ASSET CLASS OVERVIEW

PROTECTION AND CONTROL

UE BUS 4.10

2026–31 REGULATORY PROPOSAL

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1. Overview

Protection and control systems are designed to detect the presence of network faults or abnormal operating conditions and are critical to the safe and reliable operation of our network. Our protection and control systems comprise electromechanical, analogue electronic, and digital relays.

Our asset management strategy is designed to maintain network reliability and minimise safety risks while meeting regulatory obligations. Our asset management interventions for zone substation protection and control relays includes time-based routine maintenance coupled with risk-based replacement and unplanned reactive replacement. This strategy is underpinned by reliability-centred maintenance (RCM) and risk monetisation analysis. Investments for risk-based replacement is only undertaken when the total value of the underlying risks exceeds the cost of replacing existing assets.

A summary of our protection and control relay replacement expenditure is set out in table 1.

Compared to current and past regulatory periods, a smaller volume of relays are anticipated to reach the end of their economic life in the 2026-31 regulatory period. This results in a step-down in expenditure relative to the current regulatory period.

TABLE 1 FORECAST PROTECTION AND CONTROL EXPENDITURE ($M, 2026)

EXPENDITURE	FY27	FY28	FY29	FY30	FY31	TOTAL
Unplanned relay replacements	0.3	0.3	0.3	0.3	0.3	**1.4**
Risk-based relay replacements	3.8	1.7	2.8	1.6	1.5	**11.5**
Total	**4.1**	**1.9**	**3.1**	**1.9**	**1.8**	**12.9**

(1) Our protection and control expenditure included in our reset RIN includes relay replacement due to zone substation replacement. Given the driver of these works is the underlying primary plant replacement, the correspdong cost, economic anlaysis and risk modelling for these projects are presented in our zonesubstation switchgear asset class overview

(2) In addition to modelled relay replacements, our risk-based category also includes annual ongoing programs

2. Background

Zone substation protection and control systems are designed and configured to detect the presence of network faults, or abnormal operating conditions. These systems automatically initiate action to isolate the faulted network component by opening the appropriate circuit breaker(s) or correct the abnormal operating condition by initiating some pre-defined control sequence.

Protection and control systems are essential components of the network, playing a critical role in ensuring continuous supply of electricity and maintaining safety.

2.1 Compliance obligations

We operate under a combination of national and state legislation which establish our obligations and the regulatory framework under which we operate.

The National Electricity Rules sets out reliability and safety obligations and the Electricity Distribution Code of Practice include performance requirements. We must also manage our network assets in accordance with the Electricity Safety Act 1998, the Electricity Safety (Management) Regulations 2019, the Electricity Safety (Bushfire Mitigation) Regulations 2013 and the Victorian Environment Protection Act 2017.

These obligations can be summarised as follows:

- Electricity Safety Act 1998 – requires us to minimise safety risk 'as far as practicable' including bushfire danger
- Electricity Distribution Code of Practice – requires us to manage our assets in accordance with principles of good asset management and to minimise the risks associated with the failure or reduced performance of assets
- National Electricity Rules – requires us to forecast expenditure to maintain the quality, reliability and security of supply of our networks and maintain the safety of the distribution system
- Victorian Environment Protection Act (2017) – requires us to reduce the risk of harm from our activities to human health and the environment and from pollution or waste.

In short, we must maintain reliability, minimise safety risk 'as far as practicable' including bushfire danger arising from our network, and reduce the risk of harm to the environment.

2.2 Asset population

The protection and control systems asset class comprise of relays that are typically mounted in cubicles housed in zone substation building or substation control room. These relays include electromechanical relays, analogue electronic relays, and digital relays. As shown in table 2, the majority of our asset class are digital relays.

TABLE 2 RELAY POPULATION

RELAY TYPE	VOLUME
Electromechanical	70
Analogue electronic	105
Digital	2,068
Total	**2,243**

Note: This table excludes auxiliary relays and other ancillary equipment such as trip relays and repeat relays that are commonly associated with the main protection and control relays used to form a system or scheme.

