Distribution switchgear

Regulatory Business Case (RBC) 2024-29

Contents

1. Summary

This business case has been prepared to support the 2024-29 Regulatory Proposal. The business case demonstrates that Power and Water has undertaken appropriate analysis of the need for the expenditure and identified credible options that will resolve the need and ensure that Power and Water continues to meet the National Electricity Objectives and maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

The proposed investment identified in this business case will undergo further assessment and scrutiny through Power and Water's normal governance processes prior to implementation and delivery.

This business case addresses the high safety risk of the Hazemeyer MD4 type distribution switchgear.

1.1 Business need

Distribution switchgear is a critical asset for distribution of energy to our valued customers in urban residential areas or with large demand requirements. These assets are located in close vicinity to pedestrians and the general public, therefore it is very important to ensure the network is safe and reliable both during normal and abnormal operating conditions.

The current fleet of 'Hazemeyer MD4' type (Magnefix) switchgear has been found to present an elevated safety risk in the event of a failure. In addition, a proportion of the population is already being operated in areas of the network where the equipment fault ratings have been exceeded. The equipment fault rating is also well below that accepted in the Network Technical Code.

Prior to the implementation of a planned replacement program in the current regulatory period, the failure rate associated with Magnefix switchgear had been increasing. The consequences of these failures, while not yet resulting in injury, have raised concerns in relation to the portfolio's condition and changes to maintenance practices for units approaching end-of-life. The main failure modes observed are deterioration of the switchgear insulation due to harsh service conditions, and termination failures which can lead to explosive failures. Many of these installations are in public areas and presents an elevated safety risk to members of the public.

Magnefix switchgear is considered to have very poor operator safety across the industry, and many DNSPs have instigated planned replacement programs for this equipment. There are no barriers present between the operator and the switchgear in the event of a switchgear failure or incorrect operation. All operations can only be performed manually with the operator standing directly in front of the switchgear.

Our analysis of the asset fleet has quantified the risk and defined the set of distribution switchgear that needs to be addressed to ensure ongoing safety and reliability of the network. The identified assets include a total of 20 switchgear units that require replacement. Of these over a third are located in areas of the network where the fault current exceeds the equipment fault current rating of 14.4 kA. In all areas the fault current rating of the equipment is less than the requirements of the Network Technical Code of 20kA.

This business case is focused on the treatment of the elevated safety risk presented by the potential for failure of the Magnefix distribution switchgear units. Replacement of assets following a fault or failure, are covered separately by the Volumetric Replacement Program (NMFCR).

1.2 Options analysis

The options considered to resolve this need are shown in Table 1**.**

Table 1 Summary of credible options

Option No.	Option Name	Description	Recommended Option
1	Replace on failure	Replace on failure (Counter factual). This option will involve reactive replacement of switchgear upon failure.	No
2	Proactive replacement program	Implement a program to replace 20 switchgears during the next regulatory period.	Yes
3	Operational reconfiguration	Manage network configuration (switching) to reduce fault levels	No

As part of a holistic assessment, we considered non-network solutions, capex/opex trade-offs and retirement or derating, but found that none of these options addressed the underlying network issues.

A cost benefit analysis was completed for each of the options where the risk reduction, compared to Option 1, was used as the benefit achieved by the option.

1.3 Recommendation

This business case recommends Option 2 - Proactive replacement and repair at an estimated cost of $4.5 million (real 2021/22) to be most prudent and cost effective to meet the identified needs. This option mitigates risk to an appropriate level over an acceptable timeframe. The recommended option:

- is aligned to our strategy and asset objectives,
- continues the existing replacement program (NMP7) and at a volume of replacements is similar to those undertaken during the current regulatory period and therefore represents a deliverable approach,
- had the highest NPV of the options assessed, and
- is aligned to customer expectations for maintaining the reliability and safety of the network.

The scope of this option is expected to involve the replacement of 20 Hazemeyer switchgear units across the 2024-29 regulatory period. The order of replacement has been prioritised based on the safety risk taking account of the current fault rating of the equipment, proximity of the location to the public and asset condition.

The identified priority may change during implementation due to other factors such as changes to fault currents, faults experienced, or other related works being undertaken on or around the asset that could result in efficiency savings.

Each asset will require replacement of the switchgear unit, replacing any civil works required and re-termination of the cables. Recent replacements undertaken by the existing project has found the unit cost to complete all these works is $225k (real FY22) on average. We plan to undertake four replacements per year.

Table 2 shows a summary of the expenditure requirements for Regulatory Period 2024-29.

