Communications battery replacement program (NMSC2)

Regulatory Business Case (RBC) 2024-29

PowerWater

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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, compliance and obsolescence risks of battery systems relied upon by our SCADA and communications network.

1.1 Business need

The SCADA and Communications network is critical to ensure the safe and reliable operation of the electrical network. A functioning and reliable SCADA and Communications network is required for operators at System Control to:

- Monitor the state of the electrical network at all times;
- Operate the electrical network in a timely and efficient manner without the need to send a technician to site;
- React to electrical network events to ensure the network remains in a safe configuration; and
- Isolate the electrical network to allow maintenance

The communications network is reliant on battery systems to ensure that communications are not interrupted during power outages. Our analysis has found that batteries have a defined life where they can be relied upon to provide the design capacity, and that their useful life is heavily affected by temperature. Specifically that:

- There are 43 battery banks that are forecast to reach the end of their life based on the average temperature of their locations and their design capacity.
- There are four battery chargers that will reach the end of their life.

The Communications network is critical to ensure the safe and reliable operation of the electrical network. The Network Licence, enforced by the Electricity Reform Act 2000, requires the communications network to remain compliant with legislative requirements, including:

- System Control Technical Code
- Power Networks Technical Code and Planning Criteria
- ICT requirements of Power and Water and the NT government
- The forthcoming Critical Infrastructure Bill

To meet these obligations, it is necessary for Power and Water to manage assets that are obsolete, no longer supported by the vendor, or at the end of their design life.

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	Replace on failure (reactive replacement)	This option would replace the batteries at failure with a modern equivalent	No
2	Proactive age-based replacement	Proactive replacement of the batteries replaced with the modern equivalent battery type as determined by their temperature adjusted age and test results.	Yes

As part of a holistic assessment, non-network solutions, capex/opex trade-offs and retirement or derating options were also considered, 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

The recommended option is Option 2 – Proactive age-based replacement at an estimated cost of $1.36 million (real 2021/22) as the most prudent and cost effective to meet the identified needs.

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.

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	631	124	259	310	31	1,355
Opex	-	-	-	-	-	-
Total	**631**	**124**	**259**	**310**	**31**	**1,355**

2. Identified need

This PBC describes the battery systems for Communications assets that have reached the end of their serviceable life. This does not include zone substation batteries that supply substation auxiliary devices. Communications generally have their own dedicated battery banks and chargers.

2.1 Asset profile

Batteries are critical to the operation of the telecommunications system. Without batteries of sufficient capacity, high availability telecommunication rings will not operate for the durations required to maintain critical services for the region. Battery banks are most critical in the time of power outages where they are the sole source of power to ensure continued operation of the Protection, SCADA and Communications assets, and therefore to maintain control of the network.

The installed capacity is determined based on the power requirements of the assets installed in each location, the characteristics of the batteries used and the required duration of supply from batteries, ie, the expected duration of a power outage.

In the more remote locations, solar panels are installed for the purpose of charging the communications batteries. This business case also considers any investment required for the solar panels specific to the battery and charger systems.

Figure 1 shows the current age profile of the battery fleet, the volumes of batteries planned for replacement during the current period and those that are expected to reach the end of their serviceable lives during the next regulatory period (the focus of this business case).

It demonstrates that during the next regulatory period, an additional 43 battery systems are reaching the end of their serviceable life and will present a risk to the continued operation of the communications network.

