31 January 2023

Attachment 6.2: Network maintenance program

Ausgrid's 2024-29 Regulatory Proposal

Empowering communities for a resilient, affordable and net-zero future.

Contents

1. Introduction

1.1 This document's purpose

This document provides a summary of the network maintenance program forming part of Ausgrid's operating expenditure (**opex**) for the 2024-29 period. This does not include alternative control services (**ACS**) or other operational activities beyond network maintenance.

1.2 This document in context

This document includes the scope of the network maintenance program only. This does not include other operating expenditure covered under:

- Network support;
- Non-network property;
- Information and communication technology (ICT); and
- Corporate support.

1.3 Related documents

Att #	Document
6.1	Proposed operating Expenditure
5.4.a	Asset replacement programs

1.4 Document overview

To provide a safe and reliable service to customers, existing infrastructure is required to be carefully managed. This includes the maintenance of assets across their operating life. The network maintenance program includes inspections, testing, condition monitoring and preventative tasks to assess the condition of assets and ensures that they remain safe and reliable.

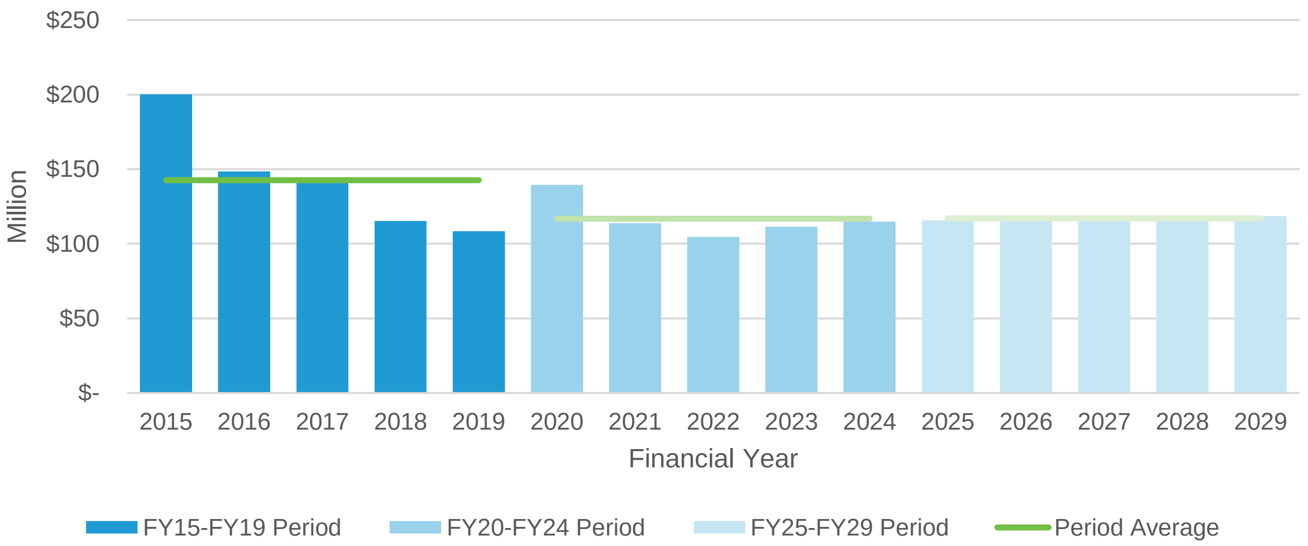
This document describes the assessment undertaken to form the 2024-29 proposed network maintenance program expenditure forecast for key standard control asset classes. It includes an explanation of our approach to determining asset maintenance requirements and the key maintenance activities undertaken for each asset class.

2. Executive summary

2.1 Overview of maintenance expenditure

Figure 1 shows the maintenance expenditure profile from 2015, compared to our 2024-29 forecast and the average expenditure during previous regulatory periods. Ausgrid has undergone significant transformation which has changed the expenditure profile of our maintenance program from its peak in 2015. The maintenance expenditure profile is now considered to be in a steady state, with further opportunities to improve, being offset by new assets, increases in asset population and risk growth for existing assets.

Figure 1. Maintenance expenditure by regulatory period (real $m, FY24)



2.2 Our forecast is largely stable

While our underlying requirement for maintenance is forecast to remain stable, the expenditure profile is impacted by the following:

1. **Growth in the asset population** is forecast due to customer growth adding additional assets to the network, increasing the population to be maintained; and
2. **An increasing asset age profile** is forecast to result in increasing defects and failures and therefore additional expenditure to manage risks. In assessing whether the age profile is increasing, the impact of future capital investment has been considered.

While maintenance and replacement activity is not primarily driven by age, there is a strong correlation between age and asset condition. As assets age, the likelihood of asset failure increases and so does the risk. There is also a relationship between repair and replacement as when assets are replaced, the requirement for repair becomes less likely, ultimately reducing the repair requirements. Forecasting repairs must be considered in conjunction with the impact of our replacement investment.

Our forecast 2024-29 replacement expenditure is lower than the current period and will result in the average age of our infrastructure increasing. Therefore, while maintenance decreases for replaced assets the overall increase in the average age is forecast to place upward pressure on maintenance expenditure.

To counteract this upward pressure, Ausgrid seeks to continually improve the efficiency of its operations, so that we continue to deliver value to our customers. This includes areas such as:

- Purchasing smart-meter data to enable earlier detection of network faults;
- Leveraging our Advanced Distribution Management System (**ADMS**) to allow improved switching/restoration of the network;

- Utilising technology such as drones to capture condition data more cost-effectively, and in areas previously unable to be reached, or to improve the timeframes for responses;
- Review and optimisation of preventative maintenance cycles; and
- Transitioning to lower cost maintenance technologies.

As a result, we are not forecasting a step change in maintenance expenditure due to the increasing asset age profile.

