6.03

Network maintenance opex plan

Ausgrid

Content

EXECUTIVE SUMMARY

This document provides additional information aimed at demonstrating that Ausgrid's forecast total operating expenditure (opex) for the 2019-24 regulatory control period (regulatory period) meets the operating expenditure objectives, criteria and factors in clauses 6.5.6(a), (c) and (e) in the National Electricity Rules (NER), and as such is appropriate for acceptance by the Australian Energy Regulatory (AER).[1]

We have provided this information as network maintenance operating expenditure (maintenance expenditure) accounts for approximately one third of our total opex forecast, and therefore represents a significant proportion of costs that make up our total opex forecast.

While we note that the AER has moved away from setting individual allowances for categories of opex expenditure, instead preferring a top down approach towards setting opex allowances, we consider that this information is relevant as it provides important evidence to demonstrate the efficiency of our base year costs used for forecasting total opex for the 2019-24 regulatory period. In addition, it provides important evidence of how in formulating our total opex forecast Ausgrid has had regard to, and has met, the opex objectives, criteria, and factors in the NER which are intended to reflect the National Electricity Objective (NEO) enshrined in the National Electricity Law (NEL).

Ausgrid has implemented significant reforms during the current regulatory period to improve the efficiency of our maintenance activities and expenditure. As noted in our Regulatory Proposal, Ausgrid has undergone a significant transformation process to reshape and refocus its business so that we deliver better value to our customers in a manner which does not compromise our obligations relating to the safety, reliability, security and quality of electricity supply. In particular, we have:

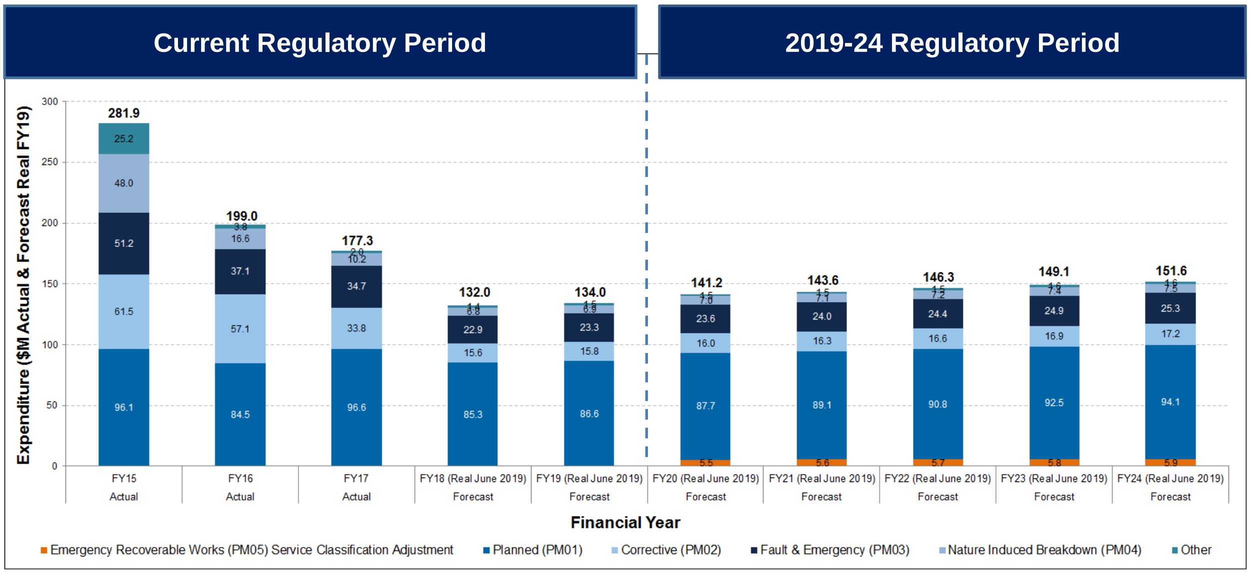
- Implemented key maintenance transformation initiatives and reforms
- Become more efficient in our maintenance delivery processes, work packaging and execution of work
- Positioned ourselves to maintain our current levels of reliability, quality and security of electricity supply at a price which is affordable for our customers
- Implemented significant reforms to 'right-size' our labour force
- Become a more agile business that can adapt and respond to future changes in our operating environment
- Considered new technology aimed at capturing more data and improving the accuracy of data and risk segmentation, enabling us to make more informed decisions on the need and timing of maintenance activities
- Embedded a culture of continual improvement in our business, so that we continue to look for new and innovative ways to improve our business processes to deliver better value to our customers.

These changes have enabled us to identify more opportunities to adjust maintenance activities where it is prudent and efficient to do so, and to deliver maintenance activities more effectively using a smaller pool of internal resources in conjunction with the use of outsourcing. Importantly, the implementation of key initiatives has enabled us to achieve a base-year which is both efficient and sustainable, which we have 'rolled forward' in

[1] The AER must accept a distribution network service provider's (DNSP) total opex forecast if it is satisfied that the forecast of required opex reasonably reflects each of the operating criteria outlined in clause 5.6.6(c) of the NER.

developing our opex forecast for the 2019-24 period. The current and forecast network maintenance expenditure profile is shown below.

Figure 1. Current and forecast network maintenance expenditure profile



1 INTRODUCTION

This document provides additional information on the forecast system maintenance operating expenditure component, of our total forecast operating expenditure (opex) for the 2019-24 regulatory control period (regulatory period). In particular, this document sets out the:

- Scope of activities that make up our opex forecast
- Considerations, processes and frameworks that govern how we conduct maintenance activities
- Key initiatives we have embedded to improve our processes and the efficiency of our delivery
- Outcomes that we have achieved during the current regulatory period
- Forecast maintenance program for 2019-24.

1.1 Document purpose and outline

We have provided this information as these activities represent the core activities for maintaining Ausgrid's network, and account for approximately one third of our total opex forecast. Importantly, the activities that underpin our maintenance forecast, our planning processes and the actions we have undertaken to improve the efficiency of our base year maintenance costs - provide key supporting evidence that demonstrates how our total opex forecast for the 2019-24 regulatory period meets the operating expenditure objectives and criteria in the National Electricity Rules (NER).[2]

Importantly, this information supports our assertion that it is appropriate that the Australian Energy Regulator (AER) accept our proposed total forecast opex, as clause 6.5.6(c) of the NER provides that the AER must accept a distribution network service provider's (DNSP) total opex forecast if it is satisfied that the forecast reasonably reflects each of the operating expenditure criteria (opex criteria).

A primary focus of this document is on demonstrating the prudency and efficiency of our base year maintenance costs. In particular, we have sought to highlight the key initiatives we have implemented during the current regulatory period to improve the efficiency of our processes, to deliver better value to our customers without compromising on the prudency in which we maintain the safety, security, and reliability of our network. This is important as we have adopted the AER's base-step trend approach towards forecasting, meaning that our efficient base year maintenance costs have been 'rolled forward' in forecasting our total required opex for the 2019-24 regulatory period.

A high level summary of each section, its key focus and the relevance to the opex objectives, criteria and factors in the NER is provided in the following table.

Table 1. Document structure

Section	Description	Relevance to the opex objectives, criteria and factors in the NER
2	Provides an overview of the key activities that comprise our forecast maintenance expenditure component of our total opex forecast for the 2019-24 regulatory period and demonstrates how these activities contribute to the	The expenditure associated with these activities is necessary in order to meet the opex objectives, particularly objectives 2, 3 and 4.

[2] See National Electricity Rules, clauses 6.5.6(a), (c) and (e).

Section	Description	Relevance to the opex objectives, criteria and factors in the NER
	achievement of the NEO and opex objectives (see Figure 2).	
3	Outlines the key considerations, planning processes, frameworks and strategies that govern how we conduct maintenance activities. This information contributes to demonstrating the efficiency of our maintenance base year costs, and highlights how capital expenditure (capex) trade-off considerations are embedded in our planning approaches.	Ausgrid has adopted a 'revealed costs' approach towards forecasting opex. This information provides evidence of the prudency and efficiency of our maintenance expenditure, therefore demonstrating how our opex forecast satisfies opex criteria 1 and 2 (clauses 6.5.6(c)(1)-(2) and opex factor 7 (clause 6.5.6(e)(7).
4	Outlines key initiatives to improve the efficiency of our base year to achieve a more sustainable level of maintenance expenditure without compromising on the safety, reliability, security and quality of electricity supply.	Demonstrates the efficiency of our base year costs which we have 'rolled forward' in forecasting the maintenance component of opex. Therefore, it satisfies opex criteria 1 and 2.
5	Provides an overview of our performance during the current regulatory period and is aimed at demonstrating the efficiency of our base year.	Relevant for the same reasons as above. In addition it provides evidence of how we have addressed opex factors 5, 7 and 8.
6	Provides an overview of our forecast maintenance expenditure for the 2019-24 period.	Provides evidence of how the opex forecast meets the opex objectives, criteria and factors 5, 5A, 7 and 8.

2 SCOPE OF ACTIVITIES

This section provides an overview of the key activities that comprise the forecast maintenance expenditure component of our total opex forecast for the 2019-24 regulatory period. The expenditure associated with these activities is necessary in order to meet the opex objectives, particularly objectives 2, 3 and 4.[3] That is, the expenditure is required to enable Ausgrid to comply with applicable regulatory obligations, and is necessary to maintain network safety, as well as the quality, reliability, and security of electricity supply to our customers.

2.1 Overview of maintenance activities

Our network is made up of a diverse range of assets, from transmission to distribution. Our forecast maintenance opex for the 2019-24 regulatory period sets out the expenditure required to manage and maintain our asset base in a manner which allows us to comply with our regulatory and legislative obligations.

Figure 3 on the following page, describes the different asset categories that comprise our asset base, and illustrates how these assets fit within the broader electricity supply chain. We perform a range of planned and corrective maintenance activities on our assets to maintain the safety and performance of our network. We have provided an overview of the maintenance activities that comprise our maintenance expenditure forecast for the 2019-24 regulatory period in Table 2 .

The performance of the maintenance activities listed in Table 2 are necessary in order 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.

Figure 2 outlines the key objectives that our forecast maintenance program is aimed at achieving and demonstrates how these objectives contribute to the achievement of both the NEO and the opex objectives.

[3] National Electricity Rules, clause 6.5.6(a).

Figure 2. Objectives of our forecast 2019-24 maintenance expenditure program

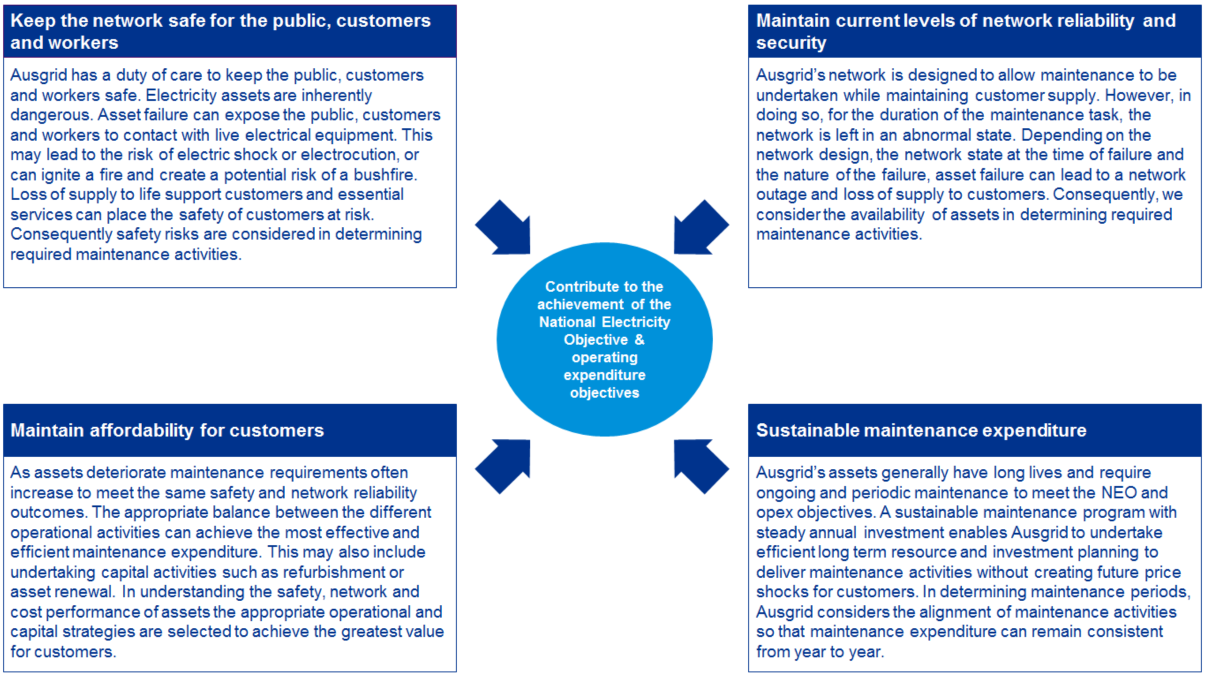


Table 2. Overview of maintenance activities by cost category

Activity Type	Description
Inspection, testing and condition monitoring	Work associated with undertaking planned assessment of asset condition. This category includes testing and measurement and all routine visual inspection tasks designed to identify corrective issues and are carried out in a repetitive manner.
Preventative maintenance	Asset treatments undertaken generally in conjunction with inspection, testing and condition monitoring and includes activities such as lubrication and exercising of moving parts.
Vegetation maintenance	Ausgrid's largest maintenance activity which includes identifying, scoping and undertaking proactive vegetation cutting to maintain safety clearances from electrical assets.
Modifications / design changes	Minor changes to the design of equipment to maintain or improve functionality.
Corrective repairs	All work associated with correcting defects that have not yet resulted in an asset 'breakdown'. Corrective maintenance is undertaken when assets fail to meet the threshold criteria set to enable it to remain in working order until the next inspection maintenance cycle. These tasks are generally driven from the results of the inspection, testing and condition monitoring process.
Repairs due to damage by a third party	All work associated with equipment that has ceased to perform its intended function due to factors beyond the equipment's design capability (e.g. digging into underground cables or a car hitting a pole causing equipment malfunction). These failures cannot be managed through normal maintenance activities and may be carried out under emergency conditions.
Repairs due to nature induced breakdowns	All work associated with equipment that has ceased to perform its intended function due to factors beyond the equipment's design capability (e.g. animals causing equipment malfunction or lightning strikes). These failures cannot be managed through normal maintenance activities and may be carried out under emergency conditions.
Fault and emergency repairs	All work associated with equipment that has ceased to perform its intended function (excluding nature induced breakdown and repairs due to third party damage).

