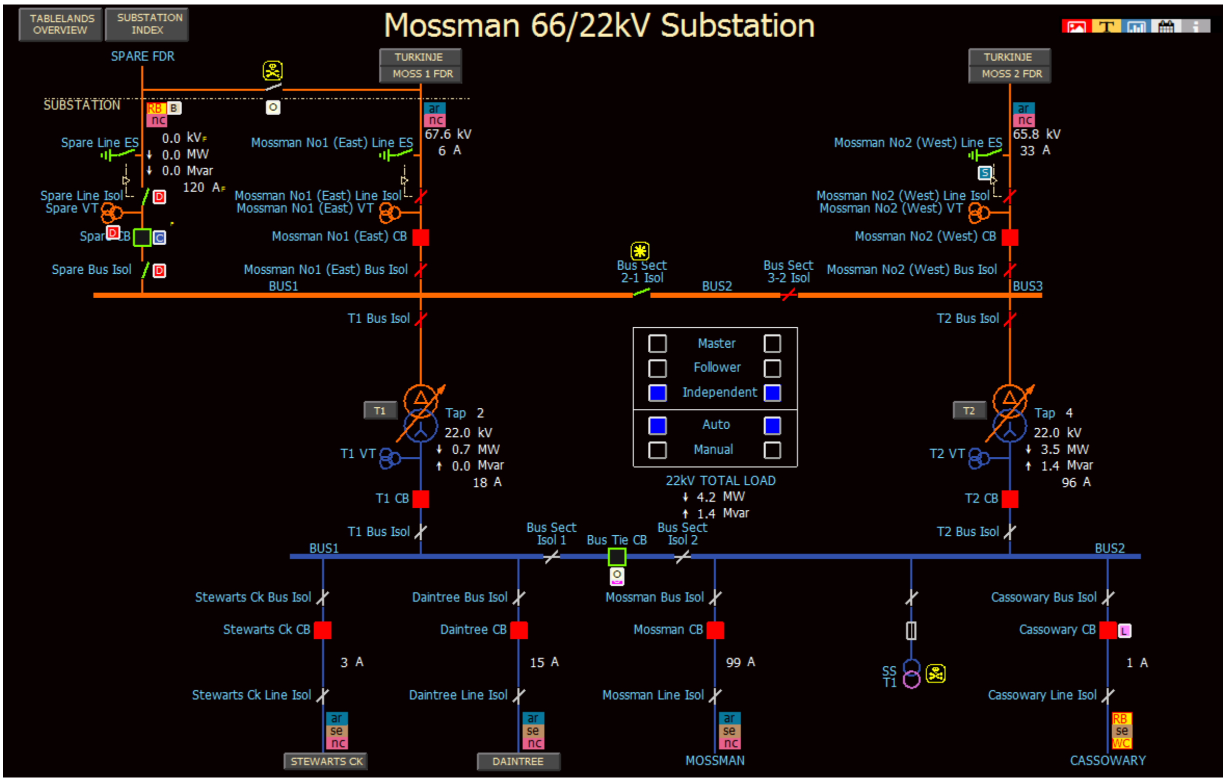


Figure 3 - SCADA screen capture of Mossman single-line operating diagram

Outgoing from the Mossman Substation are four 22kV feeders, which have intra-feeder ties and an inter-feeder tie to the adjacent 132/22kV Craiglie Substation 22kV distribution network which supplies approximately 4280 customers. The maximum demand for Mossman and Craiglie can be seen in Table 1 and Table 2 below. The 22kV feeder layout for Mossman and Craiglie can be seen in Figure 4.

Table 1 - Mossman 22kV feeder peaks (2016/17, 2017/18)

ASSET NO	ASSET NAME	MD DAY WINkVA	MD EVENING WINkVA	MD NIGHT WINkVA	PREV MD DAY WINkVA	PREV MD EVENING WINkVA	PREV MD NIGHT WINkVA	MD DAY SUM AMPS	MD EVENING SUM AMPS	MD NIGHT SUM AMPS	MD DAY WIN AMPS	MD EVENING WIN AMPS	MD NIGHT WIN AMPS
2CAS	CASSOWARY	138	158	110	127	158	149	5	5	4	4	4	3
2MOS	MOSSMAN	4499	4349	4104	4799	4420	4063	122	103	117	118	114	108
2DAI	DAINTREE	2121	2536	2407	2121	2536	2407	75	93	81	56	67	63
2SCK	STEWART CREEK	169	210	182	178	206	199	6	8	6	4	6	5

Table 2 - Craiglie 22kV feeder peaks (2016/17, 2017/18)

ASSET NO	ASSET NAME	MD DAY WINkVA	MD EVENING WINkVA	MD NIGHT WINkVA	PREV MD DAY WINkVA	PREV MD EVENING WINkVA	PREV MD NIGHT WINkVA	MD DAY SUM AMPS	MD EVENING SUM AMPS	MD NIGHT SUM AMPS	MD DAY WIN AMPS	MD EVENING WIN AMPS	MD NIGHT WIN AMPS
2INL	INLET	1820	1829	1744	1965	2047	1840	66	67	56	48	48	46
2FOM	FOUR MILE BEACH	3858	3924	1765	3943	4118	3403	137	134	85	101	103	46
2OAB	OAK BEACH	984	1038	989	1037	1013	973	30	33	26	26	27	26
2REE	REEF PARK	4564	4547	3598	4776	4744	3881	156	150	111	120	119	94
2GLK	GOLF LINKS	1785	1986	1525	1705	1975	1620	72	73	57	47	52	40

Figure 4 – Mossman and Craiglie 22kV Networks

3. Identified Need

3.1. Description of the Identified Need

The identified need can be broken down into two major components as detailed below.

3.1.1. Mossman Substation reliability, environment and end of life of aged assets

3.1.1.1. Reliability

A condition assessment of the Mossman Substation has highlighted a number of assets at end of life and in poor condition (see Appendix A for details on the retirement timeframe of primary assets at Mossman Substation). The condition of these substation assets presents a significant safety, environmental and reliability risk.

Condition data indicates that Transformer 1 (TX1) is reaching end of life within the next 5 years (i.e. YOM 1963, 61 years of age by 2024). Given that Transformer 2 (TX2) is of the same vintage and analysis indicates end of life in a similar time frame, site reliability could be adversely affected due to the increased risk of ageing asset plant failure.

The 66kV power transformer CBs are removed from service due to plant condition and safety access restrictions. To enable ongoing network operation, the 66kV and 22kV bus sections have been opened and the 66kV transformer CB protection has been re-directed to the incoming 66 kV

feeder CBs. In the meantime, reliability of supply to the Mossman 22kV distribution area will be adversely impacted during 66 kV feeder faults and TX1 / TX2 protection trips.
A significant number of remaining primary and secondary assets are at end of life in the next 10 years including; all 66kV and 22kV voltage transformers, both incoming 66kV feeder current transformers, 66kV feeder and 66/22kV transformer protection relays, associated control building and substation yard structures. If left unaddressed, these assets are likely to become less reliable as they age impacting the reliability and safe operation of the network.

3.1.1.2. Environmental

The existing 66/22kV transformers do not have bunding, as this was not required when constructed. These transformers are considerably wet and have previously been leaking oil. As a result this is considered a contaminated site. Given that Mossman is a very wet tropical location, containment of this contamination is required to prevent spreading to outside the site.

3.1.1.3. End of life of aged assets

Some of the primary & secondary system assets, including the 66/22kV power transformers, 66kV CBs, 22kV CBs, 22kV VTs, and isolators are ageing and deemed to reach their end of life within the next 10 years.

The concrete control building which has spalling in the ceiling exposing fully corroded reinforcement is at the end of its serviceable life (Figure 5). The concrete roof slab provides stability to the building walls and hold down capacity to the roof. AC and DC supply, and secondary systems including protection relays necessary to safely and reliably operate substation plant are required to be housed within a safe, secure, dry and cyclone proof structure.