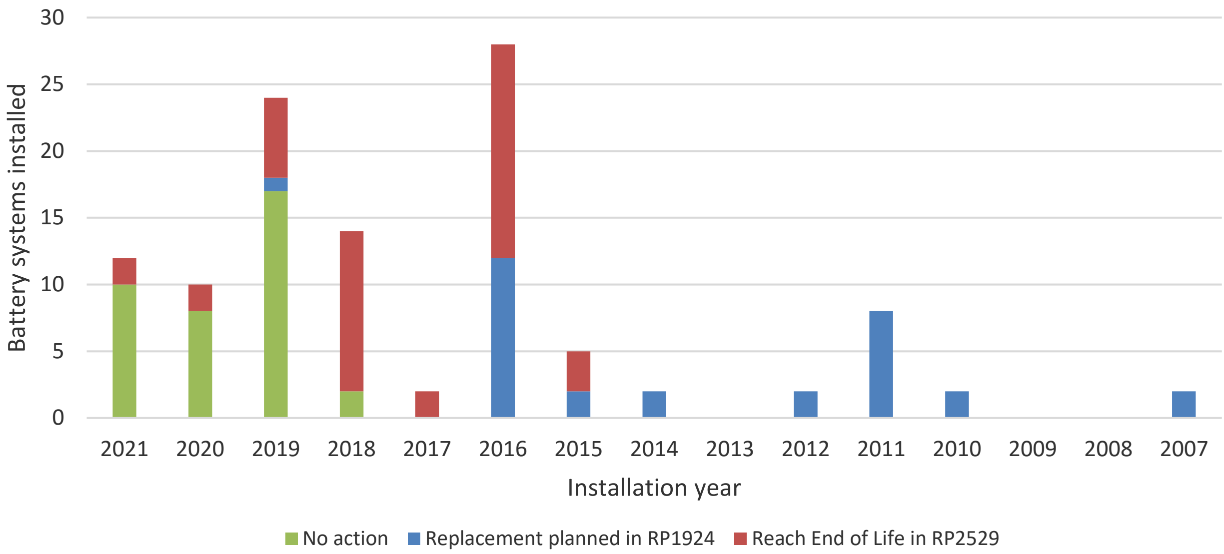

Figure 1 Age profile by battery systems with expected end of life

The end of serviceable life for batteries is based on battery age. The size and expected life of the battery systems is dictated by Power and Water's unique environmental and remote circumstances. These factors are explained below.

2.2 Condition and emerging issues

2.2.1 Loss of battery capacity with age

A well proven and understood characteristic of batteries is that they lose capacity as they age due to internal deterioration. This means that the amount of energy that batteries can store reduces over time, which results in the voltage output dropping below design levels more quickly than design requirements. When battery systems do not supply the required voltage levels, the connected devices will not operate correctly.

Batteries do not store well when not in use and hence spares are not held for large capacity battery banks.

2.2.2 Impact of temperature on batteries

Battery life is affected by the conditions in which they are used. Technical data sheets[1] show that there is a 50% reduction in battery life for every 10°C above 20°C and this is supported by Power and Water experience in the field.

The temperatures in the Northern Territory range between an average low of 23°C and an average high of 32°C[2]. Not all batteries throughout the Power and Water network are housed in air-conditioned enclosures. This is a result of these sites being designed to old standards, for solar powered sites and remote area construction. Therefore, battery lives are heavily affected by the temperature.

The battery locations not housed in air-conditioned environments are listed in Appendix B. The table shows the deign life, average temperature at the location, and the adjusted battery life.

2.2.3 Charger deterioration

Figure 2 shows the current age profile of the battery chargers by type. The expected functional life of a charger varies by type, however, modern chargers are modular so typically individual components are replaced rather than the complete assets.

The current approach to managing the fleet of chargers is to replace them at end of life with Eaton SC300 chargers. Eaton SC300 are modular, enabling replacement of components as they fail, therefore reducing the lifetime cost of the asset. They are also backwards compatible with the Eaton SC200 which was the previous model and deployed at most communications locations.

There are four chargers that have been identified as reaching the end of their design life in regulatory period 2024-29.

