5.13.H

Project justifications for distribution substation replacement programs

Ausgrid

Content

1 INTRODUCTION

1.1 Substations on Ausgrid's network

There are approximately 32,000 distribution, zone and subtransmission substations on the Ausgrid network. The equipment in substations transforms electricity from higher to lower voltages or provides equipment for switching, power quality management and protection of the network. Additional to the replacement of individual assets, Ausgrid may replace an entire substation particularly where there are inherent risks associated with the substation configuration and design including a significant collection of asset condition issues. This section relates to replacement of the entire substation and therefore does not align to a single regulatory information notice (RIN) category. As per Schedule 1 of the Reset RIN, Ausgrid have apportioned the costs and volumes covered in this chapter across the corresponding RIN categories.

Where replacement of Ausgrid's 235 zone and subtransmission substations are considered to be a potential option they are considered as Area Plan projects due to the complexity of option analysis required and the impact on the surrounding network and its configuration. This document therefore only covers distribution substations.

There are many different types, manufacturers, models and configurations covering Ausgrid's approximately 31,800 distribution substations across the broad categories of kiosks, outdoor enclosures, chambers and pole top substations where the impact of replacement is localised to this substation and immediate surrounds.

1.2 Changes in technology

Ausgrid no longer installs outdoor enclosure substations as the design is considered obsolete. Improvements in kiosk substation configurations have allowed for larger ratings to be achieved, removing the need for outdoor enclosures. Kiosks provide a reduced public safety risk and are fully enclosed, enabling more advanced technology to be installed, leading to an overall lower lifecycle cost.

Where pole top substations are being replaced, composite poles are now installed as they are expected to have a longer life, changing the key failure mode from pole condition to transformer condition, extending the life of the substation and reducing the overall lifecycle cost.

1.3 Working out what we need to replace

Ausgrid has continued its plans from the 2014-19 period to replace a small group of obsolete substations of early era kiosk and outdoor enclosure designs. These assets are beyond their technical life, have a number of condition issues and carry inherent design risks that cannot be mitigated without replacement with more modern designs.

Ausgrid is also continuing to replace pole top substations when the associated pole or the transformer itself has conditionally failed. Refurbishment by replacement of other components is also considered an appropriate strategy to extend the life of the pole top substation fleet when the pole and transformer has significant remaining life.

1.4 Summary of programs

In total, Ausgrid expects to invest $44.8 million ($, real FY19) on replacing distribution substations in the 2019-24 regulatory period. Ausgrid also replaces distribution substations reactively on conditional or functional failure (refer to Attachment 5.13K (Reactive replacement programs) for further details).

The following programs are discussed in further detail below:

- Outdoor enclosure substations ($16.5 million)
- Pole top substations ($22.4 million)
- Kiosk substations ($5.9 million).

2 OUTDOOR ENCLOSURE SUBSTATIONS

2.1 Program desciption

The program for replacement of outdoor enclosures, addresses both the condition issues with the substation equipment and the inherent design risks with the outdoor enclosure configuration. The planned replacement program relating to outdoor enclosure distribution substations is:

- Outdoor enclosure substations (REP_01.02.42).

This program continues from the current regulatory period. Ausgrid expects to replace 20 outdoor enclosure substations per year at a total cost of $16.5 million in direct cost ($, real FY19) over the 2019-24 period covered under this program.