Table 2 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	900	900	900	900	900	4,500
Opex						
Total	900	900	900	900	900	4,500

2. Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks to Power and Water and its customers, describes the current mitigation program and its delivery status, highlights the consequence of asset failure, and provides a risk assessment of the inherent risk if no investment is undertaken.

This business case is focused on a specific type issue affecting distribution switchgear. Distribution switchgear assets that are at end of life or require remedial action following a fault are covered by the Volumetric Replacement Program (NMFCR). The Hazemeyer switchgear discussed in this business case has been excluded from the modelling undertaken for the NMFCR program.

2.1 Asset profile

Power and Water owns and operates a fleet of over 4,000 distribution substations and associated switchgear across the four regions of Alice Springs, Darwin, Katherine and Tennant Creek. The switchgear currently in use includes 824 Magnefix MD4 (also known as Holec/Hazemeyer MD4) switches, most of which are installed within 11kV distribution substation enclosures in Darwin and Alice Springs.

The Hazemeyer MD4 Switchgear is a compact fully epoxy resin insulated Ring Main Unit for operating voltage of 12-15 kV in distribution networks. It is equipped with load-break switches and fused load-break switches able to withstand short circuit fault level of up to 14.4 kA.

The switchgear population is summarised in the Table 3.

Table 3 Hazemeyer switchgear population

Region	Regulated network	Non-regulated network
Alice Springs	148	**37**
Darwin	635	**3**
Katherine	1	**0**
Tennent Creek	0	**0**
Total	**784**	**40**

2.2 Historical and current mitigation programs

Power and Water has identified an emerging risk with 'Hazemeyer MD4' type switchgear. Development of the network over time has resulted in an increase of system three phase fault levels above 14.4kA in some areas of the distribution network. As a consequence, Magnefix switchgear no longer meets the minimum system fault levels. The risk of catastrophic equipment failure and the potential injury to workers and the public are key drivers for investing in the upgrade of the Magnefix switchgear.

In 2017 a program was introduced to replace high risk 'Hazemeyer MD4' type switchgear. These assets are typically older, approaching or exceeding their fault levels and do not have safety features present in modern equivalents.

A summary of the volumes replaced, actual and forecast remaining expenditure for the current period is shown in Figure 1. We also show the estimated capex included in the capex allowance for this project for the 2019-24 regulatory period.

Overall, we are on track to deliver the program as planned with less than an 8% variation (underspend).

