5.13.E

Project justifications for service lines replacement programs

Ausgrid

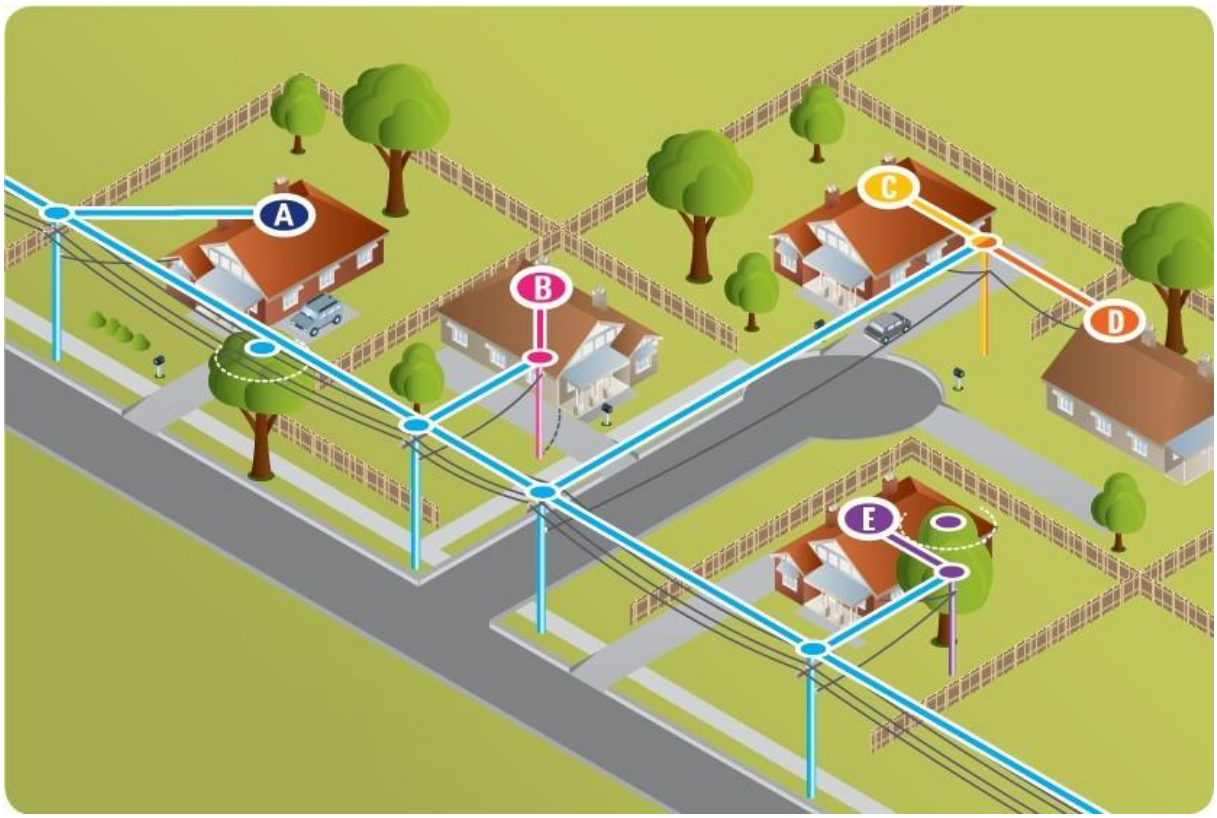
Content

1 INTRODUCTION

1.1 Overhead service lines on the network

Ausgrid has approximately 952,000 service lines, including more than 720,000 which are overhead (OH) service lines. The main function of a service line is to provide an electrical link between Ausgrid's network and the customer. Each OH service line is a physical connection between an Ausgrid pole (or mains) and a customer's connection point.

Figure 1. OH service line network



Ausgrid also has more than 232,000 underground service lines, however these are typically only replaced reactively following a failure due to their relatively low safety risk compared to OH service lines.

