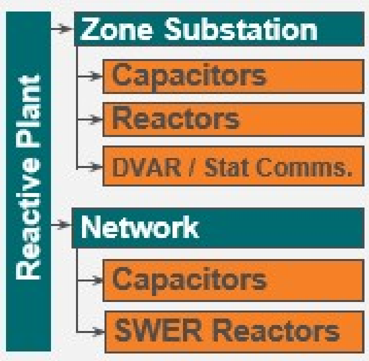
Reactive Plant Investment Case

Reactive Plant within both Zone Substation and on the network provide reactive support where required to assist with power factor correction and voltage support. In Zone Substations, capacitors and reactors are also used for coupling and decoupling of frequency injection plant. These assets are used in the operation and to improve performance of Essential Energy's network.

Scope

This investment case addresses Reactive Plant such as capacitor banks, reactors and DVAR / Static VAR compensators located both in zone substations and on the network, directly supporting their installation, safety, and maintainability.

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



Forecast $FY24

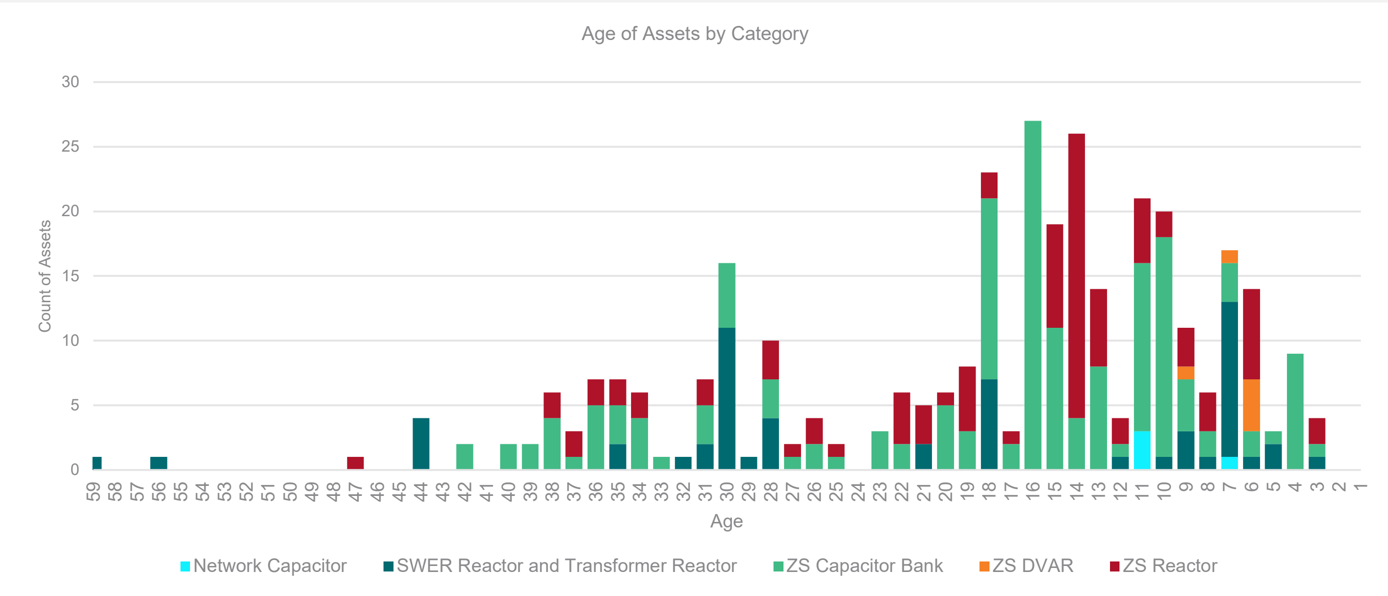
The Reactive Plant forecast accounts for 0.37% of the total Repex portfolio for FY25 to FY29.

FY25	FY26	FY27	FY28	FY29
$0.7M	$1.5M	$0.7M	$0M	$1.2M

Asset Profile/Health

Asset Profile

Essential Energy currently has 530 in service assets recorded that are related to the scope. For the analysis, groups of Zone Substation Capacitor banks, Reactors and DVAR / Static VAR compensators and Network connected Capacitor banks and SWER Reactors were included. The ZS asset groups have an average age of 17, 17, and 6 years respectively. The network asset groups have an average age of 12, and 21 years respectively.



