Regulatory Investment Test for Distribution (RIT-D)

Kingaroy Network Limitation

Final Project Assessment Report

22 October 2021

Ergon Energy Network
Part of Energy Queensland

EXECUTIVE SUMMARY

About Ergon Energy

Ergon Energy Corporation Limited (Ergon Energy) is part of Energy Queensland and manages an electricity distribution network which supplies electricity to more than 765,000 customers. Our vast operating area covers over one million square kilometres (around 97% of the state of Queensland) from the expanding coastal and rural population centres to the remote communities of outback Queensland and the Torres Strait.

Our electricity network consists of approximately 160,000 kilometres of powerlines and one million power poles, along with associated infrastructure such as major substations and power transformers.

We also own and operate 33 stand-alone power stations that provide supply to isolated communities across Queensland which are not connected to the main electricity grid.

Identified Need

Kingaroy 66/11kV Substation (KING) is located on the eastern edge of Kingaroy Town. The 11kV distribution network supplies Kingaroy and extends over 50km to supply nearby towns. KING is an important sub-transmission node in the South Burnett area, sourcing 66kV supply from Tarong Power Station which is then distributed via outgoing 66kV feeders to zone substations in the region. The 11kV distribution network supplies approximately 8,200 customers in Kingaroy Town and the surrounding region, including a number of major employers such as Swickers Bacon Factory and the Kingaroy Hospital.

KING was established in the 1960s, according to the applicable design and construction standards of the time. It has an outdoor 66kV switchyard, two 25MVA 66/11kV power transformers and a control building with an indoor oil filled 11kV switchboard.

A substation condition assessment of KING was completed and has identified some primary and secondary plant and equipment that are recommended for retirement based on Condition Based Risk Management analysis.

The assessment identified that the following assets are at the end of their serviceable life:

- All 11kV CBs due to condition;
- Protection relays for the 11kV bus scheme due to age and potential mal-operation;
- 66kV VT A1197 (3 phases) due to being problematic;

The state of these primary and secondary system assets poses safety risks to staff working within the switchyard and control room, as well as environmental risks associated with failure of oil filled components.

Approach

The National Electricity Rules (NER) require that, subject to certain exclusion criteria, network business investments for meeting service standards for a distribution business are subject to a

Regulatory Investment Test for Distribution (RIT-D). Ergon Energy has determined that network investment is essential in this case for it to continue to provide electricity to the consumers in the Kingaroy supply area in a reliable, safe and cost-effective manner. Accordingly, this investment is subject to a RIT-D.

Ergon Energy published a Notice of no non-network options for the above described identified need on 15 March 2021.

One potentially feasible option has been investigated:

- **Option A:** Replace 11kV switchboard, protection relays and 66kV VT.

This Final Project Assessment Report , where Ergon Energy provides both technical and economic information about possible solutions, has been prepared in accordance with the requirements of clause 5.17.4(o) of the NER.

Ergon Energy's preferred solution to address the identified need is Option A, replace the 11kV switchboard and 11kV protection relays in a new control building. The 66kV VT A1197 is to be replaced in-situ.

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1. INTRODUCTION

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

This report represents the final stage of the consultation process in relation to the application of the RIT-D on potential credible options to address the identified need for the Kingaroy network area.

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

1.1. Structure of the Report

This report:

- Provides background information on the network capability limitations of the distribution network supplying the Kingaroy 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 are considered in this RIT-D assessment.
- 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.

1.2. Dispute Resolution Process

In accordance with the provisions set out in clause 5.17.5(a) of the NER, Registered Participants or Interested Parties may, within 30 days after the publication of this report, dispute the conclusions made by Ergon Energy in this report with the Australian Energy Regulator. Accordingly, Registered Participants and Interested Parties who wish to dispute the conclusions outlined in this report based on a manifest error in the calculations or application of the RIT-D must do so within 30 days of the publication date of this report. Any parties raising a dispute are also required to notify Ergon Energy. Dispute notifications should be sent to demandmanagement@ergon.com.au

If no formal dispute is raised, Ergon Energy will proceed with the preferred option to construct a new control building nearby to the existing control building and install a new 11kV switchboard at Kingaroy Substation. The 66kV VT A1197 is to be replaced in-situ.

1.3. Contact Details

For further information and inquiries please contact:

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

2. BACKGROUND

2.1. Geographic Region

Kingaroy 66/11kV Substation (KING) is located on the eastern edge of Kingaroy Town. The 11kV distribution network supplies Kingaroy and extends over 50km to supply nearby towns. KING is an important sub-transmission node in the South Burnett area, sourcing 66kV supply from Tarong Power Station which is then distributed via outgoing 66kV feeders to zone substations in the region. The 11kV distribution network supplies approximately 8,200 customers in Kingaroy town and the surrounding region, including a number of major employers such as Swickers Bacon Factory and the Kingaroy Hospital.

The geographical location of Ergon Energy's sub-transmission network and substations in the area is shown in Figure 1.