The Mossman Substation has a build vintage of 1964 (i.e. 55 years old), The expected life of external structures is typically 50 years and concrete foundations will typically be at end of service life (i.e. 50 years +/- 20%, 60 years) by 2024. Safety concerns exist around operating the older 66kV isolators, as they have signs of rust and corrosion, and their mechanical strength is unknown. In early 2016, during maintenance works at the substation, inspections revealed corrosion on the structure steelwork and bolts. The corroded bolts were either replaced or treated with galvanising paint. Latest inspection revealed that this corrosion has continued on these treated bolts. Remediation work was undertaken on both the 22kV and 66kV structures.

The condition of these ageing substation assets presents an increasing safety and reliability risk particularly being operated in a high rainfall and cyclonic environment.

Figure 5 – Left: Mossman Substation yard showing aged plant. Right: Spalling of concrete ceiling exposing fully corroded reinforcement

3.1.2. 66kV feeder reliability, environment and end of life of aged assets

3.1.2.1. Reliability

Poor reliability associated with the 66kV sub-transmission feeders (i.e. MOSS 1 and 2) had become a community hot spot issue after several major outages, however, dual 66kV feeder outages are largely expected to be resolved with changes to the MOSS 1 and MOSS 2 66 kV zone 2 distance protection auto-reclose scheme.

The timber pole lines were constructed to late 1950s' design standard that did not include an overhead earth wire (see Figure 6). As such these two lines have a high exposure to and no shielding from lightning strikes. Despite the redundancy provided in the 66kV network that supplies the Mossman Substation the customers serviced by it have suffered 24 separate supply interruption events associated with faults occurring in the 66kV feeders over the past 10 years. Causes of these 24 interruptions are:

- 6 due to lightning strikes;
- 5 were a result of animals;
- 8 other feeder faults;
- 4 due to upstream 132kV outages; and
- 1 unknown cause.

On average, customers will experience 2.0 outages each year from the existing 66 kV timber pole lines and substation. These figures do not reflect individual MOSS 1 (71.8km long) & MOSS 2 (77.3km long) 66kV feeder outage rates. Feeder performance for overhead timber pole/cross-arm line construction could vary between 3 to 8 outages per 100km-years pending the terrain the line traverses. Repair periods for a single 66kV feeder failure could range from 2-3 hours to considerably longer periods for failures of aged conductor or difficult access locations across the Rex Range. Based on an average of 5 outages per 100km-years and approx. 75km length of 66kV feeder, up to 4 permanent faults each year could be expected on a single radial 66kV feeder. Where there are two 66kV feeders, the remaining feeder in service will typically maintain electricity supply to the Mossman area whilst the adjacent feeder is being repaired.

The Turkinje - Yalkula – Craiglie double circuit steel tower with overhead earth wire, 132kV line (circuits 7200 and 7201) was commissioned in early 1997. Typical high reliability line outage rates would be in the order of 1.30 to 2.50 outages per 100km-years. The 132kV circuit 7201 (approx. 81km in length) and passing immediately adjacent Mossman Substation has historically experienced 1 outage each year with an outage period of approximately 12 minutes.

Figure 6 - 66 kV delta pin construction

3.1.2.2. Environment

The timber pole 66kV Mossman feeders are of the late 1950's design standards. These feeders have ongoing access and vegetation maintenance, poor reliability and exhibit a high ongoing CAPEX and OPEX cost. The route the two lines take is through the World Heritage listed areas of the Rex Range which is managed by the Wet Tropics Management Authority.

Legacy distribution network businesses have committed to the management authority and the community to remove the 66kV feeders. Once the local 22 kV distribution network to the Mossman township area and supply north to the Daintree is secured with safe, cost effective and reliable electricity supply, the 66kV feeders can be removed.

3.1.2.3. End of life aged assets

MOSS 1 and MOSS 2 timber pole lines are a build vintage of 1958 (i.e. 61 years old) and 1975 (44 years old) respectively. The next cycle for line inspections (above/below ground) is due in late 2021, early 2022, when an increased number of defects (excluding the 35 km of 1958 vintage 7/0.104 HDBCC conductor) are anticipated for remediation based on reporting from the most recent inspection cycle.

Table 3 – MOSS 1 and 2, 4 year inspection cycle defects

Defect classification	Mossman 1 total number of defects	Mossman 1 number of defects in section of line to be recovered	Mossman 2 total number of defect	Mossman 2 number of defects in section of line to be recovered
P1	8	5	35	12
P2	73	40	256	117
C3	1395	796	1321	645
Total	**1476**	**841**	**1612**	**774**

P1/P2/C3 defects are recorded in the 4 year cycle and defined as:

- P1: Serious deterioration or damage, which requires some specific action or indicates an unacceptable risk of failure in the short term or presents an imminent danger or risk of asset failure;
- P2: Moderate deterioration or damage, which requires some specific action or indicates an unacceptable risk to safety, environment, operations, or reliability in the medium term; and
- C3: Minor deterioration or damage which requires no specific action or does not indicate an unacceptable risk of failure in the medium term.

The previous asset inspection highlighted that the section from Mount Molloy to Mossman, whilst being less than a third of the 66kV line length from Turkinje to Mossman, contributes 40-50% of the number of defects of the entire line.

When compared on a cost basis, approximately 60% of the costs (i.e. typically pole, stay and cross-arm replacements) can be attributed to the area between Mount Molloy and Mossman where the 66kV line crosses the Rex Range and Wet Tropics Area. Whilst pole nailing and detailed aerial inspections will aim to prolong asset age, there is a significant escalation of defect asset issues being reported.

The age and location of the 66kV feeders has resulted in increased operational maintenance and capital cost (Figure 8).

Strategic development of the 66 kV network to Mossman Substation will need to consider the surrounding aged plant assets at Mossman 66/22kV Substation and the associated upstream 66kV lines to Mount Molloy. Subsequently, strategic development of the 66 kV network to Mount Molloy Substation is required to account for the surrounding aged plant assets at Mount Molloy 66/22kV Substation and the associated upstream 66kV lines from Mount Molloy back towards Turkinje.

The Turkinje - Yalkula – Craiglie double circuit steel tower structure with overhead earth wire construction, 132kV line (circuits 7200 and 7201) was commissioned in early 1997. The line is relatively new, low maintenance, highly reliable in cyclonic conditions and passes adjacent Mount

Molloy and Mossman Substations. The 132kV line from Yalkula to Craiglie passes directly adjacent Mossman Substation with circuit 7201 facing the Mossman Substation.