Activity Type	Description
Non-direct maintenance	Work associated 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.
Engineering Support	Work associated with centralised defect assessment and undertaking engineering investigations for systemic faults.

Figure 3. Ausgrid asset categories

Transmission Overhead

Transmission Overhead assets include steel towers, poles (wood, concrete and steel), special termination structures, overhead mains (132kV, 66kV and 33kV), access tracks and air break switches. These assets provide direct connections between Transgrid and the Ausgrid network and interconnection between our Transmission and Zone substations.

Transmission Underground

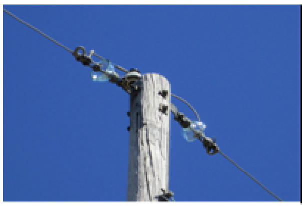
Transmission Underground assets include underground cables, of a variety of insulation technologies operating at design voltages of 132kV, 66kV and 33kV, associated pressure monitoring and alarm systems, cross bonding systems, and cable tunnels. These assets provide direct connections between Transgrid and the Ausgrid network and interconnection between our Transmission and Zone substations.

Transmission Substations

Assets include buildings, transformers, high voltage switchgear, protection systems and earthing systems. These substations are supplied at 132kV or 66kV, and supply local zone substation networks, mostly at 33kV, with smaller 66kV networks in the upper Hunter Valley and in Sydney at Epping/Hunters Hill.

Zone Substations

Assets include buildings, transformers, high voltage switchgear, protection systems and earthing systems. These substations are supplied at 132kV, 66kV or 33kV, and transform this to 11kV (with a small 5kV network) which supplies the local distribution network via overhead / underground mains.



Distribution Mains

Assets include but not limited to poles and other support structures (wood, concrete, steel and composite materials), overhead and underground 11/22kV and Low Voltage conductors, access tracks, overhead and underground services, pillars, reclosers and sectionalisers, voltage regulators, air break switches, under slung links and other equipment. These assets provide connection between Zone substations and customers via distribution substations and the LV network.

Distribution Substations

Assets include pole substations and ground type substations including kiosks, outdoor enclosures, chambers and underground structures. These substations are supplied at 11kV and transform this to 415V. The main assets associated with these substations are buildings, housings, enclosures transformers, high voltage and low voltage switchgear, fuses and earthing systems.

3 MAINTENANCE PROCESSES AND FRAMEWORKS

This section sets out the key considerations, planning processes, frameworks and strategies that govern how we conduct maintenance activities. In particular, it is aimed at demonstrating the prudency and effectiveness of our processes, as this provides an important indicator of the efficiency of our maintenance base year costs.

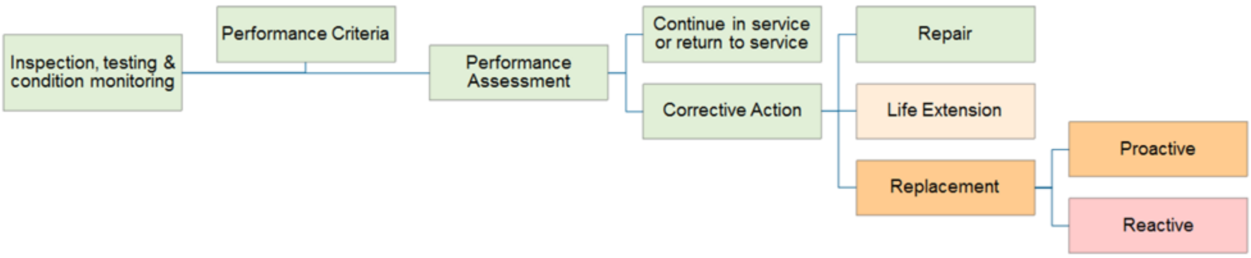
Section 3.1 outlines our overarching approach towards undertaking maintenance activities. Importantly, it seeks to demonstrate the prudency of our maintenance approach, which in turn influences the level of expenditure required to maintain our network, and seeks to highlight how capex substitution possibilities are considered as part of our business as usual planning processes. Section 3.2 describes the additional preventative measures Ausgrid takes to mitigate bushfire risks, while section 3.3 seeks to highlight the key processes in place for optimising the delivery of maintenance activities.

3.1 Overview of Ausgrid's maintenance approach

As part of its planned maintenance program, Ausgrid undertakes inspection, testing and condition monitoring of our assets to assess whether they are performing correctly, and to identify whether there are any potential defects which may require rectification. We also undertake preventative maintenance tasks, which are aimed at preserving asset functionality and condition integrity. These tasks are generally low cost and are undertaken in conjunction with inspections, testing and condition monitoring. Ausgrid's planned maintenance program utilises Condition Based Maintenance (CBM) to determine whether corrective maintenance (repairs) or capital replacement is required in order to address asset defects (i.e. risk mitigation).

Figure 4 illustrates our process for undertaking CBM. As shown by Figure 4, condition monitoring and testing is performed to understand the current condition of each asset and its ability to perform its function. The results are then assessed using corrective standards to determine if the asset meets its required performance criteria (serviceability). The use of corrective standards, which form part of the overall Network Defect Prioritisation Framework (NDPF), allows for consistency in approach and assists in streamlining the performance assessment process.

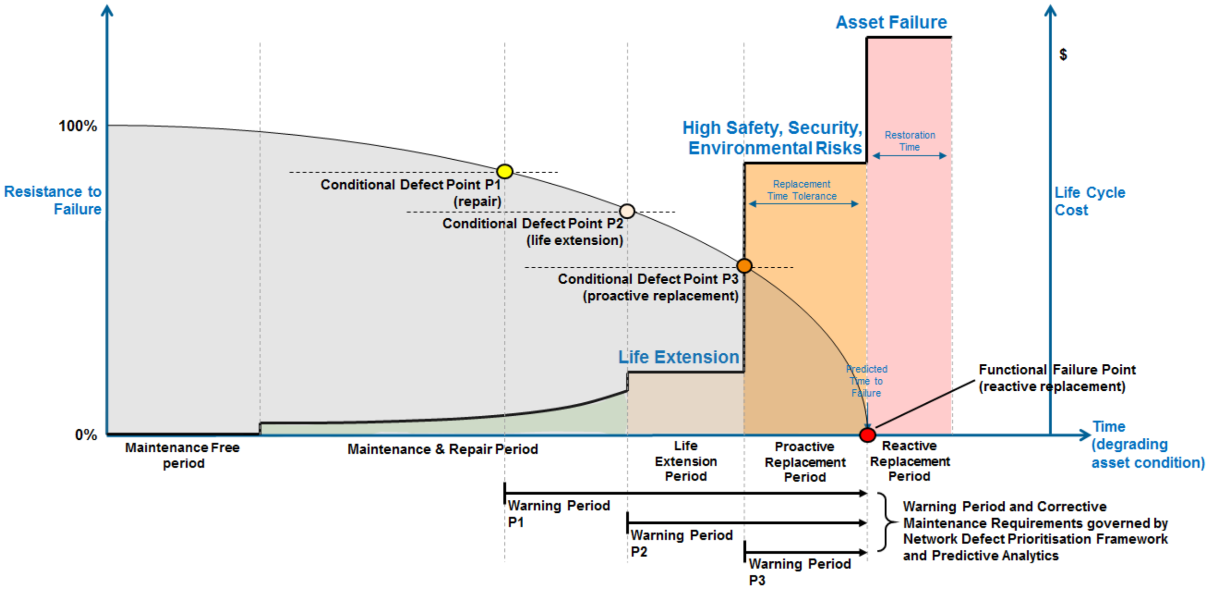
Figure 4. Condition-based maintenance (CBM) approach



If an asset meets the performance criteria, it continues in service or is returned to service. However, if the asset fails the performance criteria, we may choose to either take corrective action, which may be in the form of undertaking repairs (maintenance opex), or undertaking asset life extension or replacement (capex). Alternatively, we may elect to not undertake any planned maintenance tasks, and instead allow the asset to run to 'end-of-life' and undertake corrective action under fault and emergency conditions (reactive). Fault and emergency maintenance activities are generally only required where preventative maintenance is inefficient (there is limited value in doing proactive maintenance given the risk) or ineffective (unable to detect an imminent failure).

Figure 5 illustrates the linkage between the process for undertaking CBM, treatment options and the stages of the asset lifecycle in which these are applied (using the same colour coding as depicted in Figure 4). As can be seen, there are step changes in the life cycle cost as you pass through each phase.

Figure 5. Approach to condition based decision making



In order to establish planned maintenance requirements, Ausgrid employs the Maintenance Requirements Analysis (MRA) process which is further discussed in section 3.1.1. The MRA process includes the use of:

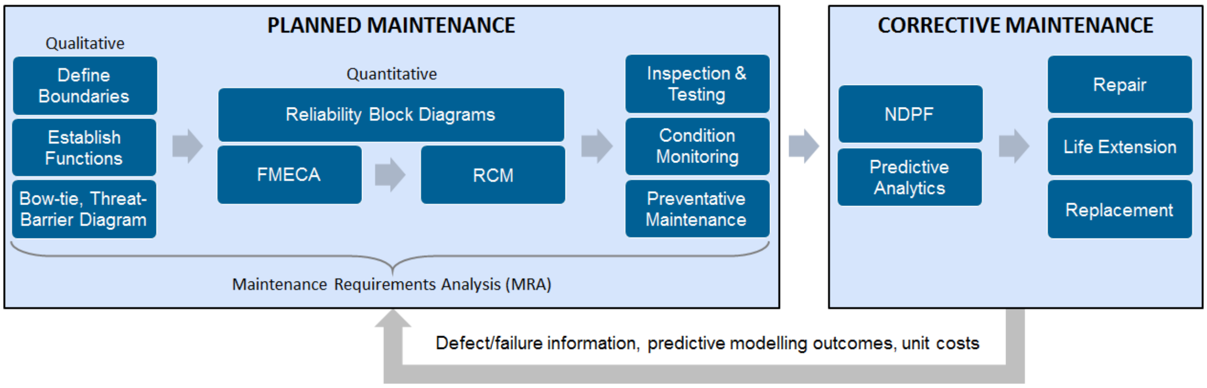
- Failure Modes, Effects and Criticality Analysis (FMECA)
- Reliability Centred Maintenance (RCM).

Our decision to undertake corrective action and the nature of the corrective action is informed by our MRA process as well through the application of our (see also sections 3.1.2 and 3.1.3 for additional detail):

- Network Defect Prioritisation Framework (NDPF)
- Predictive Analytics.

The interactions of planned and corrective maintenance are highlighted in Figure 6.

Figure 6. ***Planned and corrective maintenance process***



These processes and frameworks are undertaken to enable us to appropriately prioritise and balance the risk that we bear, so that we only undertake work that is required, and avoid imposing unnecessary costs on our customers. Inspections, testing and condition monitoring are intended to inform decision making to enable the identification and implementation of the optimal corrective action for addressing a defect in the most cost efficient manner. This information captured through maintenance is also used to inform the forecast for future capital and operational expenditure requirements.

