Circuit Breakers and Recloser Replacements

Business Case

19 January 2024

Part of Energy Queensland

CONTENTS

List of Tables

List of Figures

DOCUMENT VERSION

Version Number	Change Detail	Date	Updated by
Draft v0.1	Draft	27/09/2023	Manager Switching Plants
Draft v0.2	Initial Release	15/11/2023	Snr Engineer Asset Strategy
V1.0	Approved	25/11/2023	Manager Asset Strategy

RELATED DOCUMENTS

Document Date	Document Name	Document Type
JAN 2024	Asset Management Plan – Circuit Breakers and Reclosers	PDF
NOV 2023	Circuit Breakers and Reclosers CBRM/CNAIM Model	Excel
JUN 2023	RIN 2.2 Compare 2021-22 (Rosetta)	Excel
NOV 2023	Ergon 2022-23 - Category Analysis - RIN Response - Consolidated - 23 November 2023 – PUBLIC (16058117.2)	Excel
JULY 2023	Substation Defect Classification Manual	PDF

1 SUMMARY

Title	ERG Circuit Breaker & Recloser Business Case AER 2025-30
DNSP	Energy Queensland (EQL) - Ergon Energy
Expenditure category	☒ Replacement ☐ Augmentation ☐ Connections ☐ Tools and Equipment ☐ ICT ☐ Property ☐ Fleet
Identified need	☒ Legislation ☒ Regulatory compliance ☒ Reliability ☐ CECV ☒ Safety ☒ Environment ☒ Financial ☐ Other The objective of this Business Case report is to outline the projected limitations pertaining to Circuit Breaker (CB) and Recloser (RE) assets in alignment with the lifecycle management approaches specified in the Asset Management Plan. Additionally, this Business Case provides the necessity for interventions, both in terms of volume and financial allocations during the regulatory period 2025-30, as informed by the results of CNAIM/CBRM modelling. Ergon Energy has the obligation as a Distribution Network Service Provider to ensure safe and reliable Network around its Assets, Ergon Energy employs all reasonable measures to ensure it does not exceed minimum reliability service standards, assessed as: • System Average Interruption Duration Index (SAIDI) • System Average Interruption Frequency Index (SAIFI).
Expenditure & Volume	(see table below)
Optimal Timing and NPV analysis	Within the framework of the Network Planning Process, an assessment is conducted for the limitations associated with each Circuit Breaker and Recloser. Subsequently, individual projects are initiated and an assessment undertaken to determine the optimal timing for their replacement. This procedure involves performing Net Present Value (NPV) analysis, risk assessment, and consolidating activities with other network assets in suboptimal condition at a designated timing. Energex ensures prudency and efficiency, ultimately curbing the financial impact on our customers and the broader community. Attachment 5.2.01 SCS Capex model – January 2024 outlines our overall investments for the 2025-2030 period, which will include circuit breakers and reclosers. Business cases for those investments are available on request.

Expenditure & Volume:

Year	2025-26	2026-27	2027-28	2028-29	2029-30	2025-30
$m, direct 2022-23	8.9	8.4	9.5	9.2	12.3	**48.3**
Volume	12	80	59	45	67	**263**

2 PURPOSE AND SCOPE

The objective of this business case document is to define the projected limitations related to Circuit Breakers and Reclosers for the regulatory period 2025-30, as informed by the results of CNAIM/CBRM modelling. It is essential to read this document in conjunction with the Circuit Breaker and Recloser Asset Management Plan.

3 BACKGROUND

Circuit Breakers and Reclosers play a critical role in ensuring the safe operational control of Ergon Energy's network. They are instrumental in preventing or minimizing asset damage and reducing the likelihood of public safety issues to the extent reasonably practicable (SFAIRP).

Ergon Energy employs a regimen of periodic inspections and intrusive maintenance practices in alignment with the Maintenance Strategy to efficiently uphold the Circuit Breaker and Recloser assets. The CBRM/CNAIM model used by Ergon Energy leverages these observed and measured conditions from maintenance and inspection to predict the assets end-of-life scenarios.