[1] D2017/375703 – Sonnenschein Gel VRLA Handbook Part 2 – Page 35 of 73

[2] Bureau of Meteorology website: http://www.bom.gov.au/climate/averages/tables/cw_014015.shtml

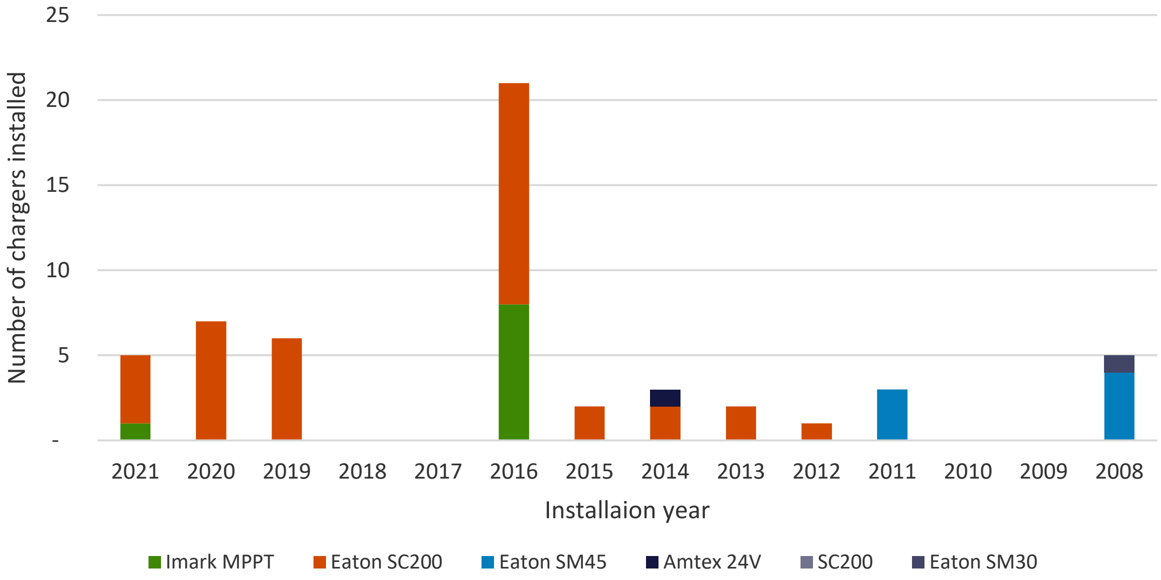

Figure 2 Age profile of chargers by type

2.2.4 Solar panel deterioration

Solar panel capacity deteriorates over time and panels have an expected serviceable life of approximately 15 years in the Northern Territory. As they degrade, their effective capacity reduces and eventually results in insufficient solar capacity to charge the battery systems to the required state of charge. This can result in the sites becoming non-operational and affecting the Communications Network, hence posing a risk to network safety and reliability.

There are only five solar powered communications sites on Power and Water network, all are in remote locations. Three of these were replaced in 2018 and are therefore in good condition and a fourth was replaced in 2022. Some of these sites may need increase an in solar charging capability as the site load increases with the introductions of new and more ‘energy consuming’ MPLS equipment.

Only the solar system at Union Reef is approaching its end of life, however, there is no action planned for that asset as the system located there is basic with low capacity and the existing system is expected to be sufficient with reduced capacity.

Table 3 Solar panel locations and installation dates

Solar Panels	Location	Units	Install date	Comment
Solar Systems	Robin Falls (RFCS)	20	2018	
Solar Systems	Pine Creek Mesa (PMCS)	20	2018	Upgraded to increase capacity 2022
Solar Systems	O'Shea (OHCS)	20	2018	
Solar Systems	Mt Bundy (MBCS)	24	2010	Being replaced 2022
Solar Systems	Union Reef (URTT)	4	2015	No planned replacement at this point as a basic system

2.2.5 Environmental considerations

Power Water has unique requirements compared to other Distribution Network Service Providers (DNSPs) around Australia due to the climatic conditions, particularly because of the wet season and cyclones.

Cyclonic or storm events result in frequent, and often prolonged, power outages. At these times, access roads maybe blocked or flooded, staff are busy handling other network outages or staff numbers are reduced as they may be attending to personal issues related to the weather event. This means that sites may not be accessible for a long period of time. Sufficient battery capacity needs to exist to ensure the site remains operational during these times.