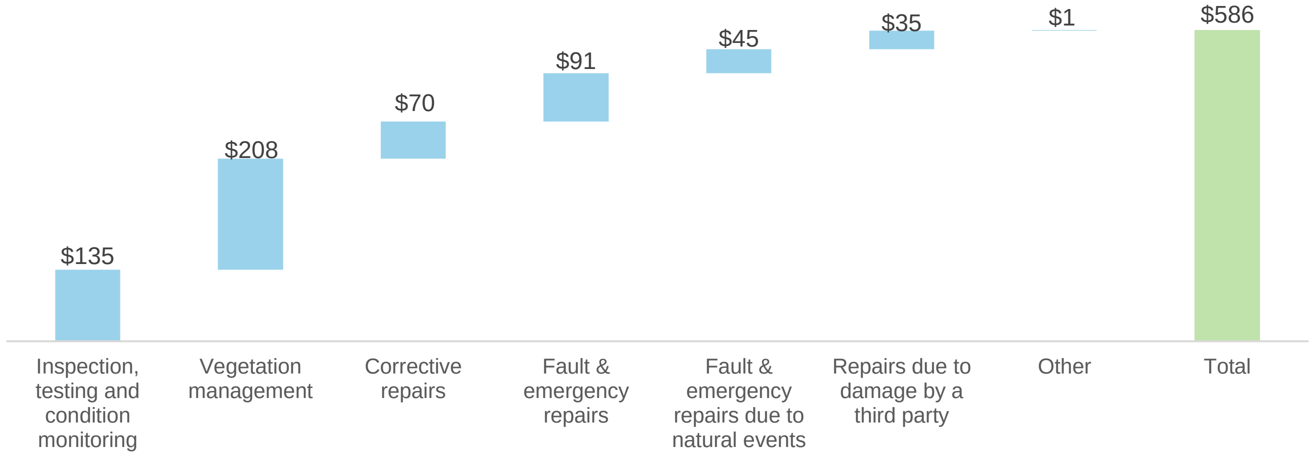
3. Maintenance activities

3.1 Overview of maintenance activities

We perform a range of planned and unplanned maintenance activities on our assets to maintain the safety and performance of the network. We have provided an overview of the maintenance activities that comprise our maintenance expenditure forecast for the 2024-29 period in **Figure 2** below.

The performance of the maintenance activities listed in **Figure 2** are necessary to maintain the safety and reliability of our network, and to enable Ausgrid to maintain the security and quality of electricity supply to our customers. A breakdown by asset class can be seen in **Figure 5**.

Figure 2. Maintenance activities for the 2024-29 period by cost category (real $m, FY24)



3.2 Our approach to determining maintenance requirements

Maintaining assets requires an understanding of the likelihood of asset failure and the resulting consequences of failure. We apply a combination of preventative and condition-based maintenance (**CBM**) to preserve the assets condition and functionality – this is informed by a robust maintenance requirements analysis process that utilises reliability centred maintenance (**RCM**) to optimise maintenance programs. The preventative maintenance activities we apply are low cost and performed in conjunction with condition monitoring activities. CBM includes inspection, testing and online condition monitoring to assess asset condition and inform corrective actions including repairs or asset replacement. How CBM informs asset interventions is shown below in **Figure 3**.

Figure 3. Condition based maintenance informs asset interventions

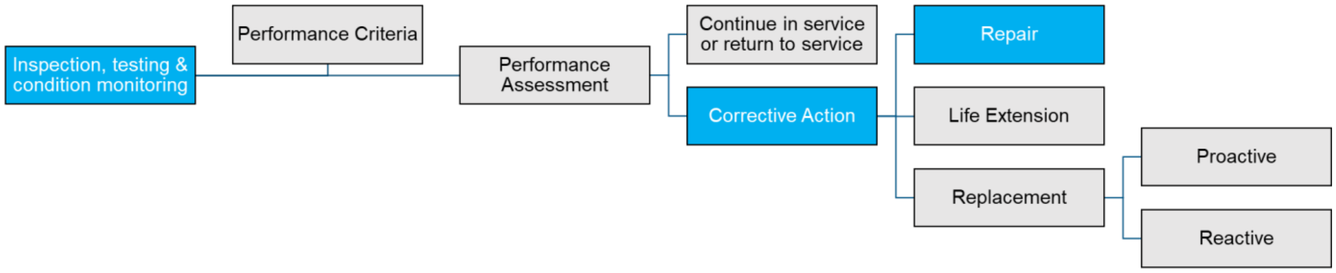
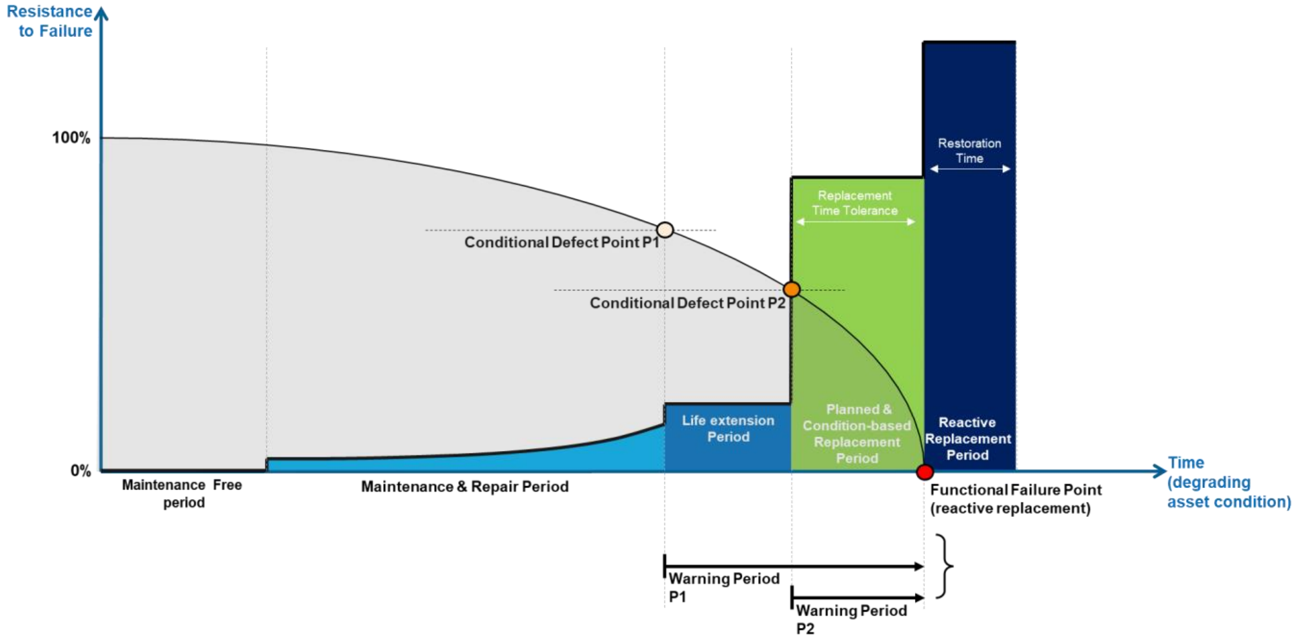


