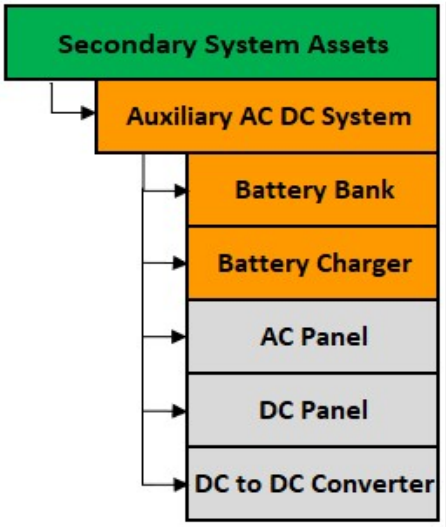
Auxiliary AC DC Systems Investment Case

Auxiliary AC DC Systems provide power to critical systems within a Zone Substations and Bulk Supply Points. These systems include Protection, Control and Electrical Network Telecommunications systems. This system is designed to ensure that the critical systems it supports can continue to function during an AC supply outage. If this system is not functioning the Zone Substation will be de-energised.

Scope

This investment case addresses Auxiliary AC DC System assets located inside Zone Substations and focusses on the most critical assets within this ACS, being Battery Chargers and Battery Banks.

The investment is required to meet the capital expenditure objectives (NER 6.5.7) for quality, reliability, safety and security of electricity supply and to meet regulatory and legislative obligations for Standard Control Services.



Forecast $FY24

The Auxiliary AC DC Systems forecast accounts for 0.48% of the total Repex portfolio for FY25 to FY29.

FY25	FY26	FY27	FY28	FY29
$2.9M	$0.4M	$0.8M	$0.2M	$1.2M

Asset Profile/Health

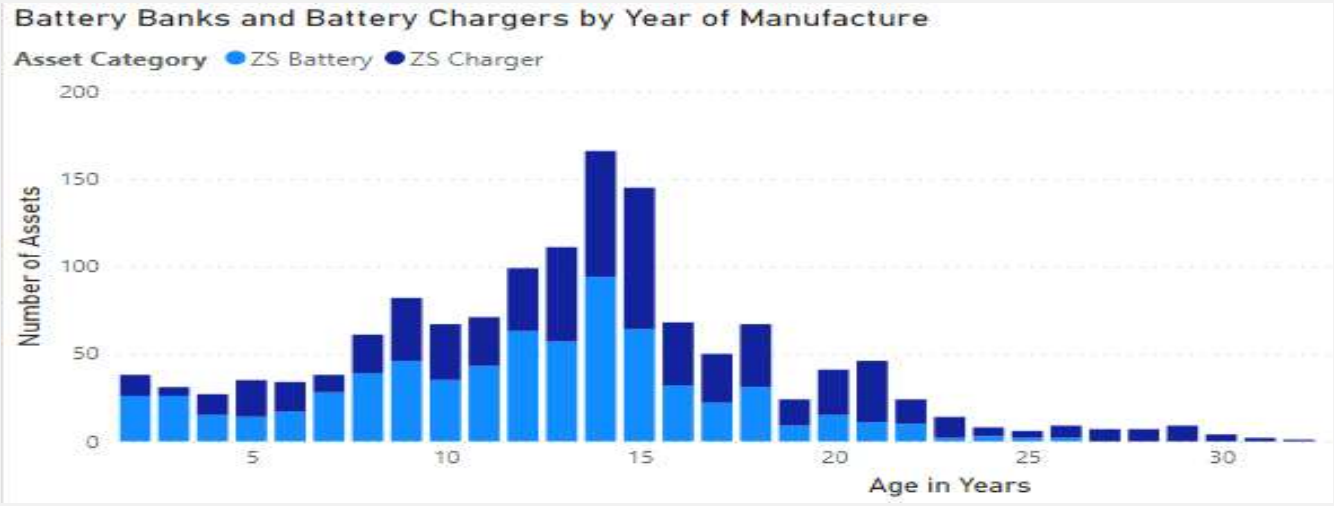
Asset Profile

Essential Energy's Auxiliary AC DC System is responsible for approximately 2,048 unique assets as shown in the table below. The number of DC to DC converters is unknown. These assets are located at 314 Zone Substation sites across NSW. Each of these sites are exposed to various environments.