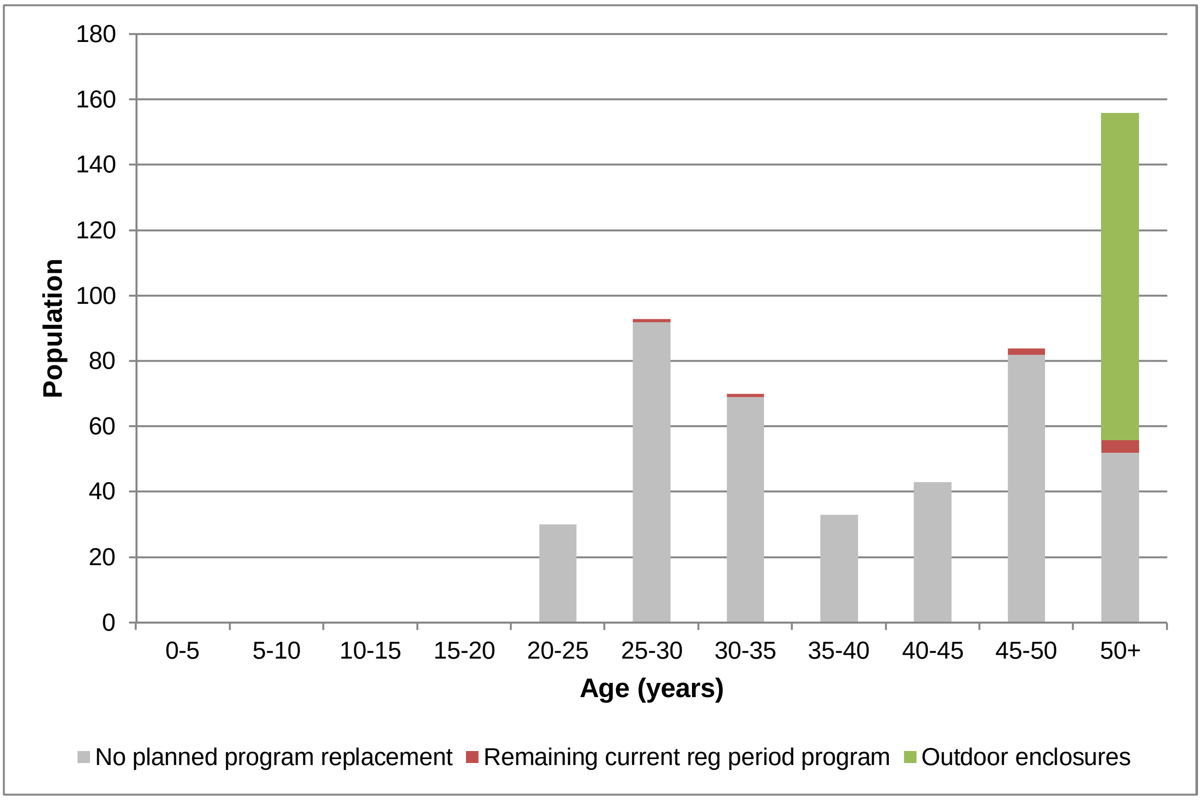
The age profile highlighting the identified programs for replacement against the total population of outdoor enclosure substations on the network is shown in 0.

2.2 Background

Outdoor enclosure substations are free standing walled or fenced structures, generally without a roof and contain outdoor distribution substation electrical equipment, designed to be fully insulated.

As at 30 June 2017, there were 523 outdoor enclosure substations of varying type, age, configuration and condition on the Ausgrid network. All outdoor enclosure substations identified for replacement during the 2019-24 period are over the standard technical life of 45 years. The substations targeted this period were high priority and targeted due to asset condition issues and therefore included some younger substations where advanced asset degradation has been experienced. The age profile for outdoor enclosure substations is shown in 0.

Figure 1. Age profile of outdoor enclosures (as at 30 June 2017)



Outdoor enclosures were originally designed with timber or chain-wire fences, with all equipment sitting directly on the ground and exposed to the elements. Later the construction of outdoor enclosure substations included brick walls and concrete slabs for equipment. Outdoor enclosures also have no oil containment and therefore a significant oil leak will directly impact the environment.

Outdoor enclosure substations ceased being constructed on Ausgrid's network in the mid-1990s and the asset class design is now regarded as obsolete. The remaining population of these assets continues to deteriorate. The outdoor arrangement of the electrical equipment leads to increased equipment condition issues and higher maintenance costs.

2.3 Risks – Consequence and likelihood

The key consequences that can result in a loss of this type of substation's function are shown in Table 1 below.

Table 1. Consequences from loss of function for outdoor enclosures

Consequences	Descriptions
Harm to the public, communities and workers	Fire caused by a loss of insulation, further propagated by the presence of highly flammable oil within the transformer tank.
	Interruptions to electricity supply for an extended period 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.
	Asbestos containing materials are present in the majority of these substations and require specialised handling. Any inadvertent release of asbestos fibres has the potential to impact the public and workers.

Consequences	Descriptions
	Physical contact with exposed 'live' components designed to be insulated may result in electrocution in the event of unauthorised access to the substation.
Harm to the environment	Mineral oil spills can lead to environmental contamination.
Damage to property	Damage to surrounding property and other substation equipment as a result of a transformer or switchboard explosion or fire.

While most of the consequences are common across the various substation types, outdoor enclosures have an increased likelihood of physical contact with exposed live components due to their inherent design. The effectiveness of the security for these substations is low, reflected by the history of vandalism on Ausgrid's substations of this type. The deteriorated condition of the insulated components and low security effectiveness leads to the increased risk of physical contact.

The failure mode details of the remaining components can be found in the respective switchgear and transformer sections of this document. The failure modes specific to the insulation of the components are:

- Failure of the insulated covers which protect the transformer cable connections
- Failure of the low voltage board housing.

Over the 5 year period from 2012/13 to 2016/17, of the outdoor enclosure substations, Ausgrid has experienced on average 146 conditional and functional failures per year. This failure rate includes all the components within the substation fence and includes equipment failures, degradation of fencing and environmental concerns. The failure rate has remained relatively constant over the period with assets being retired within this class due to the increase in age of the remaining substations.