Figure 4 shows the linkage between the process for undertaking CBM and the associated corrective actions over an asset's lifecycle. As an asset's resistance to failure decreases it approaches the end of its serviceable life and is likely suitable for replacement.

Figure 4. Asset degradation curve



Maintenance activities are informed by the following:

1. **Compliance requirements** which is most applicable to the maintenance of substation buildings and land including fire system testing in-line with building codes;
2. **Maintenance requirements analysis** which is applied to a large proportion of the asset population using quantitative RCM analysis to determine maintenance intervals. RCM compares the cost of inspection at varying intervals to the monetised impacts of failure; and
3. **Base step trend** is predominately applied to Ausgrid's largest planned maintenance activities i.e. vegetation management. The base step trend is also applied to unplanned maintenance activities i.e. corrective repairs, fault or emergency repairs and nature induced breakdowns. This approach considers historical expenditure and applies a step change informed by historical performance.

As can be seen in **Figure 4**, asset condition defect points are used to inform corrective actions such as repairs, life extension or replacement. We have established defect criteria which is used to inform these defect points. This defect criteria is informed by historical performance, industry benchmarking and engineering experience.

Details of our condition-based replacement approach are found in **Attachment 5.4.a Asset replacement programs**.

3.3 Inspection, testing and condition monitoring

The expenditure for this category for the 2024-29 period is $135 million, refer to **Figure 2**, and involves work associated with undertaking planned assessment of asset condition. This category includes testing and measurement and all routine visual inspection tasks designed to identify asset defects in line with our CBM approach. Some examples of these activities include pole and line inspections, substation inspections and switchgear testing.

The frequency of these activities may be varied depending on the asset type, the asset condition and the risk profile of individual locations (such as assets in bush fire areas or supplying critical infrastructure).

3.4 Vegetation management

Ausgrid's largest single maintenance activity which includes identifying, scoping and undertaking proactive vegetation cutting to maintain clearances from electrical assets. The expenditure for this category for the 2024-29 period is $208 million, refer to **Figure 2**. This activity manages the risks associated with bushfires, reliability and public safety. Vegetation management occurs routinely and in some areas is periodically verified and rectified from LIDAR.

3.5 Corrective repairs

The expenditure for this category for the 2024-29 period is $70 million, refer to **Figure 2**, and involves all work associated with correcting defects generally identified from inspections, testing and condition monitoring. Corrective maintenance is undertaken when assets fail to meet the defect criteria. This may also include minor changes to the design of equipment to maintain functionality and performance.

3.6 Fault and emergency repairs

The expenditure for this category for the 2024-29 period is $91 million, refer to **Figure 2**, and involves all work associated with equipment that has ceased to perform its intended function (excluding nature induced breakdown and repairs due to third party damage). This includes emergency maintenance due to asset failures resulting from defects that were not detected during routine maintenance. Asset failure data is analysed as part of maintenance reviews to determine any possible improvement opportunities.

3.7 Fault & emergency repairs due to natural events

The expenditure for this category for the 2024-29 period is $45 million, refer to **Figure 2**, and involves all work associated with equipment that has ceased to perform its intended function due to factors beyond the equipment's design capability such as natural disasters (storms and bushfires), lightning strikes or fauna. Prevention of these types of events (with the exemption of vegetation management), generally requires asset or network redesign. Capturing the impacts of these events separately allows them to be individually analysed, so that appropriate solutions can be developed.

3.8 Repairs due to damage by a third party

The expenditure for this category for the 2024-29 period is $35 million, refer to **Figure 2**, and involves all repair work associated with equipment that has ceased to perform its intended function due to factors beyond the equipment's design capability such as external parties digging into underground cables or a vehicle impacting an asset. These failures cannot be managed through normal maintenance activities and may require asset or network redesign to prevent their occurrence. Ausgrid also participates in and runs educational campaigns to minimise damage caused by third parties, including Before You Dig Australia and Look-up and Live. Whilst these costs are recovered from the responsible party where possible, a portion of these are not able to be recovered.

3.9 Other

The expenditure for this category for the 2024-29 period is $1 million, refer to **Figure 2**, and covers work associated with engineering investigations and with enabling plant, tools and equipment that is used to support the delivery of the different maintenance activities defined above to perform their respective functions appropriately.

4. Asset Classes

The forecast expenditure has been broken down into the following asset classes:

Overhead Support Structures	Used to maintain electrical clearances between live electrical equipment and ground

Includes poles, towers, and their associated cross-arms and insulators (pole-tops)

Overhead Mains	Provides electrical connection/capacity for the distribution of electricity above ground

Includes overhead conductors and connections

Underground Cables	Provides electrical connection/capacity for the distribution of electricity below ground

Includes cables, joints, terminations, pillars, pits, ducts and tunnels

Transformers & Reactive Plant	Transforms electricity between voltages and currents

Includes power transformers, reactors, instrument transformers and neutral earthing resistors

Switchgear	Used to control, protect, switch and isolate segments of the network

Includes circuit breakers, links, switches and fuses

Communications, Control & Protection	Provides monitoring, protection, control and automation to the electrical network