3.1 Asset Population

Ergon Energy manages over 5,870 Circuit Breakers and Reclosers in the Ergon Energy Network for both indoor and outdoor applications.

Ergon Energy's Circuit Breaker and Recloser asset class quantities are detailed in Figure 1. The age profile shows that 400 Circuit Breakers and Reclosers will be over 50 years old by 2030, and 200 Circuit Breakers and Reclosers will be 60 years or older.

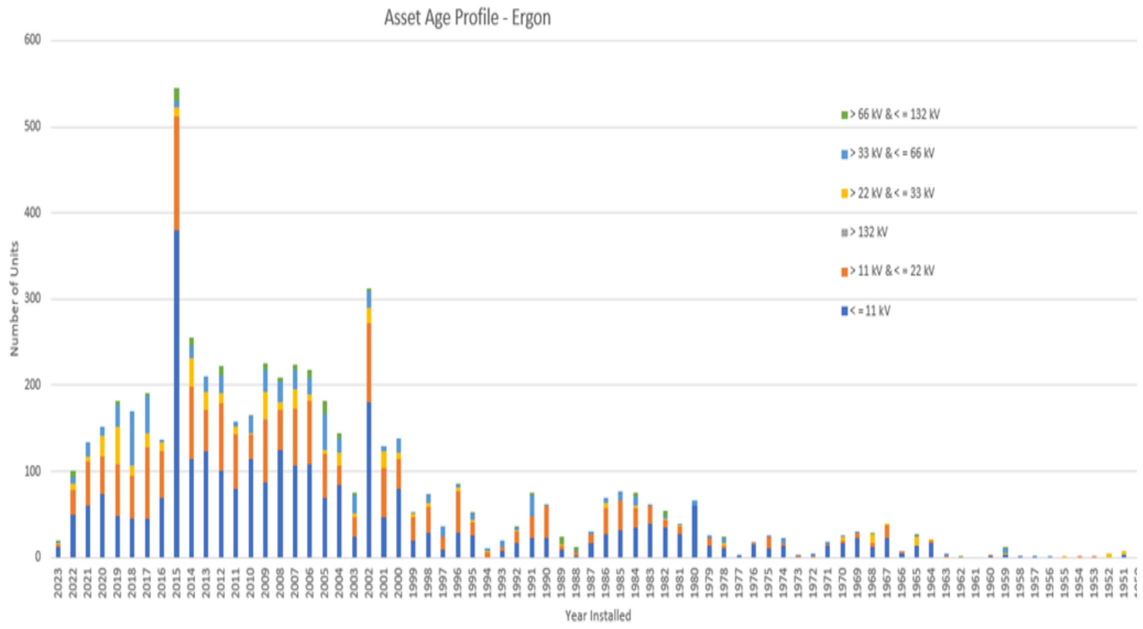

Figure 1: Asset Age Profile

3.2 Asset Management Overview

Ergon Energy adopts a number of strategies in managing the asset. These include:

- **Preventative maintenance:** which is performed in accordance with the inspection and intrusive Maintenance Standard Tasks with maintenance intervals outlined in the Maintenance Activity Frequency.
- **Corrective Maintenance:** undertaken when inspection and condition monitoring classify defects as outlined in the Lines and Substation Defect Classification Manuals.
- **Proactive Replacement:** is the management strategy used in conjunction with Condition Based Risk Management (CBRM/CNAIM) model to replace assets.
- **Reactive Replacement:** occurs when the asset has failed, and this is to be avoided as it has negative safety, reliability and reputational impact.

3.3 Asset Performance

Two main failure modes have been considered in this business case as per the following descriptions:

- **Unassisted Failures:** Functional failure of a Circuit Breaker and Recloser asset or component under normal operating circumstances and not caused by any external intervention such as abnormal weather or human.
- **Defects:** Circuit Breaker or Recloser asset or component deemed defective based on prescribed classifications and if not rectified in a prescribed time scale (P0/P1/P2) could result in an unassisted failure.

Identified defects are scheduled for repair according to a risk-based priority scheme (P0/P1/P2). The P0, P1 and P2 defect categories relate to priority of repair, which effectively dictates whether normal planning processes are employed (P2), or more urgent repair works are initiated (P1 and P0).