Risk Analysis

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

Probability of Failure – not developed

Failure modes for Reactive Plant have been identified through a Failure Mode Effects Analysis (FMEA) with subsequent analysis focusing only on those failure modes with asset life ending consequence.

TotalSafe records and corrective tasks list were used to identify capacitor bank related failures. A total of 157 tasks (from 2005-2019) were analysed. The limited availability and consistency of data made it difficult to classify failures as repair or replace. The tasks' 'Note Text' field was used to manually allocate tasks to failures using key words and common failure types (eg: **"Hot joint", "Faulty Can", "Catastrophic Failure", "Corrosion/Paint/External Damage", "Fluid Leak", 'Other Defects'**), and validated with SME input. It was concluded in the analysis that, only the end of life replacement failures are consistent. There were only two confirmed records of life ending catastrophic failures including one relating to a type fault and one due to poor protection design where in all cases the Capacitor bank was permanently decommissioned and removed from service and no replacement took place. Capacitor banks are generally utilised for limited hours or days per year or when certain conditions are required for switching, therefore, component failures are manageable under normal maintenance or fault and emergency response. Where a capacitor bank failure is determined to require a full replacement then network planning and operations would make the decision to mobilise a capacitor bank from a site where it is no longer is required.

Reactors (series and shunt) DVAR units, Network Capacitors and SWER Reactors were also considered in this analysis. The same data quality issues identified with capacitor banks were also applicable to these assets, furthermore the very low number of assets in this category, the relatively young population of DVAR units and their service regime does not justify further capital investment in the short to medium term and therefore a data driven PoF model was not developed for these assets.

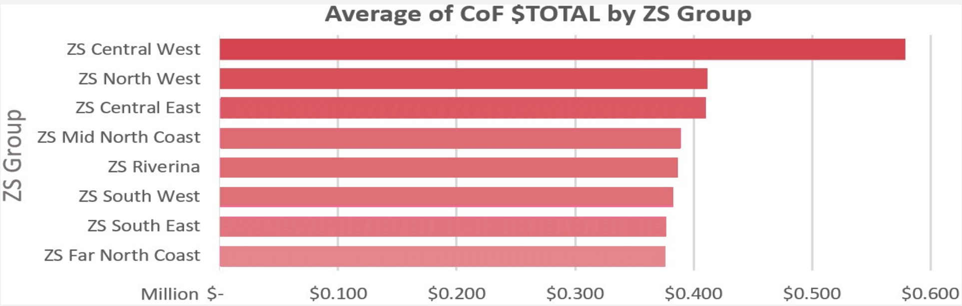
Consequence of Failure

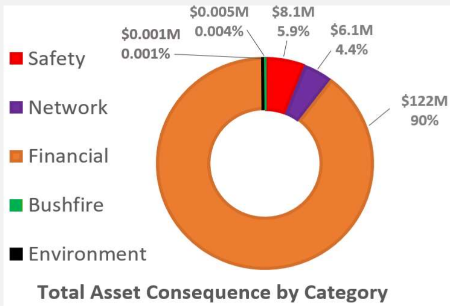
The consequence of failure for these assets describes the impact of a functional failure. Consequence of failure models have been developed for catastrophic asset failure, evaluated using **6.03.03 Appraisal Value Framework** and ranked as shown in the adjacent table:

A safety fatality rate was calculated for each of the following asset types as per **6.03.02 Network Risk Management manual**, with all assets within tolerable safety risk tolerability.