1.2 Changes in technology

Early OH service lines typically used bare conductors which used separation in air to insulate between conductors. However, due to an increased safety risk (exposure to people working on roofs and gutters), insulated conductors started to be installed from the 1960s as technology improved over time. Service lines with PVC insulation were installed between the 1960s and mid-1990s, after which Ausgrid commenced installing OH service lines with XLPE insulation. XLPE provides a higher level of electrical insulation and mechanical protection than PVC.

1.3 Working out what we need to replace

Ausgrid undertakes inspections, condition assessments and location based risk assessment of OH service lines to determine the appropriate treatment options for each service line.

Certain asset construction types have known failure modes, which informs assessment criteria for treatment. The expected life of a newly installed OH service is 45 years.

1.4 Summary of capital programs

In total, Ausgrid expects to invest $49.5 million over the 2019-24 regulatory period on replacing 17% (approximately 25,000 replacement services per year) of the OH service line population. Additional OH service line replacement work may be undertaken reactively following failures (refer to Part K (Reactive programs) for further details). Ausgrid intends to mitigate the risks associated with bare and PVC insulated OH service lines by the end of 2023/24, resulting in a higher volume of OH service line replacement work. After 2023/24, Ausgrid expects the OH service line replacement volume to reduce, ultimately aligning with the standard technical life for XLPE insulated services (equivalent to approximately 16,000 replacement services per year). Ausgrid has a 'run to failure' approach for underground service lines and these are only replaced following failure (also refer to Part K for further details).

The following program is discussed in further detail below:

- OH service line replacement ($49.5 million).

2 OVERHEAD SERVICE LINES

2.1 Program description

Ausgrid has put in place a conditional program for the management of the safety and reliability risks associated with our ageing population of OH service lines. Degradation of old technology service lines can lead to safety risks to the public, customers and workers if:

- The service line fails and falls to the ground
- The service line sags and is no longer at a safe distance from the ground, buildings, vegetation and vehicles
- Vegetation contacts the service line.

The replacement program which has been established for the treatment of the risks associated with service lines is:

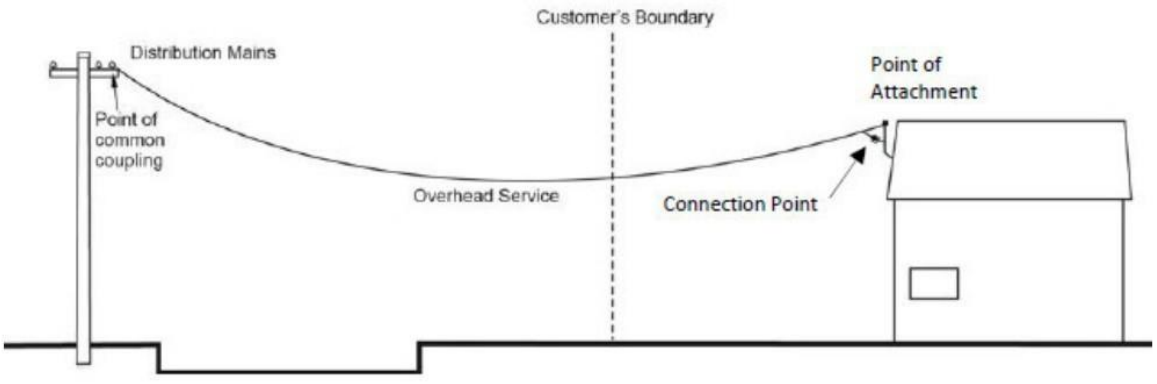
- Low voltage OH service replacement (REP_04.02.04).

This replacement program is continuing from previous regulatory periods and is expected to continue beyond the 2019-24 regulatory period to maintain a sustainable level of investment due to the volume of service lines on the Ausgrid network. In the 2019-24 regulatory period the program is forecast to replace 125,000 OH service lines, at a cost of $49.5 million.