3.1.1 Maintenance requirements analysis

Our maintenance approach is underpinned by an internationally recognised MRA approach, which utilises International and Australian Standards, and reflects legislative and industry requirements. Specifically, our MRA uses the FMECA and RCM processes for determining planned maintenance requirements. This internationally recognised process provides a structured method for:

- Assessing the likely causes of asset failure
- Assessing the consequences of that failure
- Determining tasks that can be undertaken to prevent a failure occurring or to detect a deterioration in condition.

In order to adequately understand the maintenance requirements relating to a specific asset, the initial stage of the MRA approach involves defining clear boundaries relating to the function(s) of an asset and understanding the mechanisms by which it fails to perform these functions. In this way Ausgrid can establish the appropriate maintenance requirements with the application of FMECA and RCM in conjunction with Reliability Block Diagrams (RBD) (where appropriate).

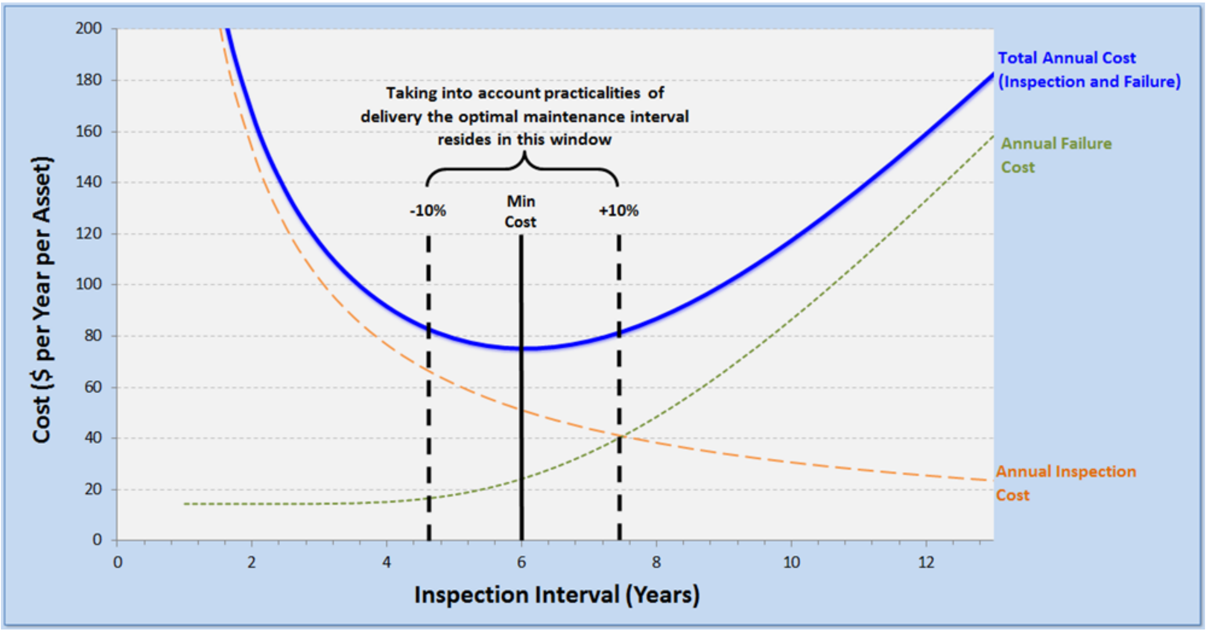
FMECA provides a prudent and structured method for assessing asset risk in terms of likelihood, causes and consequences of asset failures. The likelihood of failure is determined using actual failure rate information captured from Ausgrid's asset systems while the consequence of an event occurring is determined based on historical risk outcomes (realisation of consequences) and subject matter expert knowledge, and is tested for sensitivity. RBD can be used to expand on the FMECA information to model more complex dependent risks.

RCM is then utilised to determine the optimal maintenance tasks and intervals in order to address the risk(s) associated with those failure modes identified through the FMECA process in the most efficient manner. Effective planned maintenance and corrective tasks are determined, along with the corresponding costs to perform these tasks. Risks and preventative tasks are analysed using RCM to determine the most appropriate maintenance task(s) and associated period.

RCM compares the risks defined through the FMECA process against inspection and testing costs to determine the most appropriate maintenance task(s) and the optimal window for undertaking these maintenance task(s).

As shown by Figure 7, the optimal interval for undertaking maintenance activities is typically at the minimum point on the Total Annual Cost Curve[4]. Ausgrid applies a +/- 10% risk tolerance to the optimal interval of key maintenance tasks with initial grouping to enable flexibility and efficiency in planning and delivery to be realised. For example delivery efficiencies realised through task packaging that are anticipated to offset any change in the risk(s) and/or inspection cost(s). Consequently, this approach facilitates the efficient delivery of maintenance activities by providing greater scope for task packaging without exposing Ausgrid to unacceptable levels of risk or costs.

Figure 7. Typical RCM output



The use of FMECA and RCM, in combination with improved processes for capturing data, has allowed Ausgrid to increase the length of inspection cycles for certain maintenance activities within the defined optimal interval window. Having more accurate data on the condition of our assets reduces the uncertainty surrounding the likelihood of asset failure, allowing us to make more informed decisions on how the defect should be prioritised. Consequently, this process allows us to deliver better value to our customers by only undertaking work where it is necessary and prudent, having regard to the likelihood and consequences associated with the asset failing.

3.1.2 Network defect prioritisation framework

Ausgrid's defect prioritisation framework is formalised through the application of corrective maintenance standards that establish set criteria with which to assess potential defects. Where we have identified that corrective action is required, Ausgrid applies a defect prioritisation framework to determine the appropriate time to undertake defect rectification.

[4] As shown by Figure 7, the "Total Annual Cost" curve is the sum of the "Annual Failure Cost" curve and the "Annual Inspection Cost" curve.

The timeframes applied are determined with consideration of the expected remaining life of the asset (time to failure) from the point of defect identification. This allows maximum life of the asset to be realised whilst still mitigating the risk before risk realisation. This assessment also considers the ability to plan and execute rectification works in the nominated timeframe, given resource requirements including staff, tools and equipment as well as network availability.

The framework is aimed at enabling Ausgrid to appropriately prioritise and balance risk and meet compliance requirements so that only work that is required is undertaken, avoiding imposing unnecessary costs on our customers. Additionally, the framework is intended to inform decision making to enable the identification and implementation of the optimal corrective action for addressing the defect in the most consistent and cost efficient manner.

As outlined by Figure 4, corrective action can be in the form of opex maintenance repairs or capex replacement or life extension. The prioritisation framework outlined below is applied to both opex and capex corrective actions.

Figure 8. Network defect prioritisation framework

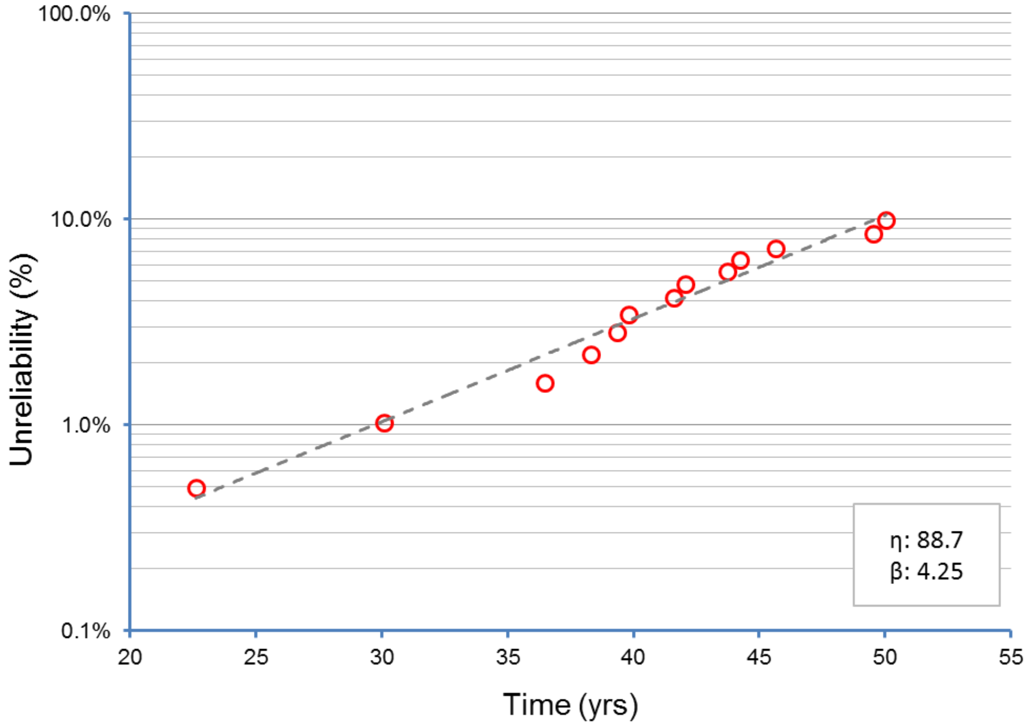
			CONSEQUENCE				
			1	2	3	4	5
			Insignificant	Minor	Moderate	Major	Severe
LIKELIHOOD	A	Almost Certain	CAT 4	CAT 3	CAT 2	CAT 1	CAT 1
	B	Likely	Unrestricted	CAT 4	CAT 3	CAT 2	CAT 1
	C	Possible	Unrestricted	Unrestricted	CAT 4	CAT 3	CAT 2
	D	Unlikely	No Report	No Report	Unrestricted	CAT 4	CAT 3
	E	Rare	No Report	No Report	No Report	CAT 4	CAT 4

CATEGORY	TIMEFRAME
CAT 1	48 hours
CAT 2	3 months
CAT 3	12 months
CAT 4	Reinspect before next maintenance (18 months)
Unrestricted	Note but no action required (unless practicable)
No Report	No action required

3.1.3 Predictive analytics

Through the collection of asset and maintenance data and improvements in data processing, Ausgrid is beginning to utilise predictive analytics to forecast asset condition degradation (e.g. wear out), defects and expected failures. Further advancements in these areas will allow for more refined forecasting and a greater understanding of future risks. For example, predictive analytics is being applied to forecasting pole replacement rates utilising condition information collected through planned maintenance. Predictive analytics is also being applied to major transformers. The example shown below highlights the relationship between age and the unreliability of 33/11kV major transformers - the Weibull model generated from this analysis is used to inform replacement decisions for this asset class.

Figure 9. Unreliability for 33/11kV major transformers



3.2 Bushfire risk mitigation

One of the key risks which we manage is the risk of bushfire, due to its potential to affect the safety of communities. Figure 10 below summarises the five key barriers used by Ausgrid for bushfire risk mitigation. These include:

- Routine maintenance activities
- Bushfire specific maintenance activities and private mains audits
- Bushfire specific corrective maintenance tasks
- Bushfire operations, stakeholder interaction and reporting
- Replacement activities as detailed in Figure 10 below.

Given the significance of the risk of bushfire, we have in place a range of activities including annual inspection and audit activities which utilise modern technology, such as high definition aerial photography and light detection and ranging (LiDAR) to provide assurance that we have managed the risk to an appropriate level. Bushfire prone areas are defined and categorised by the NSW Rural Fire Service (RFS). Figure 11 shows the bushfire prone areas overlayed onto Ausgrid's franchise area and a comparison of the 2017 and 2018 bushfire prone land coverage with the addition of the new Vegetation Category 3 area recently defined by the RFS.

Figure 10. Bushfire risk mitigation barriers

1) Routine maintenance activities

Ausgrid's routine maintenance programs address all risks associated with a particular group of assets and in doing so, trigger corrective actions that address certain defects that may mitigate against potential bushfire ignition (e.g. pole and line inspection). Ausgrid undertakes a series of specific bushfire related maintenance activities which are more targeted than the broad based maintenance activities.

2) Bushfire specific maintenance activities and private mains audits

To complement our routine maintenance program, Ausgrid also undertakes a number of bushfire specific maintenance activities, in addition to private mains audits, aimed at mitigating against potential bushfire ignition. We undertake targeted and specific maintenance activities aimed at reducing the risk of bushfire ignition to as low as reasonably practicable (ALARP) due to the potential damage and economic loss to customers and the community from bushfires. These activities are delivered via a combination of aerial and ground based resources.