Historical failure and defect data has been provided in Figure 2 and Figure 3. The failure and defect data indicates an increasing trend between the period 2018-19 and 2021-22 caused by a reduction in proactive replacement as other work was prioritised in this period. Increasing in-service failures raise the potential of a safety incident or more network-wide reliability issues.

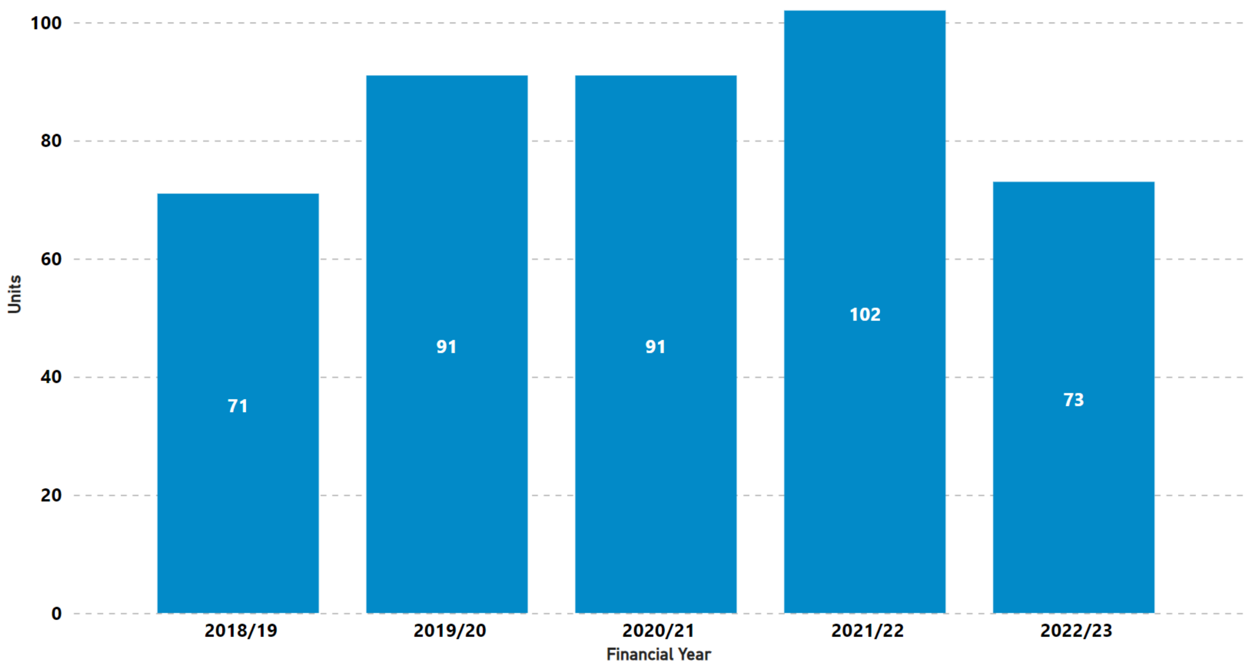

Figure 2: Unassisted CB & RE Failures

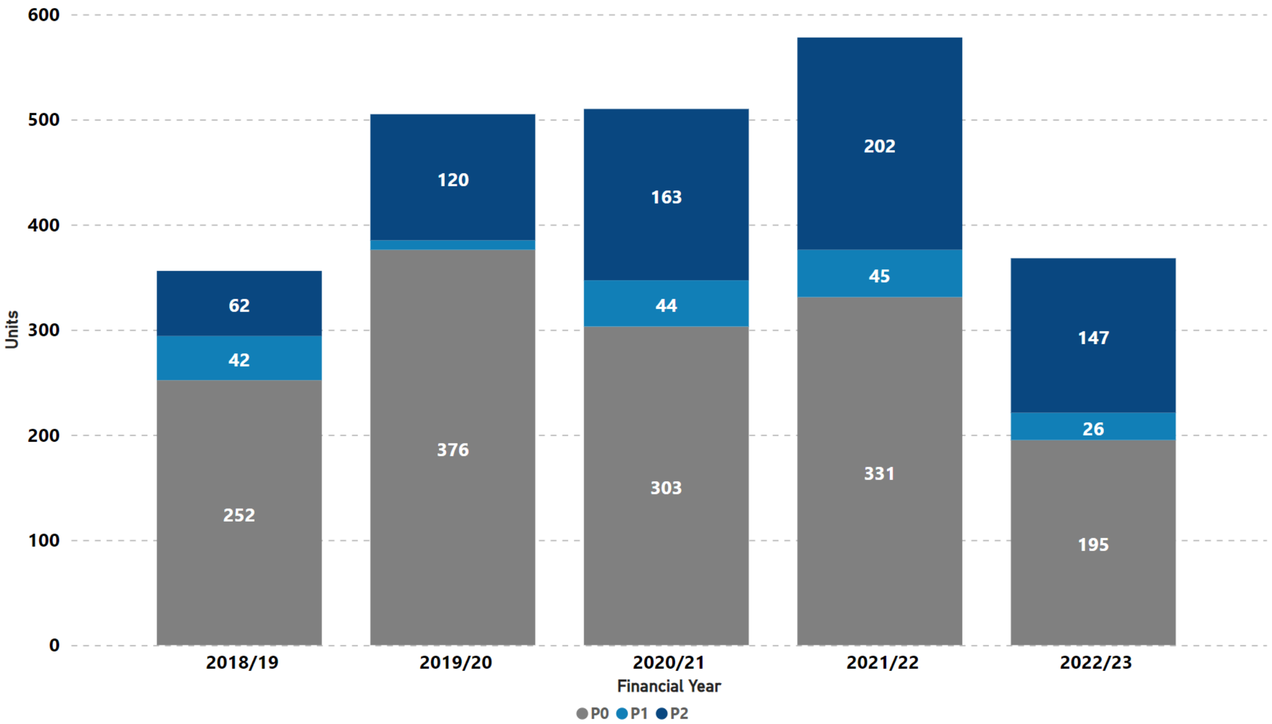

Figure 3: CB/RE Defects

3.4 Risk Evaluation

The risk is calculated as per equation in Figure 4.

Figure 4: Monetised Risk Calculations

Each consequence category follows the same calculations in Figure 4 to obtain the total monetised risk as in Figure 5. Ergon Energy broadly considers five value streams for investment justifications regarding replacement of widespread assets. In Figure 5, only four of the value streams are considered; the ‘Export’ is not material to CB/RE.