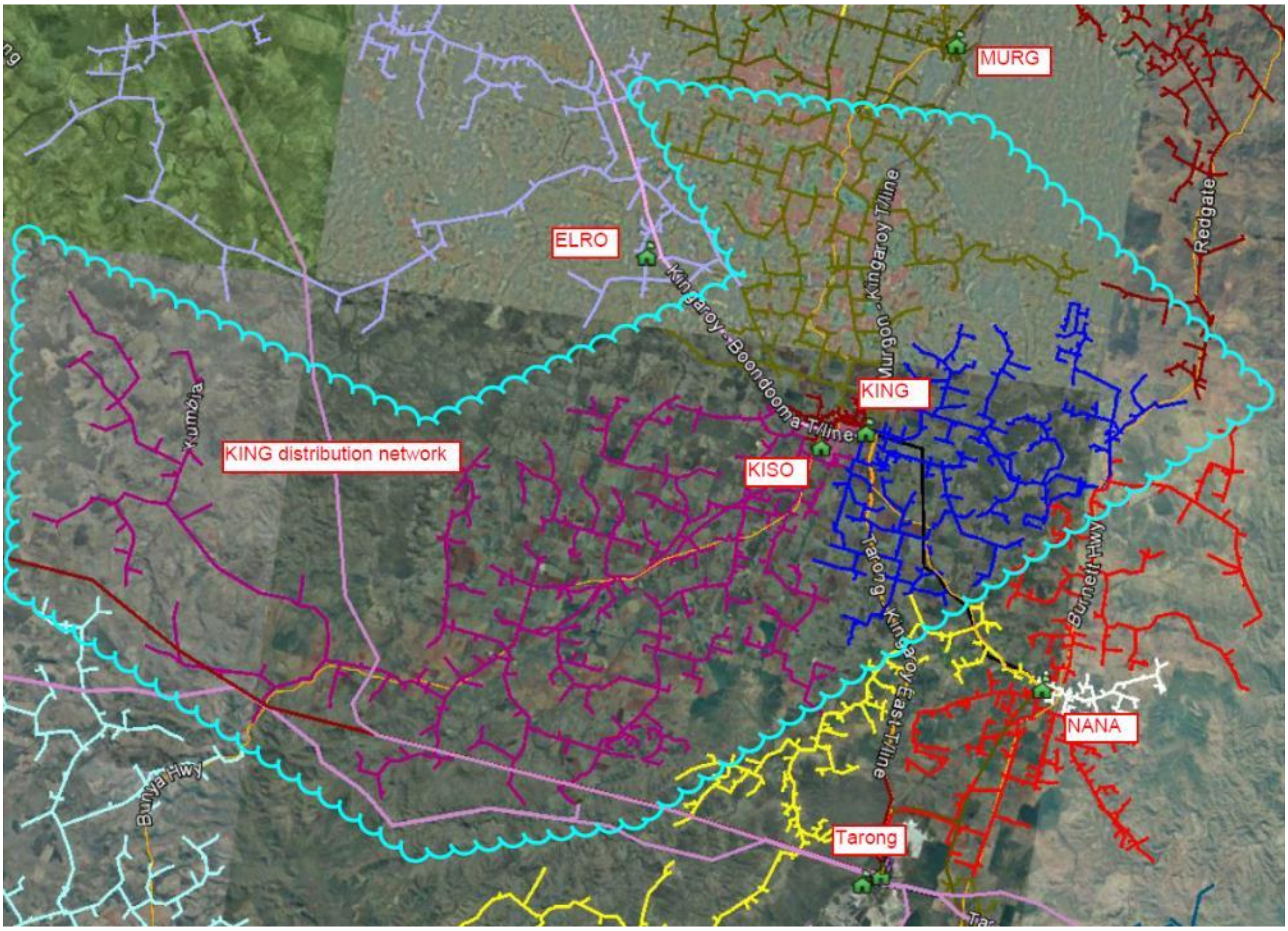

Figure 1: Existing network arrangement (geographic view)

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2.2. Existing Supply System

KING is located on the eastern edge of Kingaroy Town. The 11kV distribution network supplies Kingaroy and extends over 50km to supply nearby towns. KING is an important sub-transmission node in the South Burnett area, sourcing 66kV supply from Tarong Power Station which is then distributed via outgoing 66kV feeders to zone substations in the region.

There is an outgoing radial 66kV feeder that extends to Boondooma Dam 70km to the north west. The feeder supplies several pumping stations (via zone substations) that are a critical component of the Boyne River and Tarong Scheme which provides water for irrigation and for cooling purposes at Tarong Power Station. A 66kV feeder also extends south to supply the townships of Nanango and Yarraman, tying into nearby 66kV feeders at several locations. An additional dedicated feeder is under construction to connect the future 40MW Kingaroy Solar Farm.

KING was established in the 1960s, according to the applicable design and construction standards of the time. It has an outdoor 66kV switchyard, two 25MVA 66/11kV power transformers and a control building with an indoor oil filled 11kV switchboard. Beginning in the early 2000s, a number of asset replacement and upgrade projects have progressively replaced most of the 66kV plant, power transformers, and secondary systems. The indoor 11kV switchboard and control building are the major components that remain as originally constructed in 1968.

The existing distribution network in Kingaroy consists of six 11kV feeders, three feeders primarily supply the town area and three are longer rural feeders. The KING 11kV network is tied to Murgon 66/11kV substation (MURG) 30kms to the north, Ellwood’s Rd 66/11kV substation (ELRO) 18kms to the west, and Nanango 66/11kV substation (NANA) 20kms to the south, although these ties have limited transfer capability.

A schematic view of the existing sub-transmission network arrangement is shown in Figure 2 and the geographic view of Kingaroy Substation is illustrated in

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Control Room
(11kV switchboard
and relays inside)
66kV VT A1197

Figure 3.