2.3 Asset age profile

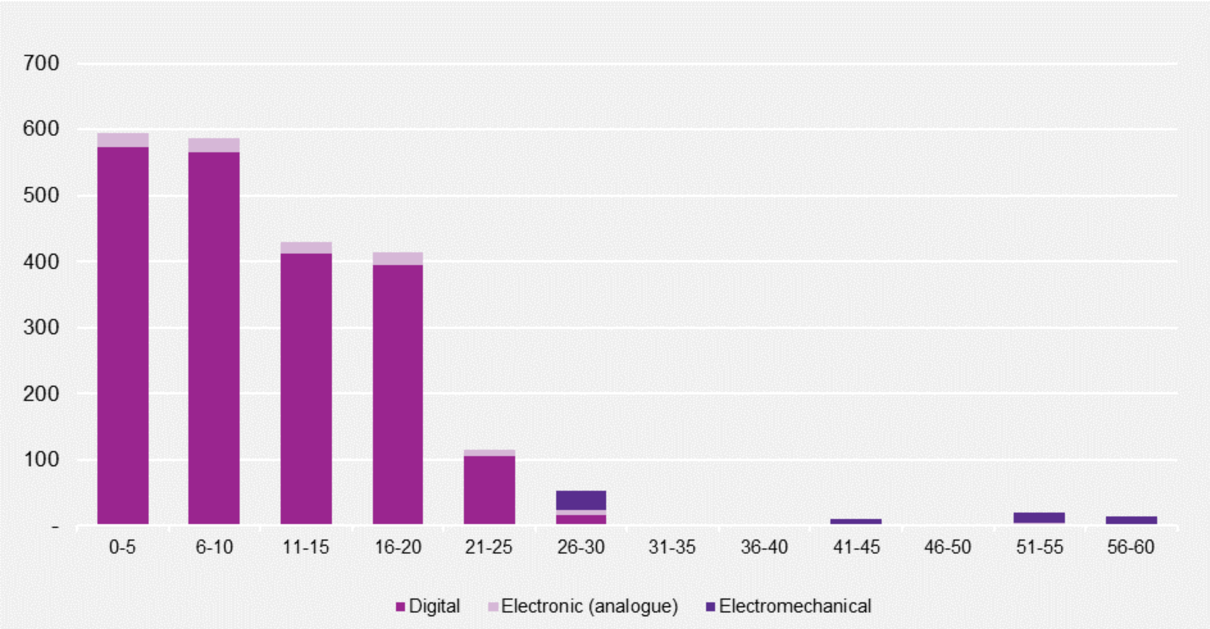
Table 3 sets out the expected service life of each relay type. Service life is the expected period of time after which the asset is unlikely to be fit for purpose, typically determined by safety, technology and/or obsolescence.

TABLE 3 RELAY SERVICE LIFE (YEARS)

RELAY TYPE	EXPECTED SERVICE LIFE
Electromechanical	51
Analogue electronic	20
Digital	28

The age profile of our relay population, by type, is also shown in figure 1**Error! Reference source not found.**. Our fleet of electromechanical, analogue electronic, and digital relays that are past their service life are planned for replacement via committed inflight relay replacement projects at Dandenong Valley, Heatherton, and Glen Waverley zone substations.

FIGURE 1 RELAY AGE PROFILE (NUMBER OF RELAYS BY AGE)



3. Identified need

The performance of our protection and control systems are critical to the safe and reliable operation of the distribution network, particularly under network fault conditions. If protection and control system failures coincide with a network fault, it can:

- result in loss of electricity supply to more customers than needed
- pose a safety risk to our personnel and public
- increase the risk of a fire start, particularly in particularly in electric line construction areas (ELCAs) and hazardous bushfire risk areas (HBRA)
- increase the likelihood of damage to key network assets such as power transformers.