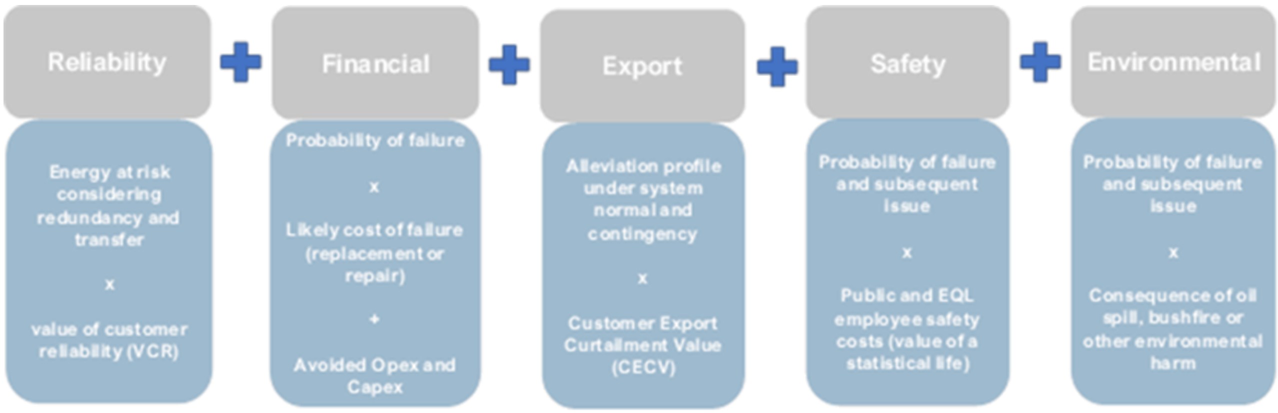

Figure 5: Total Risk Cost Calculations

3.4.1 Probability of Failure (PoF)

To determine the assets condition realistically several contributing factors have been considered including appropriate probabilistic impact scales in line with Condition Based Risk Management (CBRM) and Common Network Asset Indices Methodology (CNAIM) principles. Both observed external deterioration (oil/gas leaks, rust, corrosion etc) and measured condition data from oil samples, mechanism condition and bushings condition assessment. Also, electrical testing and operation times (closing and opening) are measured and recorded to monitor the conditions and Health Index (HI) for all CBs/REs to calculate the future probability of failure.

The PoF is calculated based on a well-established equation set out in CBRM/CNAIM modelling after analysing worldwide data about the relationship between health index and PoF for different assets.

3.4.2 Consequence of Failure (CoF)

Consequences of an in-service failure have been assessed across four value streams and are relevant to this business case:

- **Reliability:** There will be unserved energy following the in-service failure of a CB/RE. The network performance is also monitored through SAIDI and SAIFI performance of the distribution network – a key performance indicator for the business and community.
- **Financial:** There will be a financial cost associated with responding to a failed CB/RE as well as replacing the CB/RE under emergency. The unplanned cost could vary significantly from a couple of thousands to hundreds of thousands depending on scale of failure and damage.
- **Safety:** There is a risk of multiple serious injuries or fatality following a failure of a CB/RE, specifically asset with porcelain housing/bushings, dependent on the failure mode and proximity of the employee/contractor during the event. Considering that these CBs are installed within security fences public injuries are very rare and therefore has not been considered in risk assessment.
- **Environmental:** There is a risk of environmental impact/contamination under right conditions in case of failure of a CB/RE.

3.4.3 Likelihood of Consequence (LoC)

Likelihood of consequence refers to the probability of a particular outcome or result occurring because of a given event or action. To estimate the likelihood of consequence, Ergon Energy has utilised a combination of historical performances and researched results. Ergon Energy has analysed past events, incidents, and data to identify patterns and trends that can provide insights into the likelihood of similar outcomes occurring in the future. Additionally, Ergon Energy also has conducted extensive research to gather relevant information and data related to the respective risk criteria.

4 IDENTIFIED NEED

4.1 Problem Statement

The impact of a Circuit Breaker or Recloser failure or maloperation has the potential of causing significant safety risk and unnecessary prolong electricity outages causing inconvenience, loss of financial income and at worst, the loss of life.

To avoid this, it is incumbent on Ergon Energy to ensure the safe and reliable operation of the Circuit Breaker and Recloser assets by prudently investing in the maintenance of these assets and to replace these assets at the end of life before a catastrophic failure incident occurs.

Key challenges for the management of the circuit breaker and reclose asset class include:

- Ensuring continuous improvement in asset data quality, recording of accurate failure information, condition assessments, and commissioning/decommissioning data to support asset management objectives.
- Improving maintenance practices to avoid recurring incidents and to achieve optimum asset life.

- Managing the reduced asset design life of modern circuit breakers and reclosers compared to their older and more conventionally designed models, to ensure minimal impact on the economic viability of future investment of capital and operating expenditure.

4.2 Compliance

The assets described in this AMP are not specifically referenced in legislation, and therefore are expected to achieve general obligations surrounding asset safety and performance and service delivery. These obligations include compliance with all legislative and regulatory standards, including the Queensland Electrical Safety Act 2002 and the Queensland Electrical Safety Regulation 2013 (ESR).

The Queensland Electrical Safety Act 2002 s29 imposes a specific Duty of Care for EQL, which is a prescribed Electrical Entity under that Act:

1. An electricity entity has a duty to ensure that its works:
   a. are electrically safe
   b. are operated in a way that is electrically safe.
2. Without limiting subsection (1), the duty includes the requirement that the electricity entity inspects, test and maintain the works.