Forecast Group	Assets
Battery Banks	706
Battery Chargers	702
AC Panel	320*
DC Panel	320*
DC to DC Converter	Unknown*
Total	**2048**

*Asset modelling yet to be completed

The age profile of the Battery Chargers and Battey Banks asset fleet is shown in the following figure.



Asset age has been used as a proxy for asset health for this asset class.

This section provides an overview of the Auxiliary AC DC System risk model. It is supported by documents and **6.03.02 Network Risk Management Manual, 6.03.03 Appraisal Value Framework and 6.03.04 System Capital Risk and Value Based Investment** methodology.

Probability of Failure (PoF)

Failure modes for Auxiliary AC DC System assets have been identified through a Failure Mode Effects Analysis (FMEA) with subsequent analysis focusing only on those failure modes with asset life ending consequence. Detail on the development and assumptions in the Probability of Failure (PoF) Model are captured on Page 6. The resulting Weibull parameters are shown below.

Analysis of historical task data from 2005– 2021 identified 306 asset failures, the majority of which were attributable to Chargers. The component, issue, and reason asset tasks were in general difficult to determine, this was due to lack of clarity in the dominant task and cause descriptions mostly written in free text fields. Weibull parameters used in the risk model are shown below.

Weibull Parameters and Failure Data

PoF Model	Alpha	Beta	Equipment Type	Failure	Suspensions	Total
Battery Bank Nickel Cadmium	30	5.5	Battery Bank Nickel Cadmium	39	674	713
Battery Bank Lead Acid	13	4.5	Battery Bank Lead Acid	13	61	74
Battery Charger	30	4.0	Battery Charger	177	763	940

Consequence of Failure (CoF)

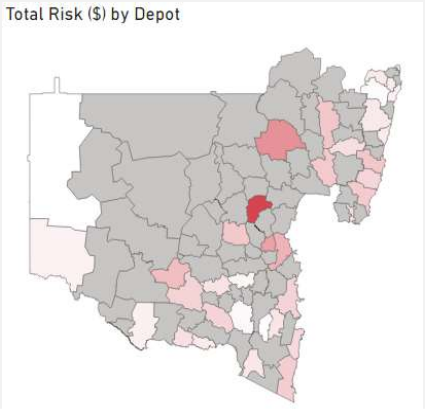
The consequence of failure for an Auxiliary AC DC System asset describes the impact of a functional failure. Consequences have been evaluated using the 6.03.03 Appraisal Value Framework.

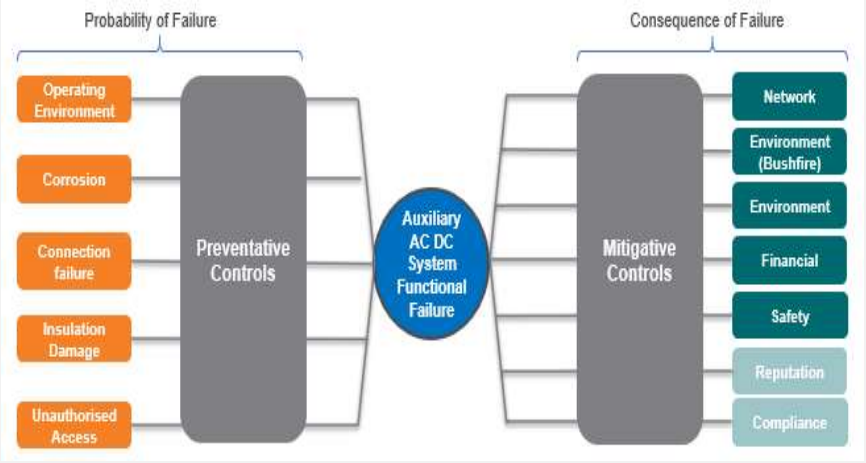
Consequence costs are mostly Network and Financial, driven by the fact that a non functioning AC DC asset can result in the Zone Substation being de-energised.

The consequence categories have been ranked based on consequence cost assuming all AC DC System assets in the network will fail (i.e. Total Consequence).

