5.13.B

Project justifications for pole top structures replacement programs

Ausgrid

Content

1 INTRODUCTION

1.1 Pole top structures on the network

Ausgrid's overhead network is comprised of poles, electrical equipment and electrical conductors. Pole top structures support the overhead conductors so they remain safely clear from the ground, buildings, infrastructure, vegetation, vehicles, watercraft and other conductors on the same pole.

Pole top structures include cross arms and additional attachments which support the conductors. Ausgrid have included ground stays in this chapter, as they are an additional asset used to support conductors by providing counter weight to balance pole load.

There are more than 446,000 poles on the Ausgrid network (excluding street light poles and columns). The poles may have pole top structures which support a single circuit or multiple circuits and can be at the same voltage or at other voltages.

There are more than 2,250 ground stays on the Ausgrid network sub-transmission network. Like pole top structures, there may be multiple ground stays installed per pole, however only a small population of poles require ground stays due to the unbalanced load on the pole.

1.2 Changes in technology

Ausgrid generally replaces pole top structures like for like, which is typically with wood cross arms (and to a lesser extent, steel) and porcelain or glass insulators. New technology components which may be installed with any pole top restructure replacement include:

- Cross arms made from composite materials, such as fibreglass – these are primarily used on circuits operating at 11kV or higher voltages
- Insulators made from polymeric materials – these are primarily used on circuits operating at 11kV or higher voltages
- Post insulators made from porcelain or polymeric materials – these are primarily used on circuits operating at 33kV or higher voltages and do not need cross arms as they are mounted directly onto the pole.

In addition to these new types of components, Ausgrid may install aerial bundled conductor on LV circuits (LV ABC). LV ABC changes the configuration of pole top structures (e.g. cross arms are not required) which inherently also reduces the life cycle costs of the circuit due to there being a reduced number of pole top components.

1.3 Working out what we need to replace

Ausgrid undertakes inspections and condition assessments of pole tope structures to determine the appropriate treatment option when condition issues are identified. The different pole top structure and ground stay types have known failure modes, which informs assessment criteria for treatment.

Based on the assessed condition, defect location and cost effectiveness, Ausgrid will undertake either a repair or replacement of the pole top structure.

1.4 Summary of programs

In total we expect to spend $23.8 million on replacing approximately 10,400 pole top structures and 125 ground stays. Ausgrid has a 'run to failure' approach for some other overhead equipment which are not demonstrating condition issues and these are replaced following failure (refer to Part K (Reactive programs) for further details).

The following programs are discussed in further detail below:

- Pole top structure replacement ($22.7 million)
- Ground stay replacement ($1.1 million).

2 POLE TOP STRUCTURE AND GROUND STAY REPLACEMENT

2.1 Program description

The conditional and planned replacement programs for pole top structures and ground stays address known condition issues associated with their degradation. These programs are outcomes of the overhead line maintenance inspections and condition assessments. Pole top structure and ground stay degradation causes safety risks to the public, customers and workers if:

- The pole or pole top structure fails and falls to the ground
- The insulators and other supports fail leading to the conductor lying directly on the cross arm
- The pole leans too far or the pole top structure fails and the overhead conductors attached to it are no longer at a safe distance from the ground, buildings, infrastructure, vegetation, vehicles, watercraft or other conductors.

The four main programs related to replacing pole top structures or ground stays are:

- Replacement of distribution pole cross-arms (No.) (REP_04.03.10)
- Refurbish 132kV overhead feeders (No.) (REP_05.02.07-3)
- Refurbish 33kV overhead feeders (No.) (REP_05.02.07-1)
- Replacement of sub-transmission ground stays (No.) (REP_05.02.26).

These programs are continuing from the current regulatory period. Ausgrid expects to spend $15.8 million replacing 10,000 distribution pole top structures, $6.9 million refurbishing 400 33kV, 66kV and 132kV pole top structures and $1.1 million replacing 125 ground stays. Given ground stays only represents 5% of the total investment for pole top structures, the focus of this section is on the three other programs specific to pole top structures.