Under its distribution licences, EQL is expected to operate with an 'economic' customer value-based approach to reliability, with "Safety Net measures" aimed at managing low probability high consequence outage risks. EQL is expected to employ all reasonable measures to ensure it does not exceed minimum service standards (MSS), assessed by feeder type, as:

- System Average Interruption Duration Index (SAIDI)
- System Average Interruption Frequency Index (SAIFI).

Safety Net targets are described in terms of the number of times a benchmark volume of energy is undelivered for more than a specific time period.

Loss of substation circuit breakers or reclosers is usually a significant event and may require Safety Net contingency plans to be exercised.

Loss of a distribution recloser will typically only impact the downstream customers on that feeder having a reduced reliability impact. Both Safety Net and MSS performance information is publicly reported annually in the Distribution Annual Planning Reports (DAPR).

5 ASSET LIMITATION FORECAST SUMMARY

5.1 Asset Condition Limitations – HI Summary

Ergon Energy uses condition-based risk management (CBRM) to predict the end of life of CBs/REs. CBRM uses age, location, duty, and condition to predict the health of the asset as an index (Health Index – HI) that has a range of 0 – 10. A higher HI value represents a more degraded asset as illustrated in Figure 6.

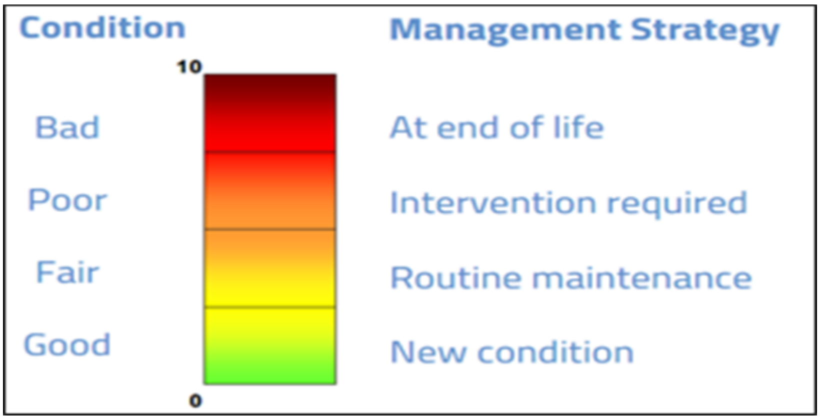

Figure 6: Health Index and Condition Summary

Ergon Energy employs a structured approach to asset replacement, utilising a Health Index (HI) threshold of 7.5 as the trigger point for consideration. The CBRM documentation details the methodology for assessing asset condition and determining the HI. After the derivation of asset limitation from CBRM, we utilise the Ergon Energy Risk Framework to prioritise asset replacement, accounting for financial and resource constraints.

To identify assets in the poorest condition, Ergon Energy utilises CBRM modelling. Additionally, older Circuit Breakers and Reclosers (CBs/REs) that have surpassed their technical life are earmarked for potential replacement to prevent the accumulation of aging assets. Replacement decisions for these candidate assets are made in conjunction with network requirements and other factors, such as augmentation and customer-requested projects, ensuring the most cost-effective solution from a holistic network perspective. The Ergon Energy Risk Framework is applied at the individual project level to further guide replacement decisions within the defined constraints.

Figure 7 presents the latest HI data for CBs/REs, with an HI of 7.5 signifying poor asset condition requiring intervention within a specified timeframe. Notably, this figure indicates that approximately 68 assets currently have an HI exceeding 7.5, necessitating intervention in the next few years.

Furthermore, Figure 8 provides an estimated forecast of the HI summary for CBs/REs at the end of the modelling period (year 2030), as determined by CBRM. It highlights that 235 assets are projected to exceed the HI threshold of 7.5, underscoring the need for a proactive replacement program over the next few years, including within the current regulatory period, to effectively manage this risk.