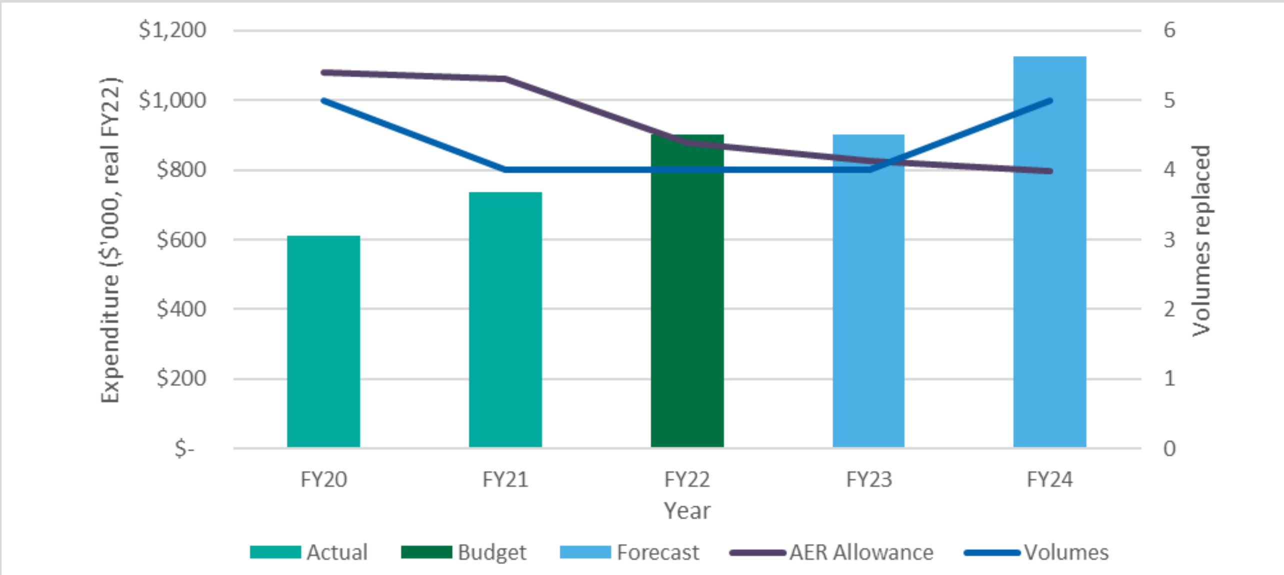

Figure 1 Summary of actual and forecast expenditure against the AER allowance

2.3 Asset condition issues and risks

2.3.1 Elevated safety risk to public and operators

Magnefix switchgear is considered to have very poor operator safety across the industry, and many DNSPs have instigated planned replacement programs for this equipment. There are no barriers present between the operator and the switchgear in the event of a switchgear failure or incorrect operation. All operations can only be performed manually with the operator standing directly in front of the switchgear.

The main failure modes observed are deterioration of the switchgear insulation due to harsh service conditions and termination failures, both of which can lead to explosive failures. Many of these installations are in public areas in and around the Darwin CBD and present an elevated safety risk to members of the public.

2.3.2 Recent network incidents

In January 2017, an explosive failure associated with Magnefix switchgear resulted in distribution substation doors being blown open and dislodged, exposing the nearby area to the fault energy. Fortunately, no injury was recorded as there were no people in proximity to the explosion at the time of the failure. A detailed investigation into the event has identified a variety of contributing factors including age, operating environment, historical construction and maintenance practices and inherent design limitations.

There were other similar incidents reported, in particular:

- A failure on Salonika Street, Stuart Park (DT-2510, identified in GRACE Incident 3811) that resulted in the doors being blown off. The investigation report noted anecdotal reports of other similar events occurring, prior to investigation processes being established for these types of asset failure events.
- Figure 2 shows DT-2850 following explosive failure. This failure resulted in a prolonged outage of 6 hours and 20 minutes that affected 96 customers.

This indicates a systemic issue with the insufficient fault rating of the switchgear type, and the resultant safety hazard.

Figure 2 Photo of switchgear enclosure following explosive failure (DT2850)

2.3.3 Insufficient fault level rating

Past equipment ratings have been based on the fault currents and system requirements at the time of installation. As a result, some of the older Hazemeyer switchgear have fault level ratings of 14.4kA. However, due to load growth and network expansion over time, there has been an increase of system three phase fault levels which have now exceeded 14.4kA in some areas of the distribution network.

Clause 15.4 of The Network Technical Code states that:

> *"For safety reasons, the fault rating of any equipment shall not be less than the fault level in that part of the network at any time and for any normal network configuration.*
>
> *As the system configuration is changed, fault levels may increase over time. New connections to the network shall therefore be designed with equipment fault level ratings reflecting modern standards that may exceed existing fault levels."*

Figure 17 of the Network Technical Code then specifies that all network equipment connected at 11kV shall have a fault level rating of 25kA in metropolitan areas and 20kA in rural areas. The current rating of 14.4kA for these substations does not comply with this requirement.

Review of the network has identified that there are currently 29 Hazemeyer MD4 switchgear installations where the system fault levels are approaching or have exceeded, the equipment rating. All of these switchgear assets do not comply with the intent and specific fault rating requirements of the Network Technical Code.

2.3.4 Poor asset condition

The assets that have been identified with insufficient fault level ratings have also been found to be in poor condition. Table 4 shows the number of major and minor defects that have been recorded against each switchgear (that are not planned for replacement during the current period) since 2014. As these are old assets, we expect continued deterioration which will continue to increase the risk that they pose to field crew and public safety and network reliability.

The deteriorated condition is likely to have contributed to the failures and failure mode of the two assets DT-2501 and DT-2850 identified in the network incidents above. Modelling of the fault level at these locations has shown that the fault level was well below their rating at 70% for DT-2850 and 30% for DT-2510, however both assets experienced explosive failures. We also note that the actual fault levels on the ground may be different to those that are modelled due to temporary network switching or changes to generation.

To account for the uncertainty in fault levels, we have identified the assets which are subject to fault levels greater than 85% of their rating under normal network conditions.

Table 4 Summary of defects and fault level for the identified 20 distribution switchgear

Distribution substation	Number of defect	Number of major defect	Fault level
DT-1197	3		85%
DT-1942	2	1	98%
DT-1952	3	1	107%
DT-1953	5	1	91%
DT-2039	2	1	91%
DT-2044			85%
DT-2075	2	2	106%
DT-2078	5	2	102%
DT-2103	3		88%
DT-2114	2	2	86%
DT-2269	4		88%
DT-2346	2		92%
DT-2423	5	2	107%
DT-2477	3	1	93%
DT-2584	3		105%

DT-2812	1	1	112%
DT-2822	2	2	104%
DT-2881	3		85%
DT-2933			875
DT-3229			88%

As stated in section 2.2, there is an existing program in place to address this issue. There are 9 planned replacements that will occur by the end of the current regulatory period (June 2024, not included in Table 4). This will leave 20 Hazemeyer switchgear units (shown in Table 4) that are considered high risk, based on the combination of poor condition and insufficient fault level rating, and are required to be replaced.