Component	Average Battery CoF	Average Charger CoF	Combined Total CoF
Safety	$ 16.90	$ 3.25	$ 14,208
Network	$ 128,821.33	$ 49,676.01	$ 125,820,419
Bushfire	$ 0.03	$ 0.01	$ 28
Environment	$ 22.44	$ 1.55	$ 16,934
Financial	$ 24,947.13	$ 21,764.60	$ 32,891,422

The image on the right displays a **summary of asset risk** (quantified by the average of total consequence per asset failure in conjunction with the assets probability of failure) for Auxiliary AC DC System assets by depot.





Network Risk

Asset risk is a function of the probability of failure and the consequence of failure. The risk model has been developed using the Asset Risk Management Framework, and represents the relationship between the primary drivers behind Auxiliary AC DC System asset functional failures and the components used to determine the consequence of failure.

Forecasting Approach

The replacement Capex forecast (FY25-FY29) has been calculated using Essential Energy's optimisation software (Copperleaf) which uses a risk based methodology to maximise the value of the investment portfolio within constraints established by Essential Energy that are consistent with our Corporate Risk Framework, Asset Management System, applicable standards, rules, regulations and licence conditions. To assure efficiency our portfolio has been constrained to meet customer and stakeholder expectations.

In line with NER capital objectives, the objectives of our total replacement portfolio have been informed through extensive stakeholder engagement and consist of:

- Maintain reliability performance (network risk)
- Long term reduction of bushfire start risk by 20% over 20 years (2.5% FY25-29)
- Maintain safety performance

The replacement quantities of Auxiliary AC DC Systems consist of:

1. Optimised **risk-based replacements to maintain overall network risk values within defined objectives.**

The above asset intervention utilises a probabilistic approach that has been developed through detailed analysis of historical asset performance to establish Weibull parameters.

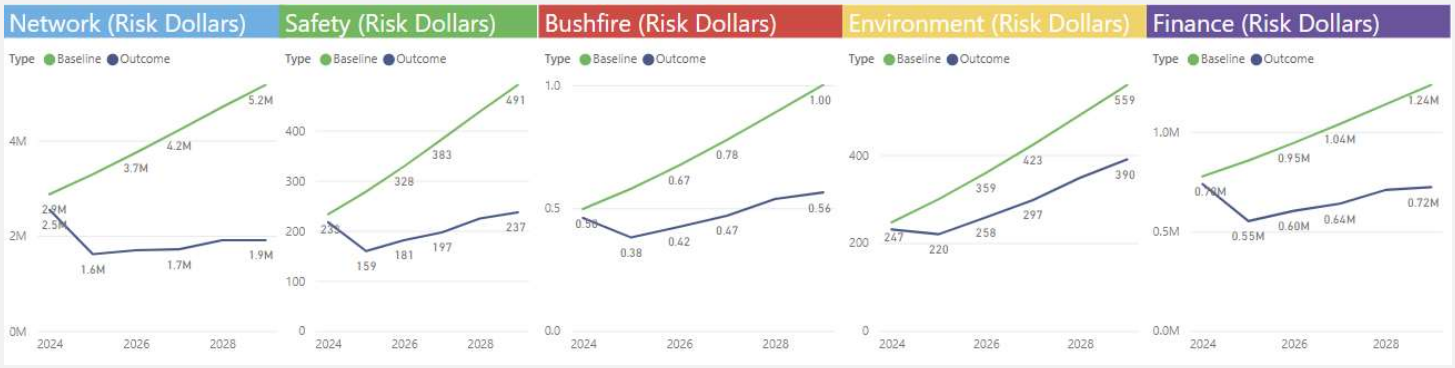
The probabilistic method has been tested and validated against historical volumes to ensure that it is accurate at the population level.

Forecast investment expenditure has been determined by multiplying the forecast replacement quantities of Auxiliary AC DC Systems assets by applicable unit rates.

Refer to **6.03.04 System Capital Risk and Value Based Investment** methodology for details on the portfolio wide optimisation planning approach and risk outcomes, and **10.01.04 Capital Unit Rates** for unit rates.

Optimised Portfolio Outcomes

Risk Trend (2024-29 Optimised portfolio)
Over the 5 year regulatory window, total **baseline** monetised risk due to **functional** Auxiliary AC DC Systems failure is estimated to increase to $6.4M by 2030. The figure below depicts the **baseline** scenario and investment **outcomes** ($2.6M) of the optimised program for Auxiliary AC DC Systems.