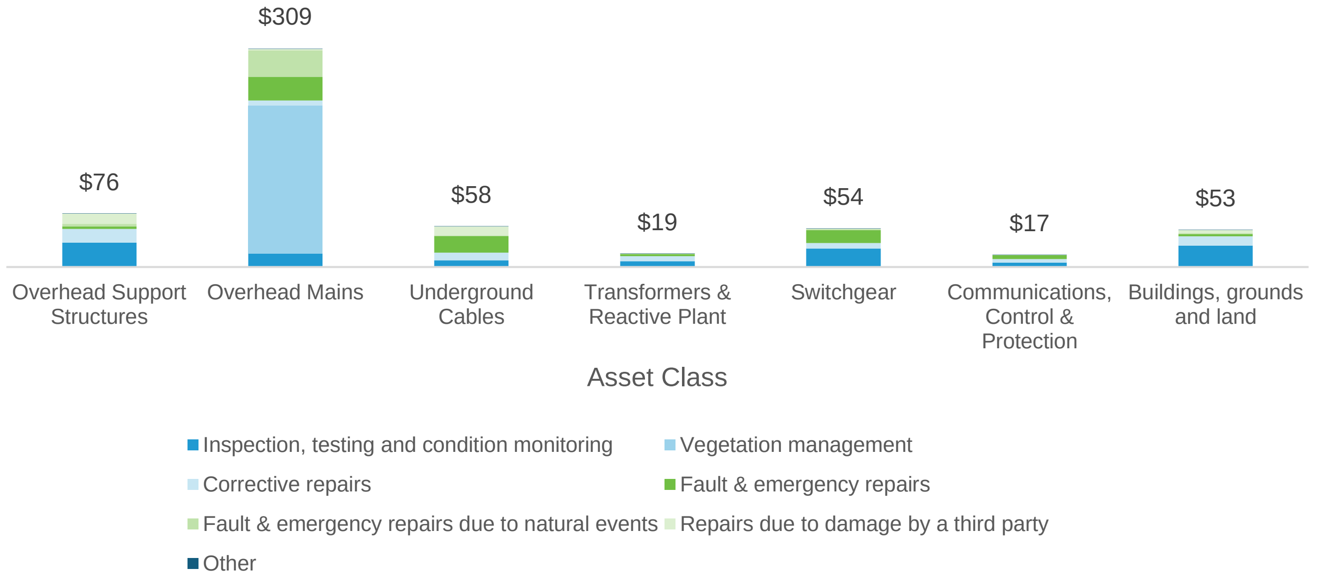
Includes relays, batteries/chargers, remote terminal units, servers and associated communications mediums

Buildings, Grounds & Land	House and physically protect electrical assets

Includes buildings, fencing, civil structures and housings and network support systems such as fire detection/mitigation, substation yard structures, oil containment, air conditioning, security and water treatment

An overview of the maintenance activities for the 2024-29 period by asset class is shown in **Figure 5**.

Figure 5. Maintenance activities for the 2024-29 period by asset class (real $m, FY24)



Expenditure for the forecast period is shown in **Figure 6**.

Figure 6. Ausgrid maintenance programs proposal by asset class (real $m, FY24)

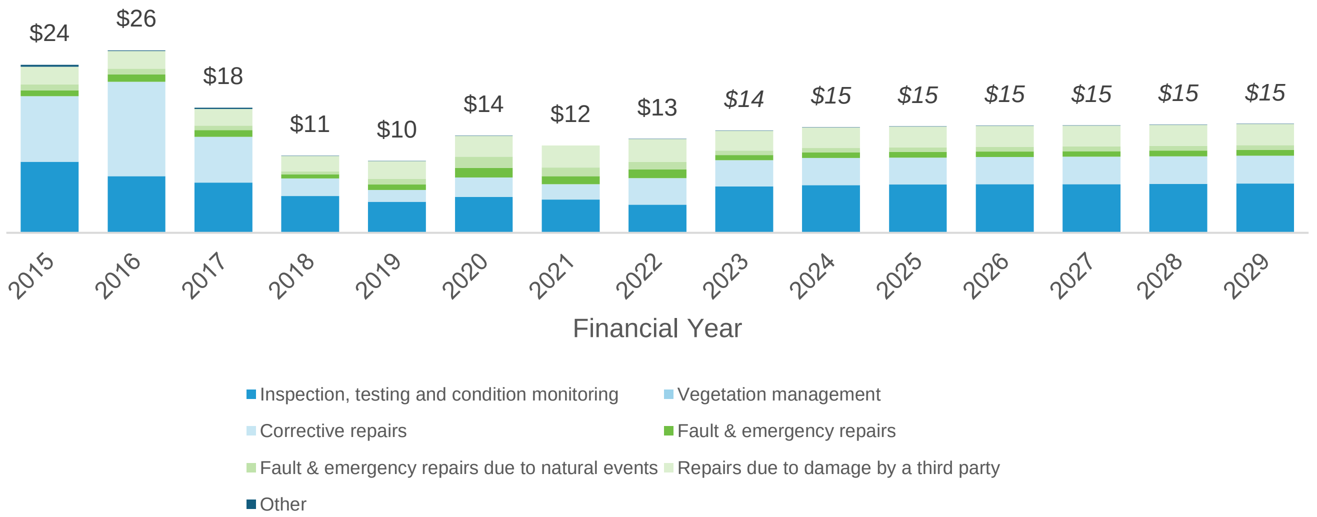
	FY25	FY26	FY27	FY28	FY29	TOTAL
Overhead Support Structures	15	15	15	15	15	**76**
Overhead Mains	61	62	62	62	63	**309**
Underground Cables	11	11	12	12	12	**58**
Transformers & Reactive Plant	4	4	4	4	4	**19**
Switchgear	11	11	11	11	11	**54**
Communications, Control & Protection	3	3	3	3	3	**17**
Buildings, Grounds & Land	10	11	11	11	11	**53**
TOTAL	**116**	**117**	**117**	**118**	**119**	**586**

The following sections outline the main drivers of expenditure for each asset class.

4.1 Overhead Support Structures

During the 2024-29 period we forecast expenditure of $76 million, representing 13% of maintenance, on Overhead Support Structures. This expenditure breakdown is shown in **Figure 7**.