Ausgrid continues to undertake routine maintenance to inspect the condition of these assets, however, given the exposure to the environment (being outdoors) and the need to maintain a high level of insulation, the maintenance requirements are higher for outdoor enclosures compared to modern kiosks.

2.4 Treatment analysis

Assessment of the planned treatment solutions considered for outdoor enclosures is shown in Table 2.

Table 2. Treatment options for managing outdoor enclosures

Treatment option	Treatment overview
1 Repair the outdoor enclosure	Undertake repairs to the outdoor enclosure as conditional issues are identified.
2 Refurbish the outdoor enclosure	Components such as the perimeter fence or wall and the low voltage board housing could be refurbished to ensure the security of the assets contained within. The HV switch, transformer and LV board would be replaced as per the respective approaches to these assets in other sections of the document.
3 Replace the outdoor enclosure	Replace the outdoor enclosure with a kiosk.

The different treatment options are all utilised at different points in the asset's lifecycle. A repair may be completed where practical and efficient. A repair or refurbishment treatment does not remove the inherent risk of the substation design and costs may be in a similar order of magnitude to a complete replacement and is therefore not the preferred option. However sites are investigated on a case-by-case basis.

The HV switch, transformer and LV board are able to be replaced in situ however where there are multiple condition drivers (such as most outdoor enclosures due to the installation of the equipment outdoors) a full replacement is likely to be more cost effective.

Due to the inherent design risk associated and higher maintenance and component replacement requirements of the outdoor enclosures as an asset class, whole substation replacement is considered the most efficient treatment option. On a net present cost basis, the refurbishment would need to extend the life of the outdoor enclosure by 28 years to be more cost effective than replacement. Outdoor enclosures are replaced with a standard procured kiosk substation.

2.5 Options

Ausgrid has considered options as set out in Table 3.

Table 3. Program options for managing outdoor enclosures

Program need options	Option overviews
1 Reactive treatment	Implement treatment such as repair, refurbish or replacement when the outdoor enclosure substation (or components of) fail.
2 Conditional treatment	Implement treatment to the outdoor enclosure substation when inspections identify they have deteriorated to the point of conditional failure based on a set of criteria.
3 Planned treatment	Implement planned treatment prior to outdoor enclosure substation assets failing at or around the standard technical life of 45 years, prioritised by known condition and configuration.

The preferred option is the planned treatment. This is due to the risk to the safety, environment, increased maintenance cost and the reliability of the network that outdoor enclosures pose. Planned treatment allows appropriate time for procurement of equipment and the planning of works enabling a change towards kiosk configurations. The planned treatment will be supported by a reactive treatment (refer to Attachment 5.13.K (Reactive replacement programs) for further information).

Modern kiosks have gas ring main isolator switches rather than oil switches, which have a lower lifecycle cost due to reduced maintenance requirements (as discussed in Program 14 – 11kV ground switches), these switches are not appropriate for an outdoor location.

The continuation of the outdoor enclosure substation replacement program will mitigate the risks on the network in a sustainable way.

2.6 Costing and volume

Each outdoor enclosure substation identified for replacement has been assessed using an asset condition assessment process and deemed approaching end of life. The replacement works are assigned a priority so that the safety, environmental and equipment risks associated with the population are progressively reduced with each replacement maximising the risk reduction. Due to the volume of assets on the network and the degree of degradation, it is proposed that approximately 20% of the outdoor enclosures across Ausgrid's network be replaced during the 2019-24 period maintaining the number of outdoor enclosure substations over their technical life.

The total cost of replaced assets is apportioned between the components of an outdoor enclosure for RIN reporting, refer to the Ausgrid Reset RIN template '2.2 REPEX' for details.

This apportionment makes detailed analysis of the REPEX unit rate at a program level impractical.

A range of factors need to be considered and the planned replacement treatment option evaluated on a case-by-case basis to determine the least cost option. The unit rates are shown in Table 4. These unit rates are high when compared to a like for like kiosk replacement, due to the additional works required to safely retire the existing outdoor enclosure and remediate the existing sites.

The summary forecast for these replacement programs is shown in Table 4. The costs shown are direct costs only.

Table 4.   Forecast for outdoor enclosures

Direct Costs (real $FY19)	2019/20	2020/21	2021/22	2022/23	2023/24
Volumes for replacement	20	20	20	20	20
Unit cost	$164,905	$164,644	$164,675	$164,817	$164,836
Total costs ($m)	**$3.30**	**$3.30**	**$3.30**	**$3.30**	**$3.30**

3 POLE TOP SUBSTATIONS

3.1 Program description

The pole top substation programs address condition issues predominately associated with the deterioration of the pole supporting the substation assets and the supported transformer. The drivers for pole condition issues are aligned to the justification provided in Program 1. The most common failures from the transformers are oil leaks, which present an environmental risk requiring mitigation and lead to a total failure of the equipment.