3) Bushfire specific corrective maintenance tasks

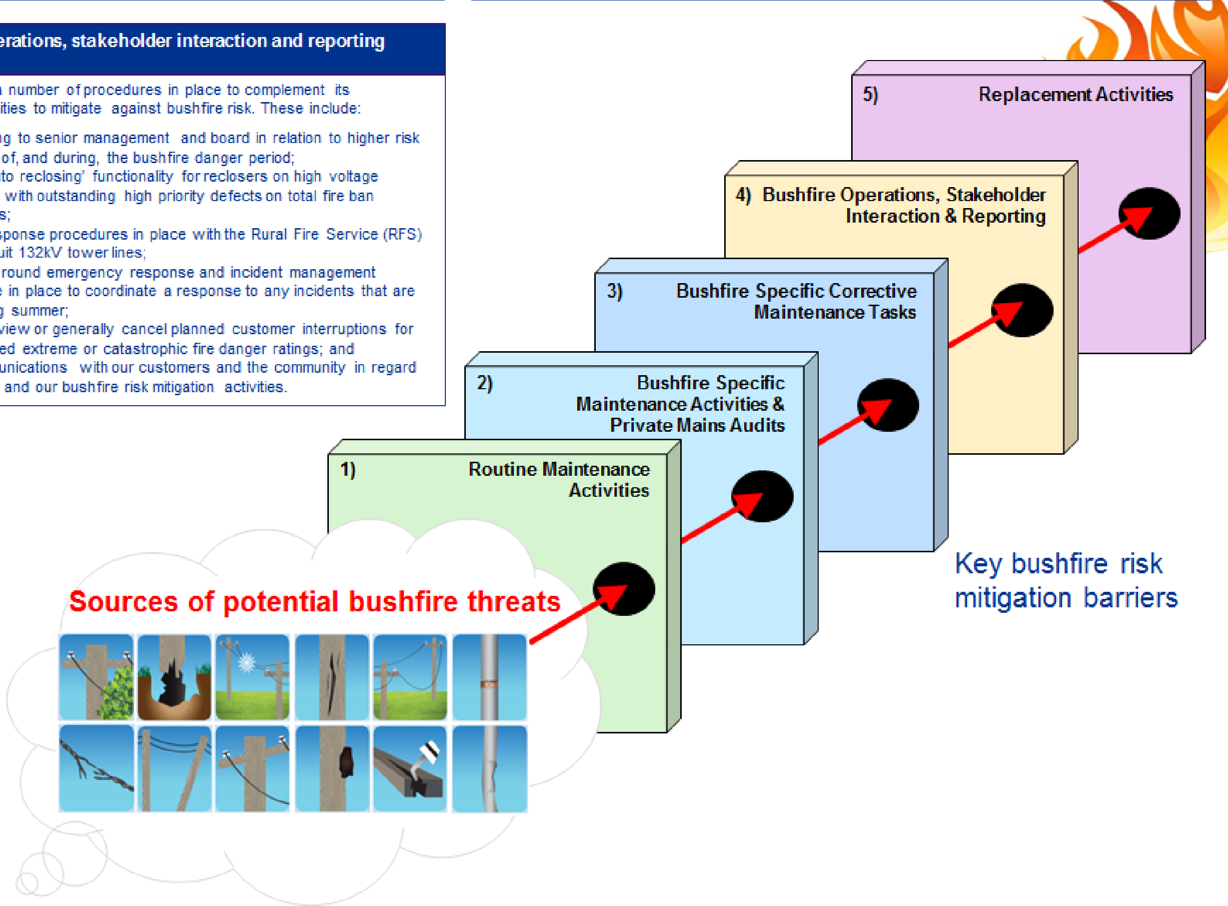
Corrective maintenance requirements ('defects') are identified during routine maintenance including pre-bushfire season inspections undertaken via LiDAR, aerial patrol and ground based patrols. Defects are assessed against Ausgrid's Network Defect Prioritisation Framework (NDPF) to determine their priority for rectification. Ausgrid identifies defects as 'Bushfire Critical Tasks' if they:

- are located within a bushfire prone area;
- have an assessed rectification priority of either 48 hours (CAT1) or one to three months (CAT2); and
- are considered to be either a genuine or possible bushfire ignition risk.

4) Bushfire operations, stakeholder interaction and reporting

Ausgrid also has a number of procedures in place to complement its maintenance activities to mitigate against bushfire risk. These include:

- regular reporting to senior management and board in relation to higher risk defects ahead of, and during, the bushfire danger period;
- disabling of 'auto reclosing' functionality for reclosers on high voltage overhead lines with outstanding high priority defects on total fire ban ('TOBAN') days;
- emergency response procedures in place with the Rural Fire Service (RFS) for double circuit 132kV tower lines;
- Ausgrid's year round emergency response and incident management systems will be in place to coordinate a response to any incidents that are declared during summer;
- protocols to review or generally cancel planned customer interruptions for days of predicted extreme or catastrophic fire danger ratings; and
- targeted communications with our customers and the community in regard to bushfire risk and our bushfire risk mitigation activities.

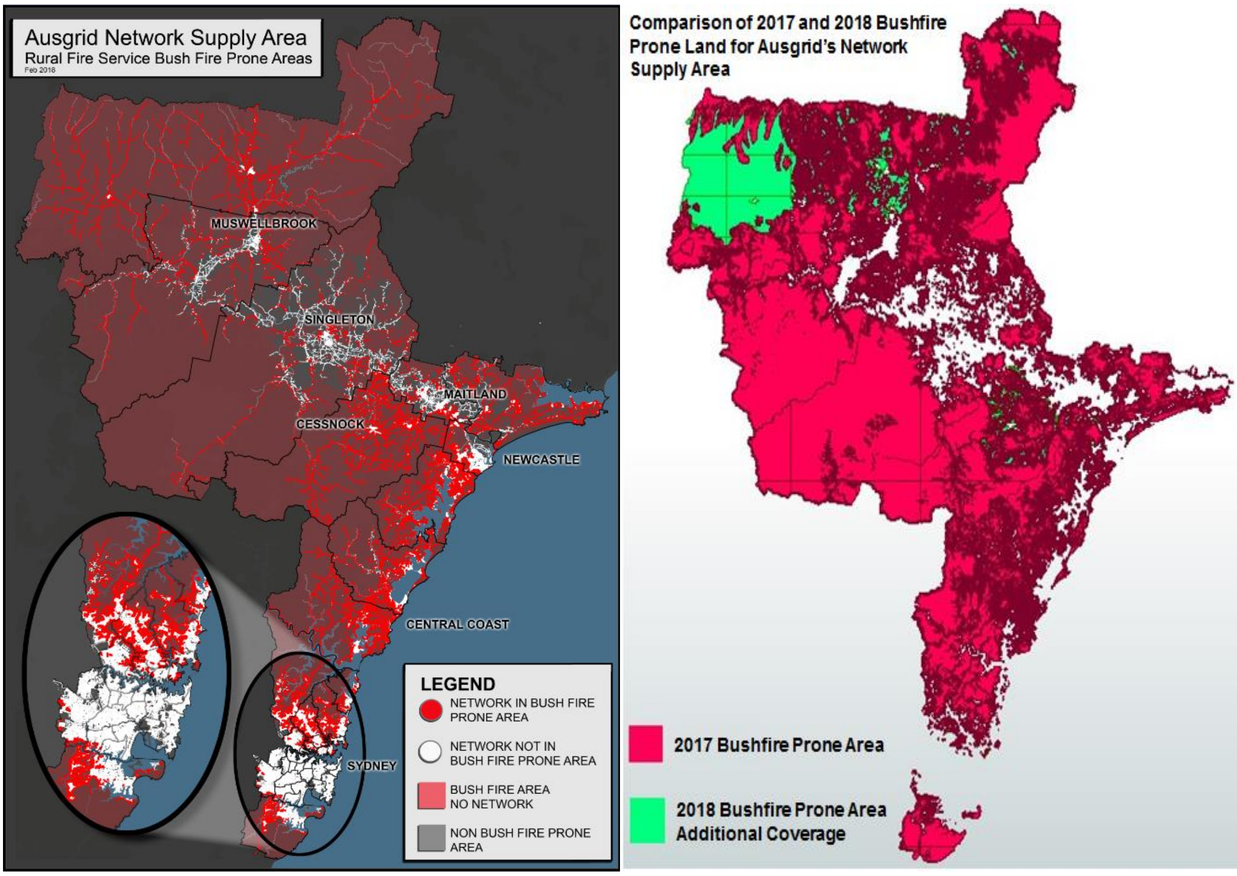


5) Replacement activities

A number of capital (capex) replacement activities complement maintenance activities in mitigating against potential bushfire and safety risks, these include:

- installation of low voltage spreaders to prevent conductors clashing where identified;
- a long spans project to review the design, vegetation clearance requirements and risks associated with overhead spans greater than 300m;
- replacement of certain types of air break switches with known risks;
- replacement of thin steel conductors and aluminium/steel conductors due to corrosion issues;
- replacement of overhead service wires;
- refurbishment of specific overhead 33kV, 66kV and 132kV transmission feeders due to condition and reliability issues;
- replacement of bare low voltage conductors with aerial bundled cable in targeted heavily vegetated areas; and
- refurbishment of access tracks to our assets - this provides benefits for both Ausgrid and firefighting services.

Figure 11. Ausgrid's bushfire prone areas



As can be seen in Figure 11 the addition of the new Vegetation Category 3 area by the RFS from 2018 has resulted in an 8% increase in the proportion of Ausgrid's network located within a bushfire prone area (based on the increase in the number of poles in bushfire prone areas).

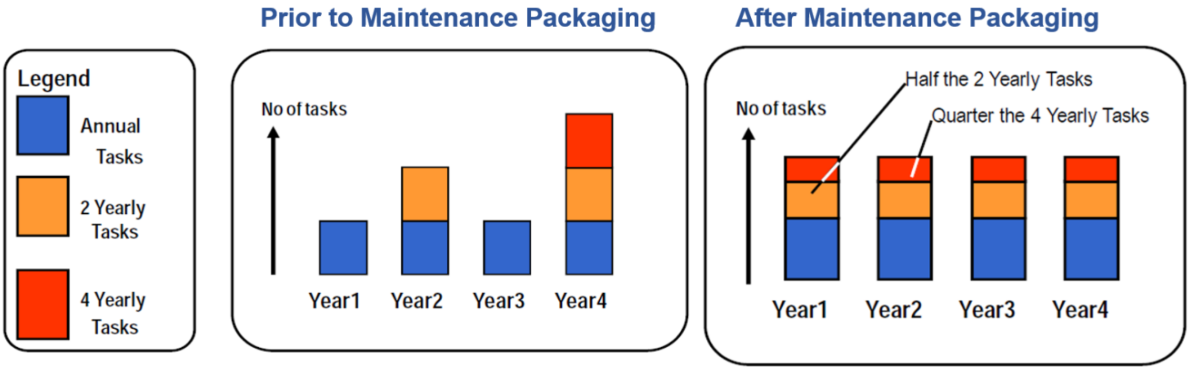
3.3 Maintenance delivery processes

This section outlines the key considerations relating to the delivery of maintenance activities. It is aimed at demonstrating the prudency and effectiveness of our processes, which in turn has improved the efficiency in which we undertake maintenance activities.

3.3.1 Work packaging

Ausgrid groups together planned maintenance and corrective tasks established through the MRA process. Task packaging and maintenance activity alignment is undertaken to minimise travel time and setup costs and allow for a more efficient delivery of planned maintenance activities. Any adjustment associated with the packaging and alignment of maintenance activities is undertaken within the respective optimal maintenance safety window. Figure 12 below seeks to highlight the efficiencies realised through maintenance packaging.

Figure 12. Maintenance packaging



As can be seen from the Figure 12 above, the packaging of tasks and the levelling and alignment of maintenance activities across different intervals allows for activities to be smoothed over the regulatory period, thereby enabling a more efficient and sustainable delivery of the maintenance program supporting a base step trend approach.

3.3.2 Spares

Ausgrid maintains efficient levels of spare equipment and parts to reduce rectification timeframes. Spares can be in the form of high turnover, low cost, inventory items or strategic emergency holdings. The use of spares plays a critical role in mitigating asset risk while allowing for the life of the asset to be maximised. For example, where spares are not available, the time taken to procure assets that have long lead times, such as major power transformers, must be considered in setting the asset performance criteria (serviceability) and may result in these assets being defected earlier than their asset life. Where spares are available, the procurement lead time is removed from the defect prioritisation timeframe and performance criteria extended.

3.3.3 Efficient use of contracted services

In conjunction with our internal staff, Ausgrid uses contracted services to deliver our maintenance program. This is to enable us to deliver more with a smaller fixed internal workforce, and to effectively manage identified gaps in resourcing or skill sets for delivering our maintenance program.

Where outsourcing has been identified as the most efficient option for addressing resourcing shortages or delivering work, Ausgrid has prudent contract and procurement arrangements in place to allow it to source contracted services at efficient market rates. These contracts are setup in such a way that enable a more agile and dynamic delivery of our maintenance program in order to meet changes to demand and business need. These contracts are set up to deliver inspection and corrective maintenance activities that are typically low complexity high volume tasks, and are capable of addressing specific demand changes that may occur holistically or in certain geographic regions of the network.