Solar powered sites need sufficient battery capacity to maintain load during adverse weather conditions, particularly monsoonal times where there can be significant cloud cover for prolonged durations, often up to two weeks, reducing the site's ability to fully charge during the day.

The impact is that the battery system capacity on the Power and Water sites is required to be much higher than for other electricity businesses in Australia, resulting in a higher cost per location.

2.3 Regulatory compliance

Power and Water is required by regulations to provide a communications network to ensure the secure and reliable operation of the electricity network. To achieve compliance with this requirement, Power and Water must act to ensure reliability communications between Darwin and Alice Springs.

Further details of the compliance requirements relevant to this business case are provided in Appendix C.

2.4 Current management program

The communications battery replacement program is an ongoing program with actual expenditure since FY17 shown in Figure 3.

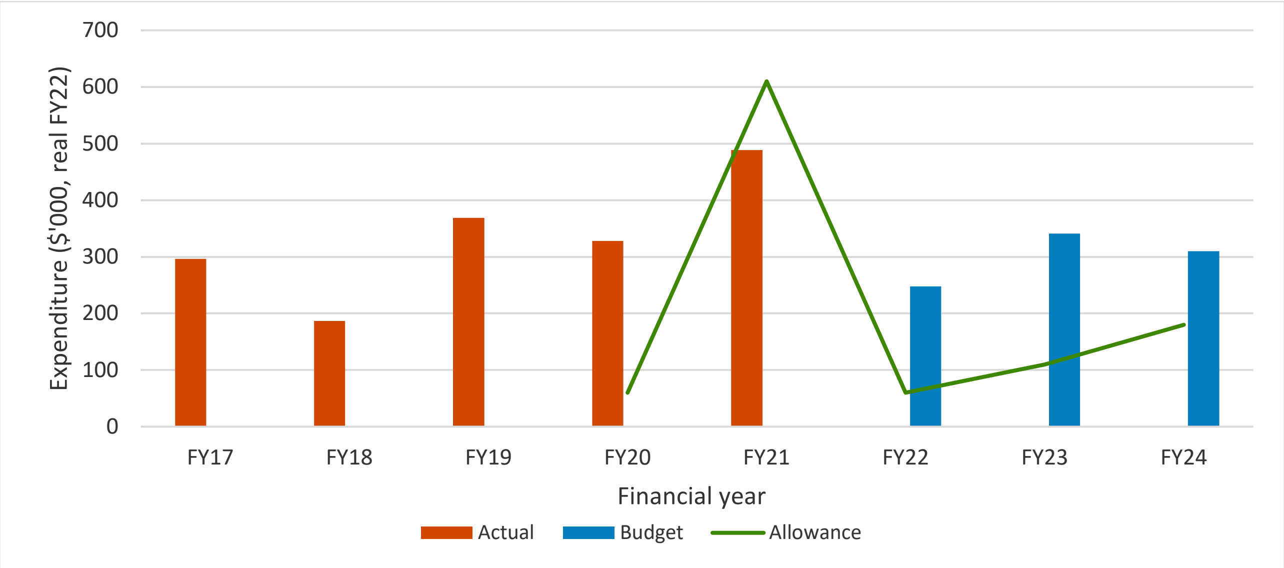

Figure 3 Historical and budgeted expenditure compared to the allowance

The expenditure since FY20 is shown in comparison to the AER's allowance. The change in expenditure reflects Power and Water improved approach to forecasting replacement requirements based on

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temperature data from the Bureau of Meteorology and calculating the impact on asset life. It demonstrates that Power and Water plans to replace more battery banks than forecast for the 2019-24 regulatory period.

The annual expenditure is variable as it is based on the temperature adjusted life of each battery installation, so annual volumes vary from year to year. The long-term average expenditure is $335k (FY22 dollars) per year. The average historical cost per site is $31k (FY22 real), however, this varies from site to site based on the installed battery type, voltage and capacity.