The two main planned replacement programs relating to pole top distribution substations are:

- Single pole top substations (REP_01.04.11)
- Refurbishment of pole transformer substations (REP_01.04.02).

As discussed in Program 1, Ausgrid's poles are subject to routine inspection and testing to ensure structural and mechanical integrity. Routine pole maintenance involves planned in-service above and below ground inspections undertaken on a five year cycle. When poles carrying the substations do not pass the testing criteria, they are either reinforced to extend their life or condemned and identified for replacement. Alternatively pole top substations that have significant oil leaks or identified condition issues through planned maintenance are highlighted for replacement.

In some cases, the equipment associated with the transformer on the pole needs to be refurbished and Ausgrid has a program to refurbish the components of pole substations that have shown signs of deterioration when the pole is in good condition and it is cost effective to do so. The scope of the program is limited to replacing or refurbishing pole top electrical equipment such as surge arresters, retro-fitting high voltage drop out fuses and replacing high voltage droppers.

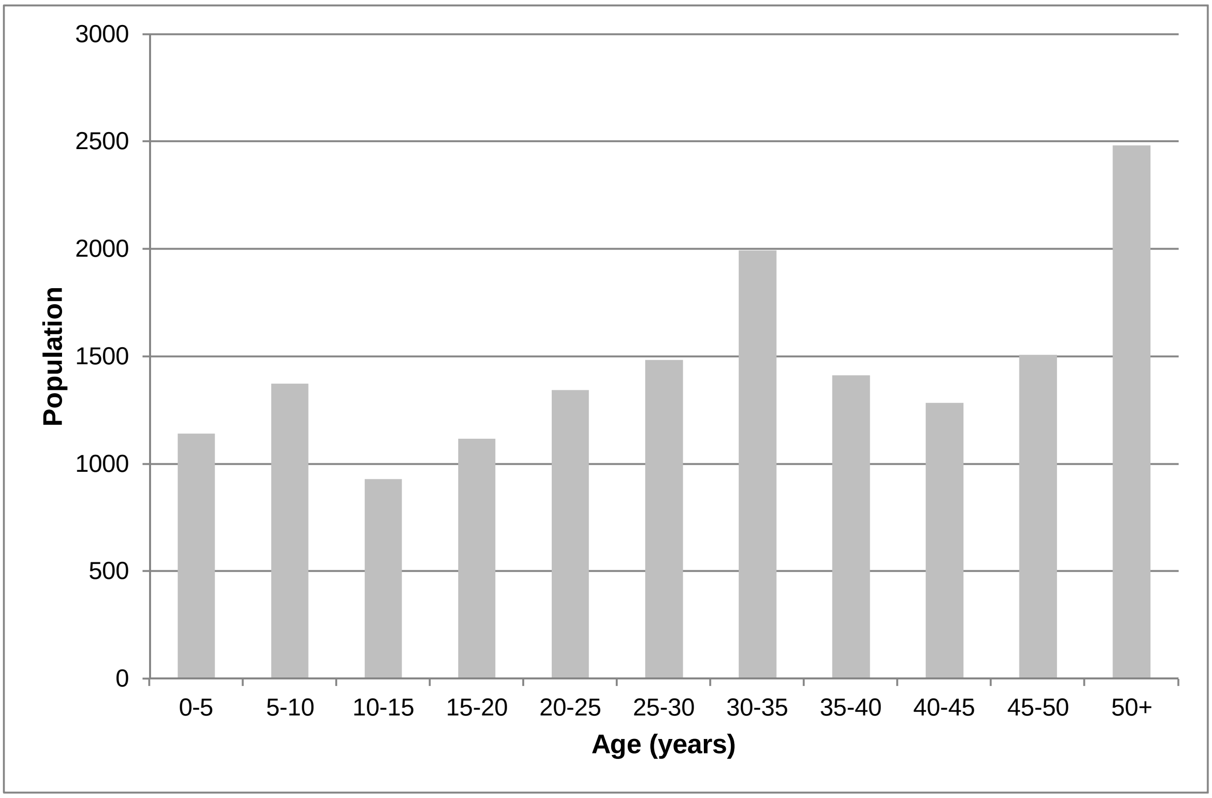
Together, these programs are forecast to cost $22.4 million in direct costs ($, real FY19) over the 2019-24 period. These programs are continuing from the current regulatory period.

The age profile of pole transformers on the network is shown in Figure 2, due to the conditional nature of the program, exact identification is impractical.

3.2 Background

Ausgrid has over 16,000 pole top substations on the network and these assets are predominantly located on the 11kV distribution network. These types of substations have been installed on the Ausgrid network since the 1950s in many different configurations. The age profile for pole top substations is shown in Figure 2.