4 DELIVERING EFFICIENT OUTCOMES FOR CUSTOMERS

This section sets out the key initiatives we have undertaken to improve the efficiency of our base year to achieve a more sustainable level of maintenance expenditure without compromising on safety, reliability, security and quality of electricity supply. During the current regulatory period, Ausgrid has undergone a significant transformation process to re-shape and re-focus our business so that we:

- Are more efficient in our delivery processes and execution of work
- Are positioned to maintain our current levels of reliability, quality and security of electricity supply at a price which is affordable for our customers
- Are better able to quickly adapt and respond to future changes in our operating environment
- Look for new and innovative ways to improve our business processes through an established culture of continual improvement embedded into our business, which enables us to deliver better value to our customers.

Key maintenance changes and reforms undertaken to achieve these objectives are:

- An improved risk segmentation approach
- Introduction of new maintenance standards
- Introduction of new technology
- Improved work packaging
- Efficient use of contracted services.

These changes have enabled us to transform our maintenance cost base to establish a more efficient base year. In particular, they have enabled us to deliver maintenance work in a more streamlined and cost effective manner so that we deliver better value to our customers. Further details on these changes and how they have contributed to improving our delivery performance and effectiveness are discussed below.

4.1 Improved risk segementation

Following the implementation of new technology aimed at capturing more data and improving the accuracy of data, we are now better placed to make more informed decisions on the need, and timing of maintenance activities. Better data capture, coupled with use of historical condition monitoring results, has reduced the uncertainty surrounding the risk of assets failing allowing us to extend maintenance periods for assets in good condition.

We have also combined FMECA information with real asset condition data and spatial (location) information to improve the categorisation of risk at an asset and location level. This has led to changes in routine pole and line inspection requirements. Beyond combining routine pole and line inspections into a single efficient task, understanding pole deterioration rates has enabled poles known to be in a good condition to have had their testing maintenance period extended. Consequently, this has reduced the need for costly, resource intensive, and intrusive testing requirements for good condition poles without exposing Ausgrid to a material increase in risk due to pole failures.

These changes allow us to deliver better value to our customers without compromising on the prudency with which we maintain the safety, security, and reliability of our overhead network.

In addition to extending inspection cycles for pole and line, better data and improved risk segmentation has also extended inspection timeframes for the following assets:

- Kiosk substation inspections (extended from 10 years to 12 years)
- Pole top inspections (extended from 10 years to 15 years)
- Oil filled fuse switch inspections (extended from 20 years to 30 years)
- Pillar visual inspections (extended from 5 years to 10 years), and thermal inspections (extended from 6 years to 10 years).

4.2 Introduction of new maintenance standards

4.2.1 Corrective maintenance standards

Ausgrid has introduced corrective maintenance standards to improve consistency in the identification, classification and prioritisation of defects. These standards align defects found in the field to the network defect rectification prioritisation framework (NDPF) explained previously. Corrective standards remove personal bias and potential conservatism by providing asset inspectors with a consistent risk based position to apply to defect classification and rectification timeframes. Ausgrid undertook a number of reviews of its outstanding defects in-line with the new standards. As a result, rectification timeframes were revised and a number of defects deferred.

The consistent classification and validation process has improved the overall efficiency of how we maintain our assets. This has resulted in us only doing the maintenance work that needs to be done, minimises the inconsistent interpretation of standards and enables us to deliver better value to our customers.

4.2.2 Vegetation maintenance standards

During 2017, Ausgrid published and implemented a new vegetation management standard that provides exceptions regarding re-growth allowances in certain circumstances. These exceptions are derived based on the vegetation clearance principles within the NSW Industry Safety Steering Committee (ISSC) Guide for the management of vegetation within the vicinity of Electricity Assets (ISSC3). ISSC3 allows for exceptions on the basis that they do not establish a lesser public safety risk outcome than adhering strictly to the predefined requirements.

An integral part of establishing the new standard was our engagement and collaboration with stakeholders, including Local Councils and the general public. During the development of the new standard Ausgrid engaged with stakeholders to better understand their needs and expectations to incorporate and reflect these views as much as possible in the new standard. While the application of exceptions defined in the new standard will require the establishment and implementation of risk mitigation including a risk assessment, once implemented, it is anticipated that the customer will see benefits and added value from the new standards. Customer benefits anticipated to arise in 2017/18 from the new standard include reduced overall cutting envelopes; reduced vegetation management costs; improved vegetation aesthetics; and reduced impacts on heritage and significant vegetation.

4.3 New technology

Our use of new technology, such as LiDAR, high resolution aerial photography and thermal imaging using infrared cameras to detect hot spots on the network, has reduced the need to undertake invasive maintenance. In particular, the use of LiDAR and high resolution aerial photography has improved and increased the identification of defects, as it provides a view of our assets that is not readily identifiable through traditional maintenance approaches. The increased visibility of defects from LiDAR and high resolution aerial photography has led to a corresponding increase in the volume of corrective maintenance required to mitigate against the risk of a fault occurring.

Figure 13. LiDAR helicopter and LiDAR image of transmission tower

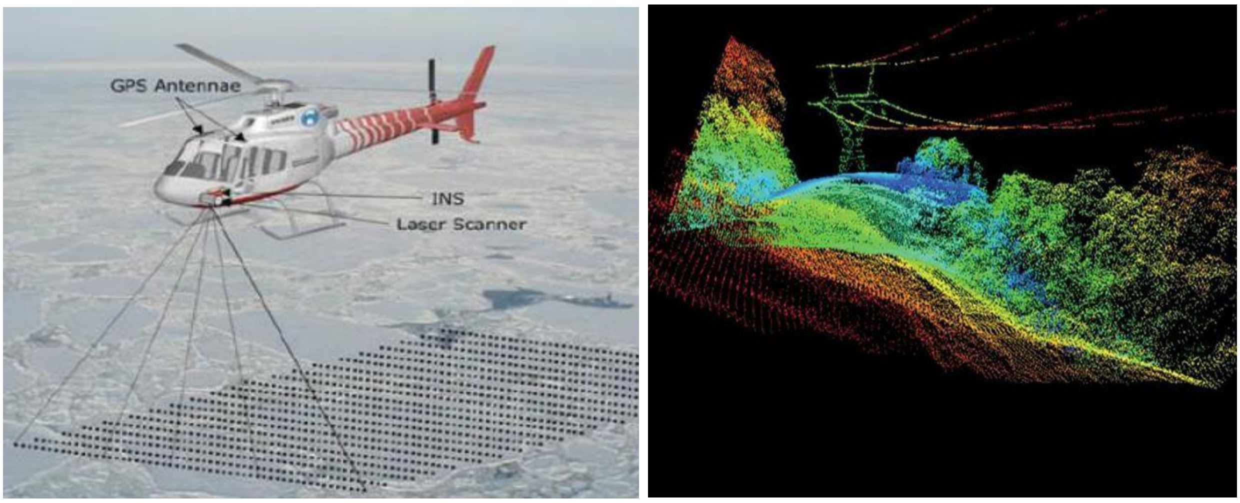
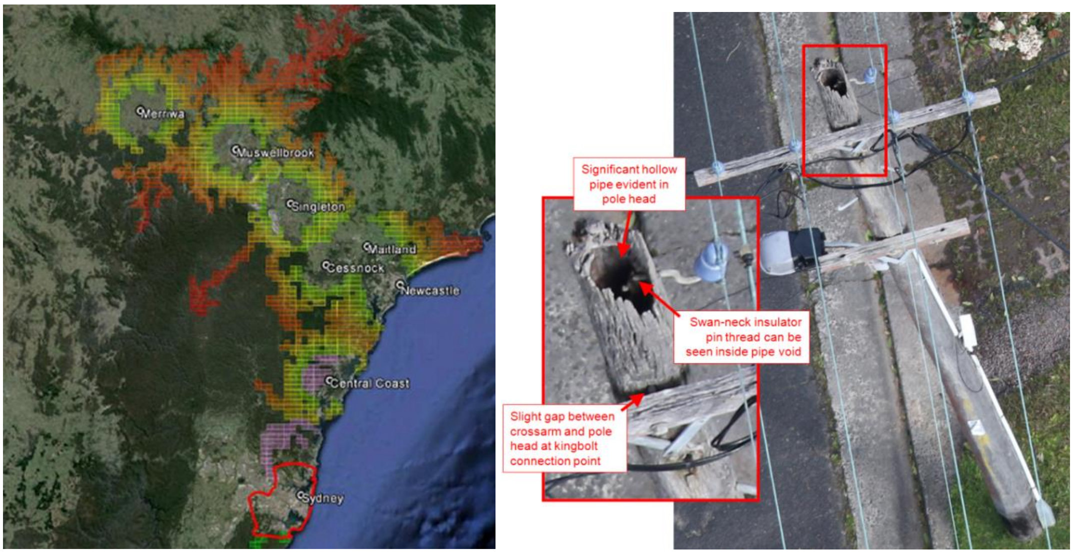


Figure 13 above, illustrates how LiDAR (using remote sensing technology) illuminates a target with a laser to build a 3-D 'picture' which can be analysed to capture detailed distances between conductors and vegetation or other objects. High resolution photography undertaken via aerial patrol is undertaken by Ausgrid in conjunction with LiDAR to improve the effectiveness of aerial inspections in bushfire prone areas by providing high resolution images of potential defects. Figure 14 shows a map detailing the aerial patrol coverage area and an example of a defect which has been identified.

Figure 14. Aerial patrol coverage map grid & example high definition photograph



In addition to LiDAR, Ausgrid has also rolled out a Field Force Automation (FFA) project which has provided access to our information systems to workers in the field utilising 4G smart phones, tablets and notebooks. The benefits of this program are:

- Improvements to job scheduling by giving better access to information required on the job and allowing crews to move from one job to the next without returning to the depot
- Providing access to GIS maps, corrective maintenance standards, defect libraries, and enabling direct data entry into our systems which reduces back office costs.

New technology provides Ausgrid with a mechanism to better understand and address asset risk and deliver our maintenance program in a more effective and efficient manner.

4.4 Packaging of maintenance tasks

While multiple site visits to individual assets provides a higher level of maintenance effectiveness, it was identified that in some cases the optimal balance between risk, cost, and performance could be achieved by grouping certain maintenance tasks together into a single maintenance activity. Examples of this include:

- Pole transformer visual inspections and overhead line inspections
- Pole and overhead line inspection tasks
- Kiosk and fuse switch inspection tasks.

Previously, routine pole and line inspections were delivered as separate maintenance activities undertaken over five (5) year intervals, and off-set by 2.5 years. Figure 15 and Figure 16 below illustrate the separate pole and line maintenance activities previously performed to detect defects and mitigate against the occurrence of failure modes illustrated in Figure 17.

Figure 15. Line inspection

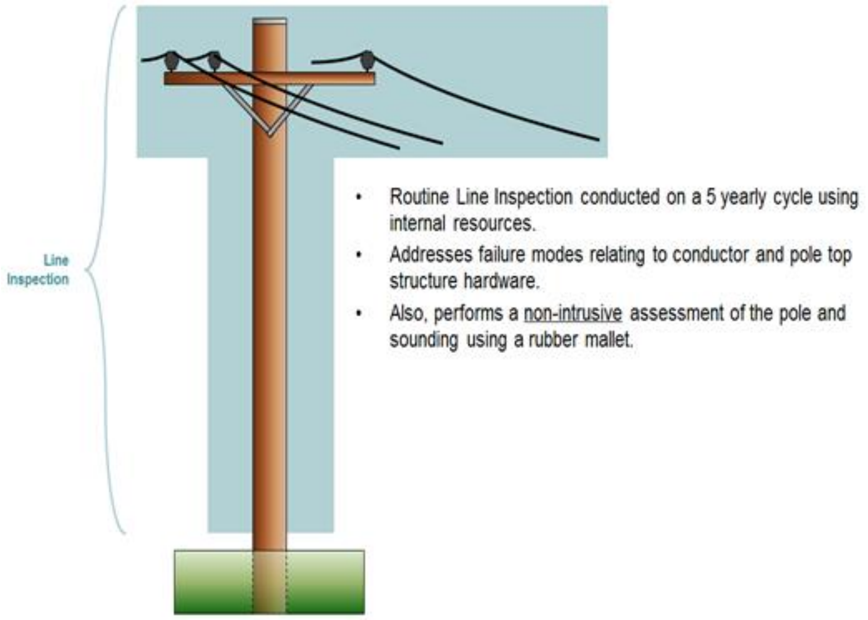


Figure 16. Pole inspection

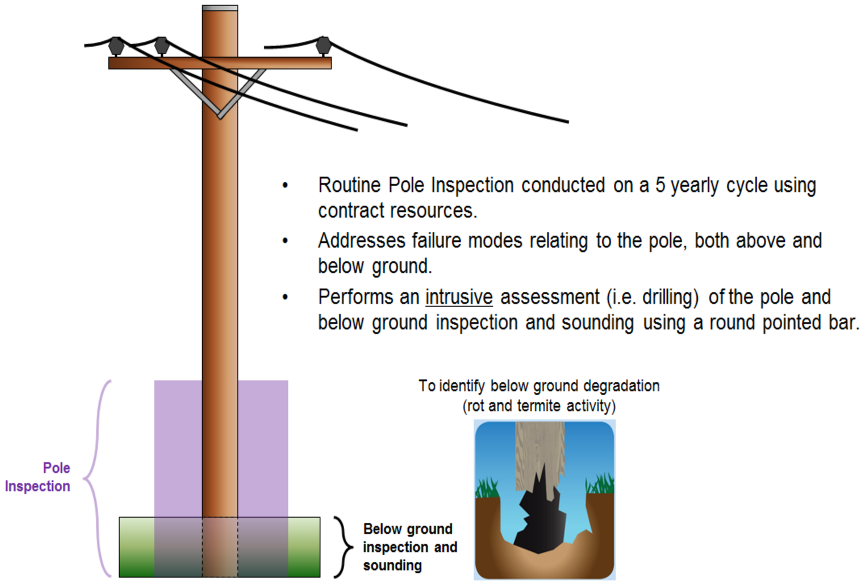


Figure 17. Examples of pole and line failure modes

Following the outcome of an MRA review of routine pole and line inspection, it was determined that this process could be optimised by combining these activities into a single maintenance activity. The grouping of these tasks reduces the number of site visits to each pole, and therefore the associated travel times and setup costs. Ausgrid implemented the changes to pole and line maintenance in 2016 with a transition through 2017.