Asset Grouping

The Auxiliary AC DC Systems assets have been grouped into three broad categories for investment optimisation purposes according to the different modes of replacement:

1. **Risk-based replacement -** e.g. The risk attributed to a asset through its combination of probability of failure and consequence of failure is high and replacement is the prudent action to reduce this risk. Assets within this risk-based replacement group have been included in the optimisation process where they will have reached Equivalent Annualised Cost (EAC) positive by FY34.

- 1,302 asset groups were loaded into 293 investments in Copperleaf to provide flexibility in portfolio optimisation.

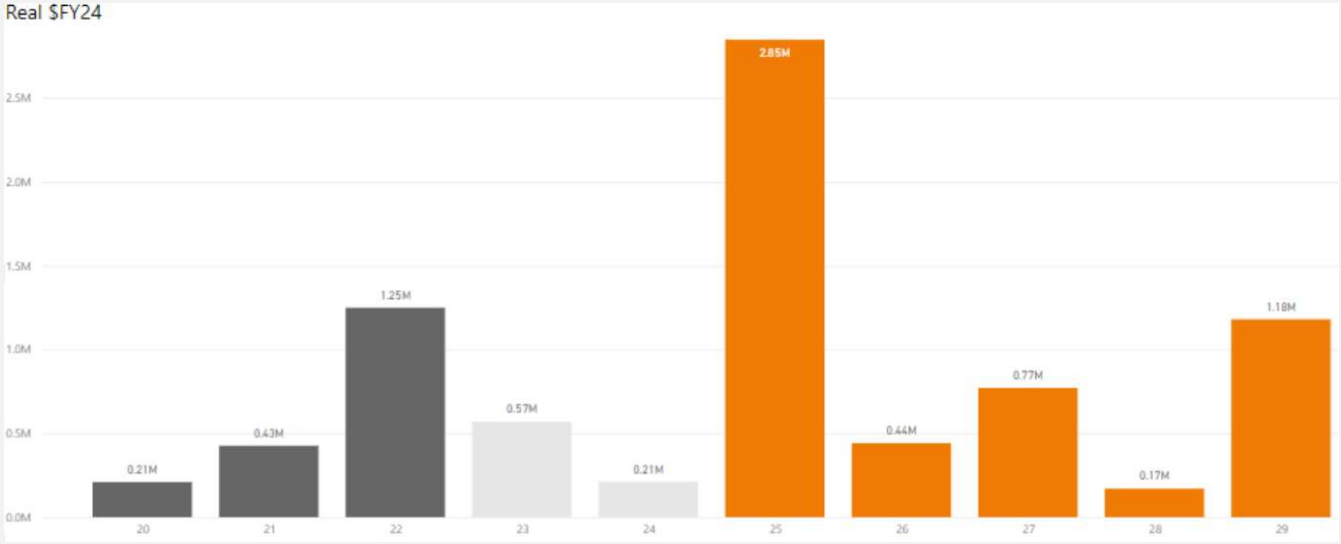
Options

1. Auxiliary AC-DC Systems replacement capex has been modelled using like-for-like replacement
2. Risk based asset groupings are treated as additional optional investments for consideration in the total optimised portfolio to meet overall portfolio objectives.
3. Auxiliary AC-DC Systems are an essential component within zone substations and no viable alternative options are available at this time to replace failed or degraded assets.

- In the planning for asset replacement, options may also consider adjacent and/or related assets – for example, protection scheme changes and/or upgrades – rather than considering the battery charger and/or battery bank replacement in isolation.

10 Year Replacement Capex Forecast

Forecast replacement expenditure for Auxiliary AC DC Systems across the 2024-29 period is $5.4M, averaging $1.1M per annum. Actual and projected expenditure for the remainder of the 19-24 period is $2.7M.



Data source: Actuals: Internal delivery reports, Forecasts: Copperleaf
Note: All values are in FY2023-24 real dollar terms

Justification

We are confident that our approach delivers an efficient and prudent level of investment as:

- **Clear drivers from Asset Management Objectives** for Reliability, Quality, Safety and Compliance (as detailed in **Attachment 10.01 Strategic Asset Management Plan**).
- **NER Capex objectives**: form the basis of our proposal
- **Review and moderation:** Our forecasts have been tested and reviewed by our executive management and the Board, subject to top-down challenges (as detailed in **6.03.04 System Capital Risk and Value Based Investment**) and the forecasts moderated based on feedback and discussion.
- **Customer needs:** Through customer engagement, refer Chapter 4 of our Regulatory Proposal, customers indicated a desire to maintain current levels of safety and reliability, and increase expenditure for resilience based projects. This asset class does not explicitly have expenditure related to resilience and therefore has a flat forecast for replacements. The investment will contribute to maintaining safety and reliability, within the wider Repex portfolio (as per copperleaf forecast).