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 communications 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 the communications network. Provision of batteries to ensure the correct operation of the communications assets during interruptions to the network supply is fundamental to meet this obligation.

The risk assessment is shown in Figure 4 in the matrix format as specified in the Enterprise Risk Management Standard. It shows the current risk ranking is High if the communications 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 4 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 communications outage.

2.6 Summary

The SCADA and Communications network is critical to ensure the safe and reliable operation of the electrical network. A functioning and reliable SCADA and Communications network is required for operators at System Control to:

- Monitor the state of the electrical network at all times.
- Operate the electrical network in a timely and efficient manner without the need to send a technician to site.
- React to electrical network events to ensure the network remains in a safe configuration, and

- Isolate the electrical network to allow maintenance.

The SCADA and Communications networks also provide tele-protection to provide improved safety to the public and minimise potential damage to the electrical assets by clearing electrical faults as quickly as possible.

The Communications network must also remain compliant with legislative requirements, including:

- Network Licence.
- Power Networks Technical Code and System Control Technical Code.
- ICT requirements of Power and Water and the NT Government.

To meet these obligations, it is necessary for Power and Water to manage the charger and battery fleet to ensure the reliability of the communications network. As discussed in section 2.1 above:

- There are 43 battery banks that are forecast to reach the end of their life based on their temperature adjusted expected life to provide the required capacity.
- Old style chargers require full replacement at end of life. Four units have been identified that will require replacement during the next regulatory period.
- No solar panel systems will require replacement during the next regulatory period.

The next section discusses the options to address the assets forecast to reach end of life in the next 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 – Replace on failure. This option would replace the batteries at failure with a modern equivalent.
- Option 2 – Proactive age-based replacement. This option involves a proactive replacement of the batteries as they reach the end of their serviceable life as determined by their temperature adjusted age. They would be replaced with the modern equivalent battery type.

A comparison of the two identified credible options and the issues they address in the identified need is depicted in Table 4.

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
NPC ($'000, real 2021/22) Note 1	NA	1,260
BCR Note 1	NA	NA
Capex ($'000, real 2021/22)	NA	1,355
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

Note 1: Project benefits were not quantified so the Net Present Cost was provided and BCR is not available.

3.1.1 Option 1 – Replace on failure

Only replace batteries once they have failed. This means accepting a period of time where the SCADA and Communications network may not function properly, therefore putting the safe and reliable operation of the network at risk.

The communications batteries and chargers do not have a status alarm, so the first indication that they are not holding sufficient capacity will be an early failure of the connected devices. Hence, this involves accepting the risk of assets not functioning correctly until a filed crew can attend on site to address the issue.

This option does not ensure compliance with Power and Water obligation under the network licence to maintain a functioning communications network hence it is not considered credible. 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 is not recommended.

3.1.2 Option 2 – Proactive age-based replacement

This option proposes to replace the batteries based on age according to the vendors technical specification and test results.

The proposed replacement schedule is established based on the temperature adjusted battery life, then moderated based on test results obtained from the annual preventative maintenance testing regime. This enables condition based optimisation of the replacement program.

The preventative maintenance test results are documented in hard copy reports and in Content Manager, however, if an issue is found on site, then an Internal Service Request is raised in Maximo and the documentation can be examined.

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

Historical expenditure shows that the average cost of a battery installation is $31k (real 2021/22) and chargers were $5.5k (real 2021/22), however the actual cost per site is dependent on the battery type, voltage and capacity required. Our forecast is based on the historical average unit rate escalated to FY22 real dollars.

On average, our expenditure on communications battery replacements has been $350k (real 2021/22). Our forecast shows a total of $1.36 million (real 2021/22) for the regulatory period with an annual average of $271k (real 2021/22) which is consistent with past expenditure.