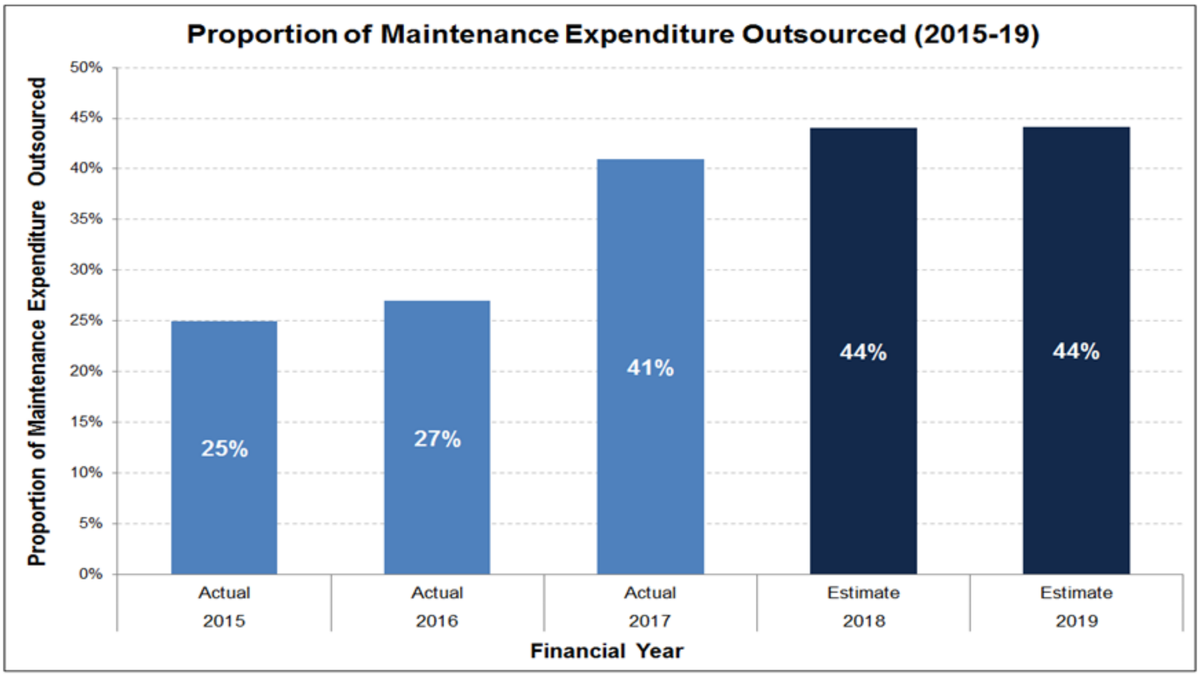
Following the decision to group pole and line inspection into a single task, Ausgrid also reviewed its delivery approach for carrying out this work. Historically pole inspection had been delivered via contracted services while line inspection was delivered via internal labour. With the new combined task, it was determined that it would be more cost effective to be delivered via contracted services.

These changes to our delivery approach for pole and line inspections has enabled us to achieve delivery efficiencies so that we provide better value to our customers without compromising the prudency with which we maintain the safety, security and reliability of our network.

4.5 Greater mix of outsourcing (contract delivery)

A key focus of our transformation program has been a review of outsourcing of various asset management activities including maintenance. This has increased the proportion of Ausgrid's outsourcing from 25% to 44% during the 2015-19 regulatory period as illustrated by Figure 18. The key focus for this review was to consider low complexity, high impact activities where efficient delivery could be achieved. The largest transformation for Ausgrid's standard control services maintenance was to combine pole and line inspection into the one activity and deliver this through a contracted service. Ausgrid's single largest maintenance activity – vegetation management – is already fully delivered via contracted services. These improvements in our delivery performance have enabled us to deliver the appropriate volume of maintenance activities while reducing the level of expenditure.

Figure 18. Proportion of maintenance expenditure outsourced[5]



[5] Proportion of contracted services of total maintenance expenditure for standard control services (SCS) which excludes street lighting which is part of alternative control services (ACS). Note: inclusion of street lighting would further increase this proportion.

5 OUTCOMES ACHIEVED DURING THE CURRENT PERIOD

The following sections seek to highlight how the initiatives outlined in Section 4 have allowed us to improve the efficiency of our base year, which we have used to 'roll forward' our costs in developing the maintenance forecast expenditure component of our total opex for the 2019-24 regulatory period. Specifically, Section 5.1 provides an overview of maintenance expenditure incurred during the 2015-19 regulatory period, while Section 5.2 seeks to highlight the efficiency of our maintenance expenditure for the current period.

5.1 Overview of network expenditure for 2015-19

The success of the actions we have taken to improve the efficiency of our maintenance program are evidenced in Figure 19 below which shows maintenance expenditure for the regulatory period by expenditure category. Table 3 provides an overview of the activities which correspond to the expenditure categories outlined below.

Figure 19. Network maintenance expenditure for 2015-19

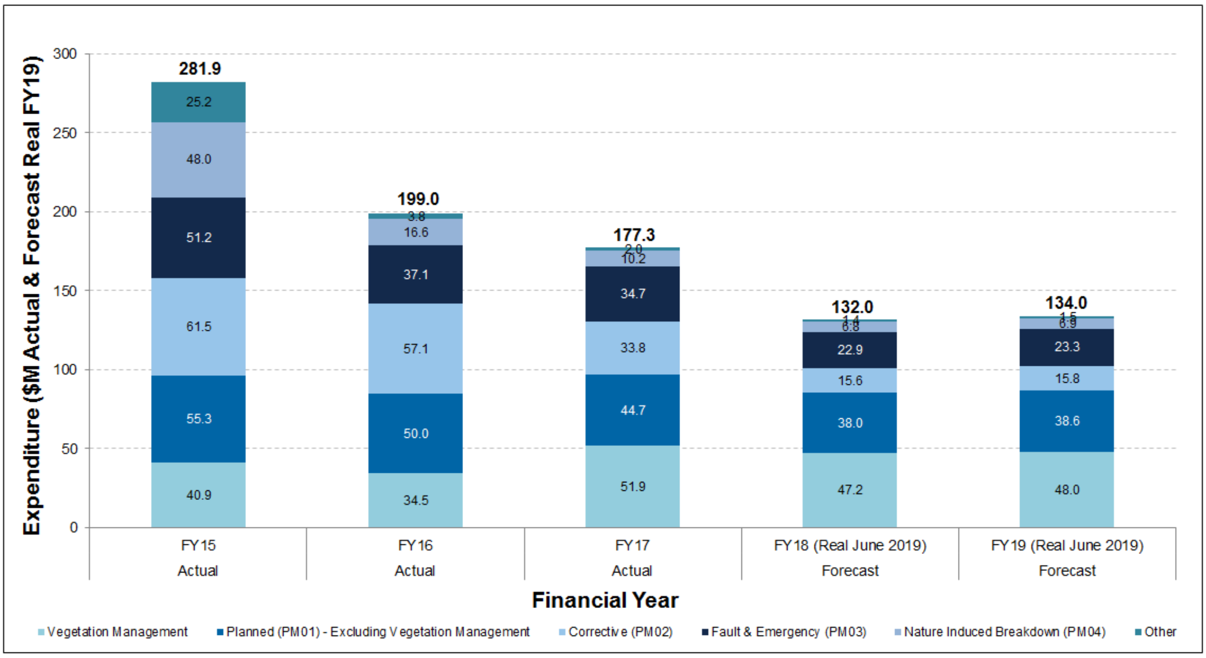


Table 3. Mapping of key maintenance activities to maintenance operating expenditure category

Work order type	Expenditure category	Activity type
PM01	Planned	Inspection, testing and condition monitoring Preventative maintenance Vegetation management
PM02	Corrective	Modifications / design changes Corrective repairs
PM03	Fault and Emergency	Fault and emergency repairs
PM04	Nature Induced Breakdown	Repairs due to nature induced breakdowns
PM05	Repairs due to damage by a third party	Repairs due to damage by a third party
PM08	Other	Non-direct Maintenance

Work order type	Expenditure category	Activity type
PM09	Other	Engineering support

5.1.1 Key observations

The changes to Ausgrid's maintenance operational expenditure profile over the 2015-19 regulatory period can be explained at a high level by the following points:

- Nature Induced Breakdown expenditure (PM04) was significantly higher in 2014/15 compared to other years due to significant storms impacting the network
- The drop in vegetation management expenditure in 2015/16 occurred as a result of a failed maintenance contract. Significant expenditure adjustments were made in 2016/17 reflecting the rectification of the failed contract and renewal of maintenance contracts
- Corrective maintenance expenditure (PM02) dropped during the period due to improved application of approved accounting standards and deferral of lower priority defects (CAT 3 and 4)
- Breakdown expenditure (fault and emergency PM03) declined during 2014/15 to 2016/17 before reaching a sustainable level from 2017/18 onwards. This change in expenditure profile has predominantly been the result of improved application of approved accounting standards
- Planned maintenance expenditure (PM01) has reduced during the period as a result of the changes to maintenance cycles and improved delivery approaches described in Section 4.
- The implementation of better data capture and cost capture in 2014/15 resulted in the other expenditure category (PM08 and PM09) decreasing significantly, however this is likely to be lessened by the establishment of a centralised defect assessment team allocating their costs to this category over the remaining years of the regulatory period.

5.1.2 Key changes in expenditure

The following section outlines key changes in expenditure for major components of our planned and corrective maintenance expenditure during the 2015-19 regulatory period. Figure 20 provides a summary of maintenance expenditure relating to:

- Bushfire maintenance
- Substation maintenance
- Overhead mains maintenance
- Underground mains maintenance.

Expenditure changes have occurred for these components as a result of efficiency improvements from the implementation of initiatives in Section 4 being realised, opportunities to defer maintenance activities, and the introduction of new obligations. Overall, a common theme that is evident in Figure 20 is the change in expenditure profile from the start of the 2014-19 regulatory period, which shows a sizable reduction across all expenditure categories.

Further details outlining the specific reason for changes for each of these categories is outlined in Table 4 below.