Figure 7 - 132kV and 66kV across the Rex Range

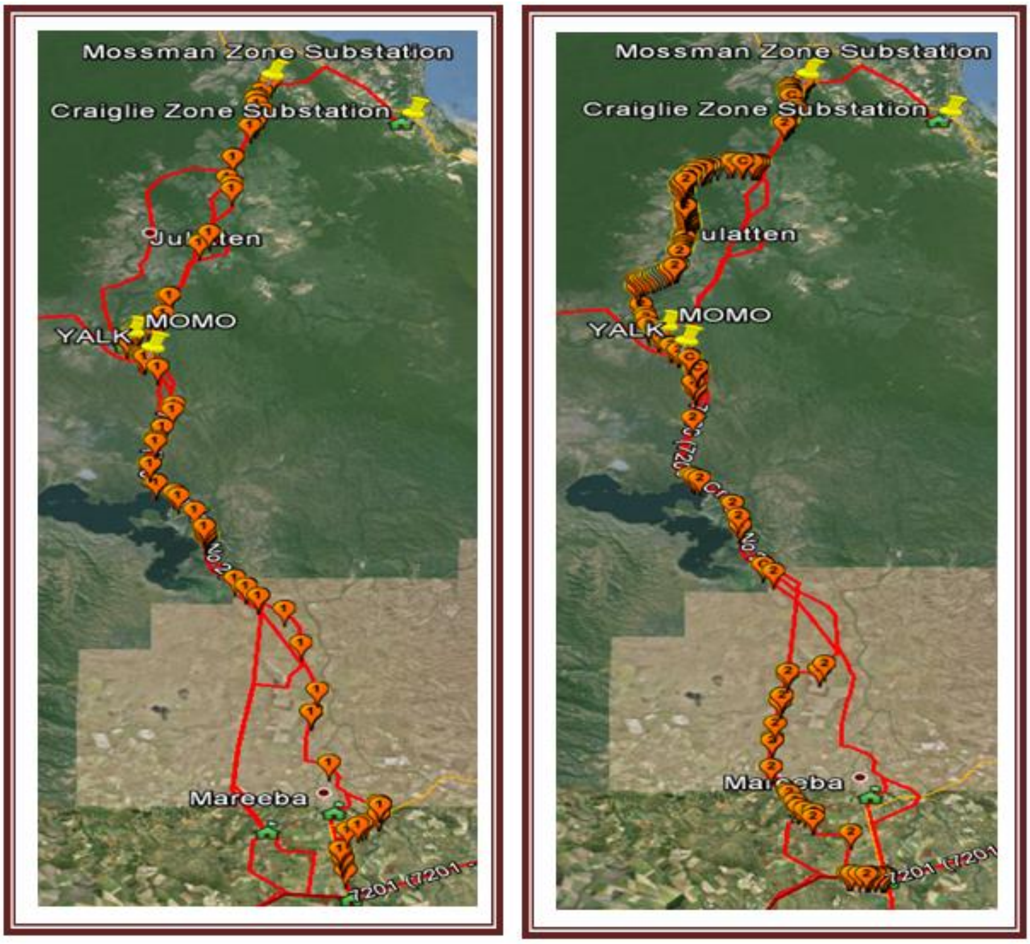


Figure 8 – Identified defects on the MOSS 1 and MOSS 2 66kV feeders

3.2. Quantification of the Identified Need

3.2.1. Reliability Impacts

The below tables show the System Average Interruption Duration Index (SAIDI) and System Average Interruption Frequency Index (SAIFI) values of each feeder being supplied from the Mossman and Craiglie Substations. These values provide a benchmark for which Ergon Energy's reliability performance can be assessed. Ergon Energy must use its best endeavours to prevent the SAIDI and SAIFI for each feeder category exceeding the relevant limits set out in its Distribution Authority for the financial year. A reliability status of 'Green' is an indication that the feeder is performing within acceptable limits. A reliability status of 'Yellow', 'Amber', or 'Red', indicate that the feeder is performing outside acceptable limits. The risk of high outage rate and ageing 66kV feeders; and out of service and ageing Mossman Substation plant becoming less reliable will adversely impact the reliability and safe operation of the network.

Retirement of one of the two 66 kV feeders from Mount Molloy to Mossman could result in an outage time increase of 10 hours pa (i.e. 4 outages at a repair time of 2.5 hours for each failure). This would result in 'Amber' and 'Red' MSS performance across all Mossman Substation 22kV feeders. The removal from service and ageing Mossman Substation plant risk will result in an upward trend and adverse impact on the 22kV feeder MSS performance figures.

Note: Table 4 to Table 7 are all YTD Figures for the Mossman Substation 22kV feeders

Table 4 - 2MOS Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	267.8	239.4	429.3	331.6	232.8
SAIFI	2.12	3.49	3.45	3.32	5.09
MAIFIe	1.01	2.01	4.0	3.0	4.97
Reliability Status	Green	Green	Yellow	Green	Green

Table 5 - 2SCK Feeder – 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	1325	1684.5	467.2	895.7	1676.1
SAIFI	5.18	9.14	3.09	5.38	8.96
MAIFIe	1.0	3.02	3.03	1.41	2.5
Reliability Status	Red	Red	Yellow	Red	Red

Table 6 - 2CAS Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	489	611.9	1410.6	259.4	229.6
SAIFI	1.92	4.12	2.58	3.57	4.07
MAIFIe	1,0	0.98	2.99	0.97	2.97
Reliability Status	Yellow	Yellow	Red	Green	Green

Table 7 - 2DAI Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	373.9	377.6	888.2	429.7	540.8
SAIFI	2.38	4.52	6.71	4.07	5.01
MAIFIe	32.4	3.12	4.44	5.63	3.01
Reliability Status	Green	Green	Red	Yellow	Yellow

Note: Table 8 to Table 12 are all YTD Figures for the Craiglie 22kV feeders

Table 8 - 2REE Feeder - 5 year MSS performance (UR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	1.74	94.6	166.2	22.5	234.2
SAIFI	0.01	2.13	2.31	0.27	1.48
MAIFIe	0.0	4.95	0.0	0.0	0.0
Reliability Status	Green	Green	Yellow	Green	Amber

Table 9 - 2INL Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	34.3	25.9	244.4	20.8	136.4
SAIFI	0.14	1.07	2.40	0.18	1.13
MAIFIe	1.98	0.0	4.04	1.99	1.02
Reliability Status	Green	Green	Green	Green	Green

Table 10 - 2FOM Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	30.3	31.0	187.4	312.5	42.6
SAIFI	0.12	2.16	1.08	1.64	0.35
MAIFIe	0.0	0.99	2.0	1.0	0.0
Reliability Status	Green	Green	Yellow	Red	Green

Table 11 - 2OAB Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	51.8	487.9	345.5	566.9	20.9
SAIFI	0.39	4.47	2.91	2.36	0.14
MAIFIe	1.97	2.26	6.32	0.0	3.96
Reliability Status	Green	Yellow	Green	Yellow	Green

Table 12 - 2GLK Feeder - 5 year MSS performance (SR feeder category)

MSS Type	2013-14	2014-15	2015-16	2016-17	2017-18*
SAIDI	4.3	46.6	65.6	1.8	241.9
SAIFI	0.07	1.19	0.50	0.05	0.58
MAIFIe	1.04	2.02	1.0	0.99	0.0
Reliability Status	Green	Green	Green	Green	Amber

3.2.2. End of life of aged asset

The age of the substation (54 years) and 66 kV feeders has resulted in an increased operational maintenance and capital cost. Over the last ten years total expenditure including overheads was:

Table 13 – MOSS 1 and 2, last 10 year expenditure

Element	OPEX	CAPEX	TOTAL
Substation	$ 1,904,429	$ 130,337	$ 1,382,781
66 kV Feeder	$ 6,579,885	$ 1,252,443	$ 8,484,314
TOTAL	$ 8,484,314	$ 1,382,780	$ 9,867,095

Actual historical OPEX costs for the vegetation management and access track remediation for the 66kV feeders has been approx. $124,800pa.

Over a 15 year forecast period, the annual average C3 spends for the 66 kV lines is estimated as:

- Turkinje - Mossman:
  - $13.818M OPEX - approx. $921,000pa for both circuits;
- Turkinje - Mount Molloy:
  - $5.578M OPEX - approx. $372,000pa for both circuits;
- Mount Molloy – Mossman:
  - $8.24M OPEX - approx. $549,000pa for both circuits;

As such, the forecast P1/P2/C3 remediation costs for the Turkinje – Mount Molloy – Mossman 66kV feeders from the next asset inspection cycle is anticipated as:

- Turkinje to Mount Molloy: $372,000pa; and
- Mount Molloy to Mossman: $549,000pa.

The remaining 35km of 7/0.104 HDBC conductor on the Mossman 66 kV feeders is approximately 55 years of age (i.e. 1958 vintage) and has been subject to a large number of faults during its life as well as being pushed to its full current rating during the Port Douglas boom in the 1990's prior to construction of the Craiglie Substation and its' 22kV feeders. The conductors are full of line splices and could be annealed which affects the conductors' mechanical strength. Cost of remediation has not been included in the above C3 defect assessment.

The Turkinje to Mount Molloy 66kV network will be further reviewed as the 1967 vintage Mount Molloy Substation and 1981 and 1998 vintage 66/22kV transformers are identified as end of life assets.

3.2.3. 66kV Sub-transmission Network Limitations

Mossman is currently supplied by two 66kV feeders; MOSS 1 and MOSS 2 which do not experience thermal rating capacity limitations (see Table 14).