Figure 7. Forecast 2024-29 expenditure breakdown for Overhead Support Structures (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 8**.

Figure 8. Top activities contributing to maintenance expenditure for Overhead Support Structures

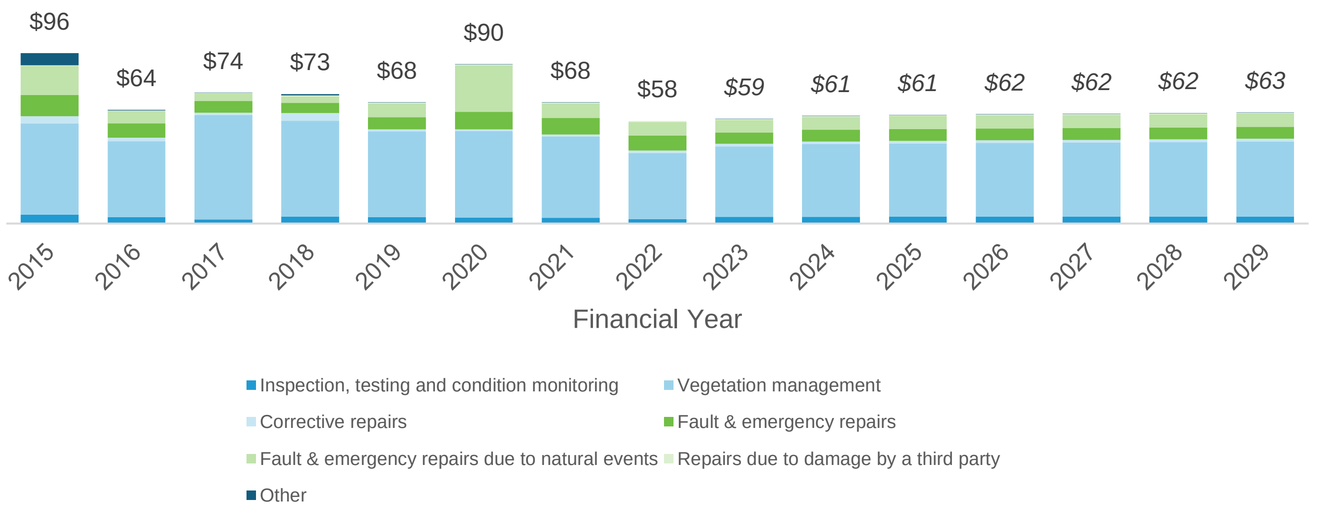
Activity Type	Description
Inspection, testing and condition monitoring ($34m)	As it is a single combined activity, overhead line inspection is included in this category. This includes visual inspection of overhead mains, visual inspection of poles, pole excavation and drilling as well as tower inspections. Following inspection, defects are assessed for repairs, refurbishment, or replacement.
Corrective repairs ($19m)	Corrective repairs include termite treatment, pole straightening, insulator repair and pole head repairs. At the time when condition issues are found, poles and towers are generally suitable for refurbishment (including reinforcement) or replacement.
Repairs due to damage by a third party ($15m)	The main expenditure in this category arises from vehicles impacting our assets requiring asset repair or replacement.

The average age of this asset class has and will continue to increase based on the historical and forecast volume of replacement activity. Despite this asset performance remains steady, therefore, our approach is to maintain maintenance expenditure at current levels and target the effectiveness of our activities to manage performance.

4.2 Overhead Mains

During the 2024-29 period we forecast expenditure of $309 million, representing 53% of maintenance, on Overhead Mains including vegetation management. The expenditure breakdown is shown in **Figure 9**.

Figure 9. Forecast 2024-29 expenditure breakdown for Overhead Mains (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 10**.

Figure 10. Top activities contributing to maintenance expenditure for Overhead Mains

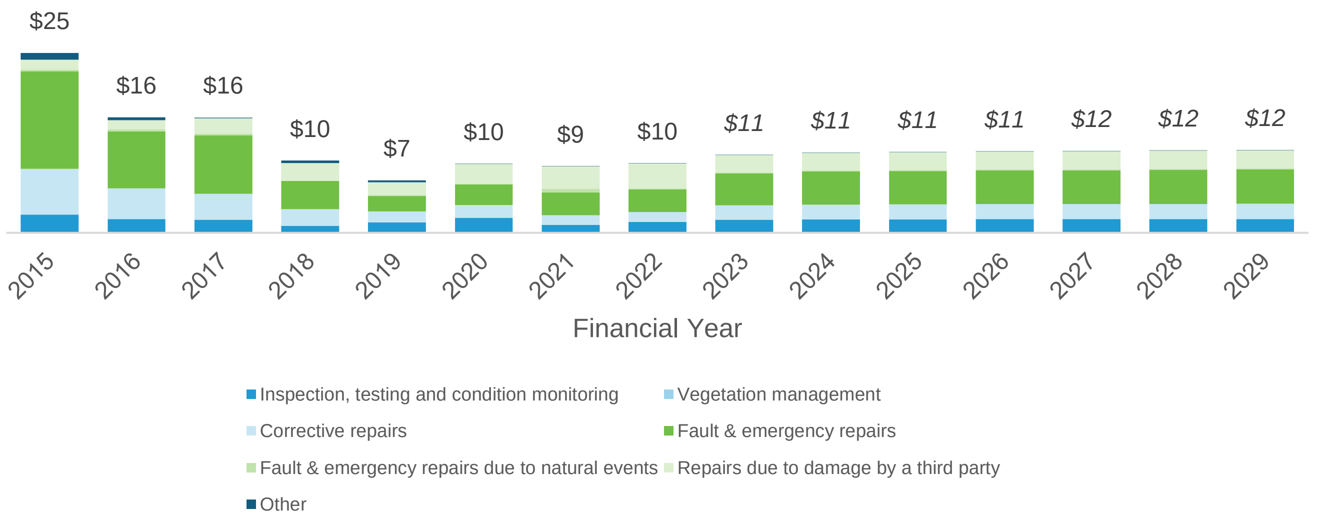
Activity Type	Description
Inspection, testing and condition monitoring ($20m)	As line inspection is captured under Overhead Support Structures, the majority of these costs relate to bushfire patrols including LiDAR and aerial based inspections. Identified defects are then considered for repair or replacement.
Vegetation Management ($208m)	This is the single largest maintenance activity. The requirements for vegetation management are determined by the Industry Safety Steering Committee (**ISSC**) as part of the NSW Government Office of Energy and Climate Change and Ausgrid's standards. Maintenance cycles must consider the balance of safety, cost, vegetation growth, tree health and canopy / amenity.
Corrective repairs ($8m)	Includes minor repairs to broken connections or damaged joints and re-tensioning of low conductors.
Faults and emergency repairs ($33m)	This includes responding and repairing 'wires down' events on overhead lines and service wires and includes the installation of joints.
Fault & emergency repairs due to natural events ($37m)	Predominantly driven by storms or adverse weather events. These events generally include vegetation induced asset failure which results in 'wires down' events. The spike in 2020 is reflective of the significant storm season.