Figure 20. Overview of changes in key components of Ausgrid's maintenance expenditure during the 2015-19 regulatory period

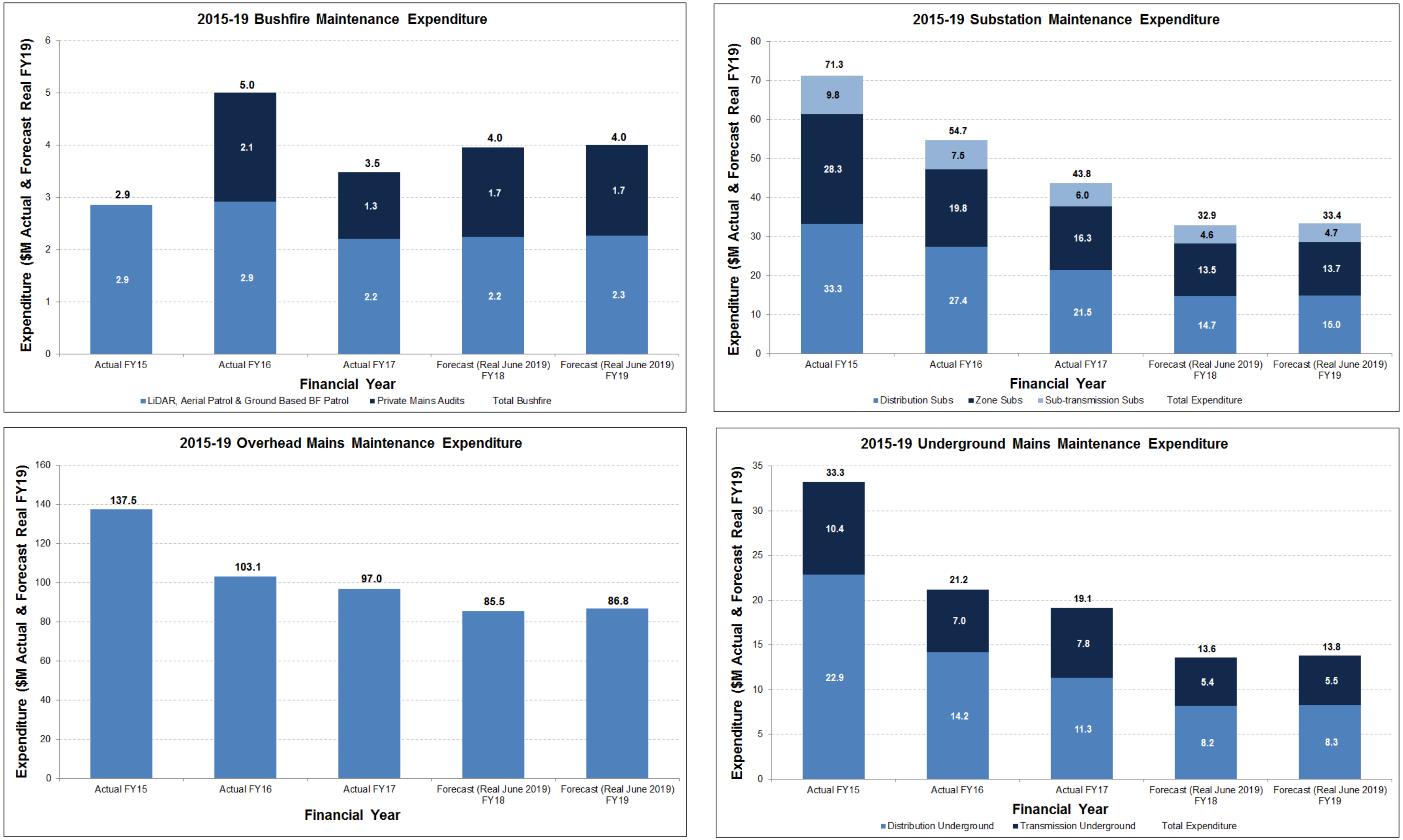


Table 4. Description of changes in expenditure components during the 2015-19 regulatory period

Expenditure component	Description of change
Bushfire maintenance	In addition to increasing areas for network related bushfire maintenance, we have established a program and process for undertaking private mains activities as a risk management activity for private assets in bushfire prone areas, which consists of the following activities: • Private (aerial customers') mains vegetation and hardware audits • Reviewed up front connection processes for High Voltage Customers (HVCs) to confirm their Installation Safety Management Plan (ISMP) takes into account bushfire risk • A formal HVC notification and ISMP verification process to confirm a HVC installation is free from defects that could pose a potential bushfire risk. These processes have been introduced consistent with our obligations under the *Electricity Supply (Safety and Network Management) Regulation 2014 (NSW)* and *Electricity Supply Act 1995 (NSW)*. Private mains audits involve a yearly vegetation audit and five (5) yearly hardware audit of approximately 44,300 private poles and overhead powerlines in bushfire prone areas to check for potential bushfire hazards in accordance with the new powers for bushfire prevention under Division 2A of the *Electricity Supply Act 1995 (NSW)*, which was introduced in November 2014 through the *Electricity Supply Amendment (Bush Fire Hazard Reduction) Bill 2014 (NSW)*.
Substation maintenance	Following an MRA review of substation maintenance, it was determined that some activities could be deferred and labour re-prioritised to undertake network capital activities as part of Ausgrid's move towards adopting a more holistic and end-to-end approach in delivering network related work. The following activities reviewed under the MRA, were either deferred, or inspection cycles extended: • Periodic oil replacement in fuse switches • Fuse switch visual inspections • Kiosk visual inspections • Pole top substation inspection and testing. These tasks will resume with more efficient packaging, such as undertaking the associated fuse switch visual inspection as part of the kiosk visual inspection, and the pole top transformer visual inspection through the combined pole and line maintenance activity. Intrusive maintenance of oil filled fuse switches has moved to a 30 year cycle for those in distribution substations (previously 20 years) followed by planned replacement at approximately 50 years. Further packaging efficiencies have been identified and implemented in major substation inspections where the technician is able to complete multiple maintenance activities whilst at the same location, each substation location has had all these tasks synchronised, thereby reducing the travel time for each task. During 2016/17 technological changes were introduced to allow tap changer counter readings to be captured remotely by Ausgrid's supervisory control and data acquisition (SCADA) system, removing the need to send workers to site and manually record readings. These workers can be diverted to more business critical tasks, resulting in a more efficient allocation of resources.
Overhead mains maintenance	To enable an efficient combination of these tasks, line inspection activities were generally deferred in 2015/16 with the majority of reductions being realised in 2016/17. During the 2015-19 regulatory period, approximately 100,000 pole inspections were undertaken per annum using contract resources, and 100,000 line inspections using internal resources. From 2017/18 onwards these activities will now be combined and delivered through contracted services as part of the one inspection (approx. 100,000 per annum). In addition, intrusive inspection/testing for those poles deemed to be in a good condition has been extended from 5 years to 10 years.
Underground mains maintenance	Following the outcome of an MRA review in FY17 which was informed by improved data, Ausgrid decided to change its pillar inspection cycles from a five (5) yearly visual and six (6) yearly thermography, to both activities being conducted on a ten (10) year cycle offset by five (5) years. These changes result in reduced pillar inspection and testing maintenance expenditure, which translates into better value for our customers for the next regulatory period, whilst achieving appropriate risk levels.

Expenditure component	Description of change
	Maintenance optimisation has also been undertaken with regard to the planned maintenance for transmission cables. The performance of this maintenance activity and associated outages has now been aligned to substation maintenance (e.g. for switchgear or protection), and reviewed against proposed retirement dates. In addition, a review of transmission underground cable maintenance activities in 2017/18 has also resulted in the deferral of certain feeders, whilst packaging others with earthing reviews.

5.1.3 Factors that have contributed to maintenance performance in 2015-2019

As evidenced by Figure 20, our expenditure has reduced significantly during the regulatory period despite our asset base increasing[6]. This result has been achieved without any material increases in failure rates. Factors that have contributed to this result include:

- Investments in the sub-transmission system and targeted replacement of more costly older assets during the 2009-14 regulatory period
- Better asset information that has allowed us to identify maintenance activities for further efficiency improvement
- The introduction of new technologies which have enabled us to improve the data and information upon which we make our decisions
- Improvements in work packaging and scheduling to improve delivery performance
- Increased use of external contractors to undertake part of the work where out-sourcing is more cost effective.

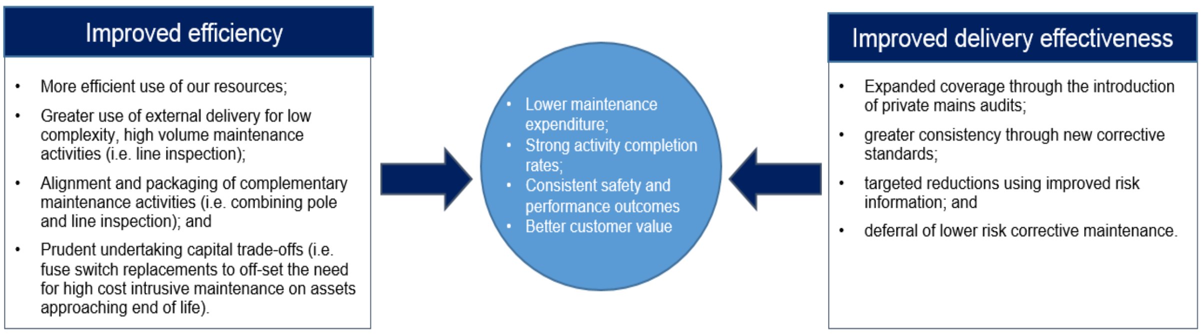
In short, we have been able to offset the increase in the number of assets on our system with efficiencies in the way we maintain our assets to yield a long-term, sustainable maintenance spend.

5.2 Demonstrating the efficiency of our base year

During the 2015-19 regulatory period we have achieved strong completion rates for maintenance activities, safety outcomes, and network performance against a backdrop of reductions in maintenance expenditure.

Figure 21 below summarises the key factors that have contributed to this performance.

Figure 21. Key maintenance outcomes achieved during 2015-19

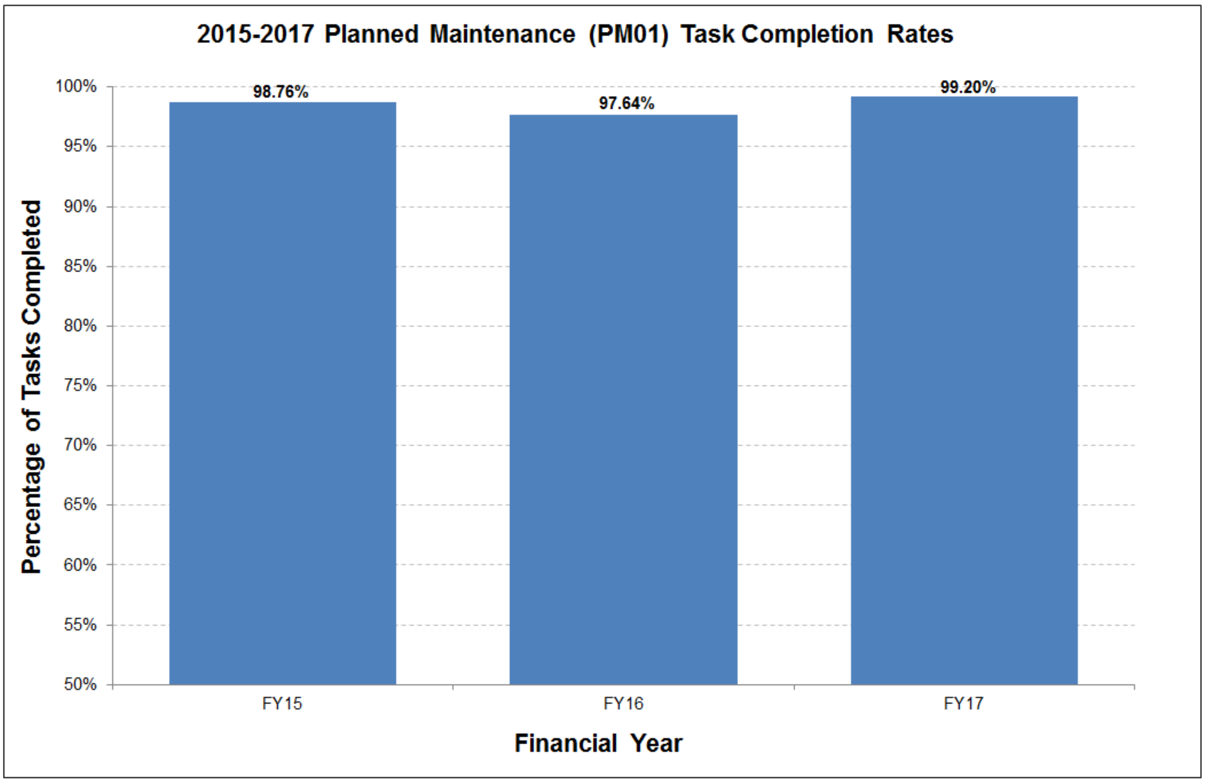


[6] Ausgrid's asset base increased during the 2014-19 regulatory period due to growing customer connections and asset line length.

5.2.1 Task completion rates

Over the 2015-19 regulatory period, our maintenance activity completion rates have remained high against targeted activities. Figure 22 below shows our actual planned maintenance completion volumes over the 2015-17. While there was a slight dip in completion rates in 2015/16, it remained above 97% against target.

Figure 22. Planned Maintenance (PM01) task completion rates 2015-17



6 OUR 2019-24 MAINTENANCE PROGRAM

This section provides an overview of the program of work underpinning the forecast maintenance component of our total opex forecast for the 2019-24 regulatory period. In particular, it seeks to:

- Provide an outline of our maintenance forecast for the 2019-24 regulatory period
- Describes the program of work that the proposed expenditure relates to
- Discusses key changes in expenditure from the current regulatory period
- Outlines continual improvement opportunities that will be investigated during 2019-24.

