Substation DC supply system replacement

Regulatory Business Case (RBC) 2024-29

PowerWater

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 condition and reliability of the Zone substation (ZSS) Direct Current (DC) supply systems.

1.1 Business need

Zone substation switchgear and protection systems require DC supply (i.e. battery systems) to ensure operation during loss of network supply. The reliability of these battery systems is critical to ensure compliance with regulations as well as the safety of people and protection assets during both normal and abnormal system events.

These assets are critical to ensure the safe and reliable operation of the electrical network. The consequence of battery system failure is considered unacceptable due to the safety, system security and compliance consequences.

Due to the aging of the battery systems, there is a business need to manage assets which reach the end of their serviceable life during the 2024-29 regulatory period. Our analysis has found that battery systems will reach end of life at 16 substation locations in the 2024-29 regulatory period.

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
1	Reactive replacement	This option would replace batteries at failure with a modern equivalent.	No
2	Proactive replacement	This option involves proactive replacement of the aged batteries informed by inspection and testing. They would be replaced with the modern equivalent battery type.	Yes

As part of a holistic assessment, we considered de-rating the assets to extend life, non-network solutions, capex/opex substitution and refurbishment, but found that none of these options addressed the underlying network issues.

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

1.3 Recommendation

The recommended option is Option 2 – Proactive replacement at an estimated capex of about $409k (real FY22) as the most prudent and cost effective to meet the identified needs.

The program will address safety, compliance with the Network Technical Code and the Network Planning Criteria objective of providing safe, secure, reliable, high quality power supply at minimal cost.

Table 2 shows a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 2 Annual capital and operational expenditure ($'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	-	150.1	52.9	126.8	79.3	409.0
Opex	-	-	-	-	-	-
Total	-	**150.1**	**52.9**	**126.8**	**79.3**	**409.0**

2 Identified need

This section provides the background and context to this business case, identifies the issues that are posing increasing risks of overhead services wires 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 the battery systems that are reaching end of life. Zone substation battery systems that are not approaching end of life during the next regulatory period, and related charging systems have been excluded from the modelling undertaken for this program.

2.1 Asset profile

Zone substation switchgear and protection systems require DC supply (i.e. battery systems) to ensure operation during loss of supply from the network. Substation DC systems are critical to ensure the safe and reliable operation of the electrical network. Functioning and reliable DC systems are required for:

- the correct operation of switchgear either as part of daily operations for maintenance of the electrical network or as part of a protection event; and
- the correct operation of protection devices so as to protect people and equipment from power system faults.

The reliability of these battery systems ensures the safety of people and protection of assets is maintained during both normal and abnormal system events.

2.1.1 Batteries

The total installed capacity of battery systems, measured in Amp Hours (Ah), is determined based on the power requirements of the substation assets installed in each location, the characteristics of the batteries used and the required duration of supply from batteries. The assessment of duration, and therefore total capacity, include the remoteness of the zone substation and accessibility during the wet season.

Modern lead acid batteries are commonly used in the industry due to their low fire risk. These batteries have a limited lifespan of 15 years and performance is monitored using condition assessment techniques such as discharge testing and cell impedance testing. Discharge testing was only introduced to the maintenance regime in 2017 in recognition of the large proportion of systems approaching end-of-life.

2.1.2 Charging systems

Zone substations also include charging systems which are comprised of devices for battery management and rectifiers for ensuring batteries remain charged. We are not anticipating charging system replacements in the 2024-29 regulatory period.

2.1.3 Battery portfolio and end-of-life

The design life of our substation DC supply battery systems is estimated to be 15 years. Our analysis has identified that battery systems will reach end-of-life at 16 substation locations in the 2024-29 regulatory period, as outlined in Table 3. Additional detail on each of these zone substations is set out 4.5Appendix A.

Table 3 End of life of battery assets in 2024-29 regulatory period

FY	Number of assets reaching end-of-life
2025	0
2026	7
2027	2
2028	4
2029	3
Total	16

2.2 Historical and current mitigation programs

The replacement of DC systems at zone substations is an ongoing program of works. This dedicated DC system replacement program was started in the 2028-19 financial year and shows a long term average of actual expenditure of $0.12 million.

The expenditure each year changes depending on the requirements and can be lumpy due to the relatively low number of 25 zone substations.