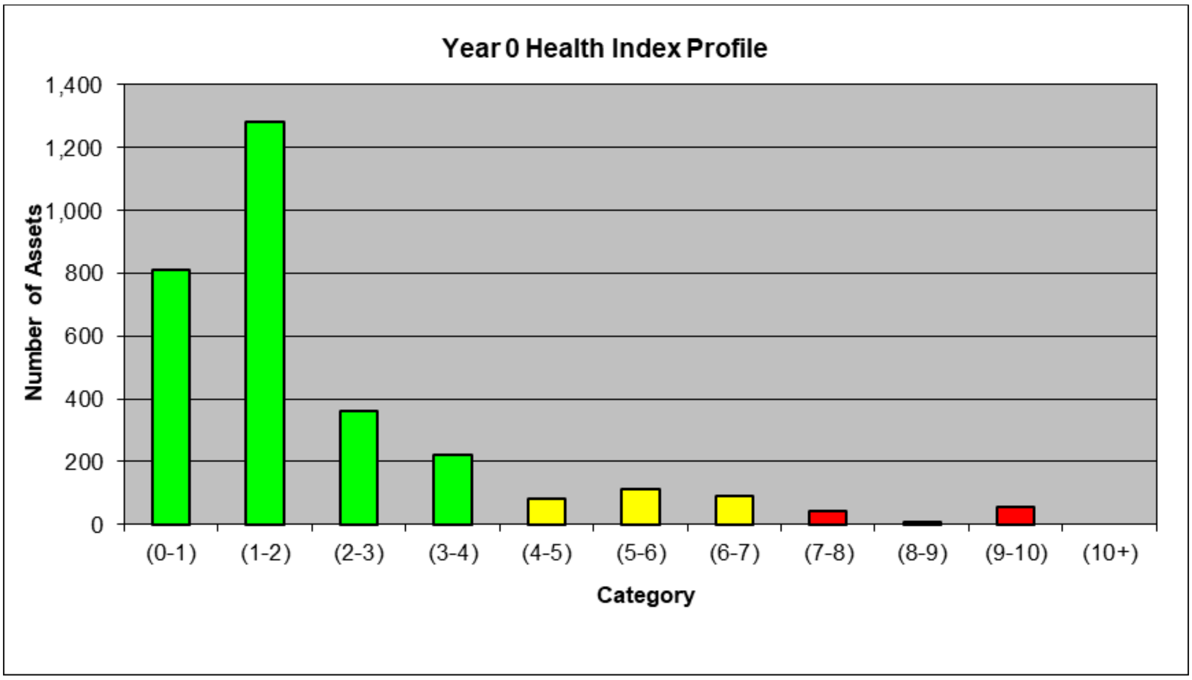

Figure 7: Current Health Index Summary – CB and RE

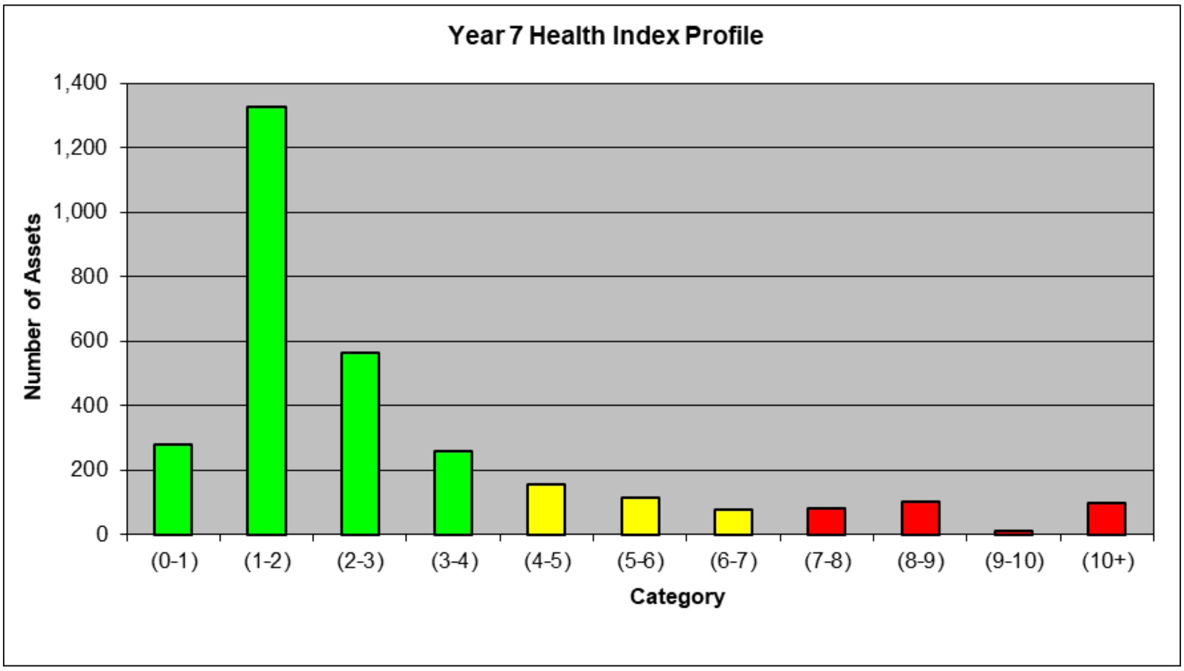

Figure 8: Future Year 7 Health Index Summary – CB and RE

5.2 Optimal Timing and NPV Analysis

This Business Case presents asset limitations in terms of CBRM modelling outcomes. However, the optimal timing of replacement of an asset, NPV analysis, risk evaluation and bundling of works with other poor condition network assets at a specific time shall be carried out in case-by-case basis under each individual projects based on overall prudency and efficiency to minimise the cost impact on customers/community. Individual projects are then created based on site-specific.

Individual project business cases are then created to evaluate project timing, risk evaluation and cost benefit outcomes.

5.3 Asset Replacement Limitation Forecast

Based on CBRM modelling and HI calculations a total of 47 CB/RE per annum are forecast to be replaced during the period 2025-30 as per Table 1.

Year	2025/26	2026/27	2027/28	2028/29	2029/30	Total
Quantity	47	47	47	47	47	**235**

Table 1: CB/RE Replacement Volume Summary – AER 2025-30 – CBRM Modelling

Furthermore, after conducting the risk evaluation, optimal timing and NPV analysis for individual project to optimise the cost/benefits for the community the proposed Replacement Program (volume and expenditures) has been provided in Table 2.

Year	2025/26	2026/27	2027/28	2028/29	2029/30	Total
$m, direct 2022-23	8.9	8.4	9.5	9.2	12.3	**48.3**
Quantity	12	80	59	45	67	**263**

Table 2: CB/RE Proposed Replacement Program – RIN Forecast