Figure 2. Age profile of pole top substations (as at 30 June 2017)



3.3 Risks – Consequence and likelihood

In the majority of cases, the risk of the pole top substation failing is related to the condition of the pole rather than the substation electrical equipment. There is a risk the pole may fail and not support the weight of the substation.

The key consequences that can result in a loss of this function are shown in Table 5 below.

Table 5. Consequence from loss of function for pole top substations

Consequences	Descriptions
Harm to the public, communities and workers	Fire caused by a loss of insulation within the transformer tank, further propagated by the presence of highly flammable oil.
	Contact with degraded or fallen live electrical conductors or equipment may cause injury (physical injury, electric shock or burns) or a fatality (electrocution).
	Collapse of the substation due to pole or support structure condition causing injury or a fatality.
	Safety issues as a result of loss of supply as detailed below.
Harm to the environment	Mineral oil spills can lead to environmental contamination.
Damage to property	Damage to surrounding property and other substation equipment as a result of a transformer explosion or fire. Damage to property could also be the result of a pole failure where the substation collapses.
Loss of supply	Network interruption to customers connected to the substation. Interruptions to electricity supply for an extended period 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.

Pole top substations are particularly prone to environmental degradation. Many of these assets are located in residential areas, high traffic industrial areas and bushfire designated areas. The substations are elevated and exposed to high stress conditions such as storms, high winds, lightning, salt air and pollution.

Pole top substations with condemned poles are a high risk to public safety if a pole structure fails and falls to the ground. Ausgrid also manages pole substations to minimise the risk of failure resulting in bushfire.

In addition to pole issues (refer to Program 1 – Poles), the key failure modes of pole top substations include:

- High resistance (hot) connections or terminations
- Damaged or broken high voltage fuse assemblies
- Damaged surge arresters
- Transformer failures (corrosion of tank, oil leak)
- Support structure failure
- Defective earthing systems.

The majority of failures are picked up through planned maintenance and can be rectified with treatment actions before posing a significant risk.

Failure of the support structures are not easy to detect from visual inspection from the ground and are generally associated with particular designs and configurations.

3.4 Treatment analysis

In identifying the treatment solutions, options are shown in Table 6.

Table 6. Treatment options for pole top substations

Treatment options	Treatment overviews
1 Repair the pole top substation equipment	Undertake repairs to the pole top substation equipment as conditional issues are identified.
2 Refurbish the pole top substation	Obsolete components with identified issues would be replaced to ensure the safe and reliable continued operation of the pole top substation.
3 Replace the pole top substation	Replace the pole top substation with a current equivalent utilising procured equipment from long term contracts.
4 Replace pole and reuse transformer	Replace the limited life pole and transfer transformer from old to new pole.

The different treatment options are all utilised at different points in the asset's lifecycle. A repair may be completed where practical and efficient.

Refurbishment options provide life extension to an existing pole top substation at a net present cost which is considerably lower than substation replacement and is Ausgrid's preferred option where it is practical to do so. Refurbishment cannot remediate all failures (e.g. poles assessed with limited remaining life – less than a year) and therefore replacement will still be required for many pole top substations. Repair options are limited, however they may be efficient where the substation is not approaching end of life.

The continuation of this program is seen as an essential component in managing the overall network risk from pole top substations. Replacing the transformer in conjunction with the pole results in an equivalent net present cost for a 20 year old transformer making this an appropriate strategy for those 20 years and older. Transformers that are less than 20 years old when the pole requires replacement are placed into a rotable pool and reused on the network as needed.

In 2017 Ausgrid determined it was efficient to replace wood poles for pole top substations with new technology composite fibreglass poles in the standard design when they are constructed. Composite fibreglass poles are manufactured from non-corrosive, non-rusting, non-metallic and environmentally inert materials. They are also easier to install than wood, concrete and steel poles and the earth wire for the substation is contained internally removing the risk of theft. Following a trial of the composite fibreglass poles in the field by Ausgrid, it is expected that these poles have an expected life of 65 years compared to current expected life of 45 years and have a similar net present cost (which would be lower if a condition based approach could be taken to pole top substations allowing their life to be extended). As the current replacement program is predominately driven by the condition of the pole, moving towards a new technology is expected to enable a longer life from the substation.

3.5 Options

Ausgrid has considered options as set out in Table 7.

Table 7. Treatment options for managing pole top substations

Program need options	Option overviews
1 Reactive treatment	Implement treatment such as repair, refurbish or replacement when the pole, transformer or other equipment fails.
2 Conditional treatment	Implement treatments to repair, reinforce or replace the pole top substation when inspections identify they have deteriorated to the point of conditional failure based on a set of predetermined criteria.
3 Planned treatment	Implement planned treatment prior to pole top substation assets failing at or around the standard technical life of 45 years.

Ausgrid's preferred approach to undertake a conditional treatment program based on an assessment of the pole condition as part of the pole inspection program. This will be supported by a reactive treatment (refer to Attachment 5.13.K (Reactive replacement programs) for further information).