2.4 Consequence of failure

All the consequences related to switchgear failure under two categories that are aligned to Risk Quantification Procedure. These are:

2.4.1 Health and Safety

Fault current generate a significant amount of heat which can melt components and cause gases to expand. When assets are not rated to withstand the expected fault current through design of sufficiently sized conductors and enclosures rated for the pressures generated, the result can be an explosion.

Hazemeyer switchgear are contained in large metal enclosures that are not rated for the fault currents now being generated on the network. The enclosures are located in publicly accessible locations where there can be high levels of pedestrian or vehicle traffic which results in an elevated probability that the public could be in close proximity when a fault occurs, therefore elevating the risk.

Further, the design of the old Hazemeyer switchgear does not provide any physical barrier/screen separating the operator and switchgear. As a result, any failure or arc-flash during switching activity exposes the operator to the resultant arc by-products. There is no remote switching functionality available.

Therefore, these assets provide an elevate risk to health and safety of both field crew and the public. This analysis is supported by recent network events that are described below in section 2.3.2.

2.4.2 Reliability

Distribution switchgear will generally supply number of customers depending upon the feeder configuration. The failure of switchgear will therefore impact number of customer and effect reliability. Typically, in the circumstance of a failure caused by excessive fault current, the switchgear unit will need to be replaced. Some examples of the quantum of the impact on reliability are:

- A failure in January 2017 resulted in an outage of 5hrs 25 mins that affected 601 customers and had an economic cost of energy not supplied of $162k.
- A failure in December 2020 resulted in an outage of 6hrs 20 mins that affected 96 customers and had an economic cost of energy not supplied of $220k

As the fault levels increase as the network grows, the likelihood of failure will increase as will the economic impact of any failures.

2.5 Risk assessment

The risk posed by switchgear due to the identified issues has been quantified by applying Power and Waters Risk-Quantification Procedure[1]. This procedure has been developed based on good electricity industry practice and taking into account the recent guidelines and determinations made by the AER, the ISO 31000 Risk Management Standard, and other professional publications.

Since Power and Water recognises there is some uncertainty in the age profile, our analysis of network risk posed by the assets is based on the results of the inspection program and population statistics.

The assessment of the base case scenario shown in Figure 3 has been undertaken based on the business-as-usual case, that is, on the basis that Power and Water does not undertake any proactive mitigation measures to address the emerging risk. The modelling is based on the following key assumptions:

- There are 29 Hazemeyer switchgear units at the end of FY22 that are considered high risk, of which 9 are planned for replacement by the end of the current regulatory period.
- Based on the failure information available through ICAM reports and other incident reporting, we have assumed:
    - One failure every two years (supported by the information in section 2.3.2)
    - An outage has an economic impact of $190k (based on the average of the known incidents)
- Under the base case, as units fail, they are assumed to be replaced, so the remaining fleet decreases, resulting in the decreasing risk profile shown in Figure 3.

Our assumptions are conservative and based on the best information available. The risk is approximately 75% safety and 25% service delivery, which appears to be a reasonable outcome considering the failure modes and historical interruption data.