2.2 Background

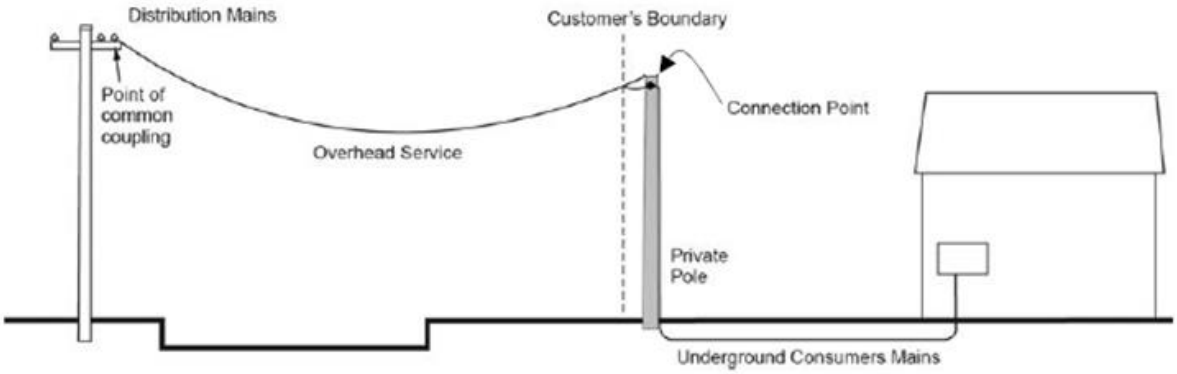
The function of an OH service line is to safely form the electrical connection between Ausgrid's distribution network and a customer's premise. OH service lines and their connection or components used for attachment also have a function to provide safe electrical clearances between conductors and the ground, buildings, infrastructure, vehicles and vegetation. Their typical arrangements[1] are shown in Figure 2 and Figure 3 below.

Figure 2. Typical arrangement of OH service lines



[1] Diagrams are from the Service and Installation Rules of New South Wales

Figure 3. Typical arrangement of OH service lines with underground customers mains