Component	Consequence		
	Total ($ million)	Average ($ per RP)	Median ($ per RP)
Safety	$ 8.092	$ 15,153	$ 7,901
Network	$ 6.035	$ 11,302	$ 5,934
Financial	$122.282	$ 228,993	$ 315,925
Bushfire	$ 0.005	$ 23	$ 23
Environment	$ 0.001	$ 5	$ 5
Compliance	$ -	$ -	$ -
Reputation	$ -	$ -	$ -

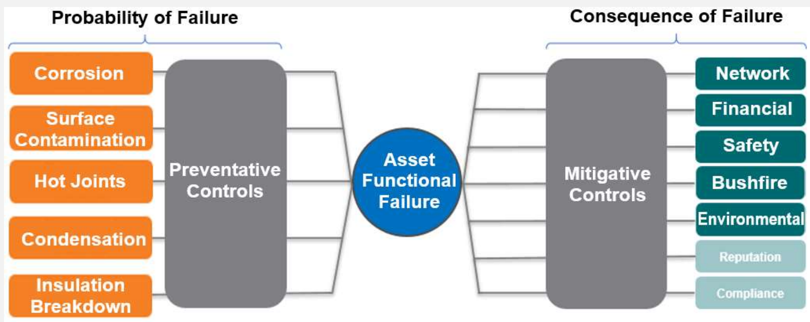
The images below display a **summary of asset criticality** (quantified by the total consequence per asset failure) for Reactive Plant by Zone Substation group. The number of assets within a ZS group area, in conjunction with individual asset CoFs, influence where the ZS Group sits in the ranked list. ZS Central West has the highest criticality assets due to DVAR units installed on the Cobar/Nyngan network.





Network Risk

Asset risk is a function of the probability of failure and the consequence of failure. The risk assessment has been developed using the Asset Risk Management Framework and represents the relationship between the primary drivers behind Reactive Plant 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). It utilises 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 Reactive Plant are based on forecast end of life asset replacement. No conditional replacements have been forecast.

REACTIVE PLANT $M	ACTUALS						FORECAST - based on preferred scenario 2 - EOL replacement													
Asset Sub category	FY16	FY17	FY18	FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
Network Capacitor	$0.11	$0.06	$0.30	$ -	$-	$-	$ -	$-	$ -	$ -	$ -	$ -	$-	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SWER Reactor	$0.01	$0.06	$ -	$0.01	$-	$-	$ -	$-	$ -	$ -	$0.03	$ -	$-	$0.09	$ -	$ -	$ -	$ -	$ -	$0.01
ZS Capacitor Bank	$0.70	$0.35	$3.13	$0.35	$-	$-	$0.70	$-	$1.04	$0.35	$0.70	$0.35	$-	$1.04	$0.70	$ -	$1.74	$1.04	$4.87	$0.70
ZS DVAR	$4.41	$ -	$ -	$ -	$-	$-	$ -	$-	$ -	$ -	$ -	$ -	$-	$ -	$ -	$ -	$ -	$ -	$ -	$ -
ZS Reactor	$2.24	$ -	$ -	$0.64	$-	$-	$ -	$-	$0.96	$0.32	$0.64	$0.32	$-	$ -	$1.28	$0.96	$0.32	$1.60	$0.64	$0.32

Forecast investment expenditure has been determined by multiplying the forecast replacement quantities of Reactive Plant 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

Risk Trend (2024-29 Optimised portfolio)

Optimised portfolio outcomes are not available for Reactive Plant as PoF models have not been developed for this asset class due to limitations of data.

The forecast quantities of replacements have been evaluated using an aged based trigger to estimate end of life replacement numbers per year. This replacement age trigger has been approximated to 40 years. There are no proactive replacements proposed as part of the portfolio and assets will be replaced on failure.

Grouping

The Reactive Plant assets have been grouped into two broad categories for investment optimisation purposes according to the different modes of replacement:

1. **Conditional** replacement - nil
2. **Functiona**l failure replacement - where the Reactive Plant (ZS capacitor bank and reactor) is no longer able to perform its function due to damage or end of life and requires replacement.

- 20 asset replacements were loaded as 1 investment in Copperleaf reflecting the forecast failure replacements predicted over the regulatory period.