While repairs may be made to keep conductors in service, they do not restore the condition of the conductor, leading to ongoing degradation. To manage the overall condition of the asset class, overhead conductors are replaced. While the replacement program has concentrated on higher-risk non-insulated overhead services lines, which has reduced the average age of this asset sub-class, the average age of the remainder of the asset class has and will continue to increase. As the number of 'wires down' events remain high, we are targeting replacement investment on older and low strength conductors such as dedicated low voltage circuits and small conductors to manage risk and performance while maintaining maintenance expenditure at current levels.

4.3 Underground Cables

During the 2024-29 period we forecast expenditure of $58 million, representing 10% of maintenance, on Underground Cables. The expenditure breakdown is shown in **Figure 11**.

Figure 11.Forecast 2024-29 expenditure breakdown for Underground Cables (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 12**.

Figure 12.Top activities contributing to maintenance expenditure for Underground Cables

Activity Type	Description
Inspection, testing and condition monitoring ($10m)	This includes testing of gas and oil filled sub-transmission cables as well as pillar inspections and thermal testing. These activities inform decisions for corrective repairs and contribute to replacement decisions based on asset condition.
Corrective repairs ($11m)	As testing of cables is minimal, the majority of corrective repairs are identified following a failure, however, repairs are undertaken on underground cable equipment such as pillars and alarm systems as well as cable oil top-ups.
Faults and emergency repairs ($24m)	This includes minor repairs following cable and equipment faults.
Repairs due to damage by a third party ($13m)	This is generally following damage to cables from excavation work.

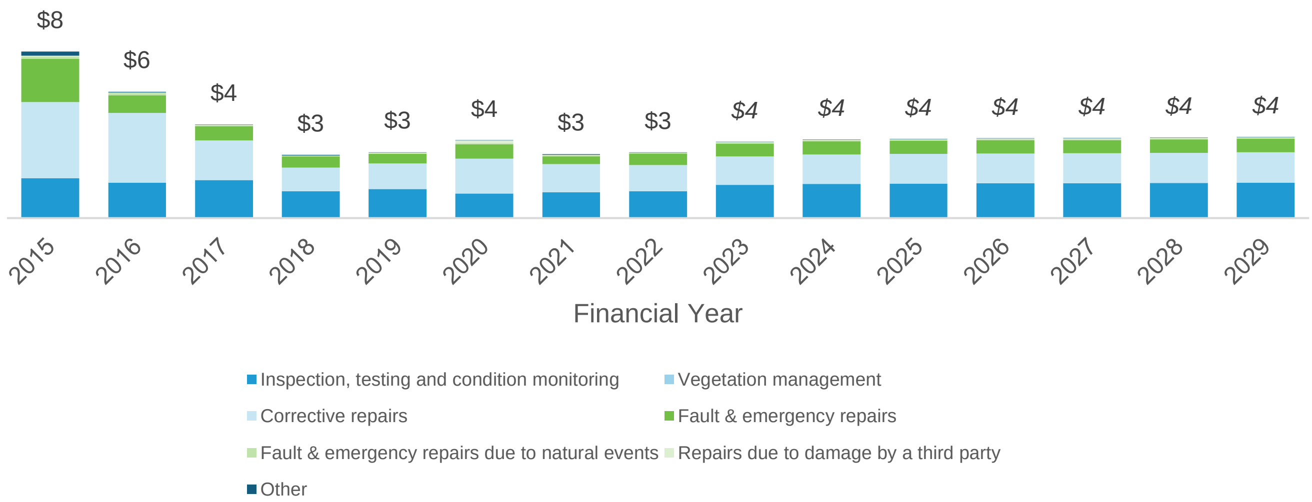
Many cable failures require portions to be replaced due to damage to a length of cable. This can introduce weak points into the cables at these joint locations, eventually requiring the entire cable to be replaced.

While the average age of Ausgrid's sub-transmission underground cables has decreased due to the significant amount of oil and gas cable replacement that has been undertaken, the remaining sub-classes increase the average age for this asset class. While this is placing upward pressure on maintenance expenditure, this is being offset by the retirement of oil cables which drive higher inspection and corrective repair costs compared to modern equivalents.

4.4 Transformers & Reactive Plant

During the 2024-29 period we forecast expenditure of $19 million, representing 3% of maintenance, on Transformers and Reactive Plant. The expenditure breakdown is shown in **Figure 13**.

Figure 13.Forecast 2024-29 expenditure breakdown for Transformers & Reactive Plant (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 14**.

Figure 14.Top activities contributing to maintenance expenditure for Transformers & Reactive Plant

Activity Type	Description
Inspection, testing and condition monitoring ($8m)	This activity includes visual inspection, tap changer maintenance and oil testing of major transformers. Expenditure for the inspection of distribution transformers is captured within the Buildings, Grounds & Land asset class since their inspection is part of general substation maintenance activities.
Corrective repairs ($7m)	Includes activities such as tap changer contact repairs, oil top-ups in leaking transformers and replacement of silica gel to prevent moisture entering the transformer tank.
Faults and emergency repairs ($3m)	Limited expenditure on tap changer and internal winding faults. In the majority of cases the failure of a transformer leads to its refurbishment or replacement.