For known support hardware issues, Ausgrid's preferred approach to managing the risk is to have a planned treatment to hardware deemed a significant risk.

3.6 Costing and volumes

The approach to forecasting the number of pole top substations to be replaced is based on the average of long term historical trends. This has been compared to the pole condition predictive model as per Attachment 5.13.A (Pole replacement programs) which is forecasting a similar number of pole condemnations for poles supporting these substations compared to history. On a population basis, considering all programs replacing pole transformers, 2.2% of the population will be replaced over the period. This volume is not sustainable longer term as the average age of the assets will continue to climb and become potentially unmanageable due to the significant volume meeting end of life, however Ausgrid considers this volume prudent for the period. Pole top substations are made up of a number of components for RIN reporting, refer to the Ausgrid Reset RIN template ‘2.2 REPEX’ for details.

There has been a significant number of refurbishments of the hardware associated with pole transformers due to known conditional drivers of this supporting equipment. These refurbishments have allowed for the life extension of the pole top substations. The intention is to complete this program during the 2019-24 period.

The approach to forecasting the number of pole top substations to be refurbished is based on the average of long term historical trends combined with the number of modification required for these identified items of equipment.

A range of factors need to be considered and the treatment strategy evaluated on a case-by-case basis, to determine the least cost option. The unit rates are shown in Table 8 for each of the preferred treatments.

Ausgrid's unit costs associated with pole top transformers is slightly higher than a calculated benchmark unit rate. Ausgrid uses pole top transformers of various capacities up to 400 kVA so there is significant variability in the unit rate for these works depending on the materials and conductor modifications required on a site by site basis.

The summary forecast for these replacement programs is shown in Table 8. The costs shown are direct costs only. A detailed forecast is provided in Ausgrid Reset RIN template ‘2.2 REPEX’.

Table 8. Forecast for 11kV overhead switches

Direct Costs (real $FY19)	2019/20	2020/21	2021/22	2022/23	2023/24
Refurbishment of Pole Transformer Substations					
Volumes for replacement	500	500	267	0	0
Unit cost	$2,682	$2,662	$2,650	$0	$0
Total costs ($m)	**$1.34**	**$1.33**	**$0.71**	**$0**	**$0**
Single Pole PT Substations					
Volumes for replacement	72	72	72	72	72
Unit cost	$53,277	$53,047	$52,929	$52,850	$52,708
Total costs ($m)	**$3.84**	**$3.82**	**$3.81**	**$3.81**	**$3.79**

4 KIOSK SUBSTATIONS

4.1 Program description

Several types of kiosk substations have been identified for planned replacement within four kiosk substation replacement programs. In particular, the corrosion of the metal housings along with obsolete equipment, poses a significant risk to the network, public, customers and workers that need to be managed. These could result in:

- Unauthorised access and potentially electric shock or electrocution
- Equipment failure causing fire
- Loss of electrical supply.

The current kiosk replacement programs are:

- A, B and C type kiosks (REP_01.02.02)
- Upper Hunter County Council kiosks (REP_01.02.41)
- Mackellar kiosks (REP_01.02.49)
- Muswellbrook kiosks (REP_01.03.16).

Each of these programs has continued from the current regulatory period. Ausgrid plans to replace 40 kiosk substations at a cost of $5.9 million in direct ($, real FY19) in the 2019-24 period. The obsolete kiosk substations are replaced with modern kiosks that have a lower lifecycle cost through the use of modern gas switchgear. Ausgrid also has programs to replace switchgear within kiosk substations (refer to Attachment 5.13.G (Switchgear replacement programs)). Before replacement of assets within kiosks, Ausgrid evaluates and implements the lowest lifecycle cost solution which may include the replacement of the entire kiosk. The additional upfront cost to fund a full kiosk replacement (not identified in one of the above programs) is drawn from Attachment 5.13.K (Reactive replacement programs). Kiosks may also be replaced as part of a network augmentation or customer connection.