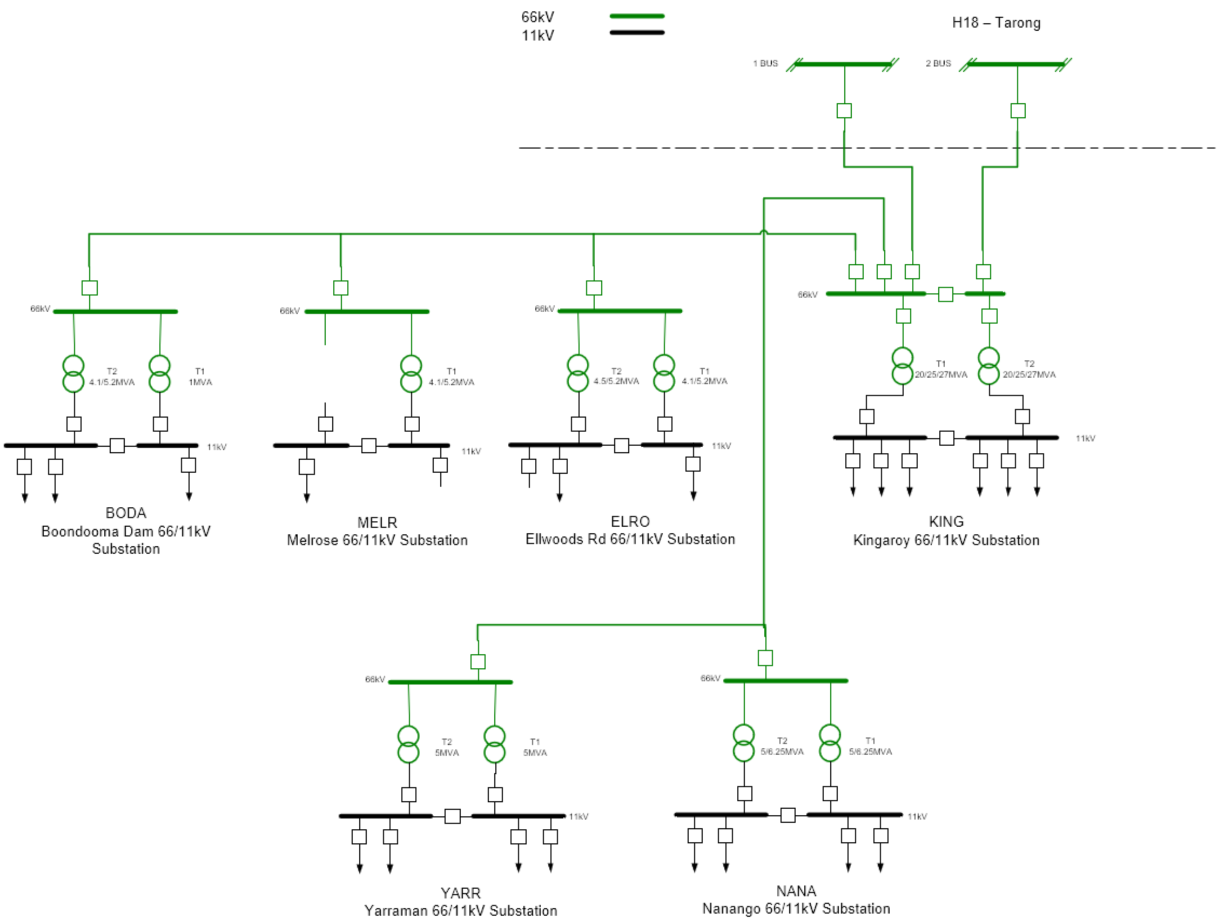

Figure 2: Existing network arrangement (schematic view)

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Figure 3: Kingaroy Substation (geographic view)

2.3. Load Profiles / Forecasts

The load at KING comprises a mix of residential and commercial/industrial customers. The load is summer peaking, and historically the annual peak loads have been predominantly driven by commercial and industrial customers. An increase in PV generation appears to be shifting this peak load into the evening and this is expected to continue in the coming years.

2.3.1. Full Annual Load Profile

The full annual load profile for KING over the 2019/20 financial year is shown in Figure 4. It can be noted that the peak load occurs during summer.

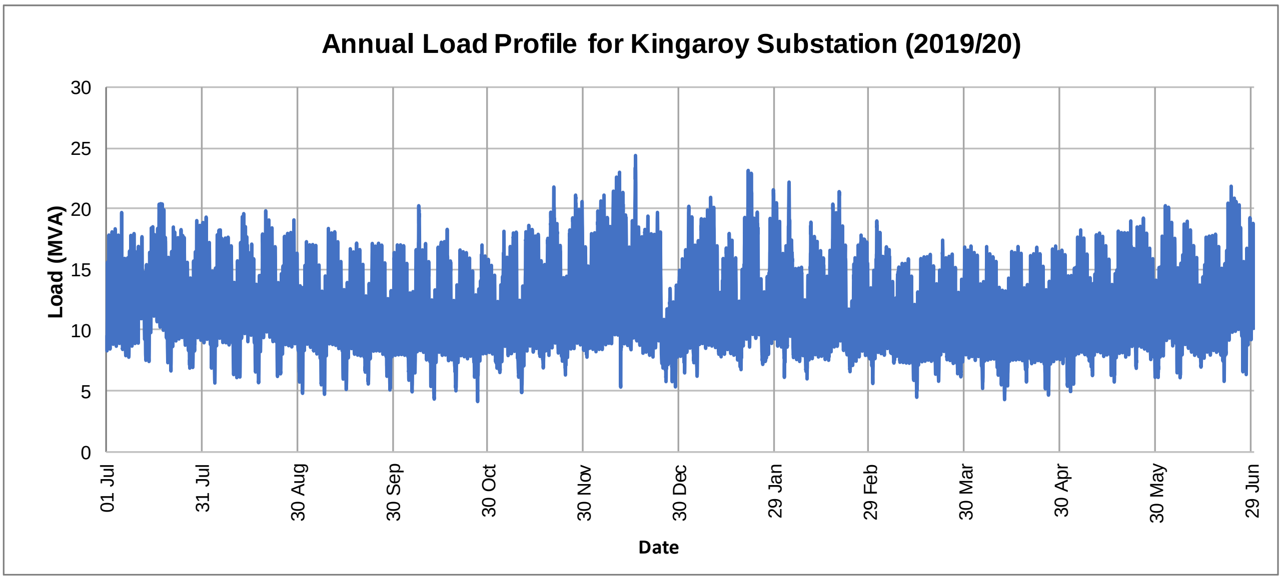

Figure 4: Substation actual annual load profile

2.3.2. Load Duration Curve

The load duration curve for KING over the 2019/20 financial year is shown in Figure 5.