Of the 260 circuit breaker replacements, half are made up of 10 individual projects. 7 of the projects are to be largely delivered in the 2025-2030 period:

- Stuart Zone Substation Circuit Breaker Replacement
- Neil Smith Zone Substation Transformer and Circuit Breaker Replacement
- Cranbrook Zone Substation Circuit Breaker Replacement
- Sarina Zone Substation Switchgear Replacement
- East Toowoomba Switchgear Replacement
- West Mackay Switchgear Replacement
- North Toowoomba Switchgear Replacement

The below 3 projects have expenditure in the 2025-2030 period, however most of the expenditure will be in the 2020-2025 period:

- Rockhampton South Zone Substation Asset Replacement (started in this regulatory period, to be finalised in early 2026)
- West Toowoomba Switchgear Replacement (started in this regulatory period, to be finalised in 2026)
- Pialba Zone Substation Transformer and Switchgear Replacement (started in this regulatory period, to be finalised in early 2026)

6 RECOMMENDATION

The proposed volume provides the best balance of benefits and risks for the organisation. As such, the decision has been made to step change in proactive replacement volume, with a focus on optimising existing processes such as bundling substation assets wherever necessary to deliver cost effective solution and benefit to the community.

7 APPENDIX A –– RESET RIN RECONCILIATION

	2025/26	2026/27	2027/28	2028/29	2029/30	Total
	Expenditure	Expenditure	Expenditure	Expenditure	Expenditure	Expenditure
$, direct 2022-23	8.9	8.4	9.5	9.2	12.3	**48.30**
$, direct 2024-25	10.1	9.6	10.9	10.6	14.3	**55.49**

Table 3: RESET RIN Reconciliation Table