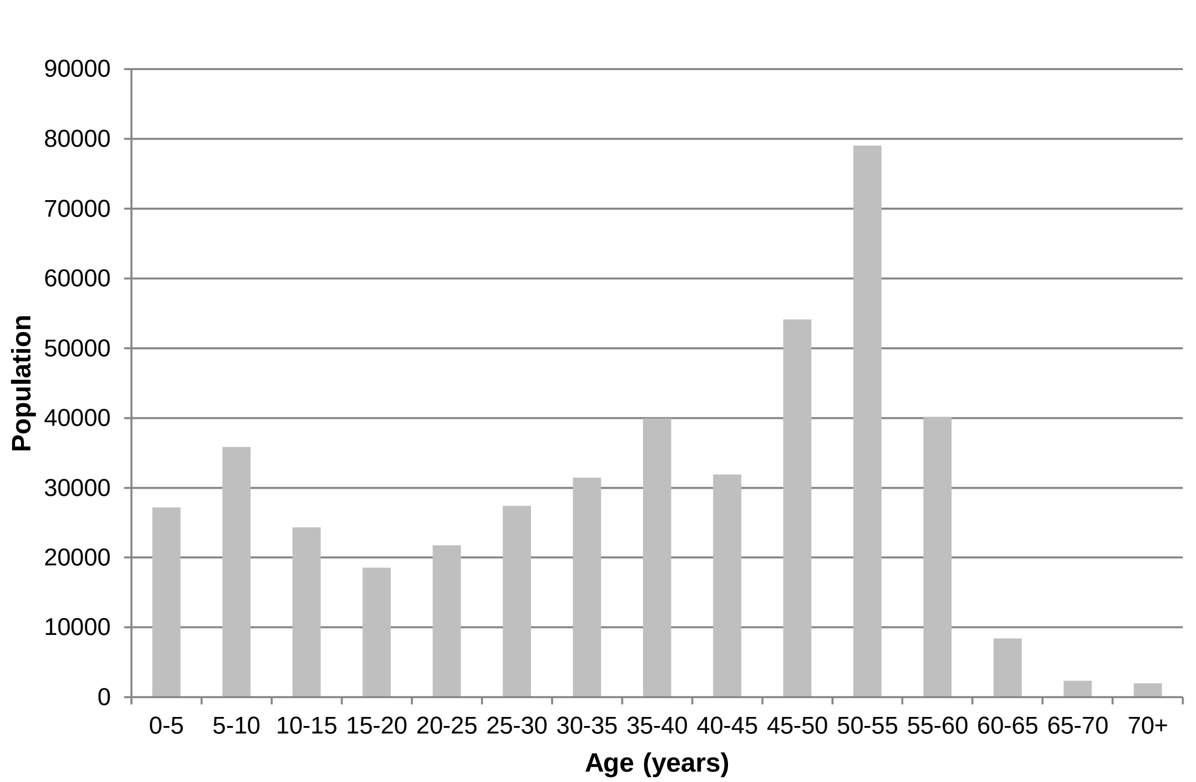
2.2 Background

Ausgrid has approximately 446,000 poles on the distribution and sub-transmission network (excluding those used solely for street lighting purposes). These have pole top structures comprising of cross arms and braces, insulators, lightning arrestors and other components. The primary function of pole top structures is to maintain safe horizontal electrical clearances of overhead conductors and equipment to:

- The ground, buildings, infrastructure, vegetation or vehicles / watercraft
- Other live overhead conductors and equipment supported by the same pole.

Ausgrid does not record pole top structure asset details to such a level that individual component age is known. The average age of pole top structures has therefore been estimated using the Ausgrid pole age profile as a pseudo. The age profile of Ausgrid poles is shown in Figure 1. The average age of poles is 35 years, with 42% over their standard technical life of 45 years.

Figure 1. Age profile of pole top structures (as at 30 June 2017)



The need for replacement of pole top structures and ground stays has been triggered by condition and inherent design issues which pose safety risks to the public, customers or workers as well as loss of supply risks. These risks are compounded by the aging asset population, noting that 42% of the population is already over 45 years old. The replacement of the pole top structure provides a life extension to the pole similar to pole reinforcement and as such using the pole age instead of the pole top structure remains an appropriate indicator of pole top replacement needs.

2.3 Risks – Consequence and likelihood

The key consequences that can result following a loss of function of a pole top structure are shown in Table 1 below.

Table 1. Consequences from loss of function for pole top structures

Consequence	Description
Harm to the public, communities and workers	Contact with live electrical conductors or equipment which have reduced clearances or have fallen may cause injury (physical injury, electric shock or burns) or a fatality (electrocution).
	Fires (including bushfires) caused by clashing with live electrical conductors or equipment which have reduced clearances or have fallen may cause injury (electric shock or burns) or a fatality.
	Safety issues as a result of loss of supply are detailed below.
Damage to property	Contact between live electrical conductors or equipment which have reduced clearances or have fallen and buildings, infrastructure or vehicles / watercraft may cause arcing, fires or physical damage.

Consequence	Description
	Buildings, property or critical infrastructure may be damaged by fires caused by vegetation contact with live electrical conductors or equipment which have reduced clearances or have fallen.
Damage to the environment	The natural environments may be damaged by fires caused by failed electrical conductors or equipment.
Loss of supply	Interruptions to electricity supply can affect a single customer or whole communities in the form of transport systems, traffic controls, emergency services, business and communication systems, critical infrastructure and vulnerable customers including those on life support systems.
	Failures associated with these pole top arrangements may result in large numbers of supply interruptions and penalties or intervention by our regulator.