Investment Options

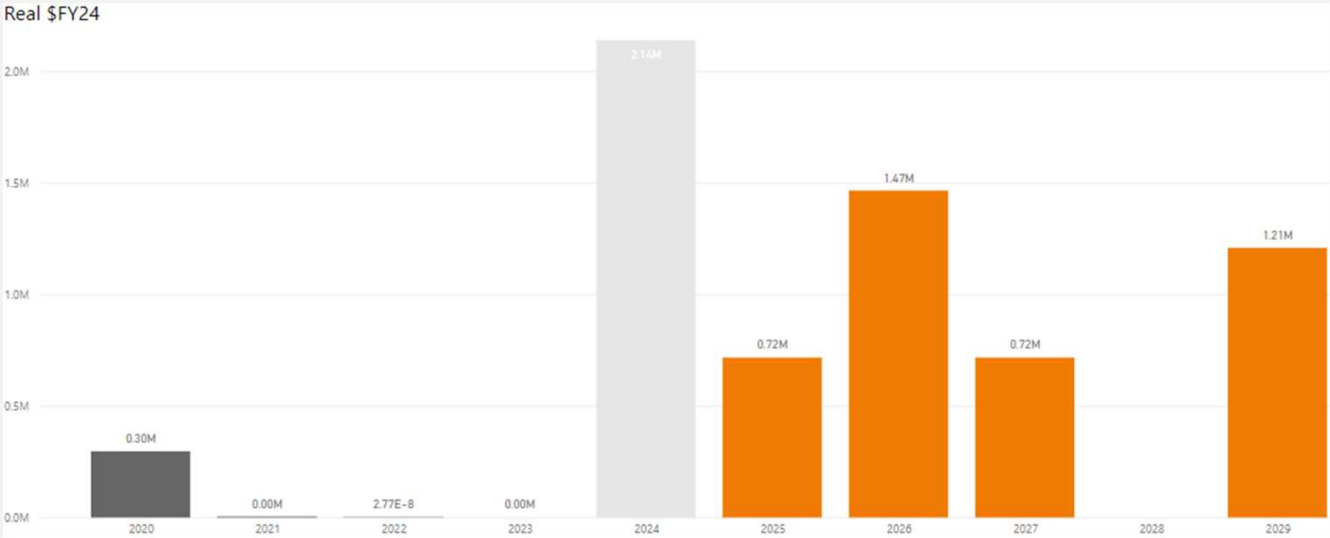
1. Reactive Plant replacement expenditure has been modelled on a replace with current standard or like-for-like.
2. Created as 'must-do' in Copperleaf based on analysis from the asset class strategy

- Non-network solutions are not considered when planning the replacement of this asset class.

10 Year Replacement Capex Forecast

Forecast replacement expenditure for Reactive Plant across the 2024-29 period is $4.1M, averaging $0.8M per annum. Forecast expenditure for 19-24 period is $2.4M.

FY24 is catch up replacements as planned work impacted by emergency bushfire and flood response during the current period



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 because:

- **Clear, prudent drivers from Asset Management Objectives (detailed in Attachment 10.01 SAMP) for Reliability, Quality, Safety and Compliance:** Our forecast has been developed in line with the asset management objectives for this asset class include: maintaining present reliability levels for our customers; maintaining safety incidents at or below present levels; and reducing unassisted fire starts;
- **NER Capex Objectives:** form the basis of our proposal
- **Review and moderation:** Our forecasts have been tested and reviewed by our customers, our executive management and the Board, and the forecasts have been moderated based on feedback and discussion.
- **Deliverable:** Adequate resources are available to deliver the work.

The major benefits expected from these investments are:

- **Maintain network and safety risk and reduce bushfire risk**: establish bulk replacement program were value demonstrated to proactively address locations of greatest risk across the network, and in a manner that minimises costs; and
- **Maintain levels of service for our customers:** Maintaining the health of the Reactive Plant fleet, and through addressing locations of highest risk, will result in fewer unplanned failures through asset degradation and therefore will enable us to maintain service reliability for customers.

Forecast Reactive Plant Repex expenditure for the 2024-29 period is $4.1M. The increase from 2019-24 actual/forecast of $2.4M is due to:

- increase in volume of replacements to reduce risk of aging fleet

Assumptions

- Attribution of tasks to specific assets was not possible in general. To approximate an age at task date for replacements, modelling assumed an installation date for the replaced asset equivalent.
- Categorisation of task maintenance activity was performed in a task code mapping spreadsheet. Tasks were categorised (Replace, Repair, Inspect, Install, Modify) based off their task group, task description, and cause description. The ‘Replace’ category was reserved for replacement of an entire assembly, with minor component replacements being categorised as ‘Repair’.
- Age profile was determined using the asset installation date where available, some assumptions were made for sites without this information.
- Consequence models were developed in accordance with 6.03.03 Appraisal Value Framework.