Distribution transformers are generally low cost to replace and are therefore suitable for replacement at the point where condition issues are observed. At the point at which major transformers have condition issues, there are limited cost-effective repair options and therefore these assets are programmed for refurbishment or replacement. As a result, only 3% of maintenance costs are attributed to transformers and reactive plant.

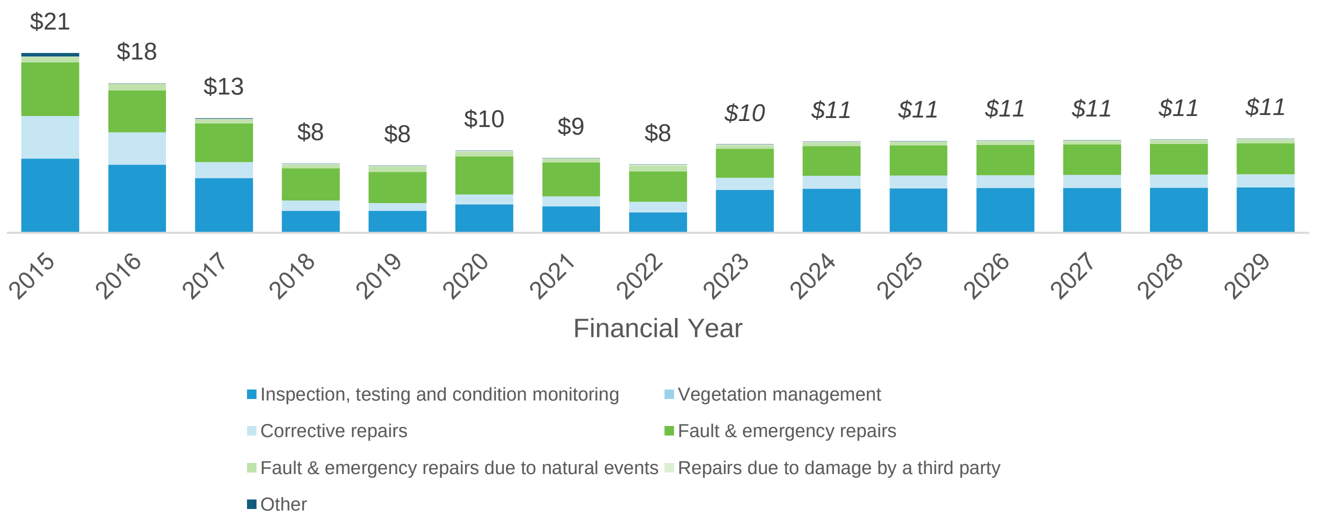
As refurbishment or replacement of major transformers is high cost and requires significant planning, minor corrective repairs such as oil top-ups are used to support the continued operation of a transformer through to its replacement. This also applies to a small sub-set of distribution transformers installed under the road in the Sydney CBD.

With the exception of the instrument transformers that are used to drive protection and monitoring systems (also known as current and voltage transformers), the average age of this asset class has and will continue to increase. Condition monitoring and timely replacement is expected to manage performance without a step change in maintenance expenditure.

4.5 Switchgear

During the 2024-29 period we forecast expenditure of $54 million, representing 9% of maintenance, on Switchgear. The expenditure breakdown is shown in **Figure 15**.

Figure 15.Forecast 2024-29 expenditure breakdown for Switchgear (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 16**.

Figure 16.Top activities contributing to maintenance expenditure for Switchgear

Activity Type	Description
Inspection, testing and condition monitoring ($26m)	This activity includes operational checks and insulation testing with minor preventative lubrication. Operational checks include timing to isolate the network under fault conditions and includes a check of the relay functionality.
Corrective repairs ($8m)	The many moving parts of switchgear result in wear to components requiring minor repairs including contact cleaning and component replacement. Oil and SF6 filled switchgear may also require top-ups when the assets begin to leak.
Faults and emergency repairs ($18m)	Where switchgear fails to operate, repairs may be required to restore functionality. If oil or gas leaks exceed insulation thresholds, the switchgear may lock-out to prevent catastrophic failure in the event an operation is triggered.

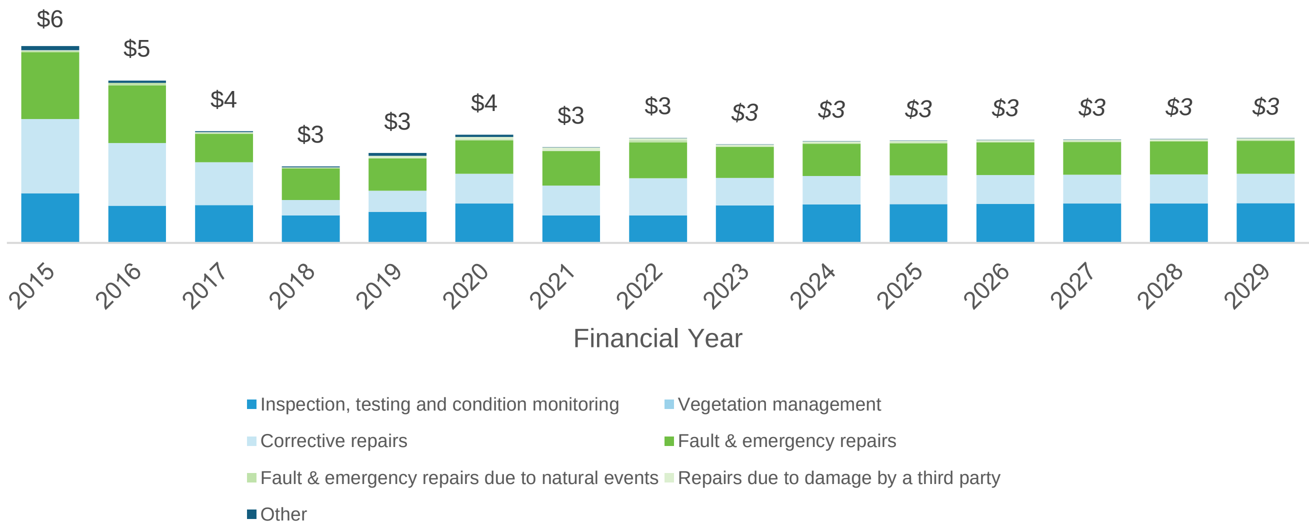
While repairs can restore asset functionality, they do not provide an extension to the life of the asset. At the point where repairs cannot restore functionality the assets are suitable for replacement.