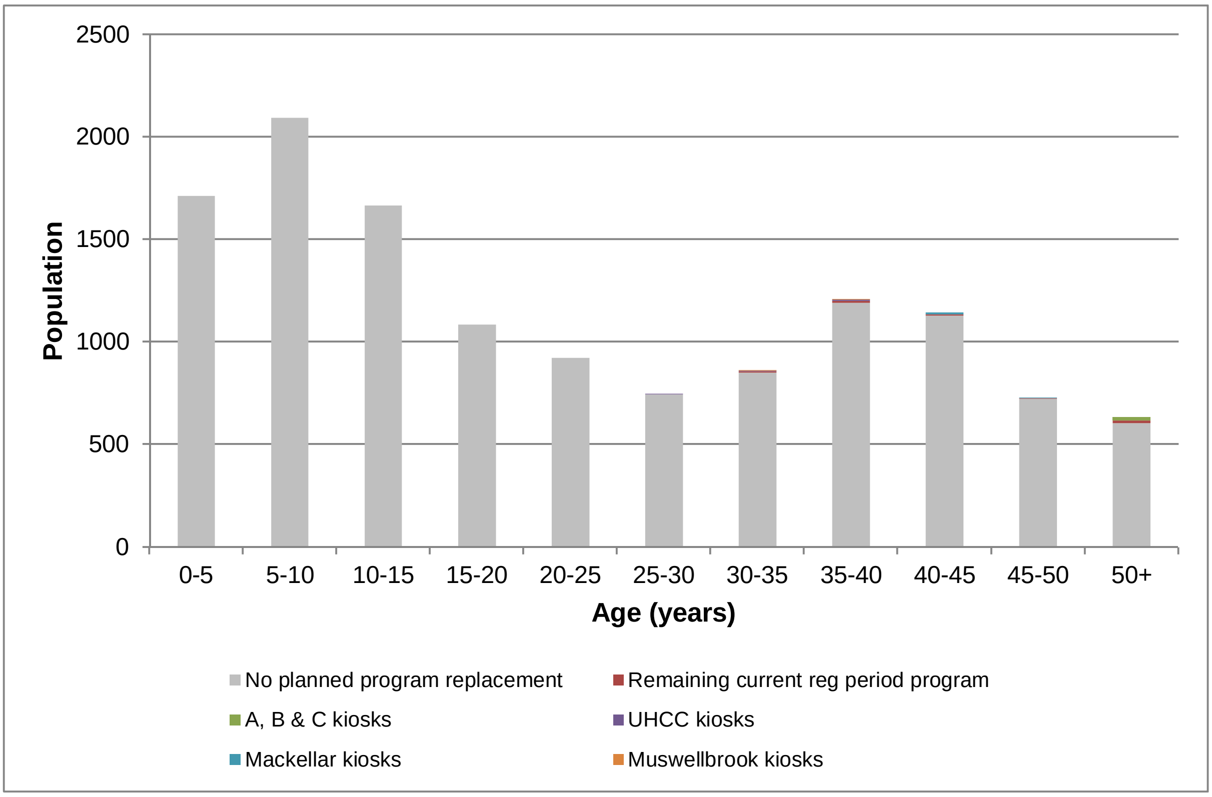
The age profile highlighting the identified programs for replacement against the total population of kiosks on the network is shown in Figure 3. These replacement works represent less than 0.5% of the kiosk substation population and Ausgrid expects to extend the average age of this type of distribution substation over the period from 2019 to 2024.

4.2 Background

Kiosk substations are compact weatherproof outdoor enclosures that typically contain electrical equipment including a high voltage switch, transformer and a low voltage switchboard. They are generally located on public land near footpaths but historically have also been installed on private property.

Ausgrid had approximately 12,800 kiosk substations at 1 July 2017 of various age, manufacturer, models and configuration on the network, the age profile is shown in Figure 3.

Figure 3. Age profile of kiosk substations (as at 30 June 2017)



4.3 Risks – Consequence and likelihood

The key consequences that can result in a loss of this function are shown in Table 9 below.

Table 9. Consequences from loss of function for kiosk substations

Consequences	Descriptions
Harm to the public communities and workers	Fire caused by a loss of insulation, further propagated by the presence of highly flammable oil within the transformer tank.
	Interruptions to electricity supply for an extended period 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.
	Exposed 'live' electricity equipment is mounted in these enclosures and could result in electrocution in the event of unauthorised access to the substation.
	Asbestos containing materials are present in some of these substations and require specialised handling. Any inadvertent release of asbestos fibres has the potential to impact the public and workers.
Harm to the environment	Mineral oil spills can lead to environmental contamination.
Damage to property	Damage to surrounding property and other substation equipment as a result of a transformer or switchgear explosion or fire.
Loss of supply	Network interruption to customers connected to the substation.

The close proximity of kiosk substations to the public creates an imperative to maintain the assets in good condition. The ongoing deterioration of these assets is resulting in functional failures.

The targeted kiosk types are no longer supported with replacement housings, transformers and low voltage boards. Obsolete kiosk substations require more corrective works and the lack of spare parts means kiosk substation replacement is often the only feasible option with extended replacement durations.

Failures can result in public and worker safety incidents through contact with live equipment; limitations to network switching; and loss of supply due to functional failure. Due to lack of compatible spare parts, there can be delays to restoring supply from outages following faults for obsolete configurations.

Equipment (transformers and switchgear) installed within the kiosk substations use oil as an insulation medium. As such, failures have the potential to cause considerable damage if a failure results in a fire and additional safety risks to the community. Many of these kiosk substations are located in residential and high traffic commercial areas and if not managed properly, equipment failures can pose serious public safety risks.