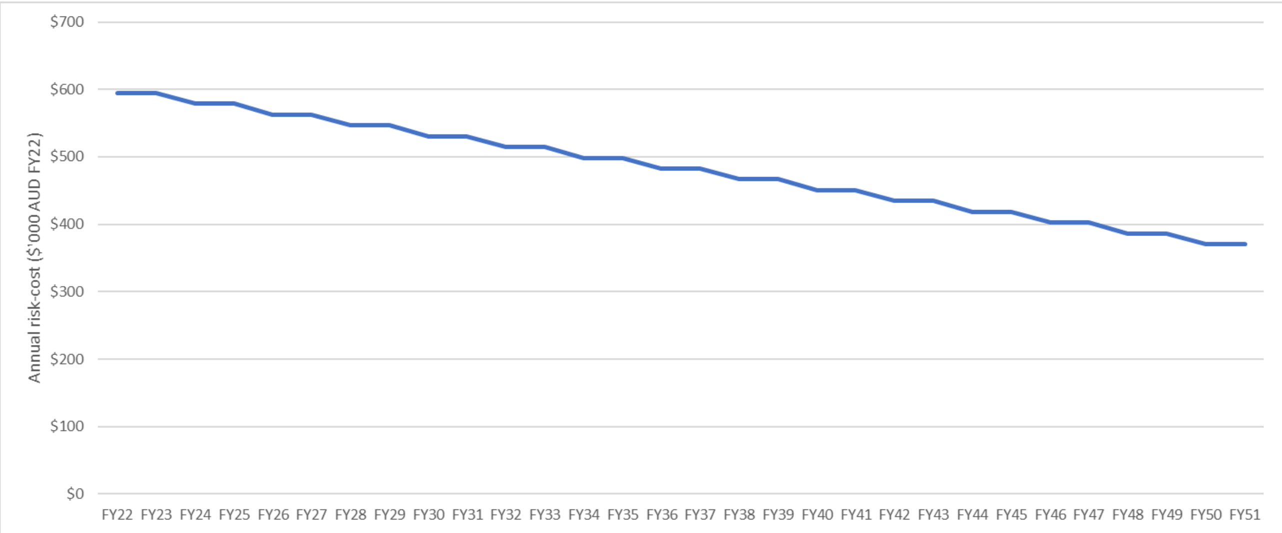

Figure 3 Current risk with base case scenario

[1] CONTROL0932, Risk Quantification Procedure for Investment Decision making

The dominant components of this level of risk are the economic impacts of outages which are calculated based on the Value of Customer Reliability (VCR). The consequence of health and safety impacts are significant, the probability of them materialising is high as the switchgear is located both in residential and industrial areas and there is a history of failures.

The risk assessment demonstrates that there is an unacceptable risk across this switchgear type in Power and Water's network. The reduction in risk that is achieved by different credible mitigation options, along with the cost of those options and any other direct financial cost savings, is used to identify the preferred option in Section 3.

2.6 Summary

Distribution switchgear are critical assets for distribution of energy to our valued customers in urban residential areas or with large demand loads requirements. These assets are located in close vicinity to pedestrian and general public therefore it is very important to ensure the network is safe and reliable both during normal and abnormal operating conditions. The current fleet of 'Hazemeyer MD4' type switchgear has been found to have a proportion of the asset fleet in poor condition, operating in the network at locations where the fault level approaches or exceeds the equipment rating and at a rating below the current standard set out in the Network Technical Code.

This presents a high and increasing safety risk. The safety hazard of these units is also increased due to the design of the switchgear unit which has been demonstrated by a number of failures which resulted in an explosion and the doors of the enclosure being blown off, without sufficient containment of the fault energy.

3. Options analysis

This section describes the various options that were analysed to address the increasing risk to identify the recommended option. The options are analysed based on ability to address the identified needs, prudency and efficiency, commercial and technical feasibility, deliverability, benefits and an optimal balance between long term asset risk and short-term asset performance.

3.1 Comparison of credible options

Credible options are identified as options that address the identified need, are technically feasible and can be implemented within the required timeframe. The following options have been identified:

- Option 1 – Replace on failure. This option would involve continuing to repair or replace distribution switchgear upon failure.
- Option 2 – Proactive replacement. This option proposes to continue the existing program (NMP7) to undertake a targeted replacement program of 20 high-risk Hazemeyer distribution switchgear units.
- Option 3 – Network reconfiguration to reduce fault levels. This option includes network reconfiguration to reduce fault levels.

A comparison of the three identified credible options and the issues they address in the identified need is depicted in the table below.

All credible options involve replacing the distribution switchgear with a modern equivalent asset. These options are described and assessed in detail in the sections below.

Table 5 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2	Option 3
NPV ($'000, real FY22)	$0	$6,338	N/A
BCR	0	2.06	N/A
Capex ($'000, real FY22)	$3,375	$4,500	N/A
Meets customer expectations	○	●	○
Aligns with Asset Objectives	○	●	○
Technical Viability	●	●	○
Deliverability	●	●	○
Preferred	✗	✓	✗

● Fully addressed the issue ◕ Adequately addressed the issue ◑ Partially addressed the issue ○ Did not address the issue

Notes:

- Option 1 is the base case that the other options are compared to, hence it has an NPV of zero. Reduction in risk and/or cost compared to Option 1 forms the benefit achieved (hence the positive NPV) of Option 2.
- The table above excludes the expenditure forecast for the remainder of the current period, but allows for the risk reduction achieved as it is a continuation of the existing program.
- The NPV and capex was calculated over a 30 year period.
- Option 3 was not assessed in the cost benefit model as it was discounted from a technical feasibility perspective.
- WACC of 2.75% (real, pre-tax)

3.1.1 Option 1 – Replace on failure (Base Case)

This option proposes to only replace switchgear with modern equivalent ones in a reactive manner post failure. This means incurring the cost of the outages and accepting the risk to public and worker safety. In addition, the cost per unit of emergency replacement or repair of switchgear post failure is higher than a planned outage and programmed replacement work.