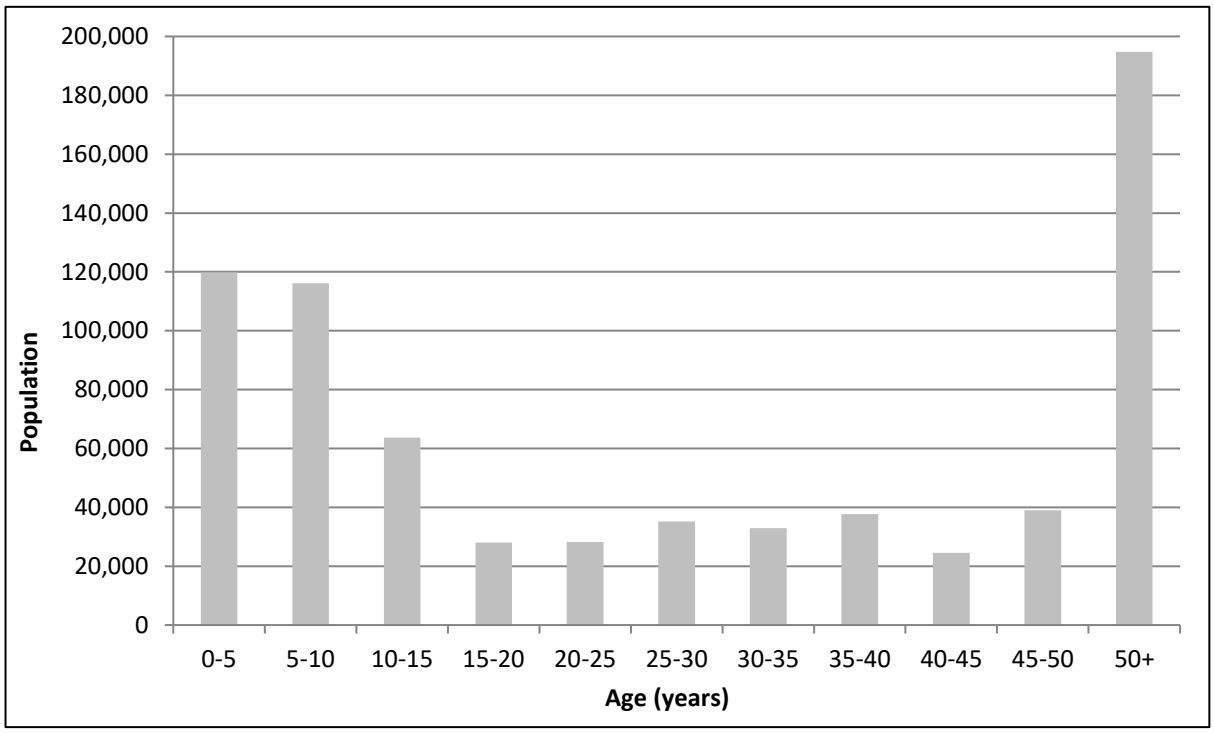


At 30 June 2017, Ausgrid had 720,016 OH service lines supplying residential, commercial and industrial customers. The age profile of these assets is shown in Table 1 and Figure 4. These show that more than 233,800 OH service lines (32%) are older than the standard technical life of 45 years. Assets greater than 25 years old are presumed to be either bare or PVC insulated OH service lines as Ausgrid did not install XLPE prior to this time.

Table 1. Age profile of OH service lines by population (as at 30 June 2017)

Service line age	% of population	Count of service lines
0 – 15 years old	42%	299,715
16 - 30 years old	13%	91,394
31 - 45 years old	13%	95,079
Older than 45 years	32%	233,828

Figure 4. Age profile of OH service lines (as at 30 June 2017)



The need to replace OH service lines has been triggered by the risks associated with their known failure modes and inadvertent contact with the service line. These risks are compounded by the ageing asset population, noting that 32% of the population is already over 45 years old.

2.3 Risks – Consequence and likelihood

The consequences associated with OH service lines compared to other OH conductors are increased given their accessibility to the public, communities and workers as most OH service lines traverse public land and private property and are connected to structures more commonly accessed by non-electrically trained people. A customer or worker undertaking activities on a private property (for example, cleaning gutters, vegetation trimming, installing signage) is at higher risk of inadvertently breaching safety clearances from, or come in contact with, live OH service lines.

The key consequences related to OH service lines are shown in Table 2 below.

Table 2. Consequences from loss of function for service lines

Consequences	Description
Harm to the public, communities and workers	Contact with a degraded or fallen live OH service lines may cause injury (physical injury, electric shock or burns) or a fatality (electrocution). As described above, this risk also exists for people (particularly non-electrically qualified people) working on and around buildings, roofs and gutters.
	Fires (including bushfires) caused by degraded or fallen live OH service lines or vegetation contact may cause injury (burns) or a fatality.
	Safety issues as a result of loss of supply are detailed below.
Damage to property	Arcing from degraded or fallen live OH service lines may initiate a fire (including bushfires) which causes damage to buildings, infrastructure or vehicles.
Damage to the environment	The natural environment may be damaged by fires caused by degraded or fallen live OH service lines or vegetation contact.

Consequences	Description
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.

Spatial factors can also increase the consequences and likelihood of a failed or fallen OH service line. These factors include them being located in:

- Areas with high pedestrian / vehicle activity or in close proximity to schools
- Salt affected areas which may increase deterioration
- Heavily vegetated areas or areas prone to bushfire.

The various OH service line configurations have different failure modes. The failure modes are generally deteriorating in nature and therefore present an increased likelihood as a product of time i.e. as the assets age and are exposed to weather and sunlight. All OH service line configurations may also fail due to physical impact (for example, by vegetation, vehicles or persons) or weather conditions. The key failure modes for each type of OH service line configuration are shown in Table 3 below.