The major benefits from the proposed Auxiliary AC DC System investments (against the **change nothing** scenario) are:

- **Improved network risk and maintainability**: Investment in this asset class will reduce network risk through replacement of degraded condition and/or in high risk locations with more resilient materials of acceptable condition; and
- **Maintain levels of service for our customers:** Maintaining the health of the assets through addressing locations of highest risk, will result in fewer unplanned failures from asset degradation and therefore will enable us to maintain service reliability for customers.

Forecast Auxiliary AC DC Systems Repex expenditure for the 2024-29 period is $5.4M. The increase from 2019-24 actual/forecast of $2.7M is due to:

- Increase volume of replacements to achieve risk outcomes

Strategic Direction

We shall

Acquisition

Selection Criteria

Battery Banks:

- Continue to select the most appropriate battery bank from the existing panel contract as per design requirements and developed standards

Chargers:

- Continue to select the most appropriate charger from the existing panel contract as per design requirements

All Auxiliary AC DC Assets:

- Conduct a trial of new battery technologies such as Lithium with an eye to reduce operational costs associated with the significant maintenance overhead required with the current battery technologies.

Procurement

Battery Banks:

- Continue to use existing contracts to purchase appropriate battery banks as required.

Chargers:

- Continue to use existing contracts to purchase appropriate battery banks as required.

DC to DC Converters:

- Establish a period contract for DC to DC converters

Panels:

- Continue to use existing approved panel manufacturers

Stock holdings:

- Investigate the feasibility of establishing a spares holding for batteries through the panel contract including delivery SLA in an effort to reduce risk and management overhead of storing batteries in Essential Energy Stores.

Supply Chain

- Maintain existing supply chain
- Continue to work with suppliers on opportunities around the improvement of the existing asset fleet.

Ops & Maintenance

Preventative Maintenance (Inspections):

- Continue to perform periodic maintenance to identify failed or defective assets in accordance with *CEOP8011*
- In medium term Replace existing DC Systems minor and major maintenance forms with an electronic form to allow for the captured maintenance information to be stored in a defined location for ease of analysis when required.

Corrective Maintenance (Repairs):

- Continue to manage Auxiliary AC DC systems defects in accordance with *CEOM7773*
- Replace existing Corrective maintenance activities field report with an electronic form

Operations:

- Implement Alarm rationalisation in POF to ensure that all sites are suitably alarmed and that the alarms are classified with the appropriate priority.

Interventions

Serviceability

- Conduct a Review of AC Tunnel Boards during onsite battery maintenance to identify if exposed 415V bus bars are present.

Prioritisation

- Continue to prioritise replacement projects with the value calculators and investment optimisation process.

Process Improvement

- Conduct a review of battery trailer locations and maintenance schedules to optimise the number of trailers and their locations to ensure battery and charger failures can be mitigated in appropriate timeframes

Reducing complexity

- Develop a standard for Auxiliary AC DC Systems which includes a battery sizing calculator, definition of duplication requirements, surge protection requirements, standardisation of charger configuration, storage of configuration files and an assessment guide for adding additional loads.

Disposals

Individual Assets or Entire Asset Variants

- Continue to investigate opportunities to re-use and recycle assets in accordance with *CECP8074.*

Hazardous Materials

- Batteries contain hazardous materials and as such need to be disposed of in accordance with *CERM1000.75e* Battery disposal guideline.

Asset Support

Process & Information

- Create individual records for all Auxiliary AC DC system assets in the EAM system including Chargers, Battery Banks, Panels and DC to DC converters. This allows work tasks to be raised against them directly. Adjust work practices accordingly to ensure that work being carried out on this asset class is captured accurately.

People & Training

- Ensure awareness of appropriate disposal and manual handling techniques for batteries.
- Continue to stress importance of checking battery chargers when entering ZS as part of Zone Substation entry techniques.
- Refine responsibilities to direct Standards ownership by Asset Engineering and specific systems load requirements ownership by Relevant systems owners.