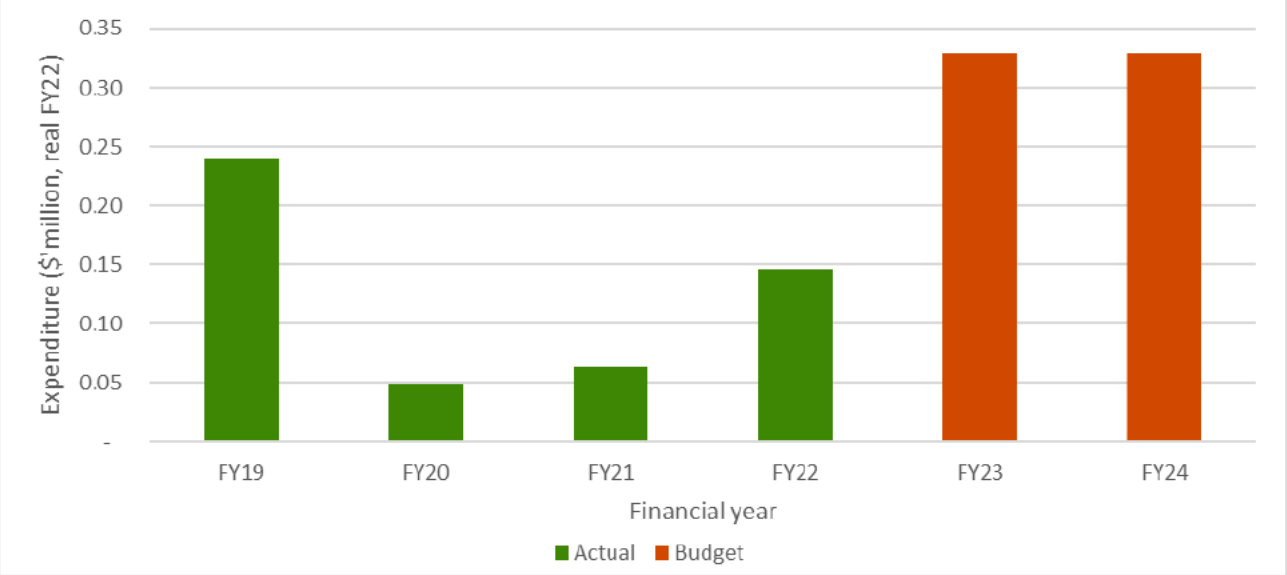

Figure 1 Historical expenditure on ZSS DC systems

2.3 Compliance

The Network Licence, enforced by the Electricity Reform Act 2000, requires Power and Water to remain compliant with legislative requirements, including:

- Power Networks Technical Code and Planning Criteria
- System Control Technical Code
- ICT requirements of Power and Water and the NT government

To maintain compliance, Power and Water must ensure they provide reliable protection systems. The zone substation battery systems are critical support assets to the protection systems and therefore must be maintained in order for power and Water to remain compliant with the regulations.

Failure to maintain compliance can result in financial penalties.

2.4 Consequence areas

Further, a possible consequence of failure of the battery systems is loss of protection which could result in a sustained fault following a network incident. This is unacceptable due to the adverse impact on system security and public safety.

2.5 Risk assessment

Power and Water has developed the Risk Quantification Procedure to enable consistent quantification of risk from their assets into dollar terms. Our analysis has found that for secondary assets, the impact on the network is not direct so it is not possible to define a cost impact in any of the value dimensions. Hence, in this case the network risk is discussed qualitatively.

Our assessment of the obligations under the network licence demonstrates a clear requirement to maintain secondary systems, including protection and the communications network. Provision of zone substations batteries to ensure the correct operation of the secondary system assets during interruptions to the network supply is fundamental to meet this obligation.

The risk assessment is shown in Figure 2 in the matrix format as specified in the Enterprise Risk Management Standard. It shows the current risk ranking is High if the zone substations batteries are not managed effectively, but this can be reduced to the target risk ranking of Low with a proper management approach.