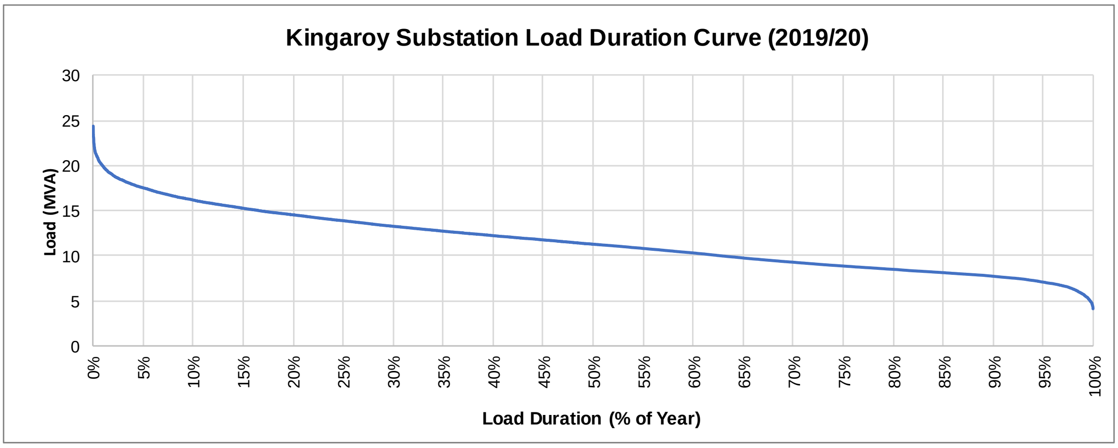

Figure 5: Substation load duration curve

2.3.3. Average Peak Weekday Load Profile (Summer)

The daily load profile for an average peak weekday during summer is illustrated below in Figure 6. It can be noted that the summer peak loads at KING are historically experienced in the late afternoon.

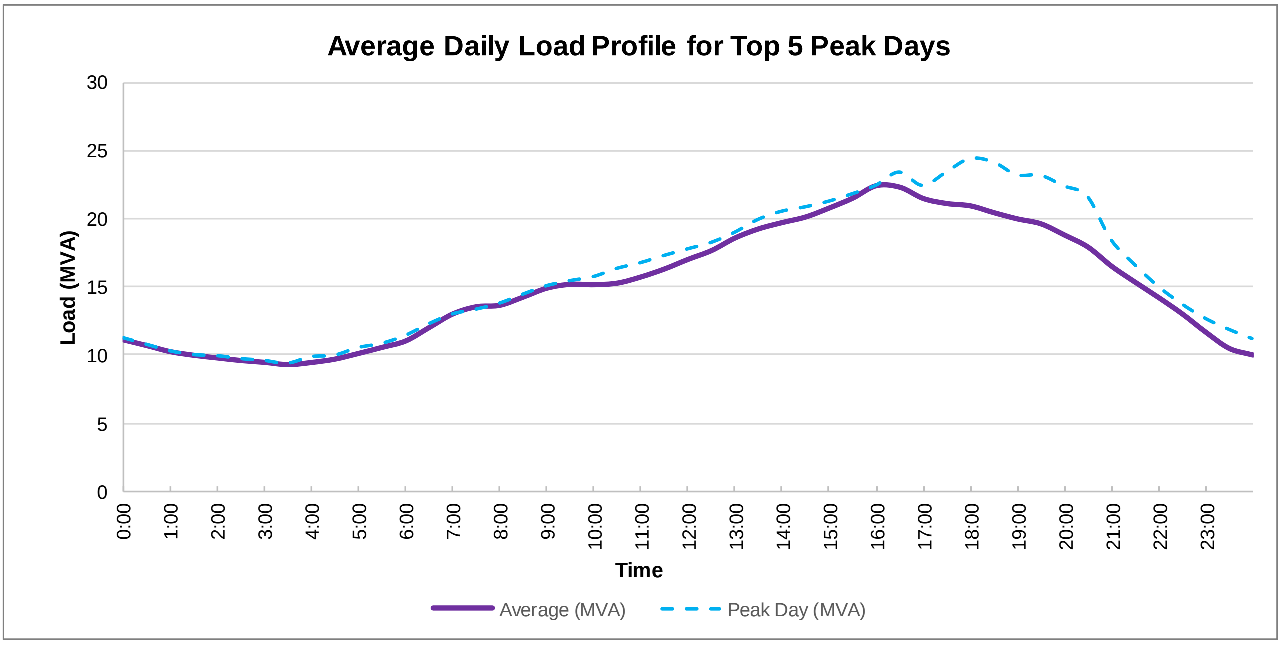

Figure 6: Substation average peak weekday load profile (summer)

2.3.4. Base Case Load Forecast

The 10 PoE and 50 PoE load forecasts for the base case load growth scenario are illustrated in Figure 7. The historical peak load for the past six years has also been included in the graph.

It can be noted that the historical annual peak loads have been rising over the past five years. This is due to an increase in large customer block loads. It can also be noted that the peak load is forecast to increase slightly over the next 10 years under the base case scenario.