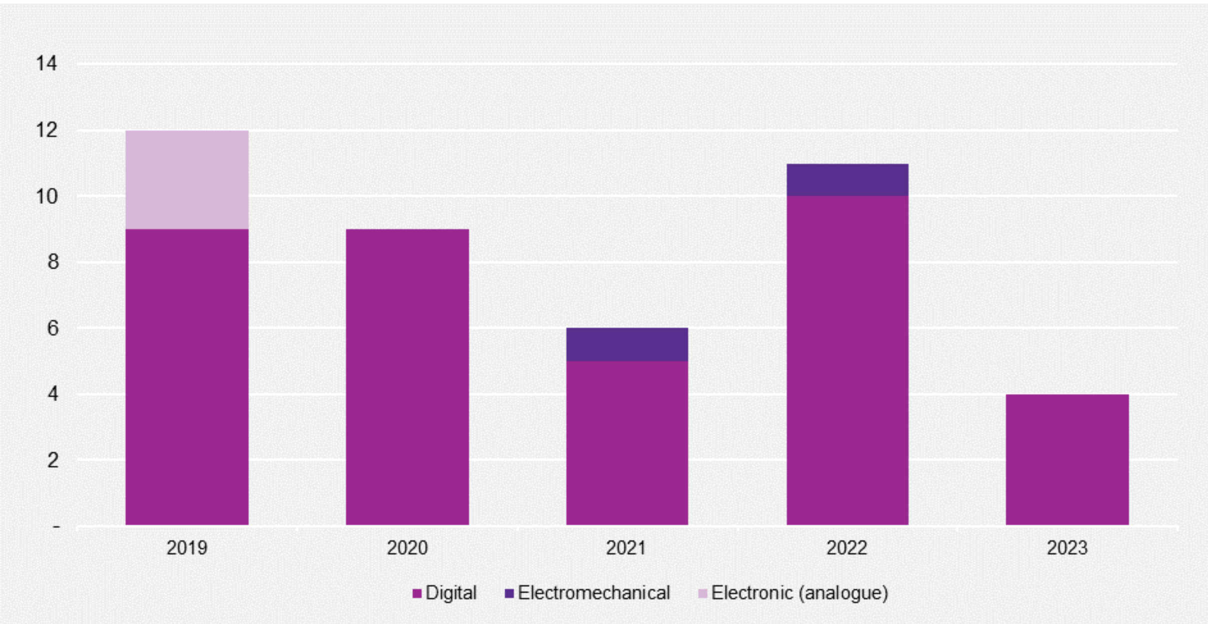
The identified need, therefore, is to manage our protection and control system asset class to maintain reliability in line with our customers preferences, minimise safety risks as far as practicable, and reduce the risk of harm to the environment, consistent with our regulatory and legislative obligations.

This section outlines the historical performance of our protection and control systems, as well as current and expected asset condition.

3.1 Historical asset performance

Figure 2 below, summarises our recent recorded failures. These failures include self-reported defects by relays, mal-operations, failures to operate, and issues discovered during routine maintenance. Relay failures can also remain undetected until they are discovered during routine maintenance. Alternatively, these failures may only be identified when a relay malfunctions unexpectedly or fails to operate correctly during a network incident.

FIGURE 2 FAILURES (NUMBER PER YEAR)



3.2 Asset condition

The condition of our protection and control assets is an important factor in considering the extent of the need to maintain the safety and reliability of our network for customers.

The majority of our protection and control relays are modern digital devices equipped with self-alarming capabilities.

As noted in section 2.3, we expect a limited number of protection and control assets to exceed their service life during the next regulatory period. However, this number is projected to increase in subsequent regulatory periods.

3.3 Demand growth

The electrification of everything from homes to transport, along with ongoing population growth, will require our energy system to evolve. By 2031, for example, we are forecasting a 25 per cent increase in annual consumption and 5 per cent growth in peak demand.

Growth in demand increases the energy that would not be supplied to customers if our distribution switchgear failed.