Table 14 - Reference: 2018 Ergon Energy DAPR

Operational Number	Feeder Name	PF Feeder Obj Name	Year Ratings Period Variable	2025		
				SD	SE	SNM
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	% of Rated A	27.6	22.5	21.2
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Loading (A)	36	38	34
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Power Factor	0.93	0.93	0.94
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Rating (A)	132	167	159
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	% of Rated A	60.1	50.1	46.3
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Loading (A)	79	84	74
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Power Factor	0.97	0.98	0.96
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Rating (A)	132	167	159

The Mossman Substation comprises of:

- two transformers, 66/22 kV Dyn11 10MVA OLTC; and
- outdoor 22kV switchgear c/w four 22kV feeders and a bus section breaker.

The transformer technical characteristics are 2.5% buck, 17.5% boost. Transformer capacity is not a constraint; however, buck range is a constraint in managing to the new 230V LV standard.

Additional Load or Generation from Mossman:

The use of different generation technologies amongst major industrial customers may result in increased export capability of the generation plant.

Pending the substantive increase in generation export capability, electricity supply via the 22 kV distribution network from Mossman substation could be less restrictive than from the Craiglie substation due to the extra 22kV feeder lengths involved.

4. Value of Customer Reliability

Value of Customer Reliability (VCR) is an economic value applied to customers' unserved energy for any particular year. Any reduction in unserved energy a solution that addresses the identified need described in Section 3 will bring will be treated as a benefit based on the corresponding reduction in customer financial consequence.

Whilst Mossman is proposed to be supplied via a single 132/22kV transformer supply, it is still an improvement to the 66kV which on the surface has N-1 reliability but has experienced double circuit outages on a number of occasions when auto-reclose on the 66kV was problematic.

Due to various reasons pertaining to the 66kV build (i.e. steel cross-arms, 3 piece pin insulators, common timber poles, no overhead earth wire, terrain and environment characteristics), the DCST 132kV offers a more reliable supply than the 66kV.

Contingent 22kV supply will be available from Craiglie Substation via remotely controlled plant to assist response transfer to 2INL feeder.

Table 15 - Customer Number Breakdown (NETDASH)

Feeder	Domestic	Commercial/Industrial	Total Customers
Mossman 66/22kV Substation, 22kV feeders			
2MOS	946	251	1197
2SCK	77	24	101
2CAS	88	9	97
2DAI	1723	130	1853
TOTAL	**2834**	**414**	**3248**
Feeder	**Domestic**	**Commercial/Industrial**	**Total Customers**
Craiglie 132/22kV Substation, 22kV feeders			
2REE	691	230	921
2INL	567	77	644
2FOM	1154	174	1328
2OAB	401	133	534
2GLK	825	32	857
TOTAL	**3638**	**646**	**4284**

Table 16 - AEMO VCR Values (AEMO VCR FACT SHEET)

Sector	$/kWh	VCR ($/MWh)
Domestic	**$25**	**$25,420**
Commercial	**$45**	**$44,720**
Industrial	**$44**	**$44,060**
Rural	**$48**	**$47,670**

The unit rate for Value of Customer Reliability for Craiglie and Mossman Substation networks that has been used for this analysis is $28/kWh and $27/kWh respectively. This is a location specific figure and is based on the customer mix shown in Table 15 and the VCR values for different customer types shown in Table 16 as published by AEMO.

5. Load Profiles

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

5.1. Mossman 66/22kV Substation

The historical load of Mossman Substation for the summer day (SD), summer night (SN), winter day (WD) and winter night (WN) periods since 1992 is shown in the figure below.

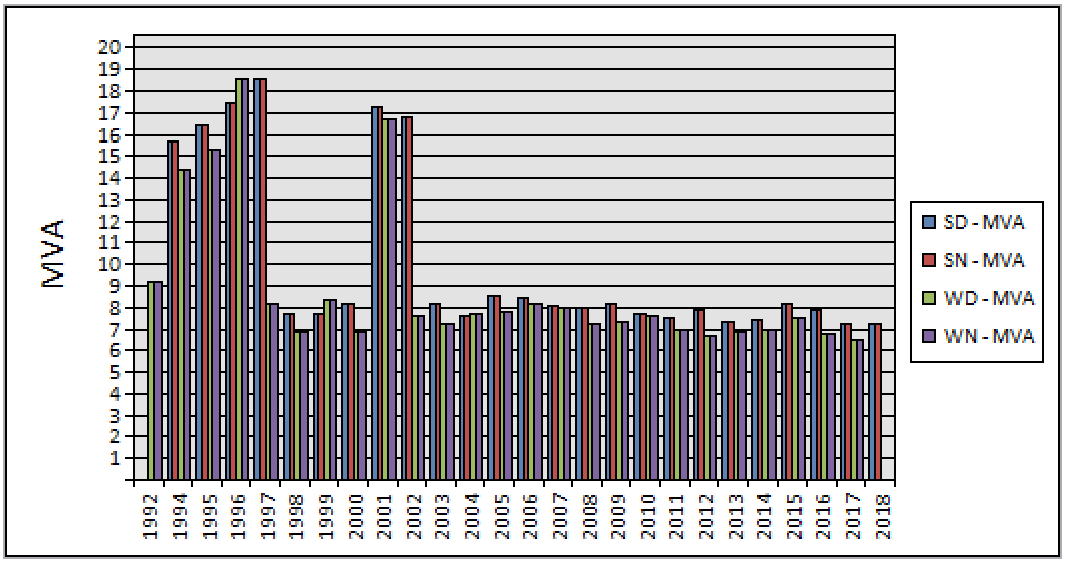


Figure 9 - Historical Load of Mossman Substation (Since 1992)

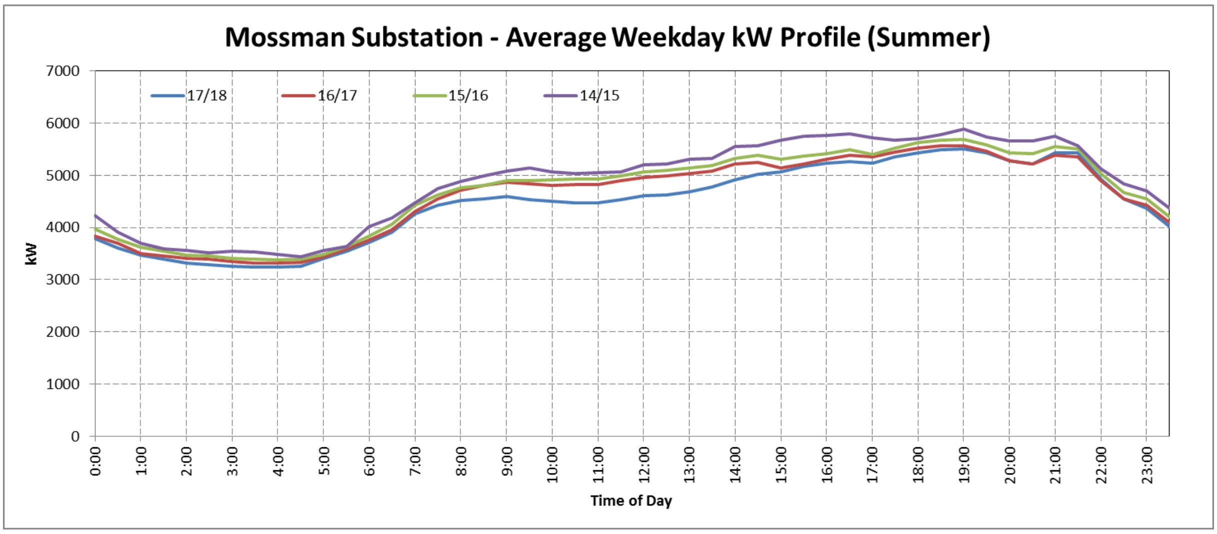


Figure 10 - Mossman Average Weekday Load Profile (Summer)