In the five year period from 2012/13 to 2016/17, there has been an average of 670 notifications per year that represent conditional or functional failures. This failure rate includes all the components within the kiosk and includes equipment failures, degradation of the housing and environmental concerns. Many of these failures are able to be repaired in situ or components replacement with only some requiring replacement of the entire kiosk.

4.4 Treatment analysis

Assessment of the treatment solutions considered for kiosk substations is shown in Table 10 below.

Table 10. Treatment options for managing kiosk substations

Treatment options	Treatment overviews
1 Repair the kiosk	Undertake repairs to the kiosk as conditional issues are identified.
2 Refurbish the kiosk	Components such as the housing would be replaced to ensure the security of the assets contained within. The HV switch and LV board would be replaced.
3 Replace the kiosk	Replace the kiosk with a current contracted equivalent.

Due to the obsolete nature of the kiosks proposed to be treated with a replacement. This is considered the most efficient treatment option. All three options would be considered on a case by case basis for any reactive failures that occur with the remaining kiosk population or once the program shifts to condition based.

Kiosk substations are replaced with modern equivalent kiosk substations. Modern kiosks have a gas ring main isolator rather than oil resulting in a lower lifecycle cost. The continuation of the kiosk substation replacement programs will mitigate the risks on the network in a sustainable way.

In some cases, it may be viable to retire the kiosk via a network rearrangement solution to enable load transfers and replace with a pole top substation. These are assessed on a case-by-case basis.

4.5 Options

To address the problems associated with this cohort of kiosk substations, Ausgrid has considered options as set out in Table 11.

Table 11. Program options for managing kiosk substations

Program need options	Option overviews
1 Reactive treatment	Implement treatment such as repair, refurbish or replacement when the kiosk fails
2 Conditional treatment	Implement treatment to the kiosk when inspections identify they have deteriorated to the point of conditional failure based on a set of predetermined criteria.
3 Planned treatment	Implement planned treatment prior to kiosk assets failing. Individual assets are built into a priority list of assets to be treated based on their level of risk. Assets are replaced in a systematic way starting from those highest in the priority (based on a condition and configuration assessment).

The preferred option is the planned treatment of assets. This is due to the risk to the safety and the reliability of the network that the asset poses. Planned treatment allows for procurement of equipment and planning of works. In the case of kiosk substations of the known types the planned treatment has a number of advantages over reactive treatment including being more cost effective due to the significant change in physical configuration and delivery efficiencies. Due to the unpredictability of failures, this will be supported by a conditional/reactive treatment for the remaining kiosk population funded from the reactive allowance (refer to Attachment 5.13.K (Reactive replacement programs)).

4.6 Costing and volumes

Each of the kiosk substations identified for replacement have been assessed using an asset condition assessment process. The kiosk replacement works are assigned a priority so that the safety, environmental and equipment risks associated with the population are progressively reduced with each replacement, maximising the total risk reduction potential. Kiosk substations are made up of a number of components for RIN reporting, refer to the Ausgrid Reset RIN template '2.2 REPEX' for details.

Increased historical replacement work can be attributed to the initiation of the program and the focus on removing high risk substations as well as augmentation projects. An increase in failure rates would trigger a further risk assessment and potential review of the replacement program. The proposed volume of 40 kiosks planned for replacement is only 0.3% of the kiosk population over the period. The kiosk population will have some impact from other programs of work for example capacity or reactive replacement work.

The summary replacement forecast is shown in Table 12. The costs shown are direct costs only.

Table 12. Forecast for kiosk substations

Direct Costs (real $FY19)	2019/20	2020/21	2021/22	2022/23	2023/24
A,B and C Type Kiosks					
Volumes for replacement	3	3	3	3	3
Unit cost	$ 164,734	$164,472	$164,508	$164,658	$164,682
Total costs ($m)	**$0.49**	**$0.49**	**$0.49**	**$0.49**	**$0.49**
UHCC Kiosk Substations					
Volumes for replacement	2	2	2	2	
Unit cost	$136,274	$135,732	$135,457	$135,278	$134,946
Total costs ($m)	**$0.27**	**$0.27**	**$0.27**	**$0.27**	**$0.27**

Direct Costs (real $FY19)	2019/20	2020/21	2021/22	2022/23	2023/24
KM Kiosks - Mackellar					
Volumes for replacement	2	2	2	2	2
Unit cost	$136,229	$135,991	$136,010	$136,127	$136,134
Total costs ($m)	**$0.27**	**$0.27**	**$0.27**	**$0.27**	**$0.27**
Muswellbrook Kiosks					
Volumes for replacement	1	1	1	1	1
Unit cost	$136,790	$136,228	$135,900	$135,654	$135,262
Total costs ($m)	**$0.14**	**$0.14**	**$0.14**	**$0.14**	**$0.14**