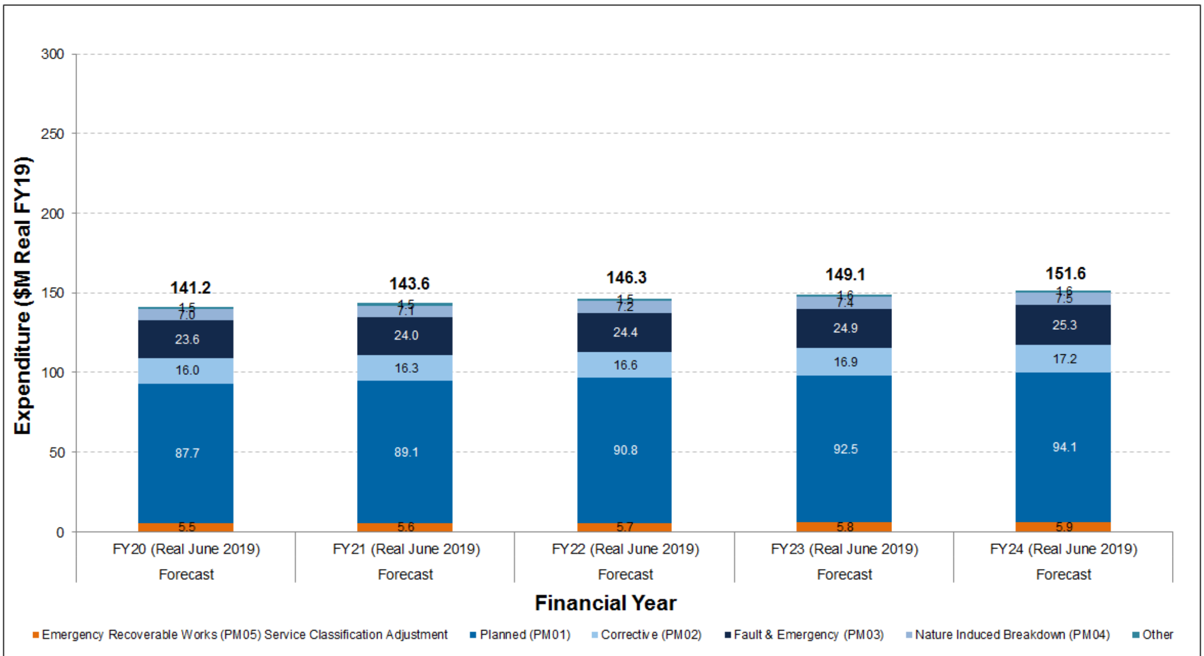
6.1 Forecast network maintenance expenditure for 2019-24

In sections 4 and 5, we have sought to demonstrate and provide evidence of the considerable changes that have been made to our operations during the current regulatory period to improve the effectiveness in which maintenance tasks are delivered. As highlighted in section 5, these changes have significantly improved the efficiency of our base year maintenance costs, which have been 'rolled forward' in forecasting our total required opex for the 2019-24 regulatory period consistent with the AER's base-step-trend approach. In rolling forward our base year costs we have applied the following cost escalators:

- Real wage growth (i.e. the delta between wage increases and CPI) applied to the labour cost component
- Output growth (i.e. based on a combination of the assumed increase in network/circuit length and customer numbers) applied to all opex expenditure.

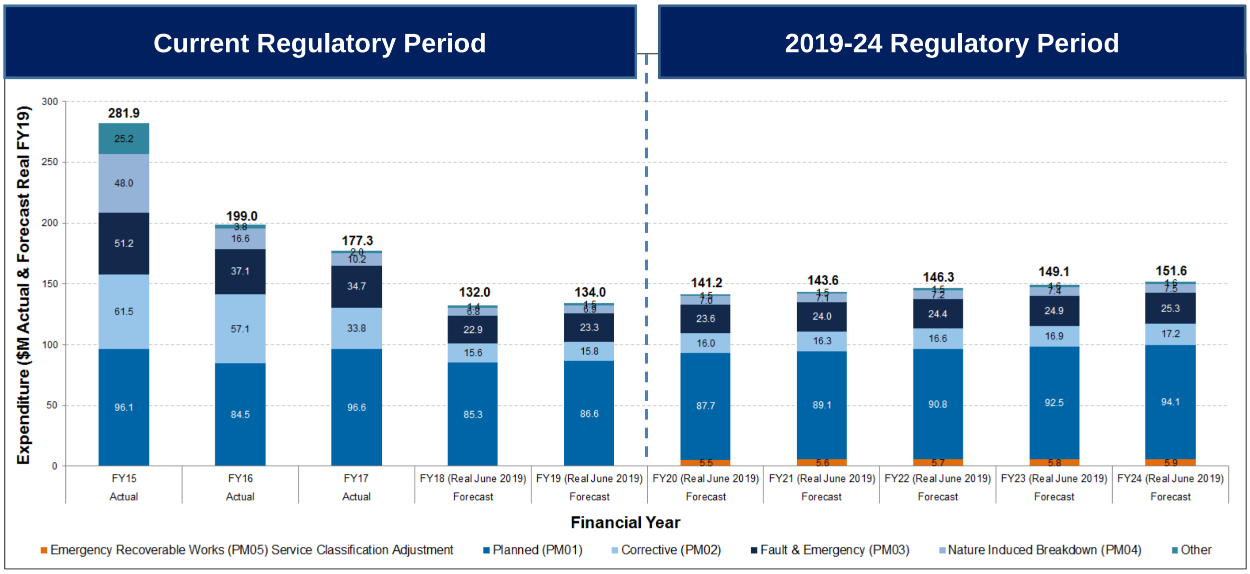
Figure 23 provides a high level overview of our forecast network maintenance expenditure for the 2019-24 regulatory period.

Figure 23. Network maintenance expenditure for the 2019-24 regulatory period



In contrast to our expenditure profile during the 2015-19 regulatory period, our maintenance profile moving forwards is relatively flat, as highlighted by Figure 24. This is due to significant transformation changes implemented during the current regulatory period which have enabled us to achieve a more efficient and sustainable maintenance expenditure profile moving forward.

Figure 24. Comparison of current and forecast network maintenance expenditure



6.2 Proposed maintenance program

Table 5 provides a high level overview of the scope of the key activities underpinning our forecast maintenance expenditure for the 2019-24 regulatory period.

Table 5. Overview of Ausgrid's proposed maintenance program for 2019-24[7]

Description of work for 2019-24 regulatory period	Rationale
Undertake over 500,000 inspections of poles, the associated conductors and support structures over the 5 years of the regulatory period.	The line inspection maintenance activity addresses failure modes relating to conductors and pole top hardware. The activity also performs a non-intrusive assessment of the pole and sounding using a rubber mallet. The pole inspection maintenance activity addresses failure modes relating to the pole, both above and below ground. It performs an intrusive assessment (i.e. drilling) of the pole and below ground inspection and sounding using a round pointed bar. Poles and the conductors they support are located where any defects can compromise the safety of the public, workers or the environment.
Maintain vegetation safety clearances from approximately 32,000km of overhead network conductors each year.	Vegetation that is not properly maintained can compromise the safety, security and reliability of the network it is encroaching on. It can also compromise the safety of the public through direct contact with in-tact conductors or direct contact resulting in live fallen conductors. Vegetation encroachments can also compromise the safety of the network and wider community in bushfire prone areas through contact leading to bushfire ignition.

[7] It must be noted that this is not an exhaustive list and there are many other activities that are not mentioned here.

Description of work for 2019-24 regulatory period	Rationale
Undertake LiDAR patrols of over 10,800km of overhead conductors (over 120,000 poles) in bushfire prone areas where it is possible to fly each year.	This activity is part of Ausgrid's bushfire risk mitigation strategy and involves the use of aerial (helicopter) patrols to audit vegetation safety clearances from poles, overhead conductors and support structures in bushfire prone areas to mitigate against vegetation encroachment defects that could result in bushfire ignition. A bushfire has the capacity to impact the safe, secure and reliable operation of the network and the safety of the wider community and environment as whole.
Undertake Aerial Patrols of around 37,500 poles (about 1/3) in bushfire prone areas where it is possible to fly each year.	This activity is part of Ausgrid's bushfire risk mitigation strategy and involves the use of aerial (helicopter) patrols to audit pole and pole top structure hardware in bushfire prone areas by taking high resolution photographs to identify potential defects that could result in bushfire ignition. A bushfire has the capacity to impact the safe, secure and reliable operation of the network and the safety of the wider community and environment as whole.
Undertake ground based bushfire patrols of approximately 15,000 poles in bushfire prone areas each year where it is not possible to fly.	This activity is part of Ausgrid's bushfire risk mitigation strategy and involves the use of ground based patrols in areas where it is not possible to fly to audit poles, conductors and pole top structures in bushfire prone areas to identify potential vegetation and hardware defects that could result in bushfire ignition. A bushfire has the capacity to impact the safe, secure and reliable operation of the network and the safety of the wider community and environment as whole.
Undertake a vegetation audit each year and a hardware audit every 5 years on approximately 44,300 private poles in bushfire prone areas.	Ausgrid has followed a due diligence process to establish private mains activities as a risk management activity consistent with our obligations under the *Electricity Supply (Safety and Network Management) Regulation 2014 (NSW)* and *Electricity Supply Act 1995 (NSW).* Private poles and overhead powerlines that are not properly maintained can become a serious bushfire or safety risk. Property owners and occupiers are responsible for the safe maintenance and operation of electrical installations located on their premises. Unsafe private poles and overhead powerlines may pose a threat not only to the safety of the physical place to which it is located, but also the safety and secure operation of the network to which it is connected.
Undertake 12 yearly inspections and testing of over 13,000 kiosk substations and an earthing test every 15 years of over 16,000 pole top substations.	Ausgrid's kiosk and pole top transformer substations are located in areas where certain failure modes could compromise the safety of the public, workers or the environment.
Undertake approximately 5,000 pillar visual inspections and 5,000 pillar thermal inspections every year.	Pillars, like poles are located where any defects that are evident can compromise the safety of the public, workers or environment.
Continue to undertake maintenance on approximately 350km of fluid filled sub-transmission cable.	Ausgrid's fluid filled cables have been installed on our network from the late 1960s. This technology is experiencing age related deterioration which poses both an environmental risk from the oil that leaks into the ground and waterways as well as compromising the safe, secure and reliable operation of the network through the risk of asset failures.
Undertake approximately 30,000 fire systems tasks per annum across all associated substation types.	Fires in substations can impact the safety of workers in the vicinity, cause significant damage to assets and building structures, disrupt the reliability and security of the network and compromise the safety of the public.

6.3 Key changes in expenditure and approach

The following section outlines the step changes that we have made to our base year costs, in rolling forward our base year costs, under the AER's base-step-trend forecasting approach. Key changes to our forecast expenditure include:

- Changes in asset population (trend)
- Emergency recoverable works (step change).

These changes are discussed further in detail below.

6.3.1 Changes in asset population and customer connections

Our maintenance costs are inherently linked to our assets and the number of customers we serve. As our customer base grows the number of assets on our network and the network supply area we service increases proportionately.

The number of assets maintained by Ausgrid increased during the 2014-19 regulatory period in line with customer connections and associated asset line length. This is expected to continue and is represented as a trend in the forecast maintenance expenditure during the 2019-24 regulatory period as shown in Figure 24 above.

6.3.2 Emergency recoverable works

Following changes to our classification of services, in light of the AER's establishment of a national ring-fencing guideline, emergency recoverable works will become a regulated distribution service from the beginning of the next regulatory period. Emergency recoverable works are defined as emergency works to repair damage following a person's act or omission, for which that person is liable (e.g. repairs to a power pole following a motor vehicle accident).

The AER has proposed to change the classification of emergency recoverable works from an unregulated distribution service to a standard control service, so this service can be provided by Ausgrid's distribution business without breaching obligations under the ring-fencing guideline. This change in classification will result in a small step increase in costs included in our 2019-24 maintenance expenditure forecast, and is represented by the orange expenditure shown in Figure 24.

6.4 Future initiatives

Ausgrid is committed to continually improving the efficiency of its operations, so that we continue to deliver value to our customers. While we have undergone a significant transformation process during the 2015-19 regulatory period to reshape and refocus our business to establish an efficient cost base, we will continue to explore the feasibility of a number of further initiatives that may assist us in driving further efficiencies into our operations. These initiatives include:

- Implementation of an advanced data management system (ADMS) forecast for completion later in the 2019-24 regulatory period to enable Ausgrid to take advantage of future industry and technological developments to better serve our customers and stakeholders
- Undertake ground based LiDAR and high definition photography trials as an alternative to aerial LiDAR and high definition photography for areas which are designated as no-fly zones
- Implement advanced data analytics and machine learning trials to further increase and make use of a data capture to better inform processes for the future

- Further develop our existing partnerships in pursuit of further technological advancements that could potentially reduce the need for invasive maintenance during pole inspections.