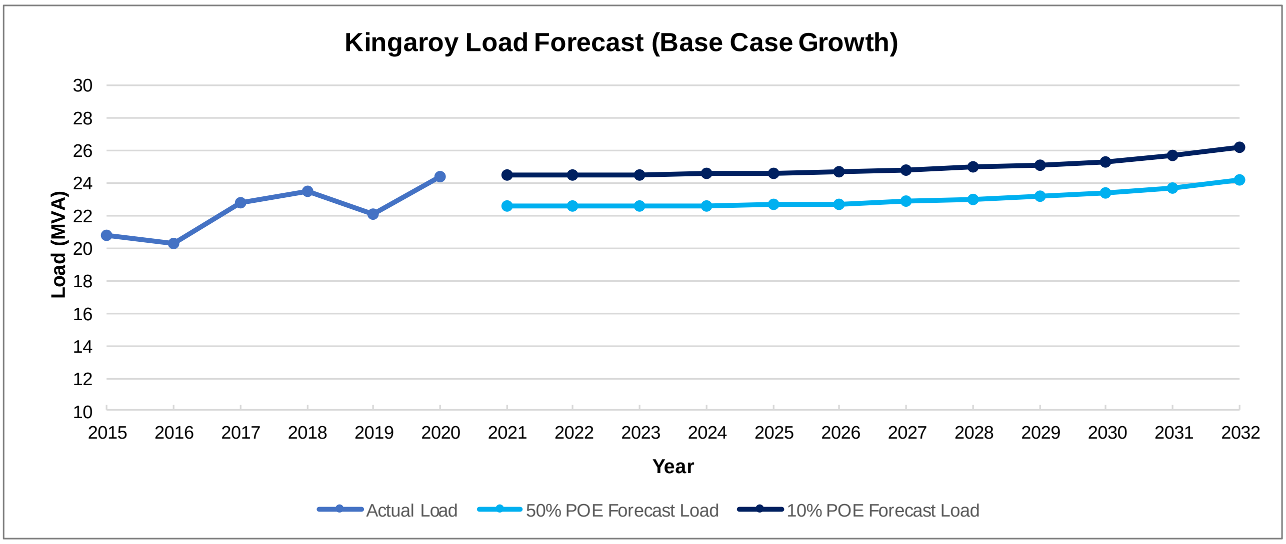

Figure 7: Substation base case load forecast

2.3.5. High Growth Load Forecast

The 10 PoE and 50 PoE load forecasts for the high load growth scenario are illustrated in Figure 8. With the high growth scenario, the peak load is forecast to increase over the next 10 years.

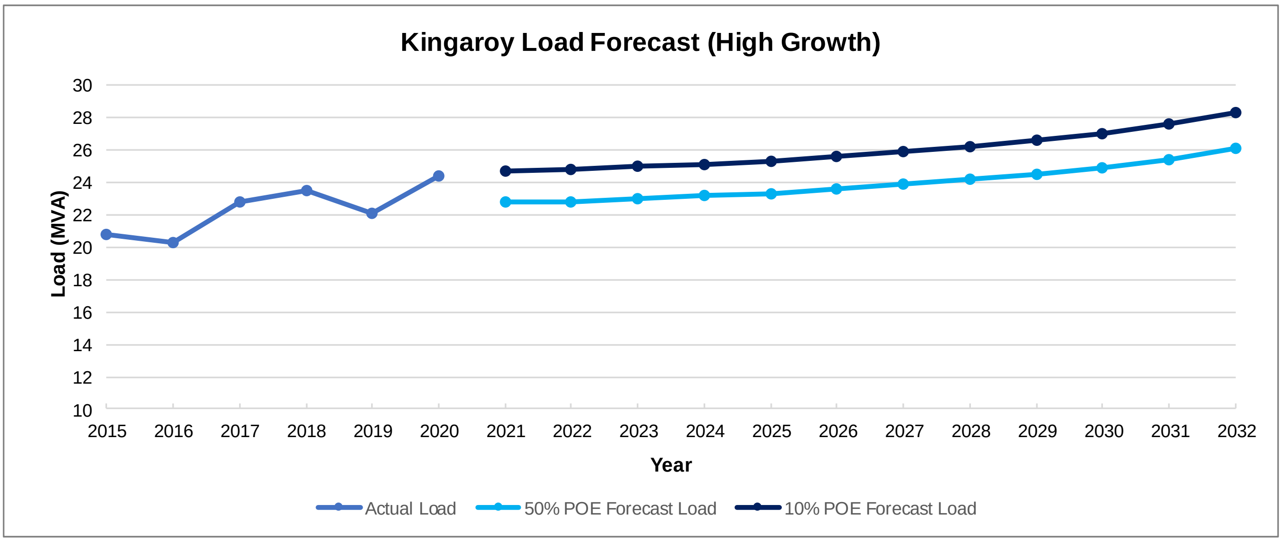

Figure 8: Substation high growth load forecast

2.3.6. Low Growth Load Forecast

The 10 PoE and 50 PoE load forecasts for the low load growth scenario are illustrated in Figure 9. With the low growth scenario, the peak load is forecast to remain relatively steady over the next 10 years.

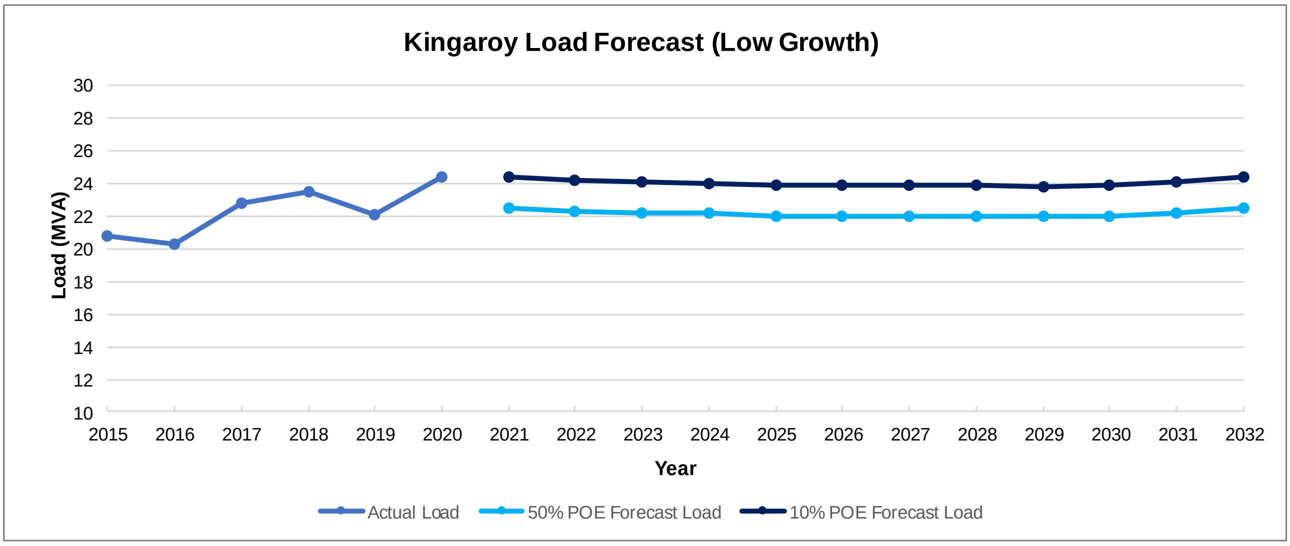

Figure 9: Substation low growth load forecast

3. IDENTIFIED NEED

3.1. Description of the Identified Need

3.1.1. Aged and Poor Condition Assets

A recent condition assessment has highlighted that several critical assets are at end of life and are in poor condition. The condition of these assets presents a significant safety, environmental and reliability risk.