We forecast demand at an asset level. Our risk modelling uses these asset level demand forecasts to accurately evaluate the energy at risk of not being supplied to customers downstream of specific assets.

4. Forecast interventions

Our asset management strategy aims to maintain network reliability and minimise safety risks while meeting regulatory obligations.

As part of this strategy, we routinely inspect our protection and control systems, and undertake planned, preventative maintenance.

Our response to both relay defects and failures is also to inspect the asset. Upon inspection, relays will typically be repaired or replaced.

Reactive interventions, however, result in elevated maintenance expenses and generally carry greater risk of protection system malfunctions and poorer customer service outcomes. As such, our asset management strategy also considers risk-based interventions, with proactive options considering both individual relay replacements as well as full station upgrades.

Our intervention forecast for the 2026–31 regulatory period is therefore based on two categories, as shown in figure 3. The basis of these forecasts is discussed in more detail below.

FIGURE 3 FORECAST CATEGORIES

Forecast interventions	=	Unplanned	+	Risk-based
		Reactive interventions based on asset failures and defects (including replacements and repairs)		Proactive interventions based on cost-benefit analysis, where risk reduction benefits outweigh intervention costs

4.1 Unplanned interventions

Unplanned interventions in response to defects and failures are expected to occur on a consistent basis with recent history. As such, we forecast unplanned intervention volumes based on an historical average of the previous five years.

4.2 Risk-based interventions

Risk-based interventions comprise relay replacements across the following two categories:

- relay replacements driven by individual asset and zone substation assessments
- relay replacements driven by the replacement of major zone substations assets, such as full switchboard replacement.

The following sections outline our forecast methodology for relay replacements driven by individual assessments only. Relay replacements driven by other primary plant interventions are discussed in the corresponding primary plant asset class overviews (given these are the driver of the underlying relay works).

4.2.1 Forecast methodology

Our asset management interventions for zone substation protection and control relays are supported by risk monetisation analysis.

The application of our risk monetisation analysis is summarised in figure 4, and ensures we invest only when the cost of replacing existing infrastructure exceeds the total value of the underlying risks. This approach is consistent with the AER's asset replacement planning application note.

FIGURE 4 RISK MONETISATION APPROACH

Probability of failure

Failure data on zone substation protection and control relays is used to estimate the failure probability (versus age) of the remaining in-service population using a Kaplan-Meier model and Weibull distribution. A hazard function is then calculated to estimate the probability of failure of the asset for a given age.

Consequence of failure

The consequence of failure is based on the identified failure modes for an asset, and their corresponding likelihoods and consequences of failures. Our risk monetisation considers three separate consequences to determine annual risk costs, as outlined in figure 5.

FIGURE 5 CONSEQUENCES OF FAILURE

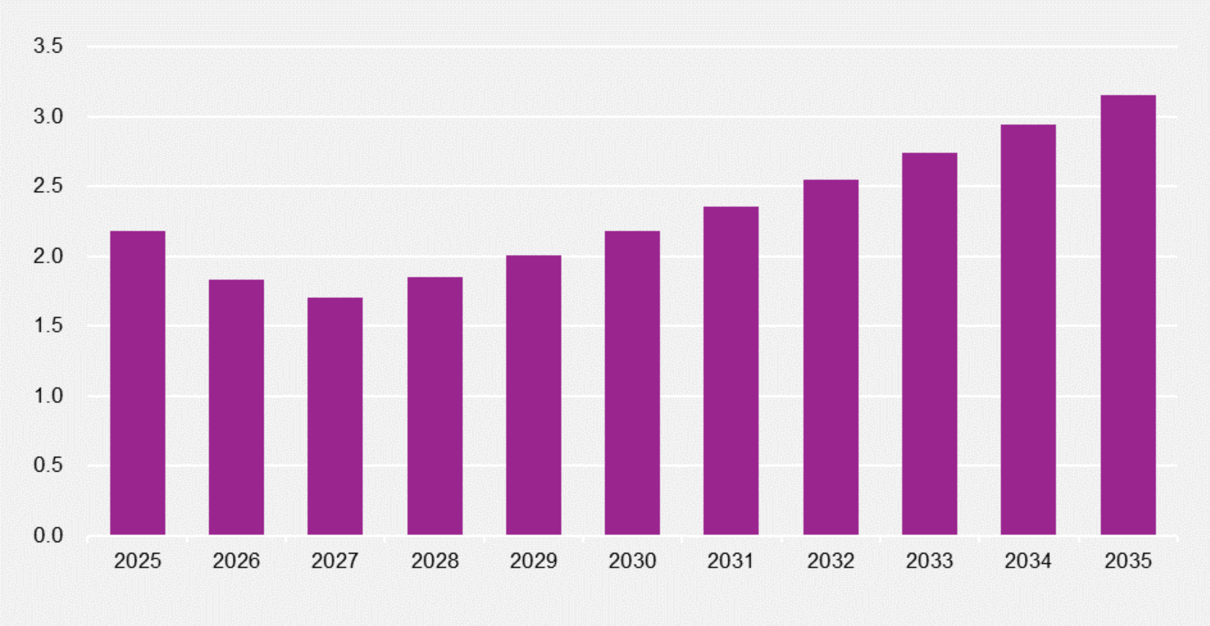
The determination of these consequences is summarised below:

- network performance risk (energy at risk) is determined based on forecast demand and load duration curves for the relevant zone substation. The value of energy at risk is based on the AER's determined value of customer reliability
- safety risks to our staff, and members of the public are determined based on the likelihood of the failure, likelihood of a person present when the failure occurs, and the likelihood and consequence of an injury or death
- financial risks comprise unplanned replacement and unplanned repair impacts respectively, and recognise challenges associated with technical obsolescence of relays (e.g. relays that no longer have manufacturer support or available spares, meaning we may be limited in our ability to repair relays or replace a like-for-like basis, both of which increase costs).

4.2.2 Forecast network risk

The forecast network risk profile for our network protection and control assets, based on our risk monetisation analysis and under a base-case (i.e. no investment scenario), is shown in figure 6. In the absence of any interventions, the annual network risk is projected to increase by 2035.

FIGURE 6 PROTECTION AND CONTROL ASSET RISK PROFILE ($M, 2026)



4.2.3 Options considered

The options considered for our risk-based relay interventions are set out in table 4.

TABLE 4 RISK-BASED INTERVENTION OPTIONS

OPTION	DESCRIPTION
Do-nothing different	No change to existing operational and maintenance practices and run to failure with no planned replacement
High priority relay replacement	Replace all high priority relays based on the asset condition and the most economic whole of lifecycle cost determined by risk and consequence of failure

We also considered the following intervention options, but these were assessed as not credible:

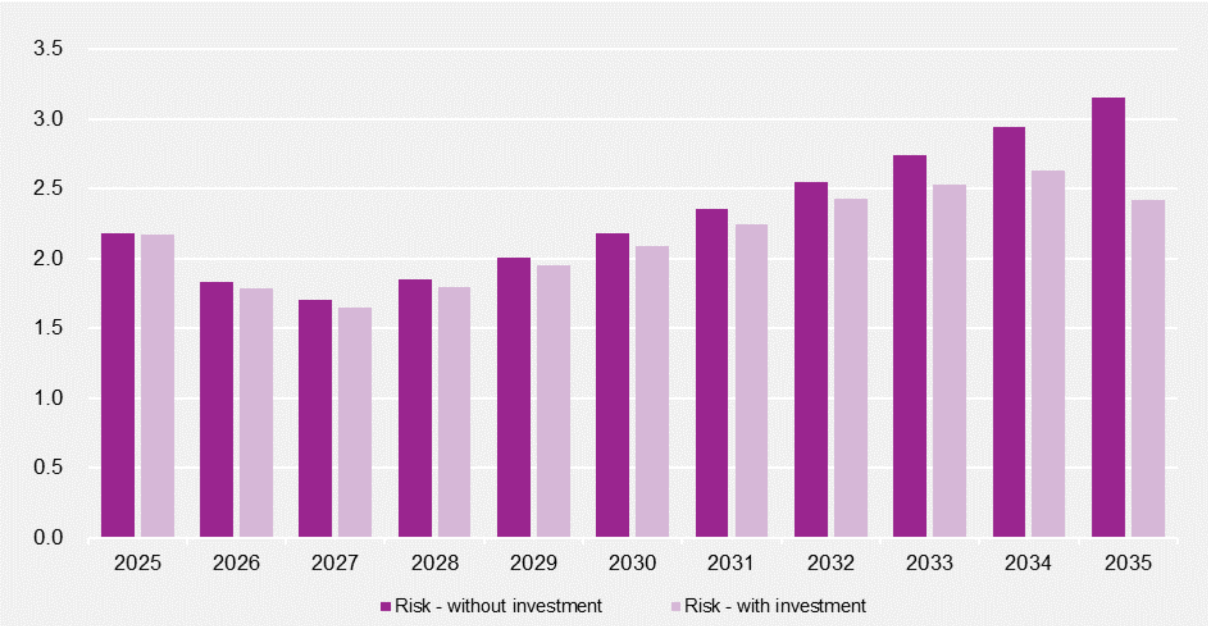
- refurbishments or repairs – this is not a long-term solution due to the technical obsolescence of our electromechanical and electronic relays. The majority of these relay types no longer have manufacturer support or available spares, making repairs inefficient and costly. Additionally, there are limited skills in the workforce to perform these tasks
- increase frequency of routine maintenance inspections – this is not a viable solution due to the substantial workforce required to perform these tasks more frequently, coupled with the minimal risk reduction achieved. Additionally, the inherent risks associated with these relays will persist, necessitating their eventual replacement. This approach is therefore considered ineffective
- whole of zone substation replacement – as per industry practice, we considered the replacement of all relays at the zone substation control room, however, we can manage our relay risk more efficiently by instead targeting only the high priority relays
- non-network solutions – we are not aware of any non-network solutions that would replace the functionality of relays.

4.2.4 Forecast risk-based interventions

Our forecast risk-based interventions, as justified in our attached risk model, will allow us to efficiently manage the increasing risk profile relative to a do-nothing option (shown below in figure 7).[1]

In summary, by continuing the current routine maintenance coupled with targeted risk-based replacement in the 2026-31 regulatory period, the risk is maintained (relative to the base case).

FIGURE 7 PROTECTION AND CONTROL ASSET RISK PROFILE ($M, 2026)



The full list of our forecast risk-based relay replacements is shown in table 5. The costs of these works are based on the underlying site and recently completed projects. Further detail is in our attached models.[2]

1 UE MOD 4.05 – Relay risk monetisation – Jan2025 – Public
2 UE MOD 4.05 – Relay risk monetisation – Jan2025 – Public; UE MOD 4.08 – Relay replacement – Jan2025 – Public

TABLE 5 RISK-BASED PROTECTION AND CONTROL EXPENDITURE ($M, 2026)

ZONE SUBSTATION	FY27	FY28	FY29	FY30	FY31	TOTAL
DVY	0.7	-	-	-	-	**0.7**
EM	0.6	-	-	-	-	**0.6**
GW	1.2	-	-	-	-	**1.2**
MTS	0.8	0.2	-	-	-	**1.0**
CDA	-	0.4	1.1	0.4	-	**1.8**
FTN	-	-	-	-	0.7	**0.7**
EL	-	-	-	-	0.2	**0.2**
Total	**3.4**	**0.6**	**1.1**	**0.4**	**0.9**	**6.3**

(1) Only partial spend for DVY, EM and GW is inlcuded as these projects are already in flight. Similarly, only partial spend for FTN and EL is included as these project is forecast to be completed in the 2031-36 regulatory period.

(2) In addition to modelled relay replacements, our risk-based category also includes annual ongoing programs

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