The quantified risk-cost of this option has been assessed using the Risk Quantification Procedure, with the outcome shown in the Figure 4 below. This option was assessed to result in the highest residual risk of the three credible options, indicating the worst network performance and highest risk to health and safety.

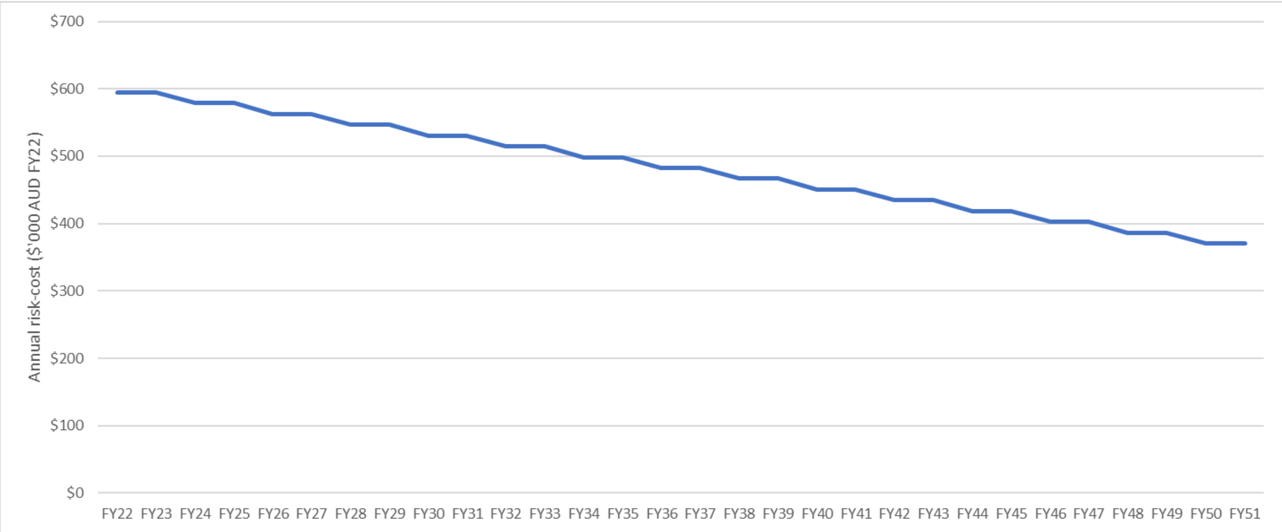

Figure 4 Risk profile achieved through Option 1

While this option is deliverable and technically feasible (it is a reactive activity), it results in deteriorating network performance and increasing safety risk to both the public and workers.

The residual risk of this option is the highest of all options considered as it does not directly address the underlying need for switchgear that is known to have insufficient fault current ratings and an explosive failure mode.

Therefore, this option is not recommended.

3.1.2 Option 2 – Proactive replacement

This option proposes to continue the existing program (NMP7) to undertake a targeted replacement program of 20 high risk Hazemeyer distribution switchgear units.

This option has the following benefits:

- It addresses the underlying issue of switchgear with inadequate ratings.
- Replaced distribution substations will be retained as spares for condition or failure based replacements in low fault current areas of the network.
- It will contribute towards achieving the Asset Objectives of maintaining reliability and safety of the network.
- The proposed volumes are at a similar level as the historical replacements, hence it is considered to be deliverable.
- The approach is consistent with the principles of As Low As Reasonably Practicable (ALARP) in reducing risk.

The resultant residual quantified risk-cost of this option is shown in the Figure 5 below. It demonstrates that the proactive targeting of these assets quickly removes a risk to the network. Further, the cost benefit analysis demonstrates that this option provides the highest benefits to customers.

The total capex for this option for the 2024-29 regulatory period is estimated to be $4.5M with a present value of $3.9M. The NPV of the option across the full program of works, including the incremental risk benefit compared to the counter factual case, is $6.3M and it has a BCR of 2.06.

We undertook sensitivity analysis, and even with an increase in capital costs of 10%, reduction in risk savings of 10% and increase of the WACC to 4%, this option remains the preferred on a cost benefit basis.