Based on a Condition Based Risk Management analysis of the effect of current condition and ageing on the expected life of the asset, the following have been deemed to reach retirement age as follows:

- All 11kV CBs due to condition;
- Protection relays for the 11kV bus scheme due to condition and potential mal-operation;
- 66kV VT A1197 (3 phases) due to being problematic;

The deterioration of these primary and secondary system assets poses significant safety risks to staff working within the switchyard and in the control room. It also poses a safety risk to the general public, through the increased likelihood of protection relay mal-operation and catastrophic failure of the 66kV voltage transformer. There is also a risk of environmental harm due to loss of oil from the voltage transformer, which would require clean up and rectification. Ergon Energy considers that without rectification, this safety risk would not be reduced to be So Far as Is Reasonably Practicable (SFAIRP).

Additionally, the poor condition of these assets significantly increases the likelihood of outages, resulting in a reduction in the level of reliability experienced by the customers supplied from KING.

3.1.2. Distribution Feeder Utilisation

The actual peak feeder loads for summer 2020/21 are shown in Figure 10. As seen below, the existing peak loads on North, Coolabunia, and West exceed 75% target maximum utilisation. The remaining feeders are also nearing 75% utilisation.

The existing switchboard cannot accommodate additional feeders and cannot be expanded within the existing control building due to space considerations. The feeder ratings are largely limited by underground exit cables which are already of the maximum size that can be terminated into the existing cable boxes.

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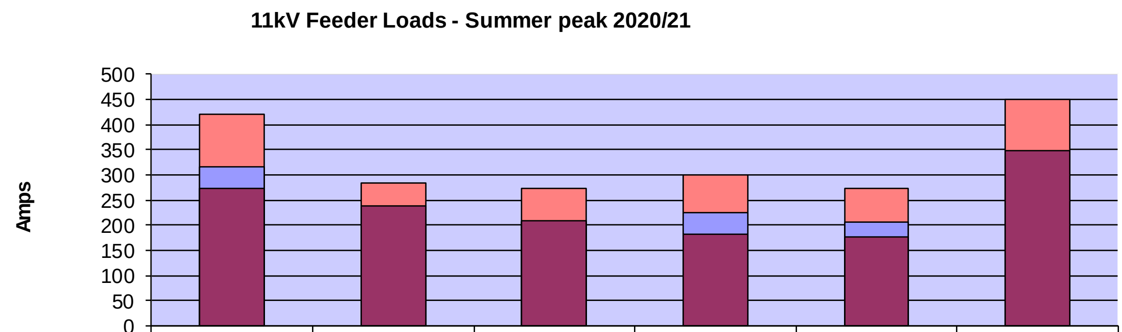

	EAST	NORTH	COOLABUNIA	KUMBIA	WOOROOLIN	WEST
NCC Rating (A)	421	283	274	300	274	450
Target Utilisation (A)	316	212	206	225	206	338
Load (A)	274	237	210	183	176	349
% of rating	65%	84%	77%	61%	64%	78%

Figure 10: 11kV feeder loads

3.2. Quantification of the Identified Need

3.2.1. Aged and Poor Condition Assets

A risk assessment has been undertaken on the condition of the deteriorated assets at KING and Ergon Energy has deemed that without undertaking remediation the safety risk associated with the asset condition would not be reduced to be SFAIRP. As such, retention of these assets in their current condition is not considered an acceptable option. Secondly, there is also an environmental risk associated with the voltage transformer that will not be As Low As Reasonably Practicable . As such, retention of these assets in their current condition is not considered an acceptable option.

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3.3. 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.

3.3.1. Forecast Maximum Demand

It has been assumed that forecast peak demand at Kingaroy Substation will be consistent with the base case forecast outlined in Section **Error! Reference source not found.**.

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

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

3.3.2. Load Profile

Characteristic peak day load profiles shown in Section **Error! Reference source not found.** are unlikely to change significantly from year to year and the shape of the load profile is assumed to remain virtually the same with increasing maximum demand.

4. CREDIBLE OPTIONS ASSESSED

4.1. Assessment of Network Solutions

Ergon Energy has identified one credible network option that would address the identified need.

4.1.1. Option A: Replace 11kV switchboard and 66kV VT

This option involves replacing the 11kV switchboard, 11kV bus relays, and the 66kV VT A1197 in order to address the identified need. The switchboard will be installed in a new building, along with the associated secondary systems and relays that are required.

A schematic diagram of the proposed network arrangement for Option A is shown in Figure 11.

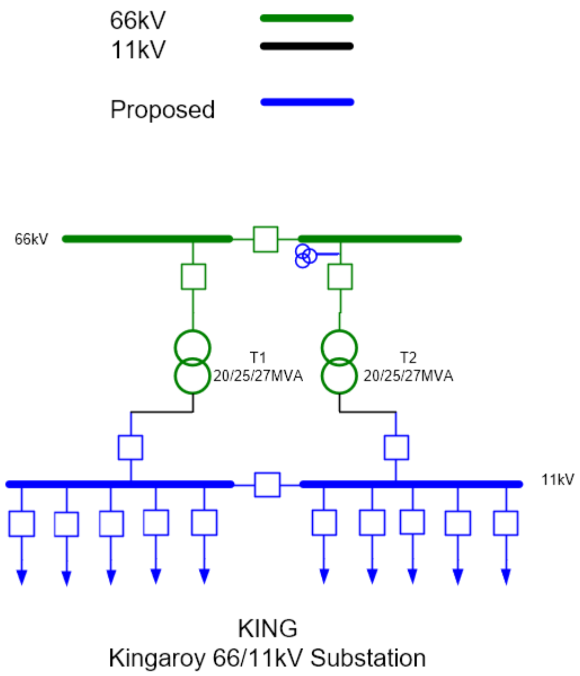

Figure 11: Option A proposed network arrangement (schematic view)

The estimated capital cost of this option inclusive of interest, and overheads is $5.86 million. Annual operating and maintenance costs are anticipated to be 0.5% of the capital cost.