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 communications network is required for safe and reliable operation of the electricity network. De-rating the batteries does not enable the

Communications system to continue to operate for the durations required, such as during storms when access to sites is restricted.

3.2.2 Non-Network alternatives – does not address the need

Due to the type and function of the assets in the SCADA and Communications network, there are no non-network alternatives or solutions that can be implemented in place of direct asset replacement with like for like or modern equivalent assets.

3.2.3 Capex/Opex substitution – does not address the need

Power and Water communications batteries are required to ensure the provision of communication services. The communications services are critical to ensure safety of the public and personnel and reliability of the network. In general, it is not possible to substitute the function of the batteries with an opex solution. However, Power and Water has considered solutions that aim to extend the life of batteries using an operational approach (Option 2).

3.2.4 Alternative battery technologies – undertaking trial to assess technology suitability

Redox flow batteries are an alternative technology that is starting to gain traction for some industrial and utility-scale battery applications. However, due to the higher cost per kWh, toxicity of the materials, size of the infrastructure and parasitic on-site loads, Power and Water does not consider these types of batteries as a credible solution to our need for batteries to support the communications system.

Instead, Lithium based batteries are being studied and trailed for potential future use due to their high energy density. A similar pathway is being followed by our southern energy utility counterparts.

4. Recommendation

The recommended option is Option 2 – Proactive age based replacement at an estimated cost of $1.36 million (real 2021/22) as the most prudent and cost effective to meet the identified needs.

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 "PWC Strategic Direction" as indicated in the table below.

Table 5 Summary of strategic direction 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

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

4.3 Deliverability

This is an existing program of works, with evidence of the delivery from FY17 to FY21 (actual) and FY22 to FY24 (budget) provided in section 2.6. The volumes vary year to year based on the battery age. The forecast expenditure is comparable to the annual historical expenditure. No delivery risks have been identified.

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

Power and Water has historically undertaken battery replacements as a business as usual program. On average, $350 thousand (real 2021/22) per year has been incurred on this program with similar expenditure expected to continue, allowing for volatility based on the age and condition of the asset fleet.

Table 6 shows a summary of the expenditure requirements for the 2024-29 regulatory period, split by battery and battery charter replacement.

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

Item	FY25	FY26	FY27	FY28	FY29	Total
Battery replacement	620	124	248	310	31	1,333
Battery charger replacement	11	-	11	-	-	22
Total	**631**	**124**	**259**	**310**	**31**	**1,355**

4.6 High-level scope

The scope of this program of works is described in Table 7 and Table 8 below.

This schedule may change slightly depending on actual test results that are performed each year and are used to amend and optimise these replacements. Battery types may also change with time as battery models constantly change with new higher capacity versions.

Table 7 Battery replacement schedule

Battery Type	Capacity	Locations	2025	2026	2027	2028	2029	Total
A406/165	165	LEZS, USPS	3					3
A602/750	750	OHCS, PMCS, RFCS			8	4		12
GF 12 072 Y	80	DWTP, BHCR		2		2		4
GF 12 072 Y	160	OSCS,	2					2
PJ150	150	KAWT				2		2
PJ2V150	150	MAWT				2		2
SBS320	320	MBCS	1					1
SBS580	580	FHCS, HUCS, LBCS, MMCS, WGTT, TCCR	12				1	13
UFX150-12FR	150	CAZS		2				2
UXF150-12	150	SYZS	2					2
Total			**20**	**4**	**8**	**10**	**1**	**43**

Table 8 Battery charger replacement schedule

Battery Type	Capacity	Locations	2025	2026	2027	2028	2029	Total
Eaton SM45	600	CAWT, DMCS, KA12	2		1			3
Eaton SM45	160	OSCS			1			1
Total			**2**		**2**			**4**

Appendix A. Cost estimation

The costs for this program have been developed based on actual costs incurred across a number of recent communications battery projects. Our forecast is based on the historical average unit rate escalated to 2021/22 real dollars.