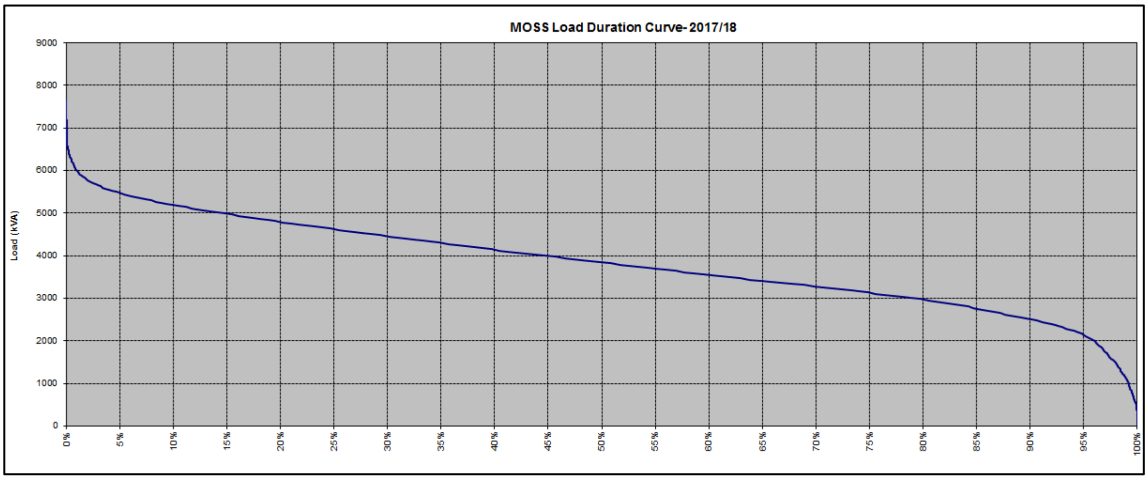


Figure 11 - Mossman load duration plot for 2016/17 period

5.2. Craiglie 132/22kV Substation

The historical load of Craiglie Substation for the summer day (SD), summer night (SN), winter day (WD) and winter night (WN) periods since its energisation in 1997 is shown in the figure below.

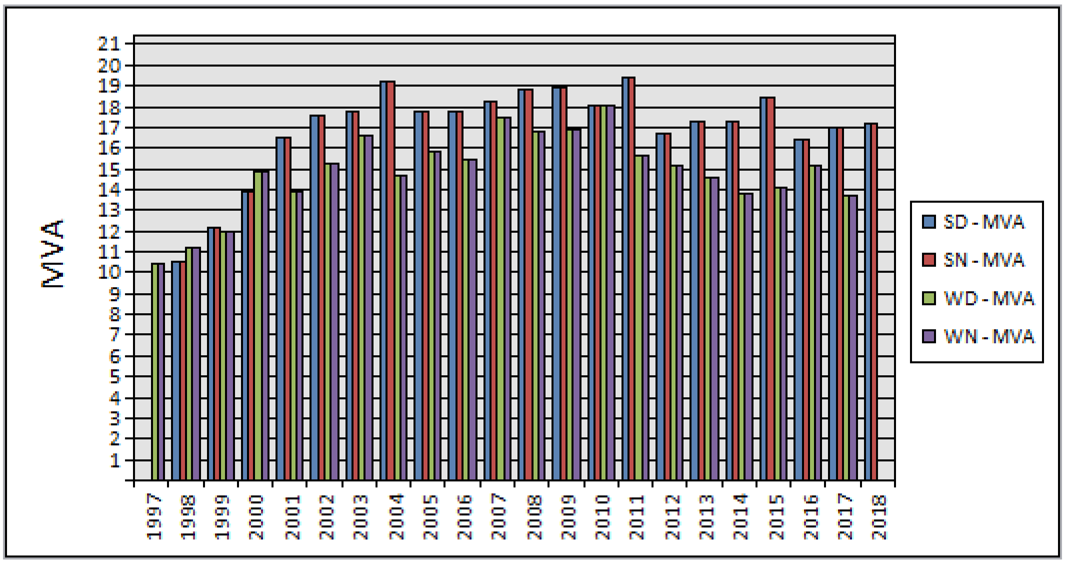


Figure 12 - Historical Load of Craiglie Substation (Since 1997)

The daily load profile is also shown in the figure below.

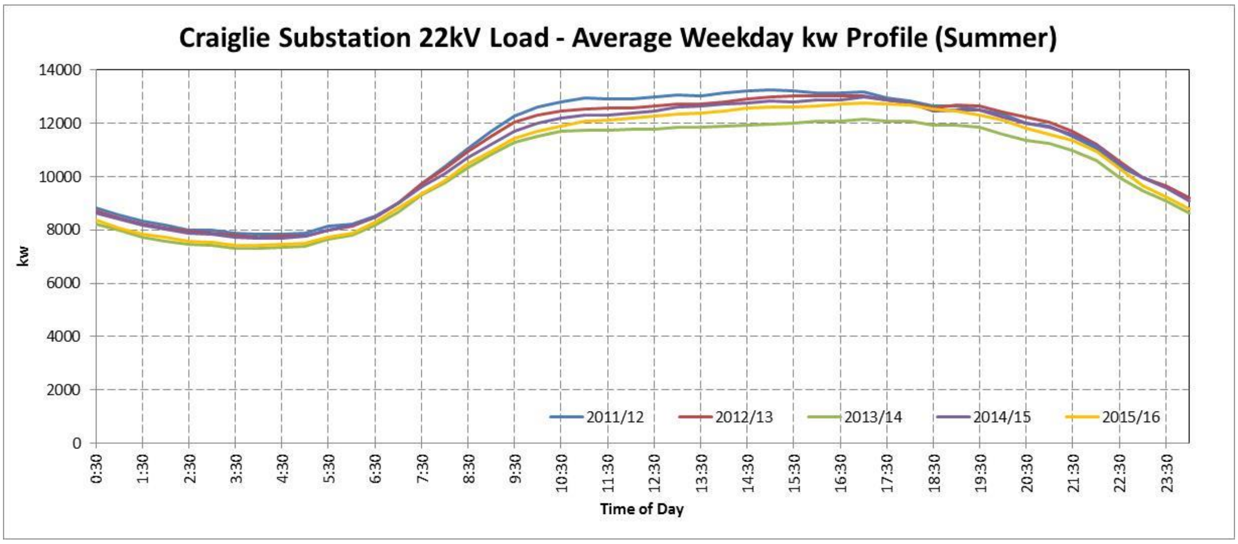


Figure 13 - Craiglie Average Weekday Load Profile (Summer)

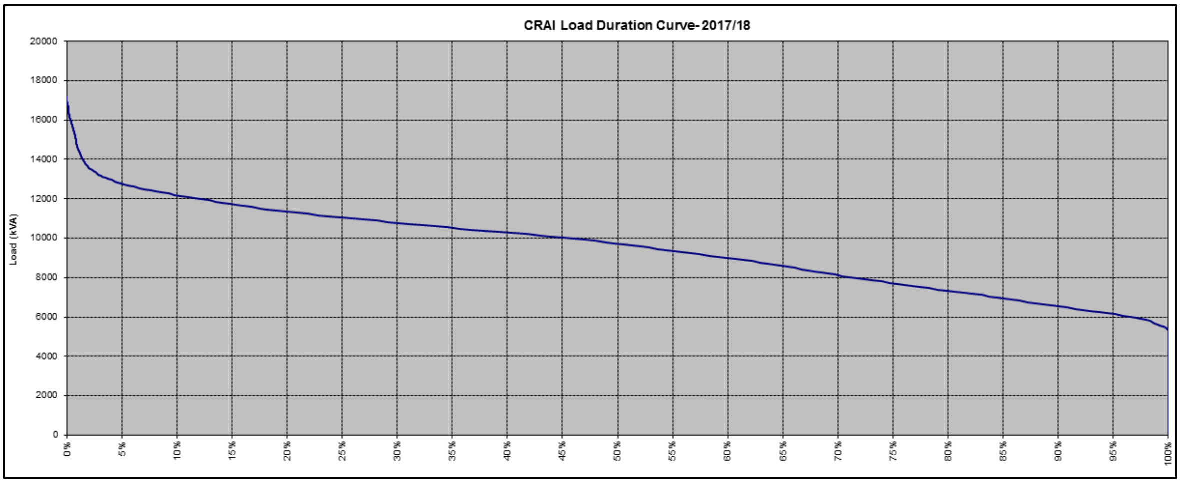


Figure 14 - Mossman load duration plot for 2017/18 period

6. 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.