This option is recommended.

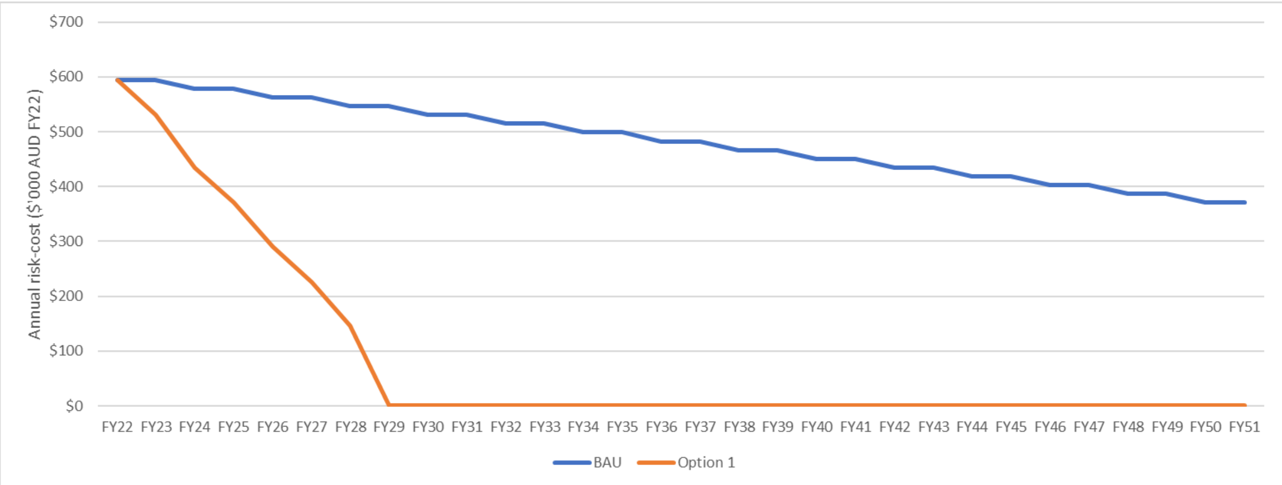

Figure 5 Risk reduction achieved through Option 2

3.1.3 Option 3 – Network reconfiguration to reduce fault levels

A network can be configured operationally to reduce fault levels, however this generally compromises reliability. For example, Palmerston ZSS is currently being operated with a split 11kV bus to maintain the fault levels below distribution switchgear fault level ratings. This configuration is not preferred as it limits the operational flexibility and often has a direct impact on customer reliability.

At Palmerston, operating in a split bus configuration has resulted in significant outages to customers in the Palmerston CBD from minor faults in secondary systems associated with power transformers and switchgear. An example of this is in 2016/17 when a minor wiring fault caused a widespread outage to the Palmerston CBD which would not have occurred had the bus been in normal closed state, and able to utilise the N-1 capacity of the zone substation. This failure accounted for the entire ZSS SAIDI contribution for 2016/17 and was a direct result of the network configuration to reduce fault levels.

This approach also adds significant time to switching programs to manage load transfers between zone substations and buses, limiting availability of equipment for maintenance and inherently increasing the risk to operators as they are required to perform more network switching operations. It also increases cost due to the additional time required for switching.

The distribution network is generally designed and operated as an open, meshed network of HV feeders run radially with open points. Fault levels are dependent on generation capacity and zone substation (ZSS) transformer capacity. Generation capacity cannot be “designed” out of the network. Therefore, to reduce fault levels and maintain the flexibility (and redundancy) provided by a distribution network, zone transformers with higher impedance are required. This would require significant investment in replacement of existing power transformers and additional zone substations to reduce individual transformer capacities. This would have a very high cost and could not be implemented in an appropriate timeframe.

This option does not address the identified need and is not recommended.

3.2 Non-Credible Options

Our analysis also identified a number of options found to be non-credible. These options are described below and were not taken through to detail analysis for the reasons provided.

3.2.1 Retire or de-rate assets to extend life – does not address the need

Total retirement of the assets is not a credible option as the switchgear is required for safe and reliable distribution of the electricity network. De-rating the switchgear will not be practically possible due to constant load growth in the Power and Water. However, when a switchgear is identified to require full replacement, we will assess if it can be done as part of planned replacement that will result in a lower cost to utility.

3.2.2 Non-Network alternatives – does not address the need

Due to the type and function of these assets, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like (modern equivalent) assets. When a switchgear is identified for replacement, Power and Water undertakes an assessment of whether the size or type can be changed to reduce cost or to meet future demand most efficiently.