4.2. Assessment of Non-Network Solutions

Ergon Energy's Demand & Energy Management (DEM) team has assessed the potential non-network alternative options required to defer the network option and determine if there is a viable demand management (DM) option to replace or reduce the need for the network options proposed.

Credible options must be technically and commercially viable and must be able to be implemented in sufficient time to satisfy the identified risk to the public and/or the network due to the identified constraints.

4.2.1. Demand Management (Demand Reduction)

The DEM team has completed a review of the Kingaroy customer base and considered a number of demand management technologies. Asset safety and performance risks are the key project drivers (i.e. the need) at Kingaroy. It has been determined that most DM options will not be viable propositions and have been explored in the following sections.

Network Load Control

The commercial, industrial, and residential customers appear to drive the daily peak demand which generally occurs between 4:00pm and 6:00pm.

There are 4922 customers on tariff T31 and T33 hot water load control (LC). An estimated demand reduction value of 2953kVA[1] is available.

KING LC signals are controlled from the AFLC installed on the 66kV bus. The T33 and T31 hot water LC channels are dynamic (that is, it responds to exceedance settings not on a timetable) and the current control strategy only calls LC when the load at KING exceeds 36MW. This strategy does not directly address demand peaks experienced on the individual feeders at Kingaroy. Therefore, network load control would not sufficiently address the identified need.

[1] Hot water diversified demand saving estimated at 0.6kVA per system

4.2.2. Demand Response

Four methods utilising demand response technology for deferring network investment are: Call Off Load (COL), Customer Embedded Generation (CEG), Large Scale Customer Generation (LSG) and customer solar power systems.

Customer Call Off Load (COL)

COL is an effective technique for deferring network investment where the need is for a short time period. However, in this instance, the need is required on a long-term permanent basis. There are a small number of large customers in the catchment area but the $/kVA funding available for demand reduction is low therefore customer call off load has been assessed as not a viable proposition as it will not address the identified need, nor benefit the community.

Customer Embedded Generation (CEG)

CEG is an effective technique for deferring network investment where the need is for a short time period. The primary driver for investment in this instance is asset safety and performance. A short-term deferral of network investment by using CEG is not a technically or financially feasible option (due to the number of contracts required to be negotiated and managed).

This option has been assessed as technically not viable as it would not address the identified network requirement to provide a continual reliable supply to this part of the network on an ongoing basis.

Large-Scale Customer Generation (LSG)

LSG sites such as renewable energy generation, solar or wind farms of multiple MW's capacity constitute an opportunity to support substation investment by reducing demand on, and potentially providing reactive power support for substation assets.

This option has been assessed as technically not viable as it will not address the identified network requirement.

Customer Solar Power Systems

A total of 1917 customers have solar photo voltaic (PV) systems for a connected inverter capacity of 8615kVA.

The daily peak demand is driven by a combination of commercial, industrial, and residential customer demand and the peak generally occurs between 4:00pm and 6:00pm. As such customer solar generation has minimal coincidence with the peak load period.

Business customers with large solar arrays are deemed to present a significant opportunity for targeted load control or load curtailment if coupled with a Battery Energy Storage System (BESS). Contracting such customers is attractive as they represent a larger load across fewer customers and therefore are cheaper and easier to engage and contract.

However, only a small percentage of customers in this supply area have solar PV systems and possibly none have a BESS. PV systems with BESS present a future portfolio opportunity for potential demand response but currently this supply area has a very limited solar/BESS. Solar customers without a BESS will not meet the technical needs of the demand reduction as their solar contribution may not be available when the network un-met need is required.

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4.2.3. Non-Network Solution Summary

Ergon Energy has not identified any viable non-network solutions internally that will provide a complete or a hybrid (combined network and non-network) solution to provide the magnitude of network support required in the Kingaroy area to address the identified need.

4.3. Preferred Network Option

Ergon Energy's preferred internal network option is Option A, to replace the 11kV switchboard and 11kV protection relays in a new control building. The 66kV VT A1197 is to be replaced in-situ.

Upon completion of these works, the asset safety and reliability risks at KING will be addressed. The preferred option will provide the greatest reliability benefit for customers, whilst also reducing expenditure on obsolete and non-compliant assets while ensuring more efficient use of design and construction resources.

The estimated capital cost of this option inclusive of interest, and overheads is $5.86 million. Annual operating and maintenance costs are anticipated to be 0.5% of the capital cost. The estimated project delivery timeframe has design commencing in early 2022 and construction completed by mid-2024.

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5. MARKET BENEFIT ASSESSMENT

The identified need is to reduce the safety and environmental risks associated with the condition of the identified primary and secondary system assets at KING to SFAIRP. As such, the assessment methodology is a lowest cost process among the credible options that have been assessed to address the identified need, rather than a cost/benefit analysis based on market benefits.

6. DETAILED ECONOMIC ASSESSMENT

Since there were no other technically feasible options established to address the identified need, a Net Present Value (NPV) assessment was not conducted.

7. CONCLUSION

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 take steps to progress the proposed preferred option to ensure any statutory non-compliance is addressed and undertake appropriately justified network reliability improvements, as necessary.

7.1. Preferred Option

Ergon Energy's preferred option is Option A, to replace the 11kV switchboard and 11kV protection relays in a new control building. The 66kV VT A1197 is to be replaced in-situ.

Upon completion of these works, the asset safety and reliability risks at KING will have been addressed. The preferred option will provide a reliability benefit for customers, whilst also reducing expenditure on obsolete and non-compliant assets while ensuring more efficient use of design and construction resources.

The estimated capital cost of this option inclusive of interest, and overheads is $5.86 million. Annual operating and maintenance costs are anticipated to be 0.5% of the capital cost. The estimated project delivery timeframe has design commencing in early 2022 and construction completed by mid-2024.