6.1. Forecast Maximum Demand

Organic load growth for Mossman and Craiglie substations has been shown to be relatively stagnant, however it is expected that growth could occur through future developments such as existing industrial customer product chain value adding or generation technology changes, new major commercial and industrial customers, residential developments, tourist facilities, etc.

6.2. Load Profile

Characteristic peak day load profiles shown in Section 5 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.

6.3. System Capability – Line Ratings

The thermal ratings of the sub-transmission lines that supply Mossman have been calculated based on the main parameters listed in the table below.

Table 17 – Far North Line Rating Parameters

Parameter	Summer Day (9am – 5pm)	Summer Evening (5pm – 10pm)
Ambient Temperature	38°C	34°C
Wind Velocity	0.8 m/s	0.4 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

Mossman Substation is currently supplied by two 66kV feeders, MOSS 1 and MOSS 2 which do not experience thermal rating capacity limitations.

Table 18 - Static Thermal Line rating and utilisation of the MOSS 2 (3MO2) and MOSS 1 (3MO1) 66kV feeders

Operational Number	Feeder Name	PF Feeder Obj Name	Year / Ratings Period / Variable	2025		
				SD	SE	SNM
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	% of Rated A	27.6	22.5	21.2
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Loading (A)	36	38	34
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Power Factor	0.93	0.93	0.94
3MO2	MOSSMAN NO 2	3MO2_Mossman No 2 66 kV	Rating (A)	132	167	159
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	% of Rated A	60.1	50.1	46.3
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Loading (A)	79	84	74
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Power Factor	0.97	0.98	0.96
3MO1	MOSSMAN NO 1	3MO1_Mossman No 1 66 kV	Rating (A)	132	167	159

Craiglie Substation is currently supplied by two 132kV feeders, circuits 7200 and 7201 which do not experience thermal rating capacity limitations.

Table 19 - Static Thermal Line rating of the Turkinje to Craiglie and Yalkula to Lakeland 132kV feeders

Description	Value	Summer Day 9am-5pm	Summer Evening 5pm-10pm	Summer Night/Morning 10pm-9am	Winter Day 9am-5pm	Winter Evening 5pm-10pm	Winter Night/Morning 10pm-9am
Turkinje-Craiglie 132kV Feeder 7200 (Turkinje-Yalkula Section)	Rating (A)	452	476	427	502	483	443
Turkinje-Craiglie (132kV) Feeder 7200 (Yalkula-Craiglie Section)	Rating (A)	379	370	322	395	359	329
Turkinje-Craiglie 132kV Feeder 7201 (Turkinje-Yalkula Section)	Rating (A)	452	476	427	502	483	443
Turkinje-Craiglie 132kV Feeder 7201 (Yalkula-Craiglie Section)	Rating (A)	379	370	322	395	359	329
Yalkula-Lakeland 132kV Feeder	Rating (A)	468	523	480	539	539	494

7. Technical Characteristics of Non-Network Options

This section describes the technical characteristics of the identified need that a non-network option would be required to comply with.

7.1. Size

To meet Ergon Energy's ongoing operational needs it is expected that any alternate solution must be capable of delivering up to 7.5MW of base load power. This figure is based on the existing substation maximum demand and forecast growth.

7.2. Location

The location where network support and load restoration capability will be measured / referenced is on the 66kV bus at Mossman Substation.

7.3. Timing

7.3.1. Implementation Timeframe

In order to ensure compliance with Ergon Energy's planning criteria and the National Electricity Rules, a non-network solution (if identified as preferred) will need to be implemented by March 2023.

7.3.2. Time of Year

Load restoration capability (for Service Safety Net Targets) may be required at any time of the year, although required magnitude will be significantly lower during seasons with low to moderate daily peak loads, e.g. late autumn, winter and early spring.

7.4. Compliance with Regulations & Standards

As a distribution network service provider (DNSP), Ergon Energy must comply with regulations and standards, including the Queensland *Electricity Act* and Regulation, Queensland *Electricity Safety Act* and Regulation, Distribution Authority, National Electricity Rules, Electricity Distribution Network Code and applicable Australian Standards.

These obligations must be taken in consideration when choosing a suitable solution to address the identified need at Mossman as discussed in this report.

7.5. Longevity

Proposed non-network options will typically be required to provide solutions to the identified need for a period of at least 10 years. However, alternative solutions that can defer additional network investment for a lesser period may also be considered where economically prudent.

8. Feasible vs Non Feasible Options

8.1. Potentially Feasible Options

The identified need presented in this report is driven by ensuring the reliability of electricity supply and management of asset risks in Douglas Shire area that entails the Mossman 22kV distribution feeder area and in future, the Mount Molloy 22kV distribution feeder area.

As such, alternative solutions that cost effectively provide base load could potentially represent technically feasible options.

A non-exhaustive list of potentially feasible options includes:

- New embedded network generation
- Existing customer generation and load curtailment
- Embedded energy storage systems.

8.2. Options that are Unlikely to be Feasible

Without attempting to limit a potential proponent's ability to innovate when considering opportunities, some technologies / approaches are unlikely to represent a technically or financially feasible solution given the network requirement date of a solution.

A non-exhaustive list of options that are unlikely to be feasible includes:

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

9. Internal Options Identified

9.1. Non-Network Options Identified

Ergon Energy has not identified any viable non-network solutions that will address the identified need.

9.2. Distribution Network Options Identified

9.2.1. Summary of Financial Analysis

The estimated total capital cost of this preferred network option is $27.2M. Four network options were costed, Option A being the lowest Net Present Value (NPV) cost option is ranked 1 and is the network option proposed to be implemented.

Base Case option was costed, but has not been considered an acceptable option due to the resultant high ongoing maintenance costs and subsequent elevated risk of equipment damage and personnel safety. Furthermore it does not consider a strategic and holistic view of the 132kV and 66kV network supplying the Douglas Shire area and Northern Atherton Tablelands, or removal of the 66kV feeders across the Rex Range.

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.

Table 20 – Commercial Summary Cashflow

Commercial Summary Cashflow

Preferred Option Selected:	Option A

Preferred Option is Rank 1 for the Commercial NPV

$ Millions	Base Case	Option A	Option B	Option C
Capex	(11.10)	(11.77)	(12.99)	(12.16)
Opex	(3.48)	(1.80)	(2.01)	(1.62)
Direct Benefits	0.00	0.00	0.00	0.00
Commercial NPV	**(14.58)**	**(13.57)**	**(15.01)**	**(13.79)**
Ranking	*3*	*1*	*4*	*2*
Indirect/Risk	0.00	0.00	0.00	0.00
Commercial + Risk	**(14.58)**	**(13.57)**	**(15.01)**	**(13.79)**
Ranking	*3*	*1*	*4*	*2*

The preferred option has a NPV difference to the Base Case of :	**1.01**

9.2.2. Option A: Recommended - Transition Mossman Substation from 66/22kV to 132/22kV and extend the Yalkula 132kV bus

Ergon Energy's preferred internal option at this stage is to transition the Mossman 66/22kV Substation to a single transformer 132/22kV Substation. This option includes the recovery of the existing aged 66kV lines through the World Heritage listed areas of the Rex Range as part of a legacy agreement with the Queensland Government Wet Tropics Management Authority.

Mossman Substation is currently supplied by two 66kV feeders, which feed the two 10MVA 66/22kV transformers, associated 66kV and 22kV bus and structures, and 22kV feeder bays.

The existing control building will be replaced with a new control building that will house new indoor 22kV switchgear. The existing 22kV distribution feeders currently being supplied from the Mossman Substation aged outdoor 22kV yard will be transitioned across to the new 22kV indoor switchgear. This will enable the recovery of the existing outdoor 22kV yard, structures and one of the 10MVA 66/22kV transformers.

Once this area has been cleared, a new 132/22kV transformer will be installed into the vacated footprint.

Subsequently a new 132kV tee-off the adjacent Turkinje to Craiglie 132kV feeder (circuit 7201/2) will land into the Mossman Substation and be connected to the new 132/22kV transformer.