3.2.3 Capex/Opex Substitution – does not address the need

Since the driver of this investment is significant deterioration across a fleet of assets caused by the same design deficiency and environmental conditions, it is not feasible to substitute capital expenditure with operational expenditure to resolve the risk. Only capital expenditure to replace the switchgear will resolve the underlying issues.

4. Recommendation

The recommended option is Option 2 - Proactive replacement at an estimated cost of $4.5 million (real 2021/22) to be the most prudent and cost effective to meet the identified needs.

The unit rates to develop this cost estimate are provided in Appendix A. The basis of the modelling is described in the Risk Quantification Procedure and Appendix B.

The proposed program is consistent with the National Electricity Rules Capital Expenditure Objectives as the expenditure is required to maintain the quality, reliability, and security of supply of standard control services and maintain the safety of the distribution system.

4.1 Strategic alignment

The “Power and Water Corporation Strategic Direction” is to meet the changing needs of the business, our customers and is aligned with the market and future economic conditions of the Northern Territory projected out to 2030.

This proposal aligns with Asset Management System Policies, Strategies and Plans that contributes to the D2021/260606 “Power and Water Strategic Direction” as indicated in the table below.

Table 6 Alignment with corporate strategic focus areas

No.	Strategic Direction Focus Area	Strategic Direction Priority
1	Customer and the community at the centre	Improve Public Health and Safety
2	Always Safe	Cost Prudency

4.2 Dependent projects

There are no known projects or other network issues that are dependent on the resolution of this network issue.

4.3 Deliverability

This project is an ongoing project with historical data that demonstrates it has been consistently delivered at a comparable level of expenditure, hence there are no concerns regarding deliverability of this project.

4.4 Customer considerations

As required by the AER’s Better Resets Handbook, in developing this program Power and Water has taken into consideration feedback from its customers.

Feedback received through customer consultation undertaken at the time of writing this PBC, has demonstrated strong support amongst the community for appropriate expenditure to enable long term maintenance of the network to ensure continued reliability, maintainability and safety of supply.

4.5 Expenditure profile

Each asset will require replacement of the padmount/package substation containing the switchgear, any civil works required and re-termination of the cables. Recent replacements undertaken by the existing project has found the unit cost to complete all these works is $225k (real FY22) on average. We plan to undertake four replacements per year. The substation removed will be available for redeployment for spare parts to areas of the network when failures occur.

There may be additional expenditure beyond the end of the next regulatory control period as fault levels increase with network growth and reconfiguration, and more sites are identified that present an elevated safety risk. We are unable to forecast the growth in fault current at this time.

Table 7 shows a summary of the expenditure requirements for Regulatory Period 2024-29.

Table 7 Annual capital and operational expenditure ($'000, real FY22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	900	900	900	900	900	4,500
Opex						
Total	900	900	900	900	900	4,500

4.6 High-level scope

The scope for this project is to replace 20 Hazemeyer switchgear units. The priority is based on the fault level, proximity of the location to the public and asset condition.

The identified priority may change during implementation due to other factors such as changes to fault currents, faults experienced, or other related works being undertaken on or around the asset that could result in efficiency savings.

Table 8 Proposed scope of works

Substation identifier	Percentage of rated fault current	Priority order
DT-1942	98%	1
DT-2078	102%	2
DT-2039	91%	3
DT-1953	91%	4
DT-2812	112%	5
DT-2423	107%	6
DT-2584	105%	7
DT-2822	104%	8

DT-2103	88%	9
DT-1197	85%	10
DT-2881	85%	11
DT-1952	107%	12
DT-2477	93%	13
DT-2346	92%	14
DT-2269	88%	15
DT-3229	88%	16
DT-2075	106%	17
DT-2933	87%	18
DT-2114	86%	19
DT-2044	85%	20

Appendix A. Cost estimation

The unit cost of each asset replacement was based on the average of recent replacement costs as incurred under the current program, inflated to FY22 dollars and adjusted for the relevant changes to labour rates. We consider this to be the best estimate of actual cost that will be incurred for the project.

The average cost was used as the scope for an individual asset can change based on location, configuration and adjacent services.

Appendix B. Assumptions

The key assumption for the Risk Model was that there would be an ongoing failure of this asset type at a rate of one every two years. This assumption was based on historical performance as described in section 2.3.2. This was implemented in the risk model as one asset failure every two years (rather than half an asset failure every year).

The remainder of the assumptions were based on the Risk Quantification Procedure.

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