	Insignficiant	Minor	Moderate	Major	Severe
Almost certain	Medium	High	Very High	Extreme	Extreme
Likely	Low	Medium	High	Very High	Extreme
Possible	Low	Low	Medium	High	Very High
Unlikely	Low	Low	Medium	High	High
Rare	Low	Low	Low	Medium	Medium

Figure 2 Qualitative risk assessment

This analysis is consistent with the principles of the Risk Quantification Procedure, and while there are legislated penalties for non-compliance, compliance has been considered in a qualitative manner as there is insufficient data available to adequately identify asset outages and likelihood of second contingencies that are required to cause a failure of the battery systems.

2.6 Summary

Battery supply systems are a critical component of the overall zone substation, including operation of the protection system. Power and Water is required by regulation to ensure reliable protection systems and to meet these obligations. It is therefore critical for Power and Water to ensure that the zone substation battery systems are correctly maintained and functional at all times.

To achieve this, 16 battery banks have been identified as reaching end of life and due for replacement during the 2024-29 regulatory period.

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 – Reactive replacement: This option would replace the batteries at failure.
- Option 2 – Proactive replacement: This option involves proactive replacement of the aged batteries informed by inspection and testing.

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

These options are described and assessed in detail in the sections below.

Table 4 Summary of options analysis outcomes

Assessment metrics	Option 1	Option 2
NPV ($'000, real FY22)	N/A	(354)
BCR	N/A	N/A
Capex ($'000, real FY22)	N/A	409.0
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

3.1.1 Option 1 – Reactive replacement

Option 1 proposes to allow DC supply system batteries to run until failure to maximise the service life of the existing portfolio of batteries. The battery systems will only be replaced once they have failed.

This option minimises the volume of planned replacement, but results in a period of time where substation DC supply systems may not function properly, therefore increasing the risk to safe and reliable operation of the network.

The batteries do not have a status alarm, so the first indication that they are not functioning will be an early failure of the connected devices or identification from field crew during testing. Hence, this involves accepting the risk of assets not functioning correctly until identified during a site visit or during system failure.

This option does not ensure compliance with Power and Water's obligation under the network licence to maintain a functioning communications network and protection systems, hence it is not considered viable. Further, it is not aligned to the asset objectives of providing a safe and reliable network nor is it aligned to common industry practice. This option has not been financially assessed.

This option is not recommended.

3.1.2 Option 2 – Proactive replacement

Option 2 proposes replacing the substation DC supply battery systems based on age according to the vendors technical specification and testing results. This option is estimated to cost $0.41 million (real 2021/22) for the 2019-24 regulatory period, which is consistent with past expenditure. 16 devices will be replaced throughout the period 2025/26 to 2028/29.

Appendix B outlines the expected replacement schedule and costs. The proposed replacement schedule is established based on the battery life, before being moderated based on test results obtained from the annual preventative maintenance testing regime. This enables condition based optimisation of the replacement program.

This option enables Power and Water to maximise the serviceable life of the assets while also managing risk to the substation and ensuring compliance with the Network Licence obligations.

This option is 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 batteries are required for safe and reliable distribution of the electricity network. De-rating the batteries will not be practically possible due to fixed need at the substation. However, when a battery 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.

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 environmental conditions, it is not feasible to substitute capital expenditure with operational expenditure to resolve the risk. Only capital expenditure to replace the batteries will resolve the underlying issues.

3.2.4 Refurbishment – does not address the need

Refurbishment is not a viable option in most instances due to the inability to source spare parts or source commercially competitive solutions.

4 Recommendation

The recommended option is Option 2 – Proactive replacement at an estimated cost of $0.41million (real 2021/22) as the most prudent and cost effective to meet the identified needs.

The program will address safety, compliance with the Network Technical Code and the Network Planning Criteria objective of providing safe, secure, reliable, high quality power supply at minimal cost.

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 Corporation Strategic Direction" as indicated in Table 6 below.

Table 5 Alignment with corporate strategic focus areas

	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

This business case considered the need for new DC supply battery installations at the Tindal Zone Substation and Batchelor Zone Substation; however, there are major projects planned for these locations which will address the battery installations. Hence, these two sites have been excluded from this regulatory business case.

4.3 Deliverability

We consider that this project is deliverable.

Power and Water has the experience and track record completing the proposed scope of works associated with the preferred option during the current and previous regulatory periods. Resourcing requirements for the preferred option are considered to be business as usual.

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

Table 6 show a summary of the expenditure requirements for the 2024-29 regulatory period.