The transition of the Mossman Substation to the 132kV network will require an extension of the 132kV bus at Yalkula Substation and minor 132kV work at the Turkinje and Craiglie Substations. Minor 22kV distribution work between Craiglie and Mossman Substations will provide single 132/22kV transformer Safety Net security to the Mossman Substation.

After commissioning of the 132/22kV transformer, the remaining 66/22kV transformer and 66 kV plant will be recovered and remediated. The two 66kV feeders back towards Mount Molloy will be recovered.

Strategically, the high cost 66kV feeders from Turkinje to Mount Molloy will be reviewed along with the aged asset condition of the Mount Molloy 66/22kV Substation. The 132kV extension at Yalkula Substation will be designed to enable a 132/22kV transformer at Yalkula to enable future retirement of Mount Molloy Substation and the 66kV feeders back towards Turkinje.

Retirement of the two aged Craiglie 132/22kV 15/20MVA transformers will be deferred. The proposed 22kV feeder tie works proposed for the Safety Net security of the Mossman Substation single 132/22kV transformer supply will provide limited contingency load transfers of the Craiglie 22kV distribution network.

The schematic single-line diagram in Figure 15 shows the proposed network configuration of this preferred network option

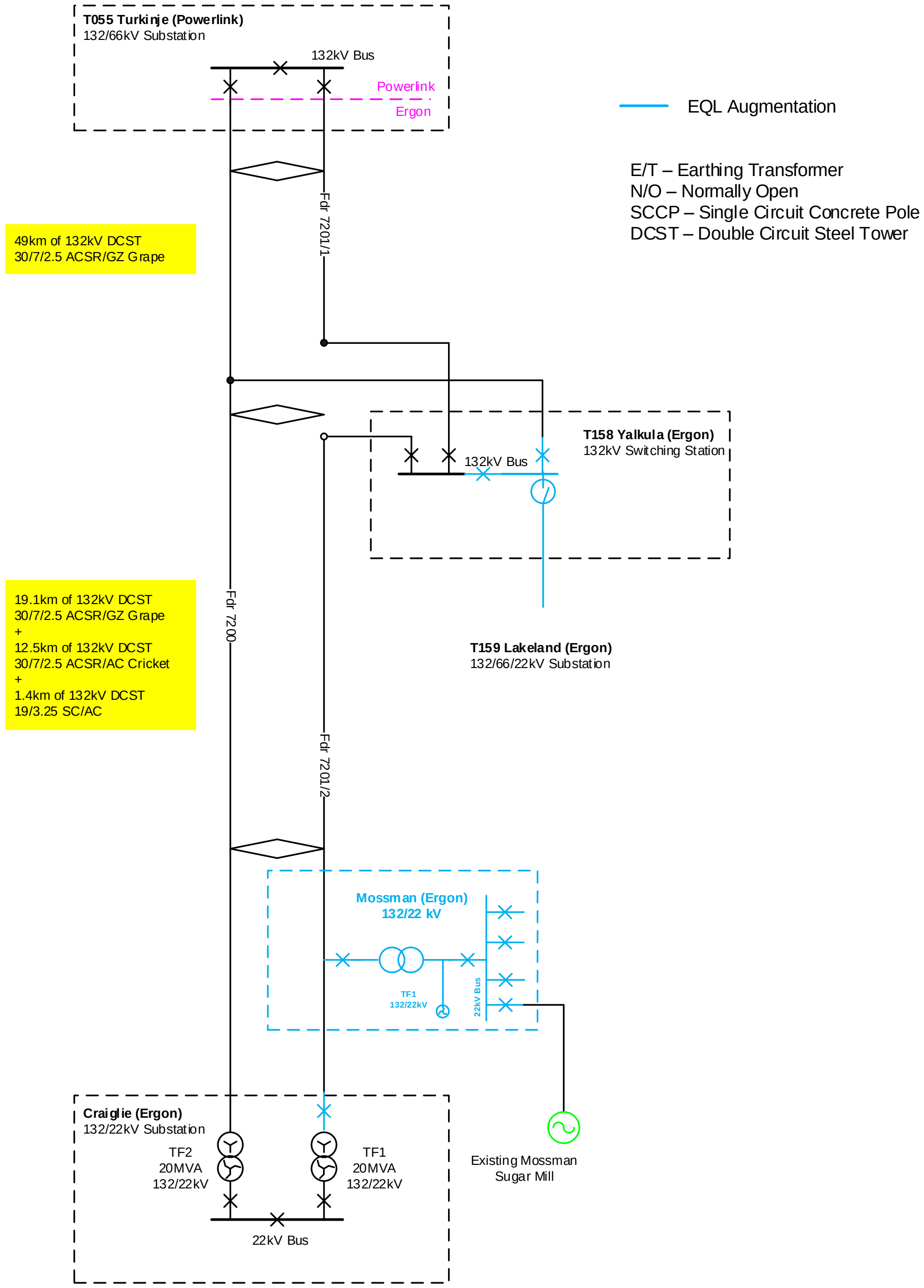


Figure 15 - Schematic single-line diagram of the Option A preferred network option

9.2.3. Option B: Staged Replacement of the 66kV Line and Aged Mossman Substation Plant as Required

This option involves the replacement of plant at Mossman 66/22kV Substation on an as required basis however includes the staged replacement of the aging 66kV feeders to reduce the anticipated increase in C3 remediation forecast from the last inspection cycle.

This option was considered for economic and sensitivity analysis but was not found to be preferred due to the significant overall capital expenditure across the area network, sub-par reduction of ongoing OPEX costs, and lack of strategic benefit to the wider network development, particularly Mount Molloy Substation and 66kV feeders back towards Turkinje.

In addition to the above, rebuilding the 66 kV feeders to the current standard with sufficient way leave is deemed to be not feasible due to unviable increased vegetation clearance required across the rainforest (as indicated by the Queensland Government Wet Tropics Management Authority) nor moving towards a commitment to remove the 66kV assets from the Rex Range.

9.2.4. Option C: Full Retirement/Recovery of Mossman 66/22kV Substation, Upgrade Craiglie Substation to Supply Mossman 22kV Distribution Area

This option involves the retirement/recovery of the Mossman 66/22 kV Substation and supplying Mossman Substation feeder loads 2DAI, 2MOS and 2SCK/2CAS via a combination of the existing overhead 2INL feeder and new 22 kV underground feeders from Craiglie Substation. One of the ageing Craiglie Substation 132/22 kV 15/20 MVA transformers will need to be replaced in 2021/22 due to the extra security required of this substation with Mossman Substation retired and the combined loading expectations.

This option does not provide the strategic 132kV network development (i.e. future retirement of 66kV feeders from Mount Molloy substation towards Turkinje substation) at Yalkula Substation, nor consider major customer product chain value adding or substantive generation technology changes in the Mossman 22kV distribution area. This proposal does enable retirement of the upstream 66kV lines from Mossman towards Mount Molloy.

10. Submissions & Next Steps

10.1. Submissions from Solution Providers

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

With reference to Section 7, all submissions should include sufficient technical and financial information to enable Ergon Energy to undertake comparative analysis of the proposed solution against other options.

The proposals should include, but are not limited to:

- Full costs of completed works including delivery and installation where applicable
- Whole of life costs including operational costs
- Project execution strategy including design, testing and commissioning plans
- Engineering network system studies and study reports
- Verified and approved engineering designs if available

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.