The high focus on the replacement of compound insulated switchgear and bulk oil circuit breakers has led to a decline in the average age of major substation switchgear. However, the average age of distribution switchgear continues to grow, increasing the overall average age of this asset class. The improvement in our major substation switchgear coupled with our ongoing replacement strategy for distribution substation switchgear is expected to manage performance without a step change in maintenance expenditure.

4.6 Communications, Control & Protection

During the 2024-29 period we forecast expenditure of $17 million, representing 3% of maintenance, on Communication, Control and Protection. The expenditure breakdown is shown in **Figure 17**.

Figure 17.Forecast 2024-29 expenditure breakdown for Communications, Control & Protection (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 18**.

Figure 18.Top activities contributing to maintenance expenditure for Communications, Control & Protection

Activity Type	Description
Inspection, testing and condition monitoring ($6m)	This includes functional and performance testing of complex protection schemes that are unable to be tested as part of switchgear testing.
Corrective repairs ($5m)	This includes component replacements in relays and communication devices including communication batteries, relay alarms and displays. Due to the monitoring and communications in modern digital devices, online monitoring reduces the risk of functional failure, noting we still have a significant population of older mechanical relays that do not have online monitoring.
Faults and emergency repairs ($5m)	This generally includes the failure of communications cables and complete failures of relays to function (in particular during operation).

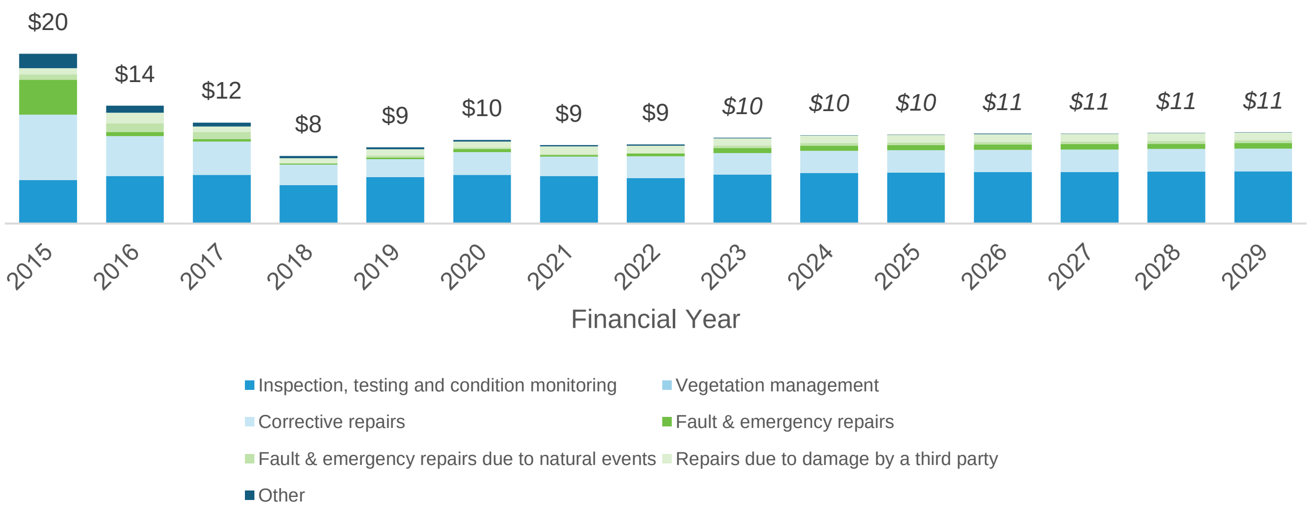
While we continue to manage a fleet of older mechanical relays (65% of the population), we are beginning to see new technology digital relays fail. While digital relays have the advantage of modern communications making them easier to monitor and remotely operate, the digital components result in shorter asset lives compared to their mechanical equivalents. A combination of technology type and age is a greater predictor of failures than using age independently.

While mechanical relays can be repaired, it is generally not practical or cost effective to repair digital relays, leading to more replacements. The increasing penetration of digital relays will likely see a transition from repair towards replacement, however, due to the current pace of the technology transition, we are not proposing a change to maintenance expenditure for the 2024-29 period.

4.7 Buildings, Grounds & Land

During the 2024-29 period we forecast expenditure of $53 million, representing 9% of maintenance, on Buildings, Grounds and Land. The expenditure breakdown is shown in **Figure 19**.

Figure 19.Forecast 2024-29 expenditure breakdown for Building, Grounds & Land (real $m, FY24)



The top contributing activities to maintenance expenditure and a description of their scope is provided in **Figure 20**.

Figure 20.Top activities contributing to maintenance expenditure for Buildings, Grounds & Land

Activity Type	Description
Inspection, testing and condition monitoring ($30m)	A large portion of this maintenance relates to ensuring compliance to building codes, in particular in relation to fire systems including hydrants, extinguisher systems and fire doors. Additional activities include managing oil containment systems, security checks and hazardous material management. The inspection of entire distribution substations e.g. kiosk substations is captured within this asset class.
Corrective repairs ($13m)	Repairs include pump out of oil from containment systems, substation cleaning, and repairs to security systems including substation fencing, gates and doors. Additionally, there are a number of low-cost high volume general building and land maintenance activities such as replacing broken lights and vegetation / weed management.

The maintenance tasks generally relate to the building systems that support the assets rather than the civil infrastructure itself. When the building or yard structures such as building roofs or outdoor busbar support structures degrade, they are generally refurbished or replaced rather than maintained since repairs are often not feasible.

The expenditure for maintaining building systems is forecast to remain steady during the 2024-29 period.