Historical expenditure shows that the average cost of a battery installation is $31 thousand (real 2021/22) and chargers were $5.5 thousand (real 2021/22). However, the actual cost per site is dependent on the battery type, voltage and capacity required.

Historical costs incurred for different battery types, capacity and voltage have been used costs to forecast the individual site costs based on the battery system configuration at each of the sites identified for replacement.

Appendix B. Asset condition data

The following table shows the battery types that are in locations without air conditioned. It shows the nominal life at 20°C, the average site temperature and the resultant temperature adjusted expected life.

Table 9 Impact of temperature on battery life for locations without air conditioning

Battery Type	Nominal Life (20C)	Site Av Temp	Expected Life Yrs
2EG200	20	22	20.0
2EG200	20	27	18.6
A406/165	12	22	10.4
A602/600	15	27	11.7
A602/600 sol	15	27	11.7
A602/750	20	27	15.6
A602/750	15	32	9.8
A602/750	15	33	9.4
A602/750	15	34	9.1
G85	10	22	8.7
G85	7	30	3.5
G85	10	35	3.5
GC48V-040LFP	20	25	14.1
GF 12 072 Y	7	22	6.1
GF 12 072 Y	7	22	7.0
PJ150	15	27	9.2
PJ2V150	15	20	15.0
PJ2V150	15	22	13.1
PJ2V150	15	27	9.2
PJ2V150	15	27	11.7
PJ2V300	15	22	13.1
PS1270	5	25	3.5
SB6	15	27	11.7
SBS320	15	27	9.2
SBS320	15	33	6.1
SBS580	15	20	15.0

SBS580	15	22	13.1
SBS580	15	27	9.2
SBS580	15	28	8.6
UFX150-12FR	10	22	8.7
UXF150-12	10	22	8.7

The following table shows the battery type in air-conditioned locations including the date when air conditioning was installed. The temperature adjusted battery life accounts for the proportion of time the battery was installed prior to air conditioning being installed.

Table 10 Impact of temperature on battery life for locations with air conditioning

Battery Type	Nominal Life (20C)	Site Av Temp	Aircon installed	Expected Life Yrs
SBS320	15	40	2018	6.3
SBS320	15	33	2019	7.7
SBS320	15	32	2019	8.0

Appendix C. Compliance requirements

Power and Water is required to maintain the communications network to ensure compliance with a number or legislative requirements. This 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.

The relevant Legislation, Regulation and Codes include:

- Electricity Reform Act 2000
- Network Licence (varied 15 May 2020)
- National Electricity (NT) Rules (NT NER)
- Network Technical Code and Network Planning Criteria (Network Technical Code)
- System Control Technical Code

The key clauses that relate to the provision of communications systems are:

- The System Control Technical Code Clause 6.18(a) requires System Participants (the definition includes Power and Water as the network operator) to provide control and monitoring, alarms and measurements to the Power System Controller's SCADA system via communication links.
- The Network Technical Code Clauses 3.2.6 and 3.3.6.2 define the communications links between a User (generator or load) and the control centre (System Control) to be the responsibility of the Network Operator.
- The Network Licence Clause 10 requires Power and Water to comply with all applicable provisions of the System Control Technical Code and the Network Technical Code.
- The Electricity Reform Act 2000 Clause 31 provides a maximum penalty of 2,500 penalty units for contravening the licence conditions. A penalty unit is worth $157 in 2021/22[3], providing a maximum penalty of $392,500 per contravention.

There are clear legislative and government requirements for Power and Water to maintain a modern communications system and that the requirements are expected to become more stringent within the next few years with the introduction of the proposed Critical Infrastructure Bill. Decisions made on the technology and asset types installed now must provide real options[4] for providing the cyber security capability and technology compatibility required in the near future.

[3] https://justice.nt.gov.au/attorney-general-and-justice/units-and-amounts/penalty-units
[4] Regulatory Investment Test for Distribution, Application Guidelines, December 2018, Australian Energy Regulator, Section 3.2.3

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