Failure modes associated with pole top structures are deteriorating in nature and therefore present an increased likelihood of failure over time. The predominant failure modes for pole top structures are shown in Table 2.

Table 2. Key failure modes for pole top structures

Asset	Key Failure Modes
Pole tope structure	Rot, termite attack or cracking / splitting of wood cross arms.
	Corrosion of steel pole top structure components including cross arms, braces, nuts / bolts and insulator pins.
	Age, weather or pollution related degradation of insulators and surge arrestors.
	Damage caused by falling vegetation, lightning, vehicles or people.

The likelihood of a pole top structure failure can increase due to a number of factors including:

- Its inherent design
- Being in high wind areas
- Being in areas with unstable / moist soil
- Being in areas that are salt affected (coastlines) or highly polluted.

The consequence of a pole top structure failure can increase due to:

- Being in areas with high pedestrian / vehicle activity or in close proximity to schools
- Supporting circuits which supply critical customers or infrastructure
- Being in areas prone to bushfire.

A functionally failed pole top structure is one that has degraded to the point where it is no longer able to support the overhead conductors in the designed aerial space or at the required safe electrical clearances. A breach of the designed aerial space may be as a result of insulator or connection failures, leading to conductors resting in an unsafe location. The reduced electrical clearances may be due to the pole top structure components failing or ground stay failure causing the pole to lean or fall to the ground.

In the period from 2013/14 to 2016/17, there were over 15,000 conditional or functional failures associated with pole top structures. These failures may result in safety risks to the public, customers and workers, loss of supply risks and environmental risks if fires occur.

Ausgrid utilises condition information from inspections and condition assessments to determine when a pole top structure is approaching functional failure and sets criteria to define the point of conditional failure. Pole top structures are replaced if the condition issues identified are not technically or economically able to repaired, i.e. if they are at end of life.

Ausgrid's asset management practices for pole top structures provide an understanding of their condition and therefore the likelihood of failure. Detecting failures before they occur and applying treatments maintains pole top structures in a serviceable condition, limiting the likelihood of failure and mitigating the potential consequences described above.

The key treatment options that can be applied are detailed below.

2.4 Treatment analysis

Assessment of the treatment options considered for pole top structures is shown in Table 3.

Table 3. Treatment options for managing pole top structures

Treatment options	Treatment overview
1 Repair the pole top structure	Undertake repairs to the pole top structure as conditional issues are identified. Indicative repair costs range from approximately $500 to $5,000 per repair.
2 Replace individual pole top structure components	Replace individual conditionally failed components of the structure like for like. Indicative replacement costs range from approximately $550 to $7,000 per individual component replacement.
3 Replace the pole top structure	Replacement of all pole top structure components with their modern equivalent. Indicative pole top structure replacement costs are approximately $1,600 for voltages up to 22kV and $20,000 for voltages 33kV or greater.
4 Replace the entire pole	Replacement of the entire pole including the pole top structures. Indicative pole and pole top structure replacement costs are approximately $7,200 for voltages up to 22kV and $25,000 for voltages 33kV or greater.

Repairs (Option 1, e.g. tightening cross arm braces) or replacement of individual components (Option 2, e.g. replacing insulators) are an operational expense associated with maintaining the assets and may be done where deemed practical and efficient. These options do not return the pole top structure to an 'as new' condition.

Where extensive condition issues are identified the pole top structure will be replaced (Option 3). This leaves the pole top structure in an 'as new' condition. Replacement is undertaken using like for like components (typical for circuits operating at voltages up to 22kV) however replacement may include a redesign of the pole top structure using modern equipment to reduce the number of pole top components (typical for circuits operating at voltages 33kV or higher).

Replacement of pole top structures may require replacement of the pole (Option 4) if the existing pole is not of sufficient height to achieve the conductor safety clearances required by modern standards. Replacing the whole asset (pole tope structure and pole) aligns the age of all components following replacement and leaves them in an 'as new' condition.

The treatment option selected for pole top structures varies and is dependent on its operating voltage, its design and the condition of all components that make up the pole top structure.

2.5 Options

The program options considered in relation to the treatment of pole top structure are summarised in Table 4.

Table 4. Program options for managing pole top structures

Program need options	Option overview
1 Reactive Treatment	Implement treatment such as replacement or refurbishment when the pole top structure (e.g. cross-arm) fails.
2 Conditional Treatment	Implement treatment to treat assets when inspections or condition assessments identify that they have deteriorated to the point of conditional failure based on a set of criteria.
3 Planned Treatment	Implement treatment such as replacement of the pole top structure at the standard technical life of 45 years.