Submissions in writing are due by **3pm on 29 November 2019** and 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

10.2. Next Steps

Ergon Energy intends to carry out the following process to assess what action should be taken to address the identified need at Mossman:

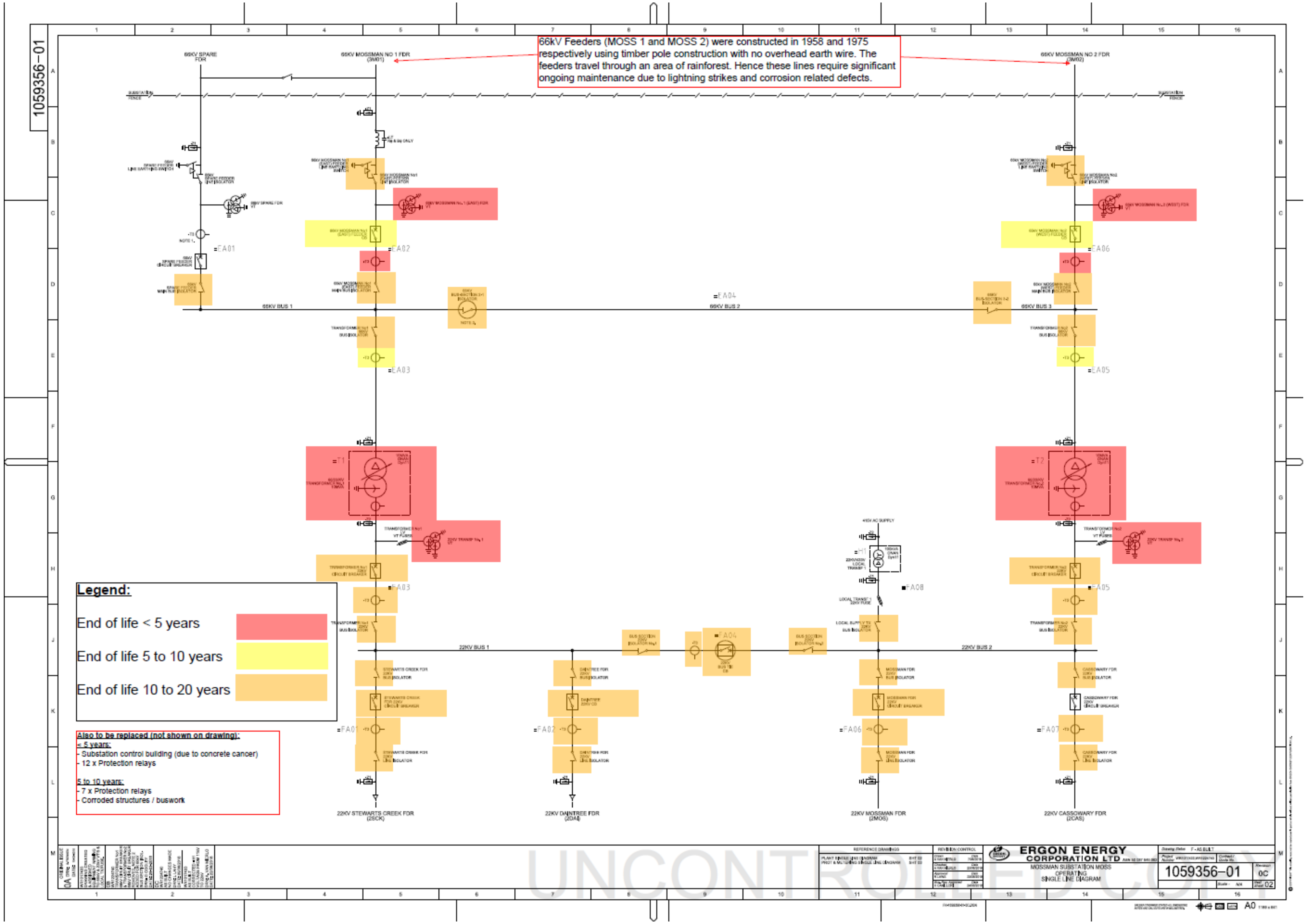
Step 1	Publish Non Network Options Report (this report) inviting non-network options from interested participants	Date Released: **20 Aug 2019**
Step 2	Consultation period	**20 Aug – 29 Nov 2019**
Step 3	Deadline for submission of proposals for non-network alternatives	**3pm 29 Nov 2019**
Step 4	Release of the Draft Project Assessment Report (DPAR)	Anticipated to be released by: **2 Dec 2019**
Step 5	Consultations in response to the Draft Project Assessment Report	**2 Dec 2019 – 31 Jan 2020**
Step 6	Publish the Final Project Assessment Report (FPAR)	Anticipated to be released by: **07 Feb 2020**
Ergon Energy reserves the right to revise this timetable at any time. The revised timetable will be made available on the Ergon Energy RIT-D website.		

Ergon Energy will use its reasonable endeavours to maintain the consultation program listed above. However, due to changing power system conditions or other circumstances beyond the control of Ergon Energy this consultation schedule may change. Up-to-date information on such changes (if applicable) will be made available on the Partner Portal.

During the consultation period, Ergon Energy will review, compare and analyse all internal and external solutions. At the conclusion of the consultation process, Ergon Energy will publish a final report which will detail the most feasible option. Ergon Energy will then proceed to take steps to progress the recommended solution to ensure any statutory non-compliance is addressed and undertake appropriately justified network reliability improvement, as necessary.

The RIT-D process is aimed at identifying a technically feasible alternative to the internal option that is also financially more competitive than the internal option. The selection of the solution provider to implement the preferred option will be done in accordance with Ergon Energy's standards for procurement.

11. Appendix A: Retirement Timeframe of Primary Assets at Mossman Substation



12. Appendix B: Glossary of Terms

Abbreviation	Term
A	Amps
ACS	Alternate Control Services
AD	Authorised Demand
AER	Australian Energy Regulator
AFLC	Audio Frequency Load Control
AP	Approved Plan
AS	Australian Standard
AVR	Automated Voltage Regulator
CAPEX	Capital Expenditure
CARE	Cyclone Area Reliability Enhancements
CAW	Contract Awarded
CICW	Customer Initiated Customer Works
CB	Circuit Breaker
CP	Connection Point
CT	Current Transformer
CVT	Capacitor Type Voltage Transformer
CRAI	Craiglie Substation
DNSP	Distributed Network Service Provider
EECL	Ergon Energy Corporation Limited
DGA	Dissolved Gas Analysis
DNAP	Distribution Network Augmentation Plan
FCA	First Capacity Available
FACTS	Flexible AC Transmission System
GSM	Global System for Mobile Communications
HV	High Voltage
IP	Internet Protocol
IED	Intelligent Electronic Device
IDR	Implementation Design Released
IRC	Investment Review Committee
kA	Kilo Amp
kV	Kilo Volt
kVArh	Kilo Volt Amps Reactive Hours
kW	Kilo Watt
kWh	Kilo Watt Hour
LCF	Local Control Facility
LED	Light Emitting Diode
LMVP	Type of VACUUM Type C/B
LTEC	Long Term Emergency Cyclic
MEGU	Micro Embedded Generating Unit
MDP	Meter Data Provider
MiCOM	Type of Brand/Model For Protection Relays

Abbreviation	Term
MOSS	Mossman Substation
MW	Mega Watt
NAR	Network Access Restriction
NATA	National Association of Testing Authorities
NCR	Normal Cyclic Rating
NIRC	Network Investment Review Committee
OPEX	Operating Expenditure
OEM	Original Equipment Manufacturer
OTD	Operational Technology Deployment
OLTC	Online Tap Changer
OCN	Operational Communications Network
OES	Operational Engineering Service
OPGW	Optical Ground Wire
PDH	Plesiosynchronous Digital Hierarchy
PoP	Plant Overload Protection
PIA	Project Initiation Advice
PSS	Project Scope Statement
PCO	Project Close Out
PDA	Protection Design Advice
RWR	Recommended Works Report
RAM	Regional Asset Management
RDAS	Remote Data Acquisition Server
RWH	Recommended Works Handover
RMS	Root Means Square
RTU	Remote Terminal Unit
RUG	Releasable User Guide
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SDH	Synchronous Digital Hierarchy
SEL	Schweitzer Engineering Laboratories
SME	Subject Matter Experts
SCR	Short Circuit Ratio
SCS	Shared Control Services
SFU	Static Frequency Unit
SP	Service Provider
SCADA	Supervisory Control & Data Acquisition
SCCP	Single Circuit Concrete Pole
SCR	Short Circuit Ratio
SVC	Static Var Compensator
SWER	Single Wire Earth Return
SNAP	Sub transmission Network Augmentation Plan
TURK	Turkinje Substation
YALK	Yalkula Substation
YOM	Year of Manufacture