7.2. Satisfaction of RIT-D

The proposed preferred option satisfies the RIT-D.

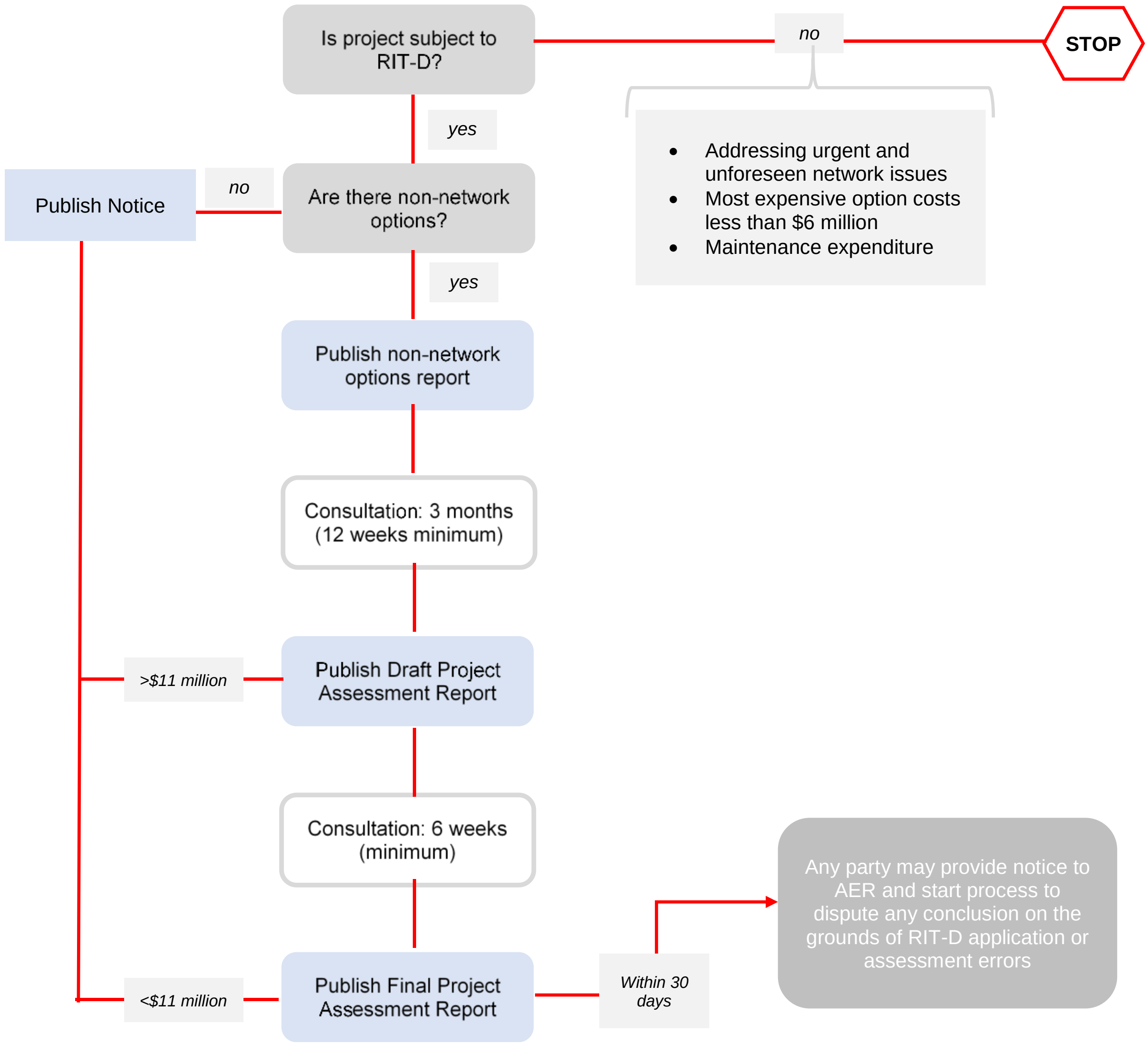
This statement is made on the basis of the detailed analysis set out in this report. The proposed preferred option is the only credible option that has been identified.

8. COMPLIANCE STATEMENT

This Final Project Assessment Report complies with the requirements of NER section 5.17.4(j) as demonstrated below:

Requirement	Report Section
(1) a description of the identified need for investment;	3
(2) the assumptions used in identifying the identified need (including, in the case of proposed reliability corrective action, why the RIT-D proponent considers reliability corrective action is necessary;	0
(3) if applicable, a summary of, and commentary on, the submissions received on the DPAR;	N/A
(4) a description of each credible option assessed	0
(5) where a *Distribution Network Service Provider* has quantified market benefits in accordance with clause 5.17.1(d), a quantification of each applicable market benefit of each credible option	5
(6) a quantification of each applicable cost for each credible option, including a breakdown of operating and capital expenditure	4.1, 4.3 & 7.1
(7) a detailed description of the methodologies used in quantifying each class of costs or market benefit	N/A
(8) where relevant, the reasons why the RIT-D proponent has determined that a class or classes of market benefits or costs do not apply to a credible option	N/A
(9) the results of a NPV analysis of each credible option and accompanying explanatory statements regarding the results	6
(10) the identification of the proposed preferred option	7.1
(11) for the proposed preferred option, the RIT-D proponent must provide: (i) details of the technical characteristics; (ii) the estimated construction timetable and commissioning date (where relevant); (ii) the indicative capital and operating costs (where relevant); (iv) a statement and accompanying analysis that the proposed preferred option satisfied the RIT-D; and (v) if the proposed preferred option is for reliability corrective action and that option has a proponent, the name of the proponent	4.1.1, 7.1 & 0
(12) contact details for a suitably qualified staff member of the RIT-D proponent to whom queries on the final report may be directed.	0

APPENDIX A – THE RIT-D PROCESS



Source: AEMC, *Rule determination: National Electricity Amendment (Replacement expenditure planning arrangements) Rule 2017*, July 2017, p. 64.