The consequence of a pole top structure falling poses serious safety risks to the public, customers, workers and the community as described above. Due to these risks, an approach that only manages these assets in a reactive manner (Option 1) is unacceptable. This option would defer capital expenditure in the short term, but would not adequately manage the existing risks associated with pole top structures. As these risks accumulate over time, this could lead to a significant uplift in public safety incidents, reactive replacement work and an accompanying step change in capital expenditure. Due to the significant and aging population of the existing assets, overcoming this in the future would require a significant increase in capital expenditure.

Planned replacement (Option 3) does not take into consideration the actual condition of the pole top structures and the additional spatial factors which may increase the risk. In Ausgrid's case, given the asset age profile, this option would likely result in an up-lift in capital replacement which is not reflective of current performance and risk requirements.

Additionally for Option 3, some pole top structures, depending on factors such as their operating environment, adjacent vegetation and other spatial considerations, may fail earlier than 45 years and so the risk of increased failure remains. Planned replacement is therefore not considered the preferred approach due to the increased costs and risks.

Ausgrid's preferred approach is to manage the risks associated with pole top structures by undertaking an assessment of each pole top structure to determine its condition (Option 2) and then to prioritise its treatment. This approach addresses the risks associated with the known failure modes for these assets rather than the long term sustainability of the asset population (average age) and provides a balance between risks and costs so far as is reasonably practicable. Where the condition of pole top structures does not warrant treatment, no treatment is undertaken.

For pole top structures operating at or above 33kV, all condition issues on individual feeders are assessed to determine the most efficient 'packaging' and timing of pole top structure replacement on a 'per feeder' basis – this approach is considered a 'refurbishment' of the feeder because not all pole top structures on the whole feeder are replaced. Other assets with condition issues on the feeders (for example, overhead conductors) may also be packaged as separate components of these feeder refurbishment projects.

2.6 Costing and volumes

In 2016/17 Ausgrid reviewed the way that costs are captured for replacement of pole top structures operating at 11kV or lower voltages and is embedding the revised cost capture process during 2017/18. There are approximately 400,000 pole top structures operating at these voltages. The forecast conditional replacement volumes reflect an expectation that approximately 0.5% of the population of pole top structures operating at these voltages will require replacement per year.

For pole top structures operating at 33kV or higher voltages, refurbishment requirements are determined by conditional assessment following asset inspections. The condition assessments are reviewed to determine the appropriate program of works required, i.e. pole top refurbishment or conductor replacement (separate replacement program). Only a small number of feeders were prioritised for planned pole top structure treatment during the 2015-19 regulatory period – many other individual 33 -132 kV pole top structures have been replaced reactively in this period due to identified poor pole top structure condition. The forecasts for the refurbishment programs have been based on historical identification of conditional failures, asset population and condition information, as well as local knowledge of feeder condition issues and feeder location issues. The forecast excludes any works involved in reactive replacement work.

Refurbishment of pole top structures is primarily undertaken by internal resources, however, external resources have been utilised on occasion. Benchmarking of Ausgrid costs is continually undertaken to drive efficiency and reduce costs.

The 2019-24 summary forecast for these replacement programs is shown in Table 5. The costs shown are direct costs only. The forecast results in an average of only 0.5% of the pole top structure population being replaced annually. The volumes substantially relate to the replacement of distribution pole top structures (LV and 11kV). Ausgrid expects similar levels of investment will be required in future periods with this condition-based approach to replacement of pole top structures.

These programs form part of the overall investment being proposed for the replacement of pole top structures, refer to the Ausgrid Reset RIN template '2.2 REPEX' for details on the overall investment proposed for this asset category during the 2019-24 regulatory period.

Table 5. Forecast for pole top structure and ground stays

Direct Costs (real $FY19)	FY20	FY21	FY22	FY23	FY24
Replacement of distribution pole cross-arms					
Volumes for replacement	2,000	2,000	2,000	2,000	2,000
Unit cost	$1,588	$1,579	$1,576	$1,575	$1,570
Total costs ($m)	**$3.18**	**$3.16**	**$3.15**	**$3.15**	**$3.14**
Refurbish of 132kV OH feeders					
Volumes for replacement	20	20	20	20	20
Unit cost	$7,609	$7,569	$7,547	$7,532	$7,506
Total costs ($m)	**$0.15**	**$0.15**	**$0.15**	**$0.15**	**$0.15**
Refurbish 33kV OH feeders					
Volumes for replacement	60	60	60	60	60
Unit cost	$20,537	$20,432	$20,383	$20,355	$20,296
Total costs ($m)	**$1.23**	**$1.23**	**$1.22**	**$1.22**	**$1.22**
Replacement of sub-transmission ground stays					
Volumes for replacement	25	25	25	25	25
Unit cost	$8,976	$8,937	$8,920	$8,911	$8,890
Total costs ($m)	**$0.22**	**$0.22**	**$0.22**	**$0.22**	**$0.22**