Table 3. Key failure modes by identified OH service line material type

Service Line Type	Key Failure Modes
Bare service lines	Conductor failure due to clashing over a prolonged period.
	Conductor failure due to fatigue from conductor 'sway' over the life of the service.
	Conductor corrosion due to exposure to weather or pollution.
	Conductor mechanical damage due to contact with vegetation, buildings or vehicles.
PVC insulated service lines	Condition related degradation due to prolonged exposure to ultraviolet ('UV') radiation from sunlight.
	Cracking of the insulation near the connection / attachments at each end of the service line due to conductor 'sway' over the life of the service.
	Mechanical damage to the PVC insulation due to contact with vegetation, buildings or vehicles.
	Conductor failure caused by electrical arcing which occurs when the PVC insulation degrades or is damaged.
XLPE insulated service lines	Premature degradation of the XLPE due to incorrect manufacturing process.

Other common failure modes are associated with the service termination clamps or fittings. These components have failure modes commonly associated with corrosion and fatigue and certain types have been identified to have a higher likelihood of failure.

The failure modes associated with PVC insulated OH service lines are widely known within the electricity industry. The risk of failure of this type of OH service line was recognised by the NSW Department of Energy in 1996[2] when they issued a safety bulletin in regard to PVC insulated service lines identifying that PVC insulated OH service lines 'should provide satisfactory performance for a period of 30 years'. Assets older than this may not be adequately insulated and, as a result of sustained exposure to the elements, this presents an increased likelihood of failure beyond this age. Ausgrid has been installing XLPE insulated service lines instead of PVC insulated service lines since approximately 1993.

[2] NSW Department of Energy Electrical Safety Bulletin 'Insulation Of Overhead Service Lines', 1996

Over the period from 2012/13 to 2016/17, Ausgrid attended to over 10,000 customer reports per year in regard to arcing or fallen OH service lines (approximately 1.5% of the asset population per year).

2.4 Treatment analysis

Assessment of the treatment options considered for OH service lines is shown in Table 4.

Table 4. Treatment options for managing OH service lines

Treatment options	Treatment overview
1 Repair the OH service line	Undertake repairs to the OH service line. This task may be required where a defective fitting, termination or connection is identified following inspection of the OH service line, but the conductor is in a serviceable condition. Indicative repair costs are approx. $390 per service, while taking a few hours to repair.
2 Replace the OH service line like for like	Replace bare and PVC insulated services with the same technology. Indicative replacement costs are approx. $400 per service, while taking a few hours to replace.
3 Replace the OH service line with new technology	This option is to replace bare or PVC insulated OH service lines with a new XLPE insulated OH service line. Indicative replacement costs are approx. $400 per service, while taking a few hours to replace.
4 Replace the OH service line with underground service line	This option involves excavating public land and private property to replace the service line. This includes negotiating with, and costs for, the customers. It would also include reinstatement of the disturbed ground and potential relocation of other services. Indicative replacement costs are approx. $8,300 per service, while taking somewhere between a few days and a number of weeks to replace the service.

The small variance in the costs for Options 1 – 3 reflects that the majority of the expenditure incurred with any OH service line replacement is due to the labour component (including task setup), not the purchasing of materials.

Repair options for OH service lines (Option 1) are extremely limited and do not provide life extension of the OH service line. Repairs may be carried out on service line fittings (for example, connectors) however conductor repairs cannot be undertaken effectively.

Like for like replacement (Option 2) of bare OH service lines is possible but does not reduce the known safety risks associated with contact by persons or vegetation. Like for like replacement for PVC insulated OH service lines is not undertaken because the XLPE insulation on new service lines provides greater mechanical and electrical protection than PVC insulation and reduces the risks associated with contact by persons or vegetation.