Table 6 Annual capital and operational expenditure ($'000, real 2021/22)

Item	FY25	FY26	FY27	FY28	FY29	Total
Capex	-	150.1	52.9	126.8	79.3	409.0
Opex	-	-	-	-	-	-
Total	-	**150.1**	**52.9**	**126.8**	**79.3**	**409.0**

Appendix A. Portfolio of substation DC supply battery systems

Table 9 below summarises the portfolio of battery systems to be replaced at end of life.

The end-of-life is calculated as 14 years after the date of manufacture to account for maturation during the 15th year.

Table 7 Portfolio of substation DC supply battery systems reaching end-of-life during 2024-29 regulatory period

Substation facility	Volt	Cell nominal capacity	FY of manufacture	Asset lifespan (years)	Replacement at end-of-life
ZSSHD	50	300	2012	15	2026
ZSSHD	50	300	2012	15	2026
ZSSMA	50	125	2012	15	2026
ZSSMA	50	125	2012	15	2026
ZSSWN	50	500	2012	15	2026
ZSSWN	50	500	2012	15	2026
ZSSWS	50	125	2012	15	2026
ZSSLE	50	500	2013	15	2027
ZSSLE	50	500	2013	15	2027
ZSSDA	50	1000	2014	15	2028
ZSSDA	50	1000	2014	15	2028
ZSSSA	50	300	2014	15	2028
ZSSSA	50	300	2014	15	2028
ZSSMS	50	500	2015	15	2029
ZSSSY	50	500	2015	15	2029
ZSSSY	50	500	2015	15	2029

Appendix B. Cost estimation

Our cost estimate for DC supply battery system replacement is based on historic expenditure of a typical 50 volt 300 AH battery installation. We reviewed the most recent battery replacement work orders, applied CPI to the material costs and applied the new labour rate for the 2024-29 regulatory period. This method shows that the average cost of replacement to be roughly [redacted] (real 2021/22).

Table 10 below summarises the historic and current cost for a 300 AH battery replacement.

Table 8 Typical cost of 50 volt 300 AH battery replacement based on historic spend ($, real 2021/22)

Item	[redacted]	[redacted]	Comments
Battery cost	[redacted]	[redacted]	CPI has been applied to update material costs
Labour cost	[redacted]	[redacted]	Labour rate has increased from [redacted]
Total	[redacted]	[redacted]	

Our costings for the portfolio of battery system replacement was based on the above cost estimate and applied to the portfolio of 16 battery replacements.

However the cost per site will be dependent on the battery capacity required. A multiplier was applied to the battery material costs based on the cell nominal capacity, to account for each asset being replaced with a like-for-like battery capacity.

We have assumed equal costs for any battery capacity under 300 Ah.

Table 11 below summarises the portfolio replacement costs.

Table 9 Estimated cost for portfolio of battery replacement

Substation facility	Cell nominal capacity ampere hour (AH)	Cost of replacement ($, real 2021/22)	Replacement at end-of-life
ZSSHD	300	[redacted]	2026
ZSSHD	300	[redacted]	2026
ZSSMA	125	[redacted]	2026
ZSSMA	125	[redacted]	2026
ZSSWN	500	[redacted]	2026
ZSSWN	500	[redacted]	2026
ZSSWS	125	[redacted]	2026

ZSSLE	500	[redacted]	2027
ZSSLE	500	[redacted]	2027
ZSSDA	1000	[redacted]	2028
ZSSDA	1000	[redacted]	2028
ZSSSA	300	[redacted]	2028
ZSSSA	300	[redacted]	2028
ZSSMS	500	[redacted]	2029
ZSSSY	500	[redacted]	2029
ZSSSY	500	[redacted]	2029
Total		[redacted]	

Based on the cost estimate for the portfolio of battery system replacement in Table 11, Table 12 below summarises the costs per financial year.

Table 10 Estimated cost for portfolio of battery replacement ($, real 2021/22)

Financial year	Replacement cost per year
2025	-
2026	150,051.80
2027	52,877.66
2028	126,767.32
2029	79,316.49
Total	409,013.27

Contact

Power and Water Corporation
55 Mitchell Street, Darwin NT 0800
Phone 1800 245 092
powerwater.com.au

PowerWater