Strategic Direction

Lifecycle Stages

Acquisition

Selection Criteria

- ZS Capacitors : Maintain current selection criteria.
- ZS Reactors : Maintain current selection criteria.
- DVAR / Static VAR compensators: Maintain current selection criteria.
- Field SWER Reactors: Maintain current selection criteria.
- Distribution capacitors: Maintain current selection criteria.

Maintain awareness of alternate supplier designs and trial where commercially and technically viable.

Investigate viability of replacing failures only where value can be demonstrated.

Procurement

- Establish a list of key spares for DVARs including current consumables and keep a stock of these available for key areas.
- Continue the current period contract approach with vendors.
- Maintain awareness of obsolescence issues and availability of critical components.

Supply Chain

- Continue to work with suppliers for new product opportunities.
- Maintain catalogue options for ZS Capacitors, Reactors and DVAR / Stat Comms and field SWER Reactors and distribution capacitors from multiple suppliers, to maintain diversity of supply.

Ops & Maintenance

Preventative Maintenance (Inspections):

- Continue to do non-intrusive examination and inspection of high voltage ZS capacitor banks, reactors and DVAR with visual inspections to detect signs of surface or corrosion defects on assets as per CEOP8011 for ZS Assets
- Continue to inspect assets as per *CEOP8011 Substation Inspection:*
- CAPACITOR BANK: ABB Abbacus Kiosk: 1year intervals.
- CAPACITOR BANK: Outdoor Generic: 6year intervals.
- CAPACITOR BANK: FI Plant Generic: 6year intervals.
- REACTOR: 6year intervals.
- DVAR: 6month intervals.
- NETWORK CAPACITORS & SWER REACTORS: AI cycle as detailed in *CEOP8009.*

Corrective Maintenance (Repairs):

- Continue with existing repair.
- Set up a replacement program for these assets where value can be demonstrated.
- Continue on-condition corrective maintenance where financially viable and spares readily available.

Breakdown Maintenance:

- Continue to carry out breakdown maintenance on ZS Capacitors, Reactors and DVAR / Stat Comms and field SWER Reactors / Capacitors assets with an economic viability assessment of repair or replacement.
- Larger investments will undergo and require demonstration of a positive value calculation.

Interventions

Replacement Programs

- For ZS Capacitors/Reactors and Network Capacitors used for PF correction/voltage support: On failure, assess and where value is demonstrated replace the asset. If value cannot be demonstrated decommission / remove the asset.
- For ZS DVAR, ZS FI Capacitors/Reactors, Network SWER Reactors: Replace where value demonstrated
- Continue to improve the Value assessments for Reactive Plant to determine the future use and where replacement of Reactive plant is required.

Prioritisation

- Continue to prioritise replacement projects with the value calculation and investment optimisation process. Establish regular network review and develop a critical RP list to ensure customers agreed transfer capacity is not compromised on failure of critical reactive plant
- Update *CEOP8032 Transmission and Zone Substation Design Guidelines* to include design recommendations for indoor / outdoor reactive plant and network reactors and capacitors.

Disposals

Individual Assets

- Continue to investigate opportunities to re-use and recycle assets in accordance with *CECP8074.*
- Continue to dispose of assets as per *CECP8074.01 Company Policy Asset Disposal.*

Entire Asset Variant

- Continue to dispose of assets as per *CECP8074.01 Company Policy Asset Disposal.*

Hazardous Materials

Continue to manage hazardous materials in accordance with *CECM1000.10.*

Asset Support

Process & Information	• Improve use of EAM as the central repository of asset information, preventative and corrective actions and test results. • Create records in EAM for Reactive Plant and their failures to capture asset profile. • Enhance asset risk-value assessments leveraging capabilities of new and existing software platforms. • Continue to follow *CEOM7074 Operational Manual: Entry into electrical stations* for safety directions for employees working in Zone Substations.
People & Training	• Continue with other current training practices, including awareness of associated conditional failure when inspecting or maintaining Reactive Plant assets. • Continue to manage knowledge and skills regarding significant repairs
Supply Chain	• Continue to manage spares for unsupported ZS and network Reactive Plant assets.