Undergrounding service lines (Option 4) improves the risk outcomes for an individual service, however, given the timeframes and costs to convert to underground construction, the same volume of replacement as forecast under Option 3 could not be reasonably achieved and therefore the risk of failure at the population level would remain high for an extended period.

Ausgrid believes the replacement with an XLPE insulated OH service line (Option 3) to be the most appropriate treatment option as it provides a balance between the risks and costs so far as is reasonably practicable. XLPE insulated OH service lines provide the additional benefit of reducing ongoing vegetation cutting requirements.

2.5 Options

The program options in Table 5 have been considered in relation to managing the conditional risks associated with OH service lines. These options are based on the need to undertake work on Ausgrid service lines.

Table 5. Program options for managing LV OH service lines

Program need options	Options overview
1 Reactive treatment	Implement treatment, such as replacement when the service line fails.
2 Conditional treatment	Service lines are assessed with consideration of condition, construction technology and their location (for example, if they are in bushfire prone areas). Replacement work is identified through this assessment until a sustainable volume of service lines requiring treatment is identified and reflected in current performance.
3 Planned treatment	Implement treatment, such as replacement of the service line at the standard technical life of 45 years, or if the service line has PVC insulation, replacement of the service line at 30 years.

The consequence of an OH service line falling poses a serious safety risk to the public, customers, workers and the community as described above. Due to these risks, an approach that only manages the asset 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 older OH service lines. 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 population, overcoming this in the future would require a significant increase in capital expenditure.

Planned replacement, does not take into consideration the actual condition of the service line 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, some OH service lines, depending on factors such as their operating environment, adjacent vegetation and other spatial considerations, may fail earlier than 45 years (or 30 years for PVC insulated OH service lines) 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 OH service lines by undertaking an assessment of each OH service line (Option 2) to determine its condition and then to prioritise its treatment. Where the condition of service lines does not warrant treatment, no treatment is undertaken.

Given the volume of the OH service lines, their proximity to the public (i.e. across driveways, front yards and near homes) and the effectiveness of asset condition assessments to identify every potential failure, a reactive component of the program is also utilised to manage those assets that functionally fail. The reactive component of this program is included in Part K of this document with other reactive programs.

2.6 Costing and volumes

Our estimated unit cost for OH service line replacement is approximately $400. Ausgrid currently delivers this work utilising internal resources. This replacement unit cost has been

benchmarked against other DNSP's in Australia and has been found to be the lowest cost based on available industry information.

In forecasting the volume of OH service line replacement required during 2019-24, Ausgrid has considered the age of the population including the quantity of assets greater than 45 years old, the remaining quantity of bare and PVC insulated service lines and the failure trend. The forecast replacement volume is expected to provide a balance between cost, risk and performance to sustainably manage an ageing OH service line population, their known failure modes and the quantity of OH service lines which will exceed their technical life.

The 2019-24 summary replacement forecast is shown in Table 6. The costs shown are direct costs only. The forecast reflects Ausgrid's intention to mitigate the risks associated with bare and PVC insulated OH service lines by the end of that period - this equates to replacement of 3.5% of the OH service line population annually.

Ausgrid expects that the OH service line replacement volume will ultimately reduce to align to the standard technical life for XLPE insulated services (equivalent to approximately 16,000 replacement services per year) in future regulatory periods when all of the bare and PVC insulated service lines have been removed from service.

This program forms part of the overall investment being proposed for the replacement of service lines. Refer to the Ausgrid Reset RIN template '2.2 REPEX' for details in regard to the overall investment proposed for this asset category during 2019-24.

Table 6. Program options for managing LV OH service lines

Direct Costs (real $FY19)	FY20	FY21	FY22	FY23	FY24
Volumes for replacement	25,000	25,000	25,000	25,000	25,000
Unit cost	$399	$397	$396	$395	$393
Total costs ($M)	$9.98	$9.92	$